

AUG 14 2017

SHERRY MURRAY
COUNTY CLERK
170642

SA&I 1-4040 (2000)

Canadian _____ County, Oklahoma
COUNTY PURCHASING OFFICE
Canadian _____ County Court House
El Reno _____, Oklahoma
Phone: (405) 295-6125

INVITATION TO BID

PLEASE REVIEW TERMS AND CONDITIONS ON REVERSE
SIDE RELATING TO SUBMISSION OF THIS BID.
Notarized Affidavit completions and signature required on reverse side.

DATE ISSUED
August 14, 2017
Page 1 of 2

BID NUMBER HVAC Replacement / #2018-#06 County Commissioners	BID CLOSING DATE AND HOUR Sept. 11, 2017 at 9:30am	REQUIRED DELIVERY DATE SEE SPECIFICATIONS _____ Days after award of Purchase Order
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TERMS Net, FOB Bids will be received beg. 9:30am Tuesday Sept. 5, until Sept. 11, 2017 @ 9:30am	DATE OF DELIVERY: SEE SPECIFICATIONS
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ITEM	QUANTITY	UNIT OF ISSUE	DESCRIPTION	UNIT PRICE	TOTAL
			<p>Canadian County Commissioners are seeking bids for a HVAC Replacement for the Canadian County Administrative Office Building.</p> <p>Specifications attached.</p> <p>The Board of Canadian County Commissioners reserve the right to reject any and all bids or to award all or any portion of the items bid. All data will be considered in the awarding of the bid including the delivery time.</p> <p><u>The terms & conditions of this document must be completed and returned or the bid will be rejected.</u></p> <p>Contact person: John Johnson, Chief of Staff 201 N Choctaw El Reno, OK 73036 (405) 295-6201</p>		<p>\$ _____</p> <p>Base Bid</p>

APPROVED

Date 8/9/2017

[Signature]
Officer or Department Head

TERMS AND CONDITIONS

1. Sealed bids will be opened in the Commissioner's Conference Room, Canadian
County Courthouse, 201 N. Choctaw Avenue, El Reno, Oklahoma, at the time and date shown on the invitation to bid form.
2. Late bids will not be considered. Bids must be received in sealed envelopes (one to an envelope) with bid number and closing date written on the outside of the envelope.
3. Unit prices will be guaranteed correct by the bidder.
4. Firm prices will be F.O.B. destination.
5. Purchases by Canadian County, Oklahoma, are not subject to state or federal taxes.
6. This bid is submitted as a legal offer and any bid when accepted by the County constitutes a firm contract.
7. Oklahoma laws require each bidder submitting a bid to a county for goods or services to furnish a notarized sworn statement of non-collusion. A form is supplied below.
8. Bids will be firm until 10/11/2017
(DATE)

AFFIDAVIT: I, the undersigned, of lawful age, being first duly sworn on oath say that he (she) is the agent authorized by the bidder to submit the above bid. Affiant further states that the bidder has not been a party to any collusion among bidders in restraint of freedom of competition by agreement to bid at a fixed price or to refrain from bidding; or with any state official or employee as to quantity; quality or price in the prospective contract or any other terms of said prospective contract; or in any discussions between bidders and any state official concerning exchange of money or other thing of value for special consideration in the letting of a contract; that the bidder/contractor has not paid, given or donated or agreed to pay, give or donate to any officer or employee of the State of Oklahoma (or other entity) any money or other thing of value, either directly or indirectly in the procuring of the award of a contract pursuant to this bid.

Subscribed and sworn before this _____ day

of _____, 20 _____

(SEAL)

Firm: _____

My commission expires _____

Signed by: _____ Title: _____
(Manual Signature of Undersigned)

NOTARY PUBLIC (CLERK OR JUDGE)

Address: _____ Phone: _____

City: _____ State: _____

Zip: _____

Please mail sealed bids to:
Canadian County Clerk's Office
Attn: Purchasing
PO Box 458
El Reno, OK 73036

Street Address:
201 N Choctaw Avenue
El Reno, OK 73036

NOTE: Other terms and conditions can be added at the discretion of the county officers.



**Canadian County
Purchasing**

Bid Specifications

Date Issued: August 14, 2017
Bid Number: **2018-#06**
Closing Date: September 11, 2017 at 9:30am
 PO Box 458, 201 N. Choctaw Ave., El Reno, OK 73036
Opening Date: September 11, 2017 at 9:30am
 Commissioner's Meeting Room, 201 N. Choctaw Ave., El Reno, OK 73036

~ SPECIFICATIONS ~

HVAC Replacement / County Commissioners

Canadian County Commissioners are seeking bids for a HVAC Replacement for the Canadian County Administrative Building located at 201 N. Choctaw, El Reno, Oklahoma.

Bids will be received beginning at 9:30am on Tuesday, September 5, until 9:30am on Monday, September 11, 2017.

For an appointment to look at the building please call John Johnson @ 405-295-6201.

Bids shall include:

- A certified check, cashier's check or bid bond equal to five percent (5%) of the bid, which shall be deposited with the awarding public agency as a guaranty; or

An irrevocable letter of credit terms the Construction and Properties Division of the Office of Management and Enterprise Services prescribes, issued by a financial institution insured by the Federal Deposit Insurance Corporation or the Federal Savings and Loan Insurance Corporation for the benefit of the state, on behalf of the awarding public agency, in an amount equal to five percent (5%) of the bid. The awarding public agency shall deposit the irrevocable letter of credit with Division.

- Non Collusion Affidavit
- Business Relationships Affidavit

Awarded vendor shall provide:

- Contract
- Payment/Performance Bond
- Insurance – Contractor must provide evidence of public liability and workers' compensation insurance during construction in reasonable amounts.

(Please review Title 61 O.S. § 101-138 for full disclosure)

Specifications:

- See Specifications Attached

Special Notation:

Brand names, specific detailed items or specific manufactures are for informational purposes only and you may offer any brand or use any manufacturer that meets or exceeds the specifications.

Note

Terms for Payment:

- A purchase order will be issued to the awarded vendor. Once the original itemized invoice is received by the receiving officer it will be processed for payment.

For Information Contact:

John Johnson, Chief of Staff

Phone: (405) 295-6201

Hours: Monday – Friday 8:00am to 4:30pm

Address: 201 N. Choctaw, El Reno, OK 73036

Gatz Mechanical Inc
PO Box 936
El Reno, OK 73036

Harrison-Orr Air Conditioning Inc
4100 North Walnut
Oklahoma City, OK 73105-3798

Integrity Restoration Specialists LLC
11532 NW 5th Street
Yukon, OK 73099

Natkin
4730 SW 20th Street
Oklahoma City, OK 73128

Precision Plumbing Service
PO Box 734
Piedmont, OK 73078

Ross Services LLC
11609 Footman's Court
Yukon, OK 73099

TA Miller Plumbing
2111 North Linn
Oklahoma City, OK 73107

Trane
PO Box 845053
Dallas, TX 75284-5053

Waggoners Mechanical Services LLC
1351 E Indian Hills
Norman, OK 73071

Orcutt Mechanical Contractors
Attn: Matthew Weber
5940 NW 38th St
Oklahoma City, OK 73122

Gentry Service & Repair Inc
12004 Southfork Road
Mustang, OK 73064

Higgins Plumbing
404 Cherryvale Road
Edmond, OK 73103

Johnson Controls Inc
4730 SW 20th Street
Oklahoma City, OK 73128

Online Data Services
3295 River Exchange Drive, Suite 213
Norcross, GA 30092

Rainbow Heat & Air Inc
501 Cedar
Yukon, OK 73099

Smith Plumbing
12333 SW 6th Street
Yukon, OK 73099

Team Air
4001 North Walnut
Oklahoma City, OK 73105

Trane
305 Hudiburg Circle
Oklahoma City, OK 73108

West Central Heat & Air LLC
2616 Fields Road
El Reno, OK 73036

RB Akins Company
Attn: Rick Adams
4425 N. Santa Fe Ave
Oklahoma City, OK 73118

Gibbens Heating & Air
1107 Sunset Drive
El Reno, OK 73036

Innovative Mechanical LLC
PO Box 721178
Oklahoma City, OK 73172

Lieber Mechanical LLC
1105 First Place Blvd
Yukon, OK 73099

Patrick's George Plumbing
401 SE 59th
Oklahoma City, OK 73129

Reed Construction Data
30 Technology Pkwy South, Suite 100
Norcross, GA 30092

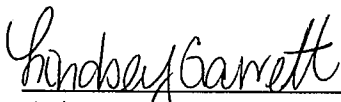
Streets Inc
100 E Commerce
Oklahoma City, OK 73129

Tipton's Plumbing & Sewer
708 NW 5th
Moore, OK 73160

Tuffcoat Inc
2896 Broce Drive
Norman, OK 73072

Dodge Data & Analytics
support@construction.com

Witness my hand and seal this 14th day of August, 2017.



Lindsey Garrett, Purchasing Agent

(SEAL)





Date Issued: August 14, 2017
 Bid Number: **2018-#06**
 Closing Date: September 11, 2017 at 9:30am
 PO Box 458, 201 N. Choctaw Ave., El Reno, OK 73036
 Opening Date: September 11, 2017 at 9:30am
 Commissioner's Meeting Room, 201 N. Choctaw Ave., El Reno, OK 73036-----

**TO HELP PREVENT BIDS FROM BEING REJECTED FOR LACK OF COMPLETION
PLEASE CHECK FOR THE FOLLOWING:**

Is the Invitation to Bid Signed and Notarized? _____

Is the bid bond or cashier's check enclosed? _____

Is the Business Relationships Affidavit enclosed? _____

Is the Non-Collusion Bidding Certificate enclosed? _____

Are all applicable spaces filled in? _____

Are all necessary papers enclosed? _____

Is the Bid # and Opening Date on outside of return envelope? _____

Bids will be received beginning 9:30am Tuesday September 5, until 9:30am Monday September 11, 2017? _____
(Do not turn bid in before Tuesday September 5 @ 9:30am – bid will not be opened or considered)

Thank You,

Lindsey Garrett, Purchasing Agent



MJD ENGINEERS, P.C.

500 Central Expressway
Suite 310
Plano, TX 75074

Canadian County Administration Office

Sheet size: 24x36

MDE # 17899

Updated: 07.27.17

Scale	100% CD - 2017.08.02				
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MECHANICAL

NO.	LEGEND AND GENERAL NOTES	NTS	X					
M0.0		NTS	X					
M0.1	MECHANICAL SCHEDULES	NTS	X					
M0.2	MECHANICAL SCHEDULES	NTS	X					
M2.0	BASEMENT FLOOR PLAN - MECHANICAL	1/8" = 1'-0"	X					
M2.1	FIRST FLOOR PLAN - MECHANICAL	1/8" = 1'-0"	X					
M5.1	PIPING AND WIRING DIAGRAMS	NTS	X					

TOTAL SHEET COUNT:			6	0	0	0	0	0
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2009 INTERNATIONAL MECHANICAL CODE VENTILATION RATES

UNIT	LOCATION (ROOM NO.)	ROOM DESCRIPTION	ROOM TYPE	NET OCCUPYABLE AREA	EST. MAX. OCCUPANCY / 1000 SF	OCCUPANCY / SF x EST. MAX. OCCUPANCY	ACTUAL OCCUPANCY	CFM / PERSON	OUTSIDE AIR (OA) CFM / PERSON	REQD. OA CFM AREA	OUTSIDE AIR CFM (OA)	REQD. EXHAUST FLOW (CFM)	TOTAL OUTSIDE AIR (CFM)
FCL-1/1	124	OFFICE	OFFICE	285	5	1.3	1	5	5	0.05	16	-	16
FCL-1/2	125	OFFICE	OFFICE	35	-	-	-	-	-	-	-	50	50
FCL-1/3	126	DIRECTOR OFFICE	OFFICE	145	5	0.7	0	5	0	0.05	9	-	9
FCL-1/4	127	WOMEN	TOILET RMS - PUBLIC	210	5	1.0	1	5	5	0.05	13	50	10
FCL-1/5	132	WOMEN	TOILET RMS - PUBLIC	90	-	-	-	-	-	-	-	100	-
FCL-1/6	133	WORK RM.	OFFICE	195	5	1.0	0	5	0	0.05	12	-	12
FCL-1/7	134	VESTIBULE	CORRIDOR	30	-	-	-	-	-	-	2	-	2
FCL-1/8	130	CUSTOMER	CORRIDOR	335	-	-	-	-	-	-	21	-	21
FCL-1/9	131	CUSTOMER	STORAGE	30	-	-	-	-	-	0.12	4	-	4
FCL-1/10	136	MEETING ROOM	LEGISLATIVE CHAMBERS	295	50	12.7	12	5	60	0.05	16	-	76
FCL-1/11	136	MEETING ROOM	LEGISLATIVE CHAMBERS	295	50	12.7	12	5	60	0.05	16	-	76
FCL-1/12	136	MEETING ROOM	LEGISLATIVE CHAMBERS	295	50	12.7	12	5	60	0.05	16	-	76
FCL-1/13	137	SCHOOL SYS.	OFFICE	330	5	1.8	1	5	5	0.05	20	-	25
FCL-1/14	138	CLOSET	STORAGE	30	-	-	-	-	-	0.12	4	-	4
FCL-1/15	142	CHIEF OF STAFF	OFFICE	375	5	1.9	1	5	5	0.05	23	-	28
FCL-1/16	141	FR	TOILET RMS - PUBLIC	50	-	-	-	-	-	-	9	-	9
FCL-1/17	141	FOYER	CORRIDOR	145	-	-	-	-	-	0.05	8	-	8
FCL-1/18	139	MEN	TOILET RMS - PUBLIC	65	-	-	-	-	-	-	50	-	50
FCL-1/19	140	WOMEN	TOILET RMS - PUBLIC	55	-	-	-	-	-	-	50	-	50
FCL-1/20	143	MEETING	CONFERENCE	245	50	12.2	12	5	60	0.05	15	-	75
FCL-1/21	143	MEETING	CONFERENCE	245	50	12.2	12	5	60	0.05	15	-	75
FCL-1/22	128	EMER. MGMT.	OFFICE	365	5	1.8	1	5	5	0.05	22	-	27
FCL-1/23	128	EMER. MGMT.	OFFICE	365	5	1.8	1	5	5	0.05	22	-	27
AREA - TOTAL INSTALLED (CFM) = 350													
MINIMUM REQUIRED (CFM) = 705													
AREA - TOTAL INSTALLED (CFM) = 375													
FCL-2/1	145	COMM. OFF.	OFFICE	190	5	0.9	0	5	0	0.05	12	-	12
FCL-2/2	146	COMM. OFF.	OFFICE	190	5	0.9	0	5	0	0.05	12	-	12
FCL-2/3	147	COMM. OFF.	OFFICE	190	5	0.9	0	5	0	0.05	12	-	12
FCL-2/4	144	COUNTY COMM.	CORRIDOR	495	-	-	-	-	-	0.05	30	-	30
FCL-2/5	148	RECEPTION	RECEPTION AREA	170	30	5.1	5	5	25	0.05	11	-	36
FCL-2/6	144	COUNTY COMM.	OFFICE	235	5	1.2	1	5	5	0.05	15	-	20
FCL-2/7	100	LOBBY	CORRIDOR	225	-	-	-	-	-	0.05	14	-	14
FCL-2/8	100	LOBBY	CONFERENCE	175	50	8.7	8	5	40	0.05	11	-	51
FCL-2/9	100	LOBBY	CONFERENCE	175	50	8.7	8	5	40	0.05	11	-	51
FCL-2/10	100	LOBBY	OFFICE	210	5	1.0	1	5	5	0.05	13	-	18
FCL-2/11	100	LOBBY	OFFICE	215	5	1.1	1	5	5	0.05	13	-	18
FCL-2/12	100	LOBBY	TOILET RMS - PUBLIC	95	-	-	-	-	-	-	50	-	50
FCL-2/13	100	LOBBY	TOILET RMS - PUBLIC	90	-	-	-	-	-	0.05	31	-	31
FCL-2/14	100	LOBBY	CORRIDOR	45	-	-	-	-	-	0.05	3	-	3
FCL-2/15	123	OFFICE	OFFICE	180	5	0.9	0	5	0	0.05	11	-	11
FCL-2/16	123	OFFICE	STORAGE	15	-	-	-	-	-	0.12	2	-	2
FCL-2/18	123	OFFICE	OFFICE	190	5	0.9	0	5	0	0.05	12	-	12
MINIMUM REQUIRED (CFM) = 100													
AREA - TOTAL INSTALLED (CFM) = 375													
FCL-3/1	108	WEST RM. LAND REC.	OFFICE	400	5	2.0	1	5	5	0.05	24	-	29
FCL-3/2	109	OFFICE	OFFICE	150	5	0.7	0	5	0	0.05	9	-	9
FCL-3/3	111	CORRIDOR	CORRIDOR	250	-	-	-	-	-	0.05	15	-	15
FCL-3/4	112	PUBLIC LAND WORK	OFFICE	185	5	0.9	0	5	0	0.05	12	-	12
FCL-3/5	112	PUBLIC LAND WORK	COMPUTER (NO PRINTING)	390	4	1.5	1	5	5	0.05	23	-	28
FCL-3/6	113	STORAGE	STORAGE	70	-	-	-	-	-	0.12	9	-	9
FCL-3/7	115	CUSTOMER	STORAGE	140	-	-	-	-	-	0.12	14	-	14
FCL-3/8	111	CORRIDOR	CORRIDOR	440	-	-	-	-	-	0.12	17	-	17
FCL-3/9	118	WOMEN	TOILET RMS - PUBLIC	145	-	-	-	-	-	0.05	27	-	27
FCL-3/10	119	MEN	TOILET RMS - PUBLIC	115	-	-	-	-	-	-	100	-	100
FCL-3/11	108	COUNTY CLERK	OFFICE	350	5	1.7	1	5	5	0.05	21	-	26
FCL-3/12	109	OFFICE	OFFICE	175	5	0.9	0	5	0	0.05	11	-	11
FCL-3/13	104	LAND RECORD	OFFICE	420	5	2.1	2	5	5	0.05	26	-	36
FCL-3/14	104	LAND RECORD	OFFICE	420	5	2.1	2	5	5	0.05	26	-	36
FCL-3/15	103	PAYROLL	OFFICE	390	5	1.9	1	5	5	0.05	23	-	28
FCL-3/16	103	PAYROLL	OFFICE	390	5	1.9	1	5	5	0.05	23	-	28
FCL-3/17	101	CORRIDOR	CORRIDOR	885	-	-	-	-	-	0.05	42	-	42
FCL-3/18	100	LOBBY	LOBBY	540	30	16.2	16	8	120	0.05	33	-	153
FCL-3/19	100	LOBBY	LOBBY	540	30	16.2	16	8	120	0.05	33	-	153
MINIMUM REQUIRED (CFM) = 200													
AREA - TOTAL INSTALLED (CFM) = 715													

NOTES:
 A. REGRULATION PROHIBITED EXCEPT AS PERMITTED BY 2009 IBC SEC. 403.2.1
 B. FRESH AIR IS PERMITTED IN ACCORDANCE WITH 2009 IBC SEC. 403.2.2
 C. REGRULATION PROHIBITED EXCEPT AS PERMITTED BY 2009 IBC SEC. 403.2.3
 D. VARIABLE OR INTERMITTENT OCCUPANCY IS ALLOWED IN ACCORDANCE WITH ASHRAE 62.2007, SEC. 6.2.5

BUILDING - MINIMUM REQUIRED OUTSIDE AIR (CFM) = 1813
 BUILDING - TOTAL INSTALLED OUTSIDE AIR (CFM) = 1795
 BUILDING - MINIMUM REQUIRED EXHAUST AIR (CFM) = 690
 BUILDING - TOTAL PRESSURIZATION TARGET = 173 ACH OR 50 CFM (MINUTE DOOR) = 1145

VRF HEAT RECOVERY BRANCH SELECTOR BOXES

DESIGN	SERIES	CONDENSING UNIT	BOX SIZE (IN)	MAX. W.H.X.D. TONS	MAX. TOTAL CAP (PORT (RHH))	ZONE PORT COUNT	VHP	MOA	MOCP	MFG	MODEL NUMBER	REMARKS
BS-1/1	FCL-1/1	CU-1	8.7x7.49x6.3"	3.2	3.2	1	208 / 1	<1	15	CARRIER	RBH-V083FL	NOTES 1-5
BS-1/2	FCL-1/2	CU-1	8.7x7.49x6.3"	3.2	3.2	1	208 / 1	<1	15	CARRIER	RBH-V083FL	NOTES 1-5
BS-1/3	FCL-1/3	CU-1	8.7x7.49x6.3"	3.2	3.2	1	208 / 1	<1	15	CARRIER	RBH-V083FL	NOTES 1-5
BS-1/4	FCL-1/4, 1/5, 1/6	CU-1	8.7x7.49x6.3"	3.2	3.2	1	208 / 1	<1	15	CARRIER	RBH-V083FL	NOTES 1-5
BS-1/5	FCL-1/5	CU-1	8.7x7.49x6.3"	3.2	3.2	1	208 / 1	<1	15	CARRIER	RBH-V083FL	NOTES 1-5
BS-1/6	FCL-1/6, 1/7, 1/8	CU-1	15.8x7.88x7.88"	8.0	8.0	1	208 / 1	<1	15	CARRIER	RBH-V083FL	NOTES 1-5
BS-1/7	FCL-1/7	CU-1	8.7x7.49x6.3"	3.2	3.2	1	208 / 1	<1	15	CARRIER	RBH-V083FL	NOTES 1-5
BS-1/8	FCL-1/8	CU-1	8.7x7.49x6.3"	3.2	3.2	1	208 / 1	<1	15	CARRIER	RBH-V083FL	NOTES 1-5
BS-1/9	FCL-1/9	CU-1	8.7x7.49x6.3"	5.0	5.0	1	208 / 1	<1	15	CARRIER	RBH-V083FL	NOTES 1-5
BS-1/10	FCL-1/10, 1/11, 1/12, 1/13, 1/14, 1/15, 1/16, 1/17, 1/18	CU-1	8.7x7.49x6.3"	5.0	5.0	1	208 / 1	<1	15	CARRIER	RBH-V083FL	NOTES 1-5
BS-2/1	FCL-2/1	CU-2	8.7x7.49x6.3"	3.2	3.2	1	208 / 1	<1	15	CARRIER	RBH-V083FL	NOTES 1-5
BS-2/2	FCL-2/2	CU-2	8.7x7.49x6.3"	3.2	3.2	1	208 / 1	<1	15	CARRIER	RBH-V083FL	NOTES 1-5
BS-2/3	FCL-2/3	CU-2	8.7x7.49x6.3"	3.2	3.2	1	208 / 1	<1	15	CARRIER	RBH-V083FL	NOTES 1-5
BS-2/4	FCL-2/4, 2/5	CU-2	8.7x7.49x6.3"	3.2	3.2	1	208 / 1	<1	15	CARRIER	RBH-V083FL	NOTES 1-5
BS-2/5	FCL-2/5	CU-2	8.7x7.49x6.3"	3.2	3.2	1	208 / 1	<1	15	CARRIER	RBH-V083FL	NOTES 1-5
BS-2/6	FCL-2/6	CU-2	8.7x7.49x6.3"	3.2	3.2	1	208 / 1	<1	15	CARRIER	RBH-V083FL	NOTES 1-5
BS-2/7	FCL-2/7, 2/8, 2/9	CU-2	8.7x7.49x6.3"	3.2	3.2	1	208 / 1	<1	15	CARRIER	RBH-V083FL	NOTES 1-5
BS-2/8	FCL-2/8	CU-2	8.7x7.49x6.3"	3.2	3.2	1	208 / 1	<1	15	CARRIER	RBH-V083FL	NOTES 1-5
BS-2/9	FCL-2/9	CU-2	8.7x7.49x6.3"	3.2	3.2	1	208 / 1	<1	15	CARRIER	RBH-V083FL	NOTES 1-5
BS-2/10	FCL-2/10	CU-2	8.7x7.49x6.3"	3.2	3.2	1	208 / 1	<1	15	CARRIER	RBH-V083FL	NOTES 1-5
BS-2/11	FCL-2/11	CU-2	8.7x7.49x6.3"	3.2	3.2	1	208 / 1	<1	15	CARRIER	RBH-V083FL	NOTES 1-5
BS-2/12	FCL-2/12	CU-2	8.7x7.49x6.3"	3.2	3.2	1	208 / 1	<1	15	CARRIER	RBH-V083FL	NOTES 1-5
BS-2/13	FCL-2/13	CU-2	8.7x7.49x6.3"	3.2	3.2	1	208 / 1	<1	15	CARRIER	RBH-V083FL	NOTES 1-5
BS-2/14	FCL-2/14	CU-2	8.7x7.49x6.3"	3.2	3.2	1	208 / 1	<1	15	CARRIER	RBH-V083FL	NOTES 1-5
BS-2/15	FCL-2/15	CU-2	8.7x7.49x6.3"	3.2	3.2	1	208 / 1	<1	15	CARRIER	RBH-V083FL	NOTES 1-5
BS-2/16	FCL-2/16	CU-2	8.7x7.49x6.3"	3.2	3.2	1	208 / 1	<1	15	CARRIER	RBH-V083FL	NOTES 1-5
BS-2/17	FCL-2/17	CU-2	8.7x7.49x6.3"	3.2	3.2	1	208 / 1	<1	15	CARRIER	RBH-V083FL	NOTES 1-5
BS-2/18	FCL-2/18	CU-2	8.7x7.49x6.3"	3.2	3.2	1	208 / 1	<1	15	CARRIER	RBH-V083FL	NOTES 1-5
BS-2/19	FCL-2/19	CU-2	8.7x7.49x6.3"	3.2	3.2	1	208 / 1	<1	15	CARRIER	RBH-V083FL	NOTES 1-5

VRF INDOOR UNIT MODELS

DESIGN	SERIES	CONDENSING UNIT	TYPE	NOMINAL TONNAGE	EAT (F) DBWB	TOTAL CAP. BTUH	SENSIBLE CAP. BTUH	CFM	OA CFM	SP N.W.G.	VPH	FANW	FANHP	MECH	MOCP	MFG	MODEL NUMBER	NOTES
FOLU1/1	OFFICE / RR	CU-1	CASSETTE	1.25	80 / 67	15.0	11.0	550	25	-	208 / 1	60	0.08	0.8	15.0	CARRIER	MANU-AP012B2L	1.2.4.7
FOLU1/2	OFFICE	CU-1	CASSETTE	1	80 / 67	11.0	8.0	550	10	-	208 / 1	60	0.08	0.8	15.0	CARRIER	MANU-AP012B2L	1.2.4.7
FOLU1/3	DIRECTOR OFFICE	CU-1	CASSETTE	1	80 / 67	11.0	8.0	550	20	-	208 / 1	60	0.08	0.8	15.0	CARRIER	MANU-AP012B2L	1.2.4.7
FOLU1/4	WOMEN	CU-1	WALL MTD.	0.8	80 / 67	6.0	5.0	340	-	-	208 / 1	30	0.04	0.3	15.0	CARRIER	MANU-AP012B2L	1.2.5.7
FOLU1/5	MEN	CU-1	WALL MTD.	0.8	80 / 67	6.0	5.0	340	-	-	208 / 1	30	0.04	0.3	15.0	CARRIER	MANU-AP012B2L	1.2.5.7
FOLU1/6	WORK RM.	CU-1	CASSETTE	1	80 / 67	11.0	7.0	550	15	-	208 / 1	60	0.08	0.8	15.0	CARRIER	MANU-AP012B2L	1.2.4.7
FOLU1/7	VESTIBLE / CORR. / JANITOR	CU-1	CASSETTE	2	80 / 67	21.0	15.0	670	80	-	208 / 1	60	0.08	1.0	15.0	CARRIER	MANU-AP024B2L	1.2.4.7
FOLU1/8	MEETING ROOM	CU-1	CASSETTE	2	80 / 67	21.0	15.0	670	80	-	208 / 1	60	0.08	1.0	15.0	CARRIER	MANU-AP024B2L	1.2.4.7
FOLU1/9	MEETING ROOM	CU-1	CASSETTE	2	80 / 67	21.0	15.0	670	80	-	208 / 1	60	0.08	1.0	15.0	CARRIER	MANU-AP024B2L	1.2.4.7
FOLU1/10	MEETING ROOM	CU-1	CASSETTE	2	80 / 67	21.0	15.0	670	80	-	208 / 1	60	0.08	1.0	15.0	CARRIER	MANU-AP024B2L	1.2.4.7
FOLU1/11	SCHOOL SYS. / CLOSET	CU-1	CASSETTE	1.5	80 / 67	15.0	12.0	550	30	-	208 / 1	60	0.08	0.8	15.0	CARRIER	MANU-AP012B2L	1.2.4.7
FOLU1/12	CHIEF OF STAFF / RR	CU-1	CASSETTE	0.8	80 / 67	6.0	5.0	470	10	-	208 / 1	60	0.08	0.8	15.0	CARRIER	MANU-AP012B2L	1.2.4.7
FOLU1/13	FOYER / MEN'S / WOMEN'S	CU-1	CASSETTE	1.25	80 / 67	14.0	11.0	550	75	-	208 / 1	60	0.08	0.8	15.0	CARRIER	MANU-AP012B2L	1.2.4.7
FOLU1/14	MEETING	CU-1	CASSETTE	1.25	80 / 67	14.0	11.0	550	75	-	208 / 1	60	0.08	0.8	15.0	CARRIER	MANU-AP012B2L	1.2.4.7
FOLU1/15	MEETING	CU-1	CASSETTE	1.25	80 / 67	14.0	11.0	550	75	-	208 / 1	60	0.08	0.8	15.0	CARRIER	MANU-AP012B2L	1.2.4.7
FOLU1/16	MEETING	CU-1	CASSETTE	1.25	80 / 67	14.0	11.0	550	75	-	208 / 1	60	0.08	0.8	15.0	CARRIER	MANU-AP012B2L	1.2.4.7
FOLU1/17	EMER. MGMT.	CU-1	UNDER CLG.	1.5	80 / 67	17.0	11.0	410	-	-	208 / 1	60	0.08	0.5	15.0	CARRIER	MANU-AP018H2L	1.2.5.7
FOLU1/18	EMER. MGMT.	CU-1	CASSETTE	2	80 / 67	22.0	15.0	670	80	-	208 / 1	60	0.08	1.0	15.0	CARRIER	MANU-AP024B2L	1.2.4.7
FOLU2/1	COMM. OFF.	CU-2	CASSETTE	0.8	80 / 67	8.0	7.0	470	15	-	208 / 1	60	0.08	0.8	15.0	CARRIER	MANU-AP009B2L	1.2.4.7
FOLU2/2	COMM. OFF.	CU-2	CASSETTE	0.8	80 / 67	8.0	7.0	470	15	-	208 / 1	60	0.08	0.8	15.0	CARRIER	MANU-AP009B2L	1.2.4.7
FOLU2/3	COMM. OFF.	CU-2	CASSETTE	0.8	80 / 67	9.0	7.0	470	15	-	208 / 1	60	0.08	0.8	15.0	CARRIER	MANU-AP009B2L	1.2.4.7
FOLU2/4	COUNTY COMM.	CU-2	CASSETTE	1	80 / 67	11.0	8.0	550	30	-	208 / 1	60	0.08	0.8	15.0	CARRIER	MANU-AP012B2L	1.2.4.7
FOLU2/5	RECEPTION	CU-2	CASSETTE	1	80 / 67	11.0	8.0	550	40	-	208 / 1	60	0.08	0.8	15.0	CARRIER	MANU-AP012B2L	1.2.4.7
FOLU2/6	COUNTY COMM.	CU-2	CASSETTE	1.25	80 / 67	15.0	12.0	550	20	-	208 / 1	60	0.08	0.8	15.0	CARRIER	MANU-AP012B2L	1.2.4.7
FOLU2/7	LOBBY	CU-2	CASSETTE	1.25	80 / 67	15.0	11.0	550	15	-	208 / 1	60	0.08	0.8	15.0	CARRIER	MANU-AP012B2L	1.2.4.7
FOLU2/8	LOBBY	CU-2	CASSETTE	1.25	80 / 67	15.0	11.0	550	15	-	208 / 1	60	0.08	0.8	15.0	CARRIER	MANU-AP012B2L	1.2.4.7
FOLU2/9	LOBBY	CU-2	CASSETTE	1.25	80 / 67	15.0	11.0	550	55	-	208 / 1	60	0.08	0.8	15.0	CARRIER	MANU-AP012B2L	1.2.4.7
FOLU2/10	LOBBY	CU-2	CASSETTE	1	80 / 67	11.0	8.0	550	20	-	208 / 1	60	0.08	0.8	15.0	CARRIER	MANU-AP012B2L	1.2.4.7
FOLU2/11	LOBBY	CU-2	CASSETTE	1	80 / 67	11.0	8.0	550	20	-	208 / 1	60	0.08	0.8	15.0	CARRIER	MANU-AP012B2L	1.2.4.7
FOLU2/12	LOBBY	CU-2	WALL MTD.	0.6	80 / 67	7.0	5.0	340	-	-	208 / 1	30	0.04	0.3	15.0	CARRIER	MANU-AP012B2L	1.2.5.7
FOLU2/13	LOBBY	CU-2	WALL MTD.	0.6	80 / 67	7.0	5.0	340	-	-	208 / 1	30	0.04	0.3	15.0	CARRIER	MANU-AP012B2L	1.2.5.7
FOLU2/14	LOBBY	CU-2	WALL MTD.	1.5	80 / 67	18.0	12.0	550	40	-	208 / 1	60	0.08	0.8	15.0	CARRIER	MANU-AP012B2L	1.2.4.7
FOLU2/15	OFFICE	CU-2	CASSETTE	1	80 / 67	11.0	8.0	550	20	-	208 / 1	60	0.08	0.8	15.0	CARRIER	MANU-AP012B2L	1.2.4.7
FOLU2/16	OFFICE	CU-2	CASSETTE	0.8	80 / 67	8.0	6.0	470	15	-	208 / 1	60	0.08	0.8	15.0	CARRIER	MANU-AP009B2L	1.2.4.7
FOLU3/1	WEST RM. LAND REC.	CU-3	CASSETTE	1.5	80 / 67	16.0	11.0	550	30	-	208 / 1	60	0.08	0.8	15.0	CARRIER	MANU-AP012B2L	1.2.4.7
FOLU3/2	OFFICE	CU-3	CASSETTE	0.8	80 / 67	8.0	6.0	470	10	-	208 / 1	60	0.08	0.8	15.0	CARRIER	MANU-AP009B2L	1.2.4.7
FOLU3/3	CORRIDOR	CU-3	CASSETTE	1.25	80 / 67	14.0	11.0	550	15	-	208 / 1	60	0.08	0.8	15.0	CARRIER	MANU-AP012B2L	1.2.4.7
FOLU3/4	PUBLIC LAND WORK	CU-3	CASSETTE	1	80 / 67	10.0	7.8	550	15	-	208 / 1	60	0.08	0.8	15.0	CARRIER	MANU-AP012B2L	1.2.4.7
FOLU3/5	PARK LAND WORK / STOR.	CU-3	CASSETTE	1.75	80 / 67	19.0	14.0	670	40	-	208 / 1	60	0.08	1.0	15.0	CARRIER	MANU-AP012B2L	1.2.4.7
FOLU3/6	RECORD	CU-3	CASSETTE	0.8	80 / 67	8.0	6.0	470	15	-	208 / 1	60	0.08	0.8	15.0	CARRIER	MANU-AP012B2L	1.2.4.7
FOLU3/7	CUSTOMER	CU-3	CASSETTE	1	80 / 67	10.0	7.0	550	20	-	208 / 1	60	0.08	0.8	15.0	CARRIER	MANU-AP012B2L	1.2.4.7
FOLU3/8	CORRIDOR	CU-3	CASSETTE	1.25	80 / 67	14.0	11.0	550	30	-	208 / 1	60	0.08	0.8	15.0	CARRIER	MANU-AP012B2L	1.2.4.7
FOLU3/9	WOMEN	CU-3	CASSETTE	0.6	80 / 67	6.0	5.0	470	-	-	208 / 1	60	0.08	0.8	15.0	CARRIER	MANU-AP012B2L	1.2.5.7
FOLU3/10	MEN	CU-3	CASSETTE	0.6	80 / 67	6.0	5.0	470	-	-	208 / 1	60	0.08	0.8	15.0	CARRIER	MANU-AP012B2L	1.2.5.7
FOLU3/11	COUNTY CLERK	CU-3	CASSETTE	1.25	80 / 67	14.0	11.0	550	30	-	208 / 1	60	0.08	0.8	15.0	CARRIER	MANU-AP012B2L	1.2.4.7
FOLU3/12	OFFICE	CU-3	CASSETTE	0.8	80 / 67	8.0	6.0	470	15	-	208 / 1	60	0.08	0.8	15.0	CARRIER	MANU-AP012B2L	1.2.4.7
FOLU3/13	LAND RECORD	CU-3	CASSETTE	1.5	80 / 67	15.2	11.0	550	40	-	208 / 1	60	0.08	0.8	15.0	CARRIER	MANU-AP012B2L	1.2.4.7
FOLU3/14	LAND RECORD	CU-3	CASSETTE	1.5	80 / 67	15.2	11.0	550	40	-	208 / 1	60	0.08	0.8	15.0	CARRIER	MANU-AP012B2L	1.2.4.7
FOLU3/15	PAYROLL	CU-3	CASSETTE	1.5	80 / 67	13.0	12.0	550	30	-	208 / 1	60	0.08	0.8	15.0	CARRIER	MANU-AP012B2L	1.2.4.7
FOLU3/16	PAYROLL	CU-3	CASSETTE	1.5	80 / 67	13.0	12.0	550	30	-	208 / 1	60	0.08	0.8	15.0	CARRIER	MANU-AP012B2L	1.2.4.7
FOLU3/17	CORRIDOR	CU-3	CASSETTE	1.5	80 / 67	15.8	11.0	550	45	-	208 / 1	60	0.08	0.8	15.0	CARRIER	MANU-AP012B2L	1.2.4.7
FOLU3/18	LOBBY	CU-3	VERTICAL AHU	4	80 / 67	45.0	30.0	1100	155	-	208 / 1	373	0.50	5.4	15.0	CARRIER	40TC0046-3	1.3.5.7
FOLU3/19	LOBBY	CU-3	VERTICAL AHU	4	80 / 67	47.0	31.0	1100	155	-	208 / 1	373	0.50	5.4	15.0	CARRIER	40TC0046-3	1.3.5.7

- NOTES:
 1. REFRIGERANT R-410A.
 2. BULKY DRAIN PUMP.
 3. PROVIDE FILTER BOX.
 4. PROVIDE 1/2" AIR FILTER CHANGER CONNECTIONS (EQUAL TO THE AIR FLOW) FOR ALL CASSETTES.
 5. UNITS SHALL BE ABLE TO PRODUCE SCHEDULED AIR FLOW EVEN WHEN CONDENSING UNIT CONNECTION RATIO IS GREATER THAN 130%.*
 6. UNITS SHALL BE ABLE TO PRODUCE SCHEDULED AIR FLOW EVEN WHEN CONDENSING UNIT CONNECTION RATIO IS GREATER THAN 130%.*
 7. EXPOSED LINE SET MUST BE INSTALLED IN WALL ESCUTCHEON.

VRF CONDENSING UNIT SCHEDULE

DESIGN	TYPE	SERIES	AMBIENT TEMP (F)	NOMINAL CAP (TONS)	COIB %	MFG.	MODEL NUMBER	MAV FT ³	DUCTED COOP AT 47F	DUCTED EBR	SHCE	VPH	ELECTRICAL MCA	MOCP	OP WEIGHT (LBS)	REMARKS
CU1	HEAT RECOVERY	FOLU1/1 - 18	100	28.0	87%	CARRIER	MANU-AP335BTR-PL	3.794	3.10	21.0	22.9	208 / 3	66.2 / 66.2	70 / 70	862 / 862	NOTES 1 - 8
CU2	HEAT RECOVERY	FOLU2/1 - 16	100	18.0	88%	CARRIER	MANU-AP2196TR-LL	1.922	3.77	23.5	28.9	208 / 3	45.4 / 34.2	50 / 40	721 / 721	NOTES 1 - 8
CU3	HEAT RECOVERY	FOLU3/1 - 19	100	34.0	85%	CARRIER	MANU-AP4096TR-LL	3.828	3.20	21.0	21.5	208 / 3	52.1 / 52.1 / 45.4	60 / 60 / 50	862 / 862 / 721	NOTES 1 - 8

- NOTES:
 1. INSTALL ON MINIMUM CONCRETE 4" HOUSEKEEPING PAD.
 2. SIZE AND INSTALL REFRIGERANT LINES IN ACCORDANCE WITH MANUFACTURERS RECOMMENDATIONS AND PER TYPING HANDBOOK.
 3. PROVIDE NEAR 3R RATED DISCONNECT SWITCH FOR EACH UNIT OR MODULE.
 4. PROVIDE MANUFACTURERS 10 YEAR COMPRESSOR & PARTS WARRANTY.
 5. PROVIDE MANUFACTURERS RECOMMENDED SERVICE AND OPERATIONAL CLEARANCES - NOT LESS THAN 36" CLEAR.
 6. UNIT SHALL PROVIDE COOLING TO 28F WITHOUT LOW AMBIENT KIT.
 7. PROVIDE ANTI-SHOCK CYCLE TIMER.
 8. PROVIDE HAL GUARDS.

Oklaoma Registered Firm No. 4510
 500 North Central Expwy., Suite 310
 Plano, TX 75074 469.467.0200
 Email: mdengca@md-eng.com
 Project Number: 17899

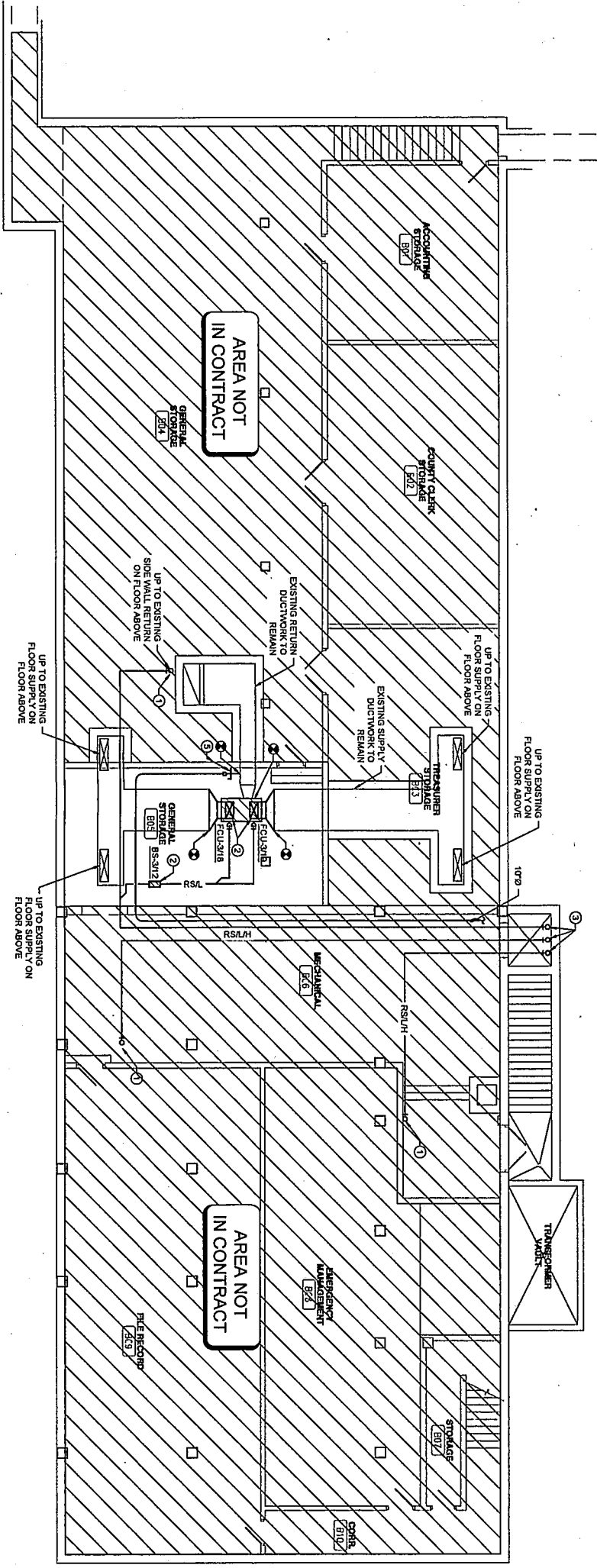


CANADIAN COUNTY -
 CLERK'S OFFICE
 201 N CHOCTAW AVE.
 EL RENO, OK 73036



Revisions:
 MECHANICAL SCHEDULES

Sheet No. M0.2



01 BASEMENT FLOOR PLAN - MECHANICAL
SCALE: 1/8"=1'-0"

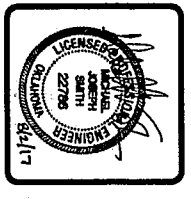
GENERAL NOTES

1. SEE PLAN SHEET TAB FOR NOTES, SYMBOLS, AND ADDITIONAL PROJECT REQUIREMENTS.
 2. REFER TO DIVISION 15 (2) BOOK SPECIFICATIONS FOR HVAC SPECIFICATIONS.
 3. SIZE REFRIGERANT LINES PER MANUFACTURERS RECOMMENDATIONS.
 4. INSTALL REFRIGERATION PIPING PER PIPING HANDBOOK AND MANUFACTURERS SPECIFICATIONS.
 5. CALCULATE FOR EXPANSION AND CONTRACTION, INSTALL EXPANSION JOINTS IF NEEDED IN REFRIGERATION PIPING.
- NOTES BY SYMBOL "O"**
1. ROUTE FULLY INSULATED DX LINES UP WITHIN WALL TO PLENUM SPACE ON FLOOR ABOVE.
 2. FULLY INSULATED 3/4" CONDENSATE ROUTED TO EXISTING ADJACENT FLOOR DRAIN. TERMINATE INDIRECTLY. REFER TO DETAIL.
 3. ROUTE FULLY INSULATED DX LINES THROUGH EXISTING COVERED PENETRATION POINTS. PROVIDE 0.015" TIGHT SEAL OF DX LINES AT WALL PENETRATION. DO NOT SEGMENT PIPE INSULATION AT PENETRATION POINT. PROVIDE 0.015" ALUMINUM JACKET WITH PROPER CLOSURE SYSTEM ON ALL EXTERIOR PIPE INSULATION.
 4. CONNECT EXISTING RETURN PLENUM TO SERVING EQUA318 AND EQUA319.
 5. BALANCE ON DRAINER TO 240 CFM AND CONNECT TO EXISTING RETURN PLENUM SERVING EQUA318 AND EQUA319.

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500 North Central Expressway, Suite 310
Plano, TX 75074 469.467.0200
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Project Number: 17899



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EL RENO, OK 73036



Revisions:

No.	Description

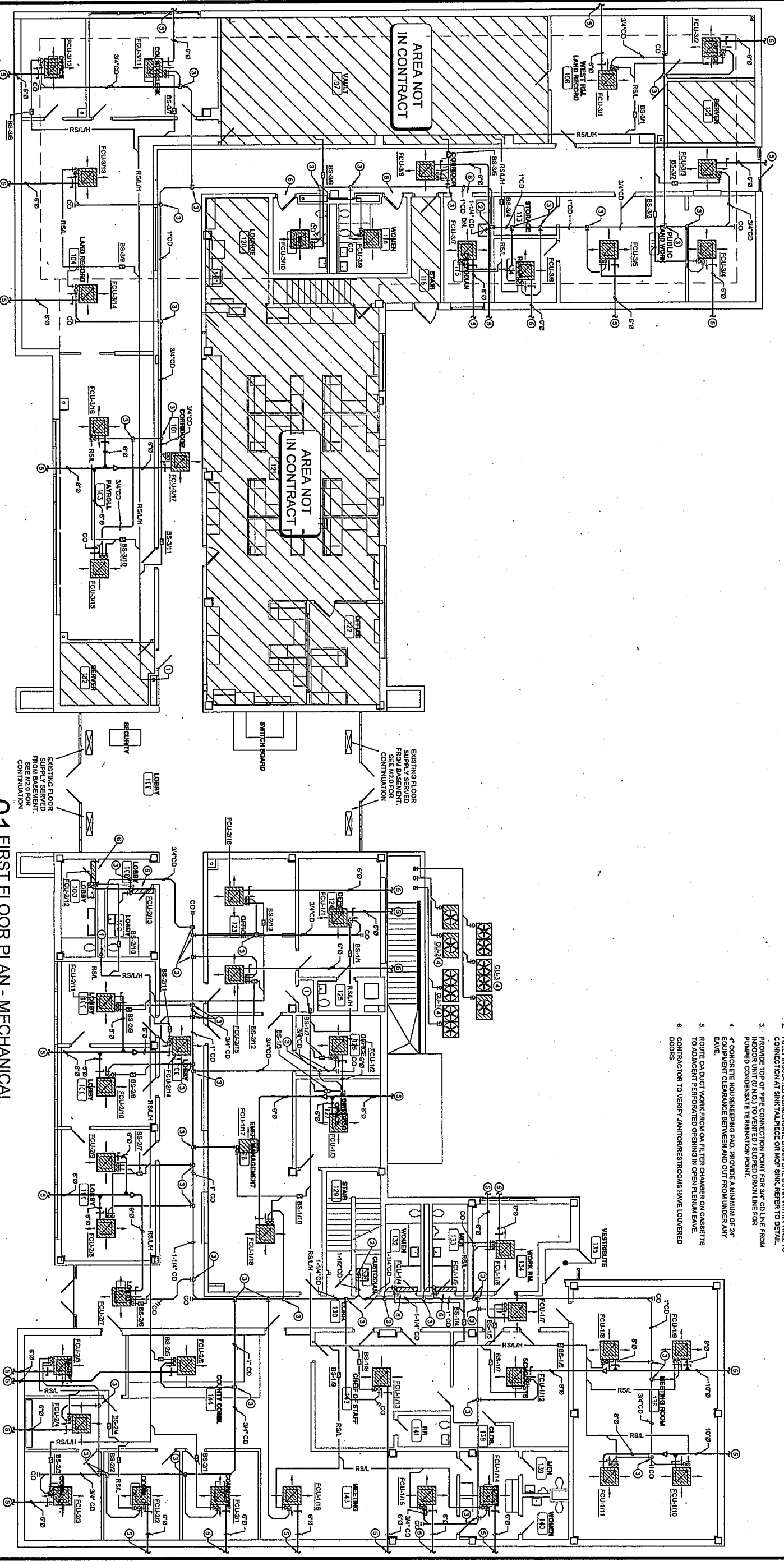
Sheet No. **M2.0**

GENERAL NOTES

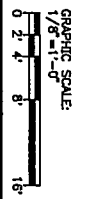
1. SEE PLAN SHEET M200 FOR NOTES, SYMBOLS, AND ABBREVIATIONS. REFER TO SPECIFICATIONS FOR ADDITIONAL PROJECT REQUIREMENTS.
2. REFER TO DIVISION 15 (20) BOOK SPECIFICATIONS FOR HVAC SPECIFICATIONS.
3. SIZE REFRIGERANT LINES PER MANUFACTURER'S RECOMMENDATIONS.
4. INSTALL REFRIGERATION PIPING PER PIPING HANDBOOK AND MANUFACTURER SPECIFICATIONS.
5. CALCULATE FOR EXPANSION AND CONTRACTION. INSTALL EXPANSION JOINTS IF NEEDED IN REFRIGERATION PIPING.
6. INSTALL ISOLATION VALVES ON EXIT OF BS BOXES.

NOTES BY SYMBOL "O"

1. ROUTE FULLY INSULATED DX LINES WITHIN WALL DOWN TO BASEMENT.
2. FULLY INSULATED CONDENSATE DRAIN LINE DOWN WITHIN WALL TO CONNECTION AT SINK/TALP/PE OR MOP SINK. REFER TO DETAIL.
3. PROVIDE TOP OF PIPE CONNECTION POINT FOR 3/4" CO LINE FROM PIPED CONDENSATE TERMINATION POINT.
4. CONCRETE HOUSEKEEPING PAD. PROVIDE A MINIMUM OF 2" EQUIPMENT CLEARANCE BETWEEN AND OUT FROM UNDER ANY DUCT.
5. ROUTE OA DUCT WORK FROM OA FILTER CHAMBER ON CASSETTE TO ADJACENT PERFORATED OPENING IN OPEN PLenum CEILING.
6. CONTRACTOR TO VERIFY JANITORRESTROOMS HAVE LOUVERED DOORS.



01 FIRST FLOOR PLAN - MECHANICAL
SCALE: 1/8"=1'-0"



Sheet No.
M2.1

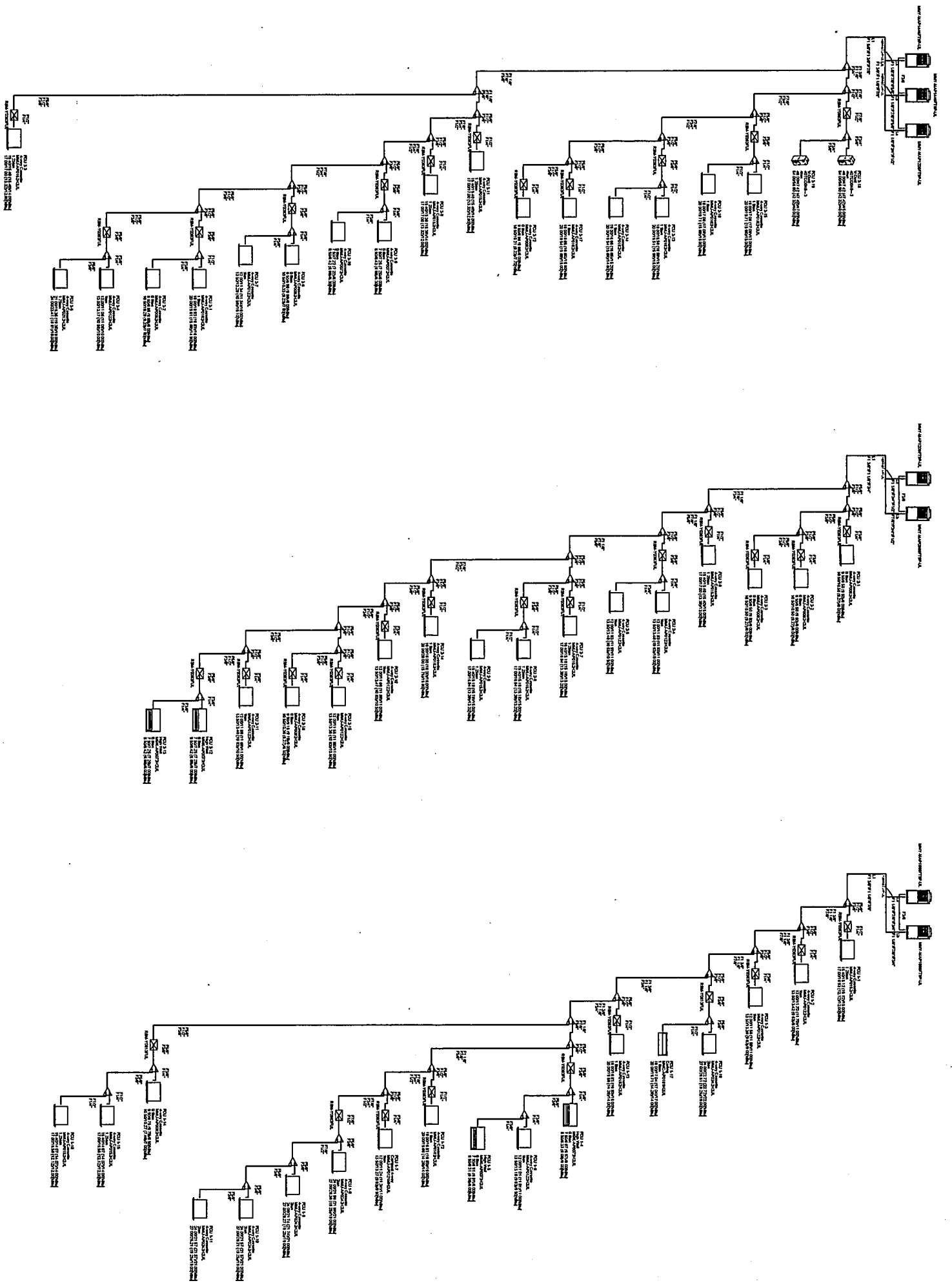
Revisions:
FIRST FLOOR PLAN
MECHANICAL



CANADIAN COUNTY - CLERK'S OFFICE
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EL RENO, OK 73036



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Project Number: 17899



GRAPHIC SCALE:
 1" = 10'-0"
 0 2 4 8 16

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 Project Number: 17899

Revisions:

Sheet No. **M5.1**

PIPING AND
 WIRING DIAGRAMS





COMcheck Software Version 4.0.6.0

Mechanical Compliance Certificate

Project Information

Energy Code: 90.1 (2007) Standard
Project Title: Canadian County Administration Office
Location: El Reno, Oklahoma
Climate Zone: 3a
Project Type: Alteration

Construction Site:
201 N Choctaw Ave
El Reno, OK 73036

Owner/Agent:

Designer/Contractor:
MD Engineering
500 N Central Expressway Suite
310
Plano, TX 75074
469-467-0200
mdengca@md-eng.com

Mechanical Systems List

Quantity System Type & Description

1 CU-1
Other Heat Pump
Heating Mode: Capacity = 360 kBtu/h,
No minimum efficiency requirement applies
Cooling Mode: Capacity = 320 kBtu/h,
No minimum efficiency requirement applies
Fan System: FCU-1/1 - 1/18 | NW Corner -- Compliance (Motor nameplate HP method) : Passes

Fans:
FCU.1.1 to 1.8 Supply, Constant Volume, 9640 CFM, 1.4 motor nameplate hp

SYSTEM COMPLIANCE REQUIRED.

1 CU-2
Other Heat Pump
Heating Mode: Capacity = 232 kBtu/h,
No minimum efficiency requirement applies
Cooling Mode: Capacity = 206 kBtu/h,
No minimum efficiency requirement applies
Fan System: FCU-1/1 - 1/18 | NW Corner -- Compliance (Motor nameplate HP method) : Passes

Fans:
FCU.1.1 to 1.8 Supply, Constant Volume, 9640 CFM, 1.4 motor nameplate hp

SYSTEM COMPLIANCE REQUIRED.

1 CU-1 copy 2
Other Heat Pump
Heating Mode: Capacity = 436 kBtu/h,
No minimum efficiency requirement applies
Cooling Mode: Capacity = 390 kBtu/h,
No minimum efficiency requirement applies
Fan System: FCU-1/1 - 1/18 | NW Corner -- Compliance (Motor nameplate HP method) : Passes

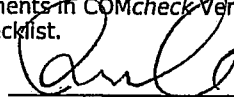
Fans:
FCU.1.1 to 1.8 Supply, Constant Volume, 9640 CFM, 1.4 motor nameplate hp

Quantity System Type & Description
SYSTEM COMPLIANCE REQUIRED.

Mechanical Compliance Statement

Compliance Statement: The proposed mechanical alteration project represented in this document is consistent with the building plans, specifications, and other calculations submitted with this permit application. The proposed mechanical systems have been designed to meet the 90.1 (2007) Standard requirements in COMcheck Version 4.0.6.0 and to comply with any applicable mandatory requirements listed in the Inspection Checklist.

BLAISE LEO
Name - Title


Signature

7/27/2017
Date



COMcheck Software Version 4.0.6.0

Inspection Checklist

Energy Code: 90.1 (2007) Standard

Requirements: 0.0% were addressed directly in the COMcheck software

Text in the "Comments/Assumptions" column is provided by the user in the COMcheck Requirements screen. For each requirement, the user certifies that a code requirement will be met and how that is documented, or that an exception is being claimed. Where compliance is itemized in a separate table, a reference to that table is provided.

Section # & Req ID	Plan Review	Complies?	Comments/Assumptions
4.2.2, 6.4.2 [PR2] ¹	Plans, specifications, and/or calculations provide all information with which compliance can be determined for the mechanical systems and equipment and document where exceptions to the standard are claimed. Load calculations per acceptable engineering standards and handbooks.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	
4.2.2, 7.4.1 [PR3] ¹	Plans, specifications, and/or calculations provide all information with which compliance can be determined for the service water heating systems and equipment and document where exceptions to the standard are claimed. Hot water system sized per manufacturer's sizing guide.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	
6.7.2.4 [PR5] ¹	Detailed instructions for HVAC systems commissioning included on the plans or specifications for projects >=50,000 ft ² .	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	

Additional Comments/Assumptions:

1 High Impact (Tier 1)	2 Medium Impact (Tier 2)	3 Low Impact (Tier 3)
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Section # & Req. ID	Footing / Foundation Inspection	Complies?	Comments/Assumptions
6:4.3.8 [F09]	Freeze protection and snow/ice melting system sensors for future connection to controls.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	

Additional Comments/Assumptions:

1 High Impact (Tier 1)	2 Medium Impact (Tier 2)	3 Low Impact (Tier 3)
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Section & Req. ID	Mechanical Rough-In Inspection	Plans Verified Value	Field Verified Value	Complies?	Comments/Assumptions
6.4.1.4, 6.4.1.5 [ME1] ²	HVAC equipment efficiency verified. Non-NAECA HVAC equipment labeled as meeting 90.1.	Efficiency: _____	Efficiency: _____	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	See the Mechanical Systems list for values.
6.4.3.4.1 [ME3] ³	Stair and elevator shaft vents have motorized dampers that automatically close.			<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	
6.4.3.4.5 [ME5] ³	Ventilation fans >0.75 hp have automatic controls to shut off fan when not required.			<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	
6.4.3.9 [ME6] ¹	Demand control ventilation provided for spaces >500 ft ² and >40 people/1000 ft ² occupant density and served by systems with air side economizer, auto modulating outside air damper control, or design airflow >3,000 cfm.			<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	
6.4.4.1.1 [ME7] ³	Insulation exposed to weather protected from damage. Insulation outside of the conditioned space and associated with cooling systems is vapor retardant.			<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	
6.4.4.1.2 [ME8] ²	HVAC ducts and plenums insulated.	R- _____	R- _____	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	
6.4.4.1.3 [ME9] ²	HVAC piping insulation thickness.	_____ in.	_____ in.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	
6.4.4.2.1 [ME10] ²	Ducts and plenums sealed based on static pressure and location.			<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	
6.4.4.2.2 [ME11] ³	Ductwork operating >3 in. water column requires air leakage testing.			<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	
6.4.4.2.2 [ME11] ³	Ductwork operating >3 in. water column requires air leakage testing.			<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	
6.4.4.2.2 [ME11] ³	Ductwork operating >3 in. water column requires air leakage testing.			<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	
6.5.2.3 [ME19] ³	Dehumidification controls provided to prevent reheating, recooling, mixing of hot and cold airstreams or concurrent heating and cooling of the same airstream.			<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	

1 High Impact (Tier 1) 2 Medium Impact (Tier 2) 3 Low Impact (Tier 3)

Section # & Req. ID	Mechanical Rough-In Inspection	Plans Verified Value	Field Verified Value	Complies?	Comments/Assumptions
6.5.4.1 [ME25] ³	HVAC pumping systems >10 hp designed for variable fluid flow.			<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	
6.5.6.1 [ME30] ¹	Exhaust air energy recovery on systems >=5,000 cfm and 70% of design supply air.			<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	
6.5.7.1 [ME32] ²	Kitchen hoods >5,000 cfm have make up air >=50% of exhaust air volume.			<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	
6.5.7.2 [ME33] ¹	Fume hoods exhaust systems >=15,000 cfm have VAV hood exhaust and supply systems, direct make-up air or heat recovery.			<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	
6.5.8.1 [ME34] ³	Unenclosed spaces that are heated use only radiant heat.			<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	

Additional Comments/Assumptions:

1 High Impact (Tier 1)	2 Medium Impact (Tier 2)	3 Low Impact (Tier 3)
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Section # & Req. ID	Rough-In Electrical Inspection	Complies?	Comments/Assumptions
10.4.1 [EL9]	Electric motors meet requirements where applicable.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	

Additional Comments/Assumptions:

1 High Impact (Tier 1)	2 Medium Impact (Tier 2)	3 Low Impact (Tier 3)
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Project Title: Canadian County Administration Office

Report date: 07/27/17

Data filename: M:\2017\17899 Canadian County Administration Office OK(4) Documents\17899 - COMCheck - Page 7 of 10
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Section # & Req ID	Final Inspection	Complies?	Comments/Assumptions
6.4.3.1.1 [F12] ²	Heating and cooling to each zone is controlled by a thermostat control.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	
6.4.3.1.2 6.4.3.2 6.4.3.3 6.4.3.3.1 6.4.3.3.2 [F13] ²	Thermostatic controls have a 5 °F deadband.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	
6.4.3.5 [F15] ³	Heat pump controls prevent supplemental electric resistance heat from coming on when not needed.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	
6.4.3.5 [F15] ³	Heat pump controls prevent supplemental electric resistance heat from coming on when not needed.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	
6.4.3.5 [F15] ³	Heat pump controls prevent supplemental electric resistance heat from coming on when not needed.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	
6.4.3.7 [F16] ³	When humidification and dehumidification are provided to a zone, simultaneous operation is prohibited.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	
6.7.2.1 [F17] ³	Furnished HVAC as-built drawings submitted within 90 days of system acceptance.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	
6.7.2.2 [F18] ³	Furnished O&M manuals for HVAC systems within 90 days of system acceptance.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	
6.7.2.3 [F19] ¹	An air and/or hydronic system balancing report is provided for HVAC systems serving zones >5,000 ft ² of conditioned area.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	
6.7.2.4 [F10] ¹	HVAC control systems have been tested to ensure proper operation, calibration and adjustment of controls.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	
6.4.3.2 [F120] ¹	Temperature controls have setpoint overlap restrictions.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	
6.4.3.3.1 [F121] ¹	HVAC systems equipped with at least one automatic shutdown control.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	

1 High Impact (Tier 1)
 2 Medium Impact (Tier 2)
 3 Low Impact (Tier 3)

Section # & Req ID	Final Inspection	Complies?	Comments/Assumptions
6.4.3.3.2 [F122] ¹	Setback controls allow automatic restart and temporary operation as required for maintenance.	<input type="checkbox"/> Complies <input type="checkbox"/> Does Not <input type="checkbox"/> Not Observable <input type="checkbox"/> Not Applicable	

Additional Comments/Assumptions:

1 High Impact (Tier 1)	2 Medium Impact (Tier 2)	3 Low Impact (Tier 3)
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DIVISION 1 – GENERAL REQUIREMENTS

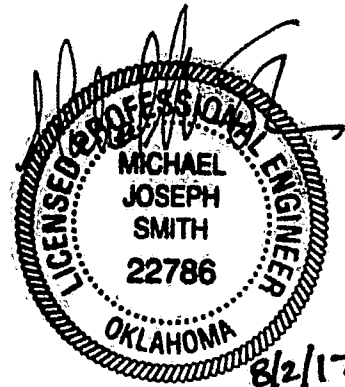
- 01 14 19 REFERENCE STANDARDS AND DEFINITIONS
- 01 25 00 PRODUCT SUBSTITUTION PROCEDURES
- 01 73 13 APPLICATIONS FOR PAYMENT

DIVISION 23 – HVAC

- 23 05 00 COMMON WORK RESULTS FOR HVAC
- 23 05 48 VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT
- 23 05 53 IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT
- 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC
- 23 07 00 HVAC INSULATION
- 23 23 00 REFRIGERANT PIPING
- 23 31 13 METAL DUCTS
- 23 81 49 VARIABLE REFRIGERANT AIR CONDITIONING SYSTEM

DRAWINGS

- M0.0 LEGEND AND GENERAL NOTES
- M0.1 MECHANICAL SCHEDULES
- M0.2 MECHANICAL SCHEDULES
- M2.0 BASEMENT FLOOR PLAN - MECHANICAL
- M2.1 FIRST FLOOR PLAN - MECHANICAL
- M5.1 PIPING AND WIRING DIAGRAMS



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SECTION 01 14 19 - REFERENCE STANDARDS AND DEFINITIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Technical Specifications Sections, apply to this Section.

1.2 DEFINITIONS

- A. Approved: The term approved, when used in conjunction with the owner's action on the Contractor's submittals, applications, and requests, is limited to the owner's duties and responsibilities as stated in the Contract.
- B. Contract: Agreement executed between owner and contractor.
- C. Directed: Terms such as directed, requested, authorized, selected, approved, required, and permitted mean directed by the owner, requested by the owner, and similar phrases.
- D. Furnish: The term furnish means supply and deliver to the Project site, ready for unloading, unpacking, assembly, installation, and similar operations.
- E. Indicated: The term indicated refers to graphic representations, notes, or schedules on the Drawings or other Paragraphs or Schedules in the Specifications, and similar requirements in the Contract Documents. Terms such as shown, noted, scheduled, and specified are used to help the reader locate the reference. There is no limitation on location.
- F. Install: The term install describes operations at the Project site including the actual unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.
- G. Installer: An installer is the Contractor or another entity engaged by the Contractor, either as an employee, subcontractor, or contractor of lower tier, to perform a particular construction activity, including installation, erection, application, and similar operations. Installer is required to be experienced in the operations they are engaged to perform.
The term experienced, when used with the term Installer, means having a minimum of five previous projects similar in size and scope to this Project, being familiar with the special requirements indicated, and having complied with requirements of the authority having jurisdiction.
- H. Project Site: Is the space available to the Contractor for performing construction activities either exclusively or in conjunction with others performing other work as part of the Project. The extent of the Project site is shown on the Drawings and may or may not be identical with the description of the land on which the Project is to be built.
- I. Provide: The term provide means to furnish and install, complete and ready for the intended use.
- J. Regulations: The term regulations includes laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, as well as rules, conventions, and agreements within the construction industry that control performance of the Work.

- K. Specialists: Certain Sections of the Specifications require that specific construction activities shall be performed by specialists who are recognized experts in those operations. The specialists must be engaged for those activities, and their assignments are requirements over which the Contractor has no choice or option. However, the ultimate responsibility for fulfilling Contract requirements remains with the Contractor. This requirement shall not be interpreted to conflict with enforcing building codes and similar regulations governing the Work. It is also not intended to interfere with local trade union jurisdictional settlements and similar conventions.
- L. Testing Agencies: A testing agency is an independent entity engaged to perform specific inspections or tests, either at the Project site or elsewhere, and to report on and, if required, to interpret results of those inspections or tests.
- M. Trades: Using terms such as carpentry is not intended to imply that certain construction activities must be performed by accredited or unionized individuals of a corresponding generic name, such as carpenter. It also does not imply that requirements specified apply exclusively to tradespersons of the corresponding generic name.
- N. Work: The term "Work" or "Scope of Work" means the construction and service required by the Contract Documents, and includes all the labor, materials, equipment and services provided by Contractor to fulfill the Contractor's obligation.

1.3 INDUSTRY STANDARDS

- A. Applicability of Standards: Except where the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.
- B. Publication Dates: Comply with the standards in effect as of the date of the Contract Documents.
- C. Conflicting Requirements: Where compliance with two or more standards is specified and where the standards may establish different or conflicting requirements for minimum quantities or quality levels, refer requirements that are different but apparently equal and other uncertainties to the Owner for a decision before proceeding.
- D. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of the requirements. Refer uncertainties to the Owner for a decision before proceeding.
- E. Copies of Standards: Each entity engaged in construction on the Project is required to be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.
- F. Where copies of standards are needed to perform a required construction activity, the Contractor shall obtain copies directly from the publication source.
- G. The owner reserves the right to require the Contractor to submit copies of standards as necessary for enforcement of requirements.

- H. Abbreviations and Names: Trade association names and titles of general standards are frequently abbreviated. Where such acronyms or abbreviations are used in the Specifications or other Contract Documents, they mean the recognized name of the trade association, standards-generating organization, authority having jurisdiction, or other entity applicable to the context of the Text provision, Refer to the "Encyclopedia of Associations," published by Gale Research Co., available in most libraries.

1.4 GOVERNING REGULATIONS/AUTHORITIES

- A. The owner has contacted authorities having jurisdiction where necessary to obtain information necessary for preparation of Contract Documents. Contact authorities having jurisdiction directly for information and decisions having a bearing on the Work.

1.5 SUBMITTALS

- A. Permits, Licenses, and Certificates: For the Owner's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, and similar documents, correspondence, and records established in conjunction with compliance with standards and regulations bearing upon performance of the Work.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

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SECTION 01 25 00 - PRODUCT SUBSTITUTION PROCEDURES**PART 1 - GENERAL****1.1 PRODUCT PERFORMANCE/SUBSTITUTIONS**

- A. Intention of these requirements is to establish equality of any proposed substitute product or method with standard product/method specified. When a product is specified by using a proprietary name or the particular manufacturer or vendor, specific item mentioned shall be understood as establishing type, function, dimension, appearance and quality desired. Other manufacturer's products are encouraged, provided sufficient information is submitted that allows Owner to determine products proposed are approved substitutes to those named.
- B. **Prior to Bid Date:** Owner will consider only written requests from prime bidders for acceptance, received at least ten (10) calendar days prior to bid date; requests received after that time will not be considered. When a product is accepted, bidders shall be notified of acceptable alternate within five (5) days prior to bid opening.
- C. **After Bid Date:** Requests for substitution will not be accepted after bid date unless:
1. Approved product or system is discontinued from Manufacturer.
 2. Owner requests substitution.
- D. Proposed Substitutions will not be considered if:
1. Any discrepancies in test data, or if tests or submittals are incomplete.
 2. Acceptance will require substantial revision of Contract Documents.
 3. Product in opinion of Owner does not meet standards or performance of product originally specified.

1.2 SUBMITTALS

- A. Submit three (3) copies of "Substitution Request Form", located at end of Section. Include three (3) copies of all requested information.

PART 2 - PRODUCTS – (Not Used)**PART 3 - EXECUTION – (Not Used)**

END OF SECTION

**SUBSTITUTION
REQUEST
(During Bidding Phase)**

Project: _____ From: _____
 To: _____ Date: _____

Specification Title: _____ Description: _____
 Section: _____ Page: _____ Article/Paragraph: _____

Proposed Substitution: _____
 Manufacturer: _____ Address: _____ Phone: _____
 Trade Name: _____ Model No: _____

Attached data includes product description, specifications, drawings, photographs and performance and test data adequate for evaluation of the request; applicable portions of the data are clearly identified.

Attached data also includes a description of changes to the Contract Documents that the proposed substitution will require for its proper installation.

The Undersigned certifies:

- Proposed substitution has been fully investigated and determined to be equal or superior in all respects to specified product.
- Same warranty will be furnished for proposed substitution as for specified product.
- Same maintenance service and source of replacement parts, as applicable, is available.
- Proposed substitution will have no adverse effect on other trades and will not affect or delay progress schedule.
- Proposed substitution does not affect dimensions and functional clearances.
- Payment will be made for changes to building design, including A/E design, detailing, and construction costs caused by the substitution.
- Pay for changes to building design and special inspection costs caused by use of product.

Submitted by: _____
 Signed by: _____
 Firm: _____
 Address: _____
 Telephone: _____

Similar Installation:
 Project: _____ Architect: _____
 Address: _____ Owner: _____
 Date Installed: _____

Supporting Data Attached: Drawings Product Data Samples Tests Reports _____

**SUBSTITUTION
REQUEST
(Continued)**

OWNER'S REVIEW AND ACTION

- Substitution approved – Provide required submittals in accordance with Specifications.
- Substitution approved as noted – Provide required submittals in accordance with Specifications
- Substitution rejected – Use specified materials. Comments:

Signed by:

Date:

**SUBSTITUTION
REQUEST
(After the Bidding Phase)**

Project: _____ From: _____
To: _____ Date: _____

Specification Title: _____ Description: _____
Section: _____ Page: _____ Article/Paragraph: _____

Proposed Substitution
Manufacturer _____ Address: _____ Phone: _____
Trade Name: _____ Model No: _____
Installer _____ Address: _____ Phone: _____

History: New Product 2-5 years old 5-10 years old More than 10 years old
Differences between proposed substitution and specified product: _____

Point-by-point comparative data attached – REQUIRED BY A/E
Reason for not providing specified item: _____

Project: _____ Architect: _____
Address: _____ Owner: _____
Date Installed: _____

Proposed substitution affects other parts of Work: No Yes, explain _____

Savings to Owner for accepting substitution: _____ (\$ _____)
 No Yes; [Add] [Deduct]

Proposed substitution changes Contract Time: _____ days

Supporting Data Attached: Drawings Product Data Samples Tests Reports _____

**SUBSTITUTION
REQUEST
(Continued)**

The Undersigned certifies:

- Proposed substitution has been fully investigated and determined to be equal or superior in all respects to specified product.
- Same warranty will be furnished for proposed substitution as for specified product.
- Same maintenance service and source of replacement parts, as applicable, is available.
- Proposed substitution will have no adverse effect on other trades and will not affect or delay progress schedule.
- Cost data as stated above is complete. Claims for additional costs related to accepted substitution which may subsequently become apparent are to be waived.
- Proposed substitution does not affect dimensions and functional clearances.
- Payment will be made for changes to building design, including A/E design, detailing, and construction costs caused by the substitution.
- Coordination, installation and changes in the Work as necessary for accepted substitution will be complete in all respects.

Submitted by: _____
 Signed by: _____
 Firm: _____
 Address: _____
 Telephone: _____
 Attachments: _____

OWNER'S REVIEW AND ACTION

- Substitution approved – Provide required submittals in accordance with Specifications.
- Substitution approved as noted – Provide required submittals in accordance with Specifications.
- Substitution rejected – Use specified materials. Comments:

Signed by: _____ Date: _____

Additional Comments: Contractor Subcontractor Supplier Manufacturer A/E _____

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SECTION 01 73 13 - APPLICATIONS FOR PAYMENT**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and other Technical Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section specifies administrative and procedural requirements governing the Contractor's Applications for Payment.

1.3 APPLICATION FOR PAYMENT AT SUBSTANTIAL COMPLETION

- A. Following issuance of Owners punch list establishing date of Substantial Completion, submit an Application for Payment. Contractor may submit application for payment after Substantial completion date is established at end of each phase of construction. A 10% retainage will be withheld from each Application for Payment until all three phases of construction are complete.
- B. Administrative actions and submittals that shall proceed or coincide with this application include:
 - 1. Owner's punch list.
 - 2. Occupancy permits.
 - 3. Warranties (guarantees) and maintenance agreements.
 - 4. Test/adjust/balance records.
 - 5. Maintenance instructions.
 - 6. Change-over information related to Owner's occupancy, use, operation and maintenance.
 - 7. Final cleaning.
 - 8. Asbestos-free Certification form.

1.4 FINAL PAYMENT APPLICATION

- A. Final payment is request for retainage.
- B. Administrative actions and submittals which must precede or coincide with submittal of the final payment Application for Payment include the following:
 - 1. Completion of Project closeout requirements.
 - 2. Completion of items specified for completion after Substantial Completion.
 - 3. Assurance that unsettled claims will be settled.
 - 4. Proof that taxes, fees and similar obligations have been paid.
 - 5. Removal of surplus materials, rubbish and similar elements.

PART 2 - PRODUCTS (Not used).

PART 3 - EXECUTION (Not used).

END OF SECTION

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SECTION 23 05 00 - COMMON WORK RESULTS FOR HVAC**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. The Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to the Work in this Section.

1.2 DESCRIPTION

- A. The General Requirements for Mechanical Work are intended to be complementary to the General Requirements of the Construction Contract.
- B. Work Included: Provide complete mechanical systems where shown on the drawings, as specified herein, and as needed for a complete and proper installation including, but not necessarily limited to the following summary of work:
 - 1. Furnish and install a complete heating and air conditioning system as shown on drawings and described herein.
 - 2. Furnish and install a complete ventilation system as shown on drawings and described herein.
 - 3. Other items and services required to complete the systems.

1.3 GENERAL REQUIREMENTS

- A. Unless otherwise specified, materials are to be new and of current U.S. manufacture, free from defects and of the best quality of their respective kinds.
- B. Equipment and/or materials damaged in shipment or handling, or otherwise damaged before installation, shall be replaced with new equipment and/or materials. Damaged equipment and/or materials shall not be repaired at the jobsite.
- C. Furnishing of the proper equipment and/or materials and to see that it is installed as recommended by the manufacturer is entirely the responsibility of the Contractor. If required for proper installation, the Contractor shall obtain advice and supervisory assistance from a representative of the specific manufacturer of the equipment being installed.
- D. Materials and adhesives to conform to Federal Standard Flame-Spread Properties, Inc., with composite fire and smoke hazard ratings, maximum 25 for flame spread and 50 for smoke developed. Adhesives to be waterproof.
- E. The Contractor shall promptly notify the Architect in writing of any conflict between the requirements of the Contract Documents and the manufacturer's directions and shall obtain the Architect instructions before proceeding with the work. Should the Contractor perform any such work that does not comply with the manufacturer's directions or such instructions from the Architect, he shall bear all costs arising in connection with the deficiencies.
- F. Belts, pulleys, chains, gears, couplings, projecting screws, keys or other rotating parts which are located so that a person can come in close proximity thereto shall be fully enclosed properly provided with a guard.

1.4 QUALITY ASSURANCE AND APPLICABLE STANDARDS

- A. Use adequate numbers of skilled workers that are thoroughly trained and experienced in the necessary crafts and are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.
- B. The Contractor shall be responsible for fitting his material and apparatus into the building and shall carefully lay out his work at the site to conform to the structural conditions, to avoid all obstructions, to conform to the details of the installation and thereby to provide an integrated satisfactory operating installation. **The contractor must support all duct, pipe, equipment, and all other items furnished and installed under this scope from steel joists or structural steel frames. It is prohibited to support duct, pipe, equipment, and all other items furnished under this scope from the metal deck.**
- C. Without additional cost to the Owner, provide such other labor and materials as are required to complete the work of this Section in accordance with the requirements of governmental agencies having jurisdiction, regardless of whether such materials and associated labor are called for elsewhere in these Contract Documents.
- D. Codes: Perform all work in accordance with the latest edition of the following codes:
1. State and city building, fire, plumbing and mechanical codes.
 2. International Fire Code
 3. Uniform Mechanical Code
 4. Uniform Plumbing Code
 5. National Electrical Code
 6. Energy Conservation Code
 7. National Fire Protection Association (NFPA)
 8. American with Disabilities Act (ADA)
 9. ICC/ANSI A117.1 Accessible and Useable Buildings and Facilities.
 10. All authorities having jurisdiction.
 11. Architectural code review drawing.
- E. The Contractor shall comply in every respect with all requirements of National Fire Protection Association, local Fire Department regulations and utility company requirements. In no case does this relieve the Contractor of the responsibility of complying with these Specifications and Drawings where specified conditions are of higher quality than the requirements of the above-specified authorities. Where requirements of the Specifications and Drawings are more lenient than the requirements of the above authorities having jurisdiction, the Contractor shall make installations in compliance with the requirements of the above authorities with no extra compensation.
- F. Where conflicts occur between drawings, specifications or code requirements, the most stringent requirement shall take precedence.
- G. Standards: The specifications and standards of the following organizations are by reference made a part of these specifications. All work, unless otherwise indicated, shall comply with the requirements and recommendations wherever applicable:
1. American National Standards Institute (ANSI).
 2. Air Conditioning and Refrigeration Institute (ARI).
 3. American Gas Association (AGA).
 4. American Society for Testing and Materials (ASTM).
 5. American Society of Mechanical Engineers (ASME).

6. American Society of Refrigeration, Heating and Air Conditioning Engineers (ASHRAE).
7. Electrical Testing Laboratories (ETL).
8. National Bureau of Standards (NBS).
9. National Electrical Manufacturer's Association (NEMA).
10. National Fire Protection Association (NFPA).
11. Sheet Metal and Air Conditioning National Association (SMACNA).
12. Underwriters Laboratories, Inc. (UL).

H. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. ASME Boiler and Pressure Vessel Code: Section IX.

1.5 REQUIREMENTS OF REGULATORY AGENCIES

A. The requirements and recommendations of the latest edition of the Occupational Safety and Health Administration (OSHA) Act are by reference made a part of these specifications. All work shall comply with the requirements and recommendations wherever applicable.

1.6 SUBMITTALS

A. Comply with all submittal provisions of Division 1.

B. Submit electronic copies of the submittal to the prime consultant (i.e. architect) in order to process and track the submittals properly in accordance with Division 1 and 23 submittal requirements. Submittals shall be labeled by their project specification section or CSI specification section if not listed in project specifications

C. Product Data: Submit the following:

1. Materials list of items proposed to be provided under Division 23.
2. Manufacturer's specifications and other data needed to prove compliance with the specified requirements. The term "Compliance" is understood to mean that the Contractor certifies that the submitted equipment will meet or exceed the contract document requirements. Items that do not clearly meet this definition should be identified and explained as required in the following paragraph.
3. Identify the difference between the specified item or function and the proposed. Explain with enough detail so that the Engineer/Owner can easily determine that the item complies with the functional intent. List any disadvantages or advantages of the proposed item versus the specified item. Submit technical data sheets and/or pictures and diagrams to support and clarify. Organize in a clear and concise format. All substitutions shall be approved in writing by Architect. The Architect's decision shall be final.
4. Allow a minimum of ten (10) working days for the review of submittals and each re-submittal.
5. Submittals that have been reviewed and marked as REJECTED (REJ) or MAKE CORRECTIONS NOTED (MCN) should be resubmitted within 10 days to be reviewed again by engineer.
6. Compliance with the Contract documents shall be the sole responsibility of the Contractor. Items on equipment that are were not accepted by the Architect in writing as an approved equal shall be replaced or revised to comply with the contract documents at the Contractor's expense.
7. Manufacturer's recommended installation procedures which, when reviewed by the Architect, shall become the basis for accepting or rejecting actual installation procedures used on the work.

8. Sign the submittal as an indication of compliance with the contract documents. Any deviations from the contract documents shall be indicated on the submittal prior to signing. Any deviations not indicated shall be cause for rejection and removal of the non-complying equipment at the Contractor's expense.

D. Submittals required of materials and equipment under this section include the following:

1. Piping and Accessories Materials:
 - a. **Clearly marked up** manufacturer's data showing compliance with the specifications for: **(Include model numbers and highlight products)**
 - 1) Piping material proposed for each system.
 - 2) Valves, cocks, and specialties.
 - 3) Flexible connectors for piping.
 - 4) Flanges.
 - b. 1/8" scale (minimum) refrigerant piping shop drawings showing coordinated piping routing and arrangements with all equipment, accessories and system expansion and contraction compensation methods.
2. Vibration Isolation and Sound Control Materials:
 - a. **Submit shop drawings** showing the structural design and details of inertia bases, steel beam bases, and other custom-fabricated work not covered by manufacturer's submitted data.
 - b. Furnish layouts of templates to be furnished to fabricators of equipment bases, foundations, and other support systems, as needed for coordination of vibration isolation units with other work.
 - c. Submit shop drawings indicating the scope of vibration isolation work, locations of units and flexible connections. Include support isolation points for piping, air handling units, inertia bases, etc.
 - d. Include schedule of isolation units, showing size or manufacturer's part number, the weight supported and resulting deflection of each unit.
 - e. For spring isolation units, show wire size, spring diameter, free height, solid-compression height, operating height, fatigue characteristics and ratio of horizontal to vertical stiffness.
 - f. For spring-and-pad type isolation units, show the basis of spring rate selection for the range of loading weights.
3. Mechanical Identification Materials:
 - a. **Clearly marked-up** product literature or samples showing compliance with specified materials for: **(Include model numbers and highlight products)**
 - 1) Valve tagging.
 - 2) Pipe marking.
 - 3) Equipment marking.
4. Insulation:
 - a. Manufacturer's certified data on thermal performance.
 - b. Details, when required, of methods to be used in providing for unusual piping expansion and contraction.
 - c. Manufacturer's data on any alternate insulation material of reduced thickness, including pre-insulated pipe.
 - d. Manufacturer's data on all jacketing materials, sealants and fasteners.
5. Refrigeration:
 - a. **Provide clearly marked-up** manufacturer's data showing compliance with scheduled values and specifications for: **(Include model numbers and highlight products)**
 - 1) Condensing Units
 - b. Provide all electrical characteristics.

6. Air Handling:
 - a. **Provide clearly marked-up** manufacturer's data showing compliance with scheduled values and specifications for: **(Include model numbers and highlight products)**
 - 1) AHU, factory assembled.
 - 2) Fan coil units.
 - 3) Filters.
 - b. Provide all electrical characteristics.
 7. Air Distribution Materials:
 - a. **Provide clearly marked-up** manufacturer's data showing compliance with scheduled values and specifications for: **(Include model numbers and highlight products)**
 - 1) Air devices.
 - 2) 1/4" scale ductwork shop drawings for all systems showing equipment locations, detailed data such as bottom of duct elevations, airstream sizes, all duct accessories, and duct construction details showing compliance with SMACNA requirements for the specified duct pressure of each system.
 - 3) Fire dampers, fire and smoke dampers.
 8. Testing and Balancing:
 - a. Brief description of test and balance contractor experience.
 - b. Certificate of Qualification from AABC.
 - c. Biographical information of the Registered Professional Engineer and certified Test and Balance Supervisor proposed to manage the project.
 - d. List of instruments to be used with latest date of calibration test for each.
 - e. Test and balance reports.
 - f. VRF experience.
 9. Record Documents: Reference the requirements detailed in this section.
 10. Operation and Maintenance Data: Reference the requirements detailed in this section.
- E. Resubmission of rejected submittals shall be limited to one (1) in number. Costs for processing subsequent resubmittals in excess of the first resubmittal, resulting from the Contractor's disregard of Architect/Engineer's primary submittal rejection comments, shall be borne by the Contractor. Costs shall be based on Architect/Engineer's hourly rates as published in their current professional fee schedules and shall also include reimbursable costs for delivery, mailing, and photocopies at direct cost plus ten percent (10%).

1.7 SUBSTITUTIONS

- A. Comply with all provisions of Division 1.
- B. The use of manufacturers' names and catalog numbers followed by the phrase "or equal" is generally used to establish a standard of quality and utility for the specified items and to provide a dimensional reference for construction documents that are drawn to scale.
- C. Submittals for "equal" items shall, where applicable, include the following data that are not necessarily required for specified items:
 1. Performance characteristics.
 2. Materials.
 3. Finish.
 4. Certification of conformance with specified codes and standards.

5. Manufacturer's specifications and other data needed to prove compliance with the specified requirements. The term "Compliance" is understood to mean that the Contractor certifies that the submitted equipment will meet or exceed the contract document requirements. Items that do not clearly meet this definition should be identified and explained as required in Paragraph 6 below.
 6. Identify the difference between the specified item or function and the proposed. Explain with enough detail so that the Architect/ Engineer/Owner can easily determine that the item complies with the functional intent. List any disadvantages or advantages of the proposed item versus the specified item. Submit technical data sheets and/or pictures and diagrams to support and clarify. Include shop drawings for all piping and ductwork equipment per Paragraph 1.5 Submittals. Organize in a clear and concise format.
- D. Submittals of "equal" components or systems may be rejected if:
1. The material or equipment would necessitate the alteration of any portion of the mechanical, electrical, architectural or structural design.
 2. Dimensions vary from the specified material or equipment in such a manner that accessibility or clearances are impaired or the work of other trades is adversely affected.
- E. Proposed substitutions for materials or equipment must be submitted ten (10) days prior to final bid date for consideration as approved equals. Otherwise, such substitutions will not be permitted. Proposals for substitutions shall be made only by the prime bidders. Manufacturers, distributors, and sub-contractors shall not make proposals to the Architect for substitutions.
- F. All equipment installed on this project shall have local representation, local factory authorized service, and a local stock of repair parts
- G. No substitution shall be made unless authorized in writing by the Architect. Should a substitution be accepted, and should the substitute material prove defective or otherwise unsatisfactory for the service intended, and within the guarantee period, the Contractor shall replace this material or equipment with material or equipment specified, at his own expense, and to the satisfaction of the Architect.
- H. Contractors submitting bids on substitute materials and equipment must also provide a written performance guarantee certifying that the substitute materials and equipment will produce the specified effects and meet the approval of the Architect.
- 1.8 ORDINANCES, PERMITS, METERS, UTILITIES AND ROYALTIES
- A. Procure all permits and licenses necessary for completion of this project and pay all lawful fees required and necessary pursuant in obtaining said permits and licenses. All required certificates of approvals and inspections by local governing and regulating authorities shall be obtained and paid for by the Contractor.
 - B. Pay any royalty payments required or fees for the use of patented equipment or systems. Defend all law suits or claims for infringement of any patent rights and shall hold the Owner and/or Architect/Engineer harmless from loss as a result of said suits or claims.

1.9 COMPATIBILITY OF EQUIPMENT

- A. Assume full responsibility for satisfactory operation of all component parts of the mechanical systems to assure compatibility of all equipment and performance of the integrated systems in accordance with the requirements of the specifications. Should the Contractor consider any part of the specifications or drawings as rendering his acceptance of such responsibility impossible, prohibitive, or restrictive, he shall notify the Engineer before submitting his bid, and the bid shall be accompanied by a written statement of any objections or exceptions to the specifications and drawings.
- B. The size of mechanical and electrical equipment indicated on the Drawings is based on the dimensions of a particular manufacturer. While other manufacturers may be acceptable, it is the responsibility of the Contractor to determine if the equipment he proposes to furnish will fit in the space. Fabrication Drawings shall be prepared when required by the Architect/Engineer or Owner to indicate a suitable arrangement.
- C. All equipment shall be installed in a manner to permit access to all surfaces. All valves, motors, drives, filters, and other accessory items shall be installed in a position to allow removal for service without disassembly of another part.

1.10 CONSTRUCTION REQUIREMENTS

- A. The drawings show the arrangements of work. Should project conditions necessitate rearrangement, or if the materials or equipment can be installed to a better advantage in a different manner, the Contractor shall, before proceeding with the work, prepare and submit five copies of Drawings of the proposed arrangement for the Architect's review. Allow a minimum of ten (10) working days for review.
- B. Should the Contractor propose to install equipment requiring space conditions other than those shown, or rearrange the equipment, he shall assume responsibility for the rearrangement of the space and shall have the Architect review the change before proceeding with the work. The request for such changes shall be accompanied by shop drawings of the space in question. Identify monetary credits proposed or other benefits of the change. Allow a minimum of ten (10) working days for review.
- C. The Contractor shall be responsible for the proper location and size of all slots, holes or openings in the building structure pertaining to his work and for the correct location of pipe sleeves.

1.11 CONNECTIONS FOR OTHERS

- A. The Mechanical Contractor shall rough in for and make all gas connections to all equipment, machinery, etc., provided by others in accordance with detailed roughing-in Drawings provided by the equipment suppliers, by actual measurements of the equipment connections, or as detailed.
- B. After the equipment is set in place, this Contractor shall make all final connections and shall provide all required pipe, fittings, valves, traps, etc.
- C. Provide all air gap fittings required, using materials hereinbefore specified. In each service line connected to an item of equipment or piece of machinery, provide a shutoff valve. On each drain not provided with a trap, provide a suitable trap.
- D. All pipe fittings, valves, traps, etc., exposed in finished areas and connected to chrome plated lines provided by others shall be chrome plated to match.

- E. Provide all galvanized sheet metal ductwork, transition pieces, etc., required for a complete installation. Exposed sheet metal shall be paint-grip type.

1.12 LOCATION OF OUTLETS

- A. Supply and return air outlets in suspended acoustical tile ceilings shall occur symmetrically in tile joints or in the centers of whole tiles. The final determination of the exact location of each outlet and the arrangement to be followed shall be acceptable to the Architect.
- B. The drawings show the locations of the various outlets and equipment. Exact locations of these outlets and equipment shall be determined by reference to the general construction plans and to all detail drawings, equipment drawings, roughing-in drawings, etc., by measurements at the building, and in cooperation with the other trades. The Architect reserves the right to make any reasonable change in location of any outlet or equipment before installation, without additional cost.
- C. The Contractor shall install his work complete and in good working order. If any of the requirements of the drawings and specifications are impossible to perform, or if the installation when made in accordance with such requirements will not perform satisfactorily, he shall report same to the Architect for correction.
- D. No extra compensation will be allowed for extra work or change caused by failure to comply with the above requirements.

1.13 PROJECT RECORD DOCUMENTS

- A. Provide the record documents associated with the work of Division 23 in strict accordance with the provisions of these specifications.
- B. Throughout progress of the Division 23 Work, maintain an accurate record of changes in the Contract Documents that apply to work of Division 23. Changes shall include all addendums issued during bidding. Maintain an accurate record of the location of mechanical service lines and outlets and all outside utilities.
- C. Delegate the responsibility for maintenance of Record Documents to one person on the Contractor's staff as approved by the Architect.
- D. Accuracy of Records
 - 1. Thoroughly coordinate changes within the Record Documents, making adequate and proper entries on each page of Specifications and each sheet of drawings and other documents where such entry is required to show the change properly. Match the symbology and format of the base documents.
 - 2. Accuracy of records shall be such that a future verification of items shown in the Contract Documents may rely reasonably on information obtained from the approved Project Record Documents.
- E. Maintain the job set of Record Documents completely protected from deterioration and from loss and damage until completion of the work and transfer of all recorded data to the final Project Record Documents.

F. Making Entries on Drawings

1. Using an erasable colored pencil (not ink or indelible pencil), clearly describe the change by graphic line and note as required.
2. Date all entries.
3. Call attention to the entry by a "cloud" drawn around the area or areas affected.
4. In the event of overlapping changes, use different colors for the overlapping changes.
5. Make entries within 24 hours after receipt of information that the change has occurred.
6. Maintain the base drawing format and use the same symbology.
7. Convert field mark-ups to finished CADD record drawings when required in this section.

G. Conversion of Schematic Layouts

1. In some cases on the drawings, arrangements of ductwork and piping and similar items are shown schematically and are not intended to portray precise physical layout. Determine final physical arrangement subject to the Architect's approval. However, design of future modifications of the facility may require accurate information as to the final physical layout of items which are shown only schematically on the drawings.
2. Show on the job set of record drawings, by dimension accurate to within one inch, the centerline of each run of items such as all sleeves and piping, etc., below grade, in walls, or in the concrete slab. A surface mounted device indicates the exact location:
 - a. Clearly identify the item by accurate note such as "Sanitary Sewer" and the like.
 - b. Show, by symbol or note, the vertical location of the item "under slab," "in ceiling plenum," "exposed," and the like.
 - c. Make all identification sufficiently descriptive that it may be related reliably to the specifications.

H. Final Project Record Documents

1. The purpose of the final Project Record Documents is to provide factual information regarding all aspects of the Work, both concealed and visible, to enable future modification of the Work to proceed without lengthy and expensive site measurement, investigation, and examination.
2. Provide CAD electronic files in .dwg format using AutoCAD software. Upon written request, completion of a release form, and payment of the Engineer's standard fee of \$200 plus applicable sales tax for a set-up charge and \$50 per drawing plus applicable sales tax for copies of such files, Engineer will provide AutoCAD electronic files of base Contract Drawings in dwg format on compact discs. Engineer will also provide a list of drawing layers and names that shall be maintained.
3. Provide completed record drawings on CD-R and one full size hard copy of each drawing.
4. Refer to Division 1 for additional requirements.

1.14 OPERATION AND MAINTENANCE DATA

- A. Submit two copies of a preliminary draft of the proposed manual or manuals to the Architect for review and comments. Allow a minimum of ten (10) working days for review.
- B. Submit specified number copies of the approved manual to the Architect prior to indoctrination of operation and maintenance personnel.

C. Prepare in accordance with the following standards:

Format:

Size: 8½" x 11"

Paper: White bond, at least 20 lb. weight

Text: Neatly written or printed

Drawings: 11" in height preferable; bind in with text; foldout acceptable; larger drawings acceptable but fold to fit within the Manual and provide a drawing pocket inside rear cover or bind in with text.

Flysheets: Separate each section of the Manual with neatly prepared flysheets briefly describing contents of the ensuing section; flysheets may be in color.

Binding: Use heavy-duty plastic or fiber-board covers with binding mechanism concealed inside the manual; 3-ring binders will be acceptable; all binding is subject to the Architect's approval.

Measurements: Provide all measurements in U.S. standard units such as feet-and-inches, lbs, and cfm. Where items may be expected to be measured within ten years in accordance with metric formulae, provide additional measurements in the "International System of Units" (SI).

D. Provide front and back covers for each manual, using durable material approved by the Architect, and clearly identified on or through the cover with at least the following information:

OPERATING AND MAINTENANCE INSTRUCTIONS

(SEE NEXT PAGE)

OPERATING AND MAINTENANCE MANUAL (Required Layout)

- Title Page
 - Job Name
 - Site Address
 - Include Contact information of prime contractor.
- Table of contents
- Warranty Information.
 - Include all contractor warranties
 - Signed and dated documents
- Permits-Inspections
- Subcontractor list
 - Include all subcontractors.
 - Company name, Contact info.
 - Trade Responsibility.
- Vendor list
 - Include name and addresses of vendors
 - Warranty information
 - Replaceable parts
- Approved submittals
 - Include all approved product submittals
- Reports/Certificates/Redlines
 - Engineers Observation Reports
 - Engineer/Manufacturer Start-up Report (VRF only)
 - Contractor Start-up Report
 - Manufacturer Start-up Report
 - Test & Balance Report
 - As-builts for FS, Duct, Plumbing & refrigeration piping
 - Updated VRF Selection Report (Refrigeration line measurements and refrigeration calculations)
 - RPZ Certifications
 - Fire Marshal Approval
 - Owners Training Report (All Trades)
- O&M Manuals
- Equipment Information.
 - Include Model, Serial and location.
- Signed Approval
 - Page for approval signature of the engineer and approval date.

E. Contents: Include at least the following:

1. Neatly typewritten index near the front of the manual, giving immediate information as to location within the manual of all emergency information regarding the installation.
2. Complete instructions regarding operation and maintenance of all equipment provided including lubrication, disassembly, and reassembly.
3. Complete nomenclature of all parts of all equipment.

4. Complete nomenclature and part number of all replaceable parts, name and address of nearest vendor, and all other data pertinent to procurement procedures.
5. Copy of all guarantees and warranties issued.
6. Manufacturer's bulletins, drawings, and descriptive data, clearly indicating the precise items included in this installation and deleting, or otherwise clearly indicating, all manufacturers' data with which this installation is not concerned.
7. Such other data as required in other sections of these specifications.

1.15 WARRANTY

- A. Contractor shall warranty all equipment and workmanship for a period of one year after date of substantial completion and replace or repair any faulty equipment or installation at no cost to the Owner for such service during this period, all in accordance with requirements of Division 1.
- B. This warranty shall not void specific warranties issued by manufacturers for greater periods of time. Nor shall it void any rights guaranteed to the Owner by law.
- C. Warranties shall be in writing in a form satisfactory to the Owner, and shall be delivered to the Owner before final payment is made.
- D. Upon completion of the work of Division 23, thoroughly clean all exposed portions of the mechanical installation, removing all traces of soil, labels, grease, oil and other foreign material and using only the type cleaner recommended by the manufacturer of the item being cleaned.

PART 2 - PRODUCTS

2.1 ACCESS DOORS

- A. Access doors mounted in painted surfaces shall be of Milcor (Inland-Ryerson Construction Products Company) manufacturer, Style K for plastered surfaces and Style M or DW for non-plastered surfaces. The Style K doors shall be set so that the finished surface of the door is even with the finished surfaces of the adjacent finishes. Access doors mounted on tile surfaces shall be stainless steel materials. Access doors shall be a minimum of 18" x 18" in size.

PART 3 - EXECUTION

3.1 ACCESS DOORS

- A. In fire-rated walls, access door shall be fire rated same as wall.
- B. In detention areas provide minimum 16 gauge access door with keyed lock approved by Owner.

3.2 TESTING AND INSPECTION

- A. Provide personnel and equipment, make required tests, and secure required approvals from the Architect and governmental agencies having jurisdiction.
- B. Make written notice to the Architect adequately in advance of each of the following stages of construction:
 1. When all rough-in is complete, but not covered.
 2. As specified in all Division 23 sections.
 3. At the completion of the work of Division 23.

- C. When material or workmanship is found to not comply with the specified requirements, remove the noncomplying items from the job site and replace them with items complying with the specified requirements at no additional cost to the Owner. This shall be performed within 3 days after receipt of written notice of noncompliance.

3.3 INSTALLATION METHODS

- A. Unless noted otherwise, piping and ductwork may be run exposed in mechanical rooms and janitor's closets. Piping and ductwork exposed in mechanical rooms and janitor's closets shall be run tight against the structure, as required by the Architect, allowing for expansion.
- B. Conceal piping and ductwork to be installed as hereinbefore specified.
- C. Piping suspended from the structure shall be adequately and properly supported on hanger rods or clamps as specified in Section 23 0529 "Hangers and Supports for HVAC Piping and Equipment". Perforated strap hangers will not be permitted. **The contractor must support all duct, pipe, equipment, and all other items furnished and installed under this scope from steel joists or structural steel frames. It is prohibited to support duct, pipe, equipment, and all other items furnished under this scope from the metal deck.**
- D. Where space is limited above ceilings, below concrete beams or other concrete projections, piping shall be sleeved through the beam or projection, rather than hung below. Provide sleeves where required and locate where approved by the Architect.
- E. Cut pipe accurately to measurements established at the building and install into position without springing or forcing. All open ends of pipes shall be capped or otherwise closed until the systems are closed with final connections.
- F. No pipe joints nearer than 12" to a wall, ceiling or floor penetration will be permitted, unless joint is of the welded type.
- G. Piping systems shall be made up straight and true and run at proper grades to permit proper flow of the contained material. Piping shall be graded for proper drainage.
- H. Piping shall follow as closely as possible the routes shown on plans, which take into consideration conditions to be met at the site and in the building. Should any unforeseen conditions arise, lines shall be changed or rerouted as required after approval from the Architect.
- I. All piping shall be installed with due regard to expansion and contraction and so as to prevent excessive strain and stress in the piping and in connections to equipment.
- J. All piping shall be clean when it is installed; rust and/or dirt shall be removed.
- K. Screw joints shall be made with taper threads, properly cut. Threads shall be cut using graphite and oil applied to the pipe only. When threads are cut on pipes, the ends shall be carefully reamed to remove any burrs. Pipe shall be up-ended and hammered to remove all shavings and foreign material, before installing.
- L. Requirements for assembling joints in cast iron and copper lines are set forth elsewhere in these specifications. For any special materials, consult the manufacturers for the recommended procedures in assembling the joints.
- M. This Contractor shall provide wall or ceiling access doors for unrestricted access to all concealed items of the fire suppression system.

- N. Install roof pipe penetrations through sleeves, and flash with membrane flashing and roofing mastic compatible with roofing system. Roofing Supplier/Contractor shall approve roof penetration and flashing.
- O. For additional installation requirements, refer to individual sections in Division 23.

3.4 CUTTING AND PATCHING

- A. Perform cutting and patching associated with the work in strict accordance with the provisions of Division 1 of these Specifications and the following:
 - 1. Coordinate work to minimize cutting and patching work. Cut and patch walls, floors, etc., resulting from work in existing construction or by failure to provide proper openings or recesses in new construction. If cutting and patching is required, it shall be performed by trades specializing in that type work.
 - 2. Perform Architect-approved cutting and demolition by methods which will prevent damage to other portions of the work and provide proper surfaces to receive installation of new work and/or repair.
 - a. Openings cut through concrete and masonry shall be made with masonry saws and/or core drills and at such locations acceptable to the Architect. Impact-type equipment will not be used except where specifically acceptable to the Architect.
 - b. Openings in precast concrete slabs or walls for pipes, etc., shall be core drilled to exact size. Oversize the hole to allow for link seals, and to deter pipe corrosion condensation from forming.
 - c. Where openings are cut through masonry walls, provide and install lintels or other structural supports to protect the remaining masonry. Adequate supports shall be provided during the cutting operation to prevent any damage to the masonry occasioned by the operation. All structural members, supports, etc., shall be of the proper size and shape, and shall be installed in a manner acceptable to the Architect.
 - d. Openings cut through plaster or drywall shall be cut prior to plaster finish coat or texture coat on drywall. Cutting of the finish coat of plaster or texture coat of drywall will not be permitted unless written approval of the Architect is obtained.
 - e. Openings shall be restored and/or repaired as required to replace the cut surface to an "as-new" and/or "as original" condition. Refer to the appropriate section of the specifications for the material involved.
 - 3. Perform fitting and adjusting of products to provide finished installation complying with the specified tolerances and finishes.
 - 4. Provide all core drilling of holes. Where sleeves and/or blockouts are required, they shall be cut or provided at locations required. On completion of this work or as work progresses, make all repairs and do all patching required as a result of work under this Contract. All patching shall be performed in a manner that will restore the surrounding work to its original condition to the satisfaction of the Architect.
 - 5. Assume responsibility for the proper size of all sleeves and/or blockouts in the building structure pertaining to the work and for providing the correct location of pipe sleeves and/or blockouts.
 - 6. No cutting, boring or excavating which will weaken the structure will be permitted.

3.5 EXISTING UTILITIES AND TEMPORARY SERVICES FOR CONSTRUCTION

- A. Verify the location and capacity of existing utility services pertaining to work of Division 21. Relocate existing utilities unearthed by excavation as directed by the utility service companies affected.
 - 1. Temporary Services for Construction
 - 2. Provide temporary services in strict accordance with the provisions of these specifications.
- B. When any piece of fire suppression equipment is operable and it is to the advantage of the Contractor to operate the equipment, he may do so, providing that he properly supervises the operation, and has the Architect's written permission to do so. The warranty period shall, however, not commence until such time as the equipment is operated for the beneficial use of the Owner, or date of substantial completion, whichever occurs first.
- C. Regardless of whether or not the equipment has or has not been operated, the Contractor shall properly clean the equipment, install clean filter media, properly adjust, and complete all deficiency list items before final acceptance by the Owner. The date of acceptance and performance certification will be the same date.

3.6 DEMOLITION AND RELOCATION

- A. The Contractor shall modify, remove, and/or relocate all materials and items so indicated on the Drawings or required by the installation of new facilities. All removals and/or dismantling shall be conducted in a manner as to produce maximum salvage. Salvage materials shall remain the property of the Owner, and shall be delivered to such destination or otherwise disposed of as directed by the Owner. Materials and/or items scheduled for relocation and which are damaged during dismantling or reassembly operations shall be repaired and restored to good operative condition. The Contractor may, at his discretion, and upon the approval of the Owner, substitute new materials and/or items of like design and quality in lieu of materials and/or items to be relocated.
- B. All items which are to be relocated shall be carefully removed in reverse to original assembly or placement and protected until relocated. The Contractor shall clean and repair and provide all new materials, fittings, and appurtenances required to complete the relocations and to restore to good operative order. All relocations shall be performed by workmen skilled in the work and in accordance with standard practice of the trades involved.
- C. When items scheduled for relocation and/or reuse are found to be in damaged condition before work has been started on dismantling, the Contractor shall call the attention of the Owner to such items and receive further instructions before removal. Items damaged in repositioning operations are the Contractor's responsibility and shall be repaired or replaced by the Contractor as approved by the Owner, at no additional cost to the Owner.
- D. Service lines and wiring to items to be removed, salvaged, or relocated shall be removed to points indicated on the Drawings, specified, or acceptable to the Owner. Service lines and wiring not scheduled for reuse shall be removed to the points at which reuse is to be continued or service is to remain. Such services shall be sealed, capped, or otherwise tied-off or disconnected in a safe manner acceptable to the Owner. All disconnections or connections into the existing facilities shall be done in such a manner as to result in minimum interruption of services to adjacent occupied areas. Services to existing areas or facilities which must remain in operation during the construction period shall not be interrupted without prior specific approval of the Owner as hereinbefore specified.

3.7 EXCAVATION AND BACKFILLING

- A. Perform all excavation and backfilling necessary for the installation of the work. This shall include shoring and pumping in ditches to keep them in dry condition until the work has been installed. All shoring required to protect the excavation and safeguard employees shall be properly performed.
- B. Perform excavation and backfilling in strict accordance with the provisions of these specifications including trench safety requirements.
- C. All excavations shall be made to the proper depth, with allowances made for floor slabs, forms, beams, etc. Ground under piping shall be well compacted before piping is installed.
- D. Backfilling shall be made with selected soil, free from rocks and debris and shall be pneumatically tamped with 6 inch layers to secure a field density ratio of 95 percent as defined by ASTM Designation D698-57T (Proctor Soil Compaction Test).
- E. Excavated materials not suitable and not used in the backfill shall be removed from the site.
- F. Field check and verify the locations of all underground utilities. Avoid disturbing these as far as possible. In the event existing utilities are damaged, they shall be repaired at no cost to Owner.
- G. In a lime stabilized area, the lime stabilization shall be fully restored after the excavation is complete.
- H. Replace concrete, curbs, paving and other surface improvements cut during excavation to their original condition.

3.8 JOBSITE CONDITIONS

- A. Examine the areas and conditions under which work of this Section will be performed. Include required work to correct conditions detrimental to the timely and proper completion of all Division 21 Work. Do not proceed until unsatisfactory conditions are corrected.
- B. The Contractor shall at all times take such precautions as may be necessary to properly protect all materials and equipment from damage from the time of delivery until the completion of the work. This shall include the erection of all required temporary shelters and supports to adequately protect any items stored in the open on the site from the weather, the ground and surrounding work; the cribbing of any items above the floor of the construction; and the covering of items in the incomplete building with tarpaulins or other protective covering; the installation of electric heaters in electrical switchgear and similar equipment to prevent moisture damage. Failure on the part of the Contractor to comply with the above will be sufficient cause for the rejection of the items in question.
- C. Take particular care not to damage the building structure in performing work. All finished floors, step treads, and finished surfaces shall be covered to prevent any damage by workmen or their tools and equipment during the construction of the building.
- D. Equipment and materials shall be protected from rust both before and after installation. Any equipment or materials found in a rusty condition at the time of final inspection must be cleaned of rust and repainted as specified elsewhere in these Specifications.

3.9 STORAGE AND PROTECTION

- A. Contractor shall provide the required protection of equipment and materials from the time of delivery until the completion of the Work. Protect from damage, rust, rain, humidity and dust.
- B. Do not receive equipment or materials on the jobsite until adequate space has been provided for storage.
- C. Provide adequate supports for protection from the ground and erect required shelters for items stored in the open.
- D. Items stored within the building are to be adequately protected and covered with tarpaulins or other protective covering.
- E. Protect the building at all times during construction from damage by workmen, their tools and/or equipment. Protect floors, steps, wall, ceilings, doors, windows and other finish surfaces.
- F. Equipment and materials found in a rusty condition at completion of the work will be thoroughly cleaned of rust and refinished as required to its original condition.

3.10 PREPARATION AND COORDINATION

- A. Perform coordination work in strict accordance with provisions of these specifications and the following:
 - 1. Coordinate as necessary with other trades to assure proper and adequate interface with all work.
 - 2. Where pipes or other fire suppression items are shown in conflict with locations of structural members and other equipment, include labor and materials required for extensions, offsets and supports to clear the encroachment.
 - 3. Although such work is not specifically indicated, furnish and install all supplementary or miscellaneous items, appurtenances and devices incidental to or necessary for a sound, secure and complete installation of the fire suppression system.
 - 4. Coordinate accepted equipment changes from those scheduled or specified with other trades affected. Additional compensation to other trades for equipment changes is the responsibility of the Contractor making the change.
- B. The Mechanical and associated Drawings are necessarily diagrammatic by their nature, and are not intended to show every connection in detail or every pipe or conduit in its exact location. These details are subject to the requirements of standards referenced elsewhere in these specifications, and structural and architectural conditions. The Contractor shall carefully investigate structural and finish conditions and shall coordinate the separate trades in order to avoid interference between the various phases of work. Work shall be organized and laid out so that it will be concealed in furred chases and suspended ceilings, etc., in finished portions of the building, unless specifically noted to be exposed. All exposed work shall be installed parallel or perpendicular to the lines of the building unless otherwise noted.
- C. When the mechanical and electrical Drawings do not give exact details as to the elevation of pipe, conduit and ducts, the Contractor shall physically arrange the systems to fit in the space available at the elevations intended with proper grades for the functioning of the system involved. Piping, exposed conduit and the duct systems are generally intended to be installed true and square to the building construction, and located as high as possible against the structure in a neat and workmanlike manner. The Drawings do not show all required offsets, control lines, pilot lines and other location details. Work shall be concealed in all finished areas.

- D. The general installation precedence of materials shall be as follows. Note that if an interference is encountered, this shall guide the contractor in the determination of which trade shall be given the "Right-of-Way".

Building lines
Structural Members
Soil and Drain Piping
Condensate Drains
Vent Piping
Supply, Return, and Outside Air Ductwork
Exhaust Ductwork
Fire Protection Piping
Gas Piping
Domestic Water (Cold and Hot)
Electrical Conduit

- E. Where items such as diffusers, thermostats, switches, and control panels are not specifically located on the Drawings, locate as determined in the field by the Architect. Where such items are installed without such specific direction, relocate as directed by the Architect and at no additional cost to the Owner.
- F. Verify all dimensions and distances. No additional compensation will be allowed because of differences between work shown on the Drawings and actual dimensions and distances at the jobsite.

3.11 PAINTING

- A. All equipment shall be delivered to the job with suitable factory finish. Should the finish be damaged in transit or during the installation, it shall be finished to match appearance of original finish. All work shall be subject to approval by Architect.
- B. All equipment, piping, conduit, insulation, etc., furnished and installed in exposed areas under Divisions 23 of these Specifications and as hereinafter specified shall be cleaned, prepared, and painted according to the following specification. In the event of a conflict between the specifications referenced, the provisions of this specification shall prevail only for Division 23 work.
- C. Before painting, materials and equipment surfaces shall be thoroughly cleaned of cement, plaster, and other foreign materials, and all oil and grease spots shall be removed. Such surfaces shall be carefully wiped and all cracks and corners scraped out. Exposed metal work shall be carefully brushed down with the steel brushes to remove rust and other spots and left smooth and clean.

END OF SECTION

SECTION 23 0548 - VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. The Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to the Work in this Section.

1.2 SUMMARY

- A. The extent of vibration isolation work is indicated by drawings and schedules, and by the requirements of this section.
- B. The types of vibration isolation work specified in this section include the following:
 - 1. Support isolation for motor-driven mechanical equipment.
 - 2. Isolation including support isolation for piping risers.
 - 3. Support isolation of piping.
 - 4. Flexible connections for piping at equipment.
- C. Refer to other sections of these specifications for equipment foundations, hangers, sealants, gaskets, flexible connections for piping, and other work related to vibration isolation work.

1.3 QUALITY ASSURANCE

- A. **Product Qualification:** Provide each type of vibration isolation unit produced by a specialized manufacturer, with not less than 5 years' successful experience in the production of units similar to those for the project.
 - 1. Except as otherwise indicated obtain support isolation units from a single manufacturer.
 - 2. Engage the manufacturer to provide technical supervision of the installation of support isolation units produced by him, and of associated inertia bases (if any).
- B. **Manufacturer:** Acceptable vibration isolation support unit manufacturers are as follows:
 - 1. Mason Industries, Inc.
 - 2. Vibration Mountings and Controls, Inc.
 - 3. Amber Booth
 - 4. Peabody Kinetics
- C. **Manufacturer Certification:** Where vibration isolation support units are indicated for a minimum static deflection, provide manufacturer's certification that units have been tested and comply with the indicated requirements.
- D. All items of equipment, whether suspended, floor mounted or otherwise supported, which are capable of producing vibration, shall be installed with vibration isolation. The isolation shall prevent the transmission of objectionable noise or vibration to the building structure.
- E. Submit for approval data showing disturbing frequency, supported weight, static deflection or natural frequency, and calculations supporting same for each isolator.

1.4 SUBMITTALS

A. Manufacturer's Data, Vibration Isolation:

1. **Provide submittals as required in Section 23 0500, "Common Work Results for HVAC".**
2. For information, submit manufacturer's specifications, detailed drawings, performance characteristics data and installation instructions for each type of unit required.
3. Include data for each type and size of unit, showing isolation efficiency, stiffness, natural frequency and transmissibility at lowest operating speed of equipment.
4. Where required, include independent test agencies certified report of test results for each type of unit.
5. For spring units, show wire size, spring diameter, free height, solid-compression height, operating height, fatigue characteristics and ratio of horizontal to vertical stiffness.
6. For spring-and-pad-type units show basis of spring-rate selection for range of loading weights.
7. Include performance certifications where required.

PART 2 - PRODUCTS

2.1 ISOLATION MATERIALS AND SUPPORT UNITS

- A. Double deflection neoprene mountings shall have a minimum static deflection of 0.35". All metal surfaces shall be neoprene covered to avoid corrosion and have friction pads both top and bottom so they need not be bolted to the floor. Bolt holes shall be provided where bolting is required. On equipment such as small vent sets and close coupled pumps, steel rails shall be used above the mountings to compensate for the overhang.
- B. Vibration hangers shall contain a steel spring and 0.3" deflection neoprene element in series. The neoprene element shall be molded with a rod isolation bushing that passes through the hanger box. Spring diameters and hole sizes shall be large enough to permit the hanger rod to swing through a 30 degree arc before contacting the hole and short-circuiting the spring. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection.
- C. Vibration hangers shall be as described above, but they shall be precompressed to the rated deflection so as to keep the piping or equipment at a fixed elevation during installation. The hangers shall be designed with a release mechanism to free the spring after the installation is complete and the hanger is subjected to its full load. Deflection shall be indicated by a scale.
- D. Vibration hangers shall contain a steel spring located in a neoprene cup manufactured with a grommet to prevent short-circuiting. The cup shall contain a steel washer designed to properly distribute the load on the neoprene and prevent its extrusion. Spring diameters and hole sizes shall be large enough to permit the hanger rod to spring through a 30 degree arc before contacting the hole and short circuiting the spring. Springs shall have as minimum additional travel to solid equal to 50% of the rated deflection. Hangers shall be provided with an eyebolt on the spring end and provision to attach the housing to the flat iron duct straps.
- E. Vibration isolator shall be steel members welded to height saving brackets to cradle machines having legs or bases that do not require a complete supplementary base. Members shall be sufficiently rigid to prevent strains in the equipment.

- F. Flexible neoprene connectors shall be used on all equipment as indicated on the drawings. They shall be manufactured of multiple plies of nylon tire cord fabric and neoprene. No steel wire or rings shall be used as pressure reinforcement. Straight connectors shall have two spheres. Neoprene elbows shall have a single sphere forming the corner of the joint itself. Connectors up to and including 2" diameter may have threaded ends. Connectors 2-1/2" and larger shall have floating steel flanges. All connectors shall be rated a minimum of 150 psi at 200 degrees F. All sizes operating at pressures above 100 psi shall employ control cables with end fittings isolated from the anchoring plates by means of 1/2" thick bridge bearing neoprene washer bushings designed for a maximum of 1000 psi.
- G. Flexible stainless steel hose shall have stainless steel braid and carbon steel fittings. Sizes 3" and larger shall be flanged. Smaller sizes shall have male nipples. Lengths shall be as tabulated:

<u>Flanges</u>		<u>Male Nipples</u>	
3 x 14	10 x 26	1/2 x 9	1-1/2 x 13
4 x 15	12 x 28	3/4 x 10	2 x 14
5 x 19	14 x 30	1 x 11	2-1/2 x 18
6 x 20	16 x 32	1-1/4 x 12	
8 x 22			

- H. Hoses shall be installed on the equipment side of the shut-off valves horizontally and parallel to the equipment shafts wherever possible. Hoses shall be type BSS.
- I. Where piping passes through equipment walls, floors or ceilings, the vibration isolator shall be a split seal consisting of two bolted pipe halves with 3/4" or thicker neoprene sponge bonded to the inner faces. The seal shall be tightened around the pipe to eliminate clearance between the inner sponge face and the piping. Concrete may be packed around the seal to make it integral with the floor, wall or ceiling if the seal is not already in place around the pipe prior to the construction of the building member. Seals shall project a minimum of 1" past either face of the wall. Where temperatures exceed 240 degrees F., 10# density fiberglass may be used in lieu of the sponge.
- J. Isolator pads shall be neoprene waffle rated for 60#/sq. in.
- K. Pipe Riser Isolators: Provide manufacturer's standard pad-type isolator bonded to steel plate, formed for welding to pipe sleeve extension.

PART 3 - EXECUTION

3.1 PERFORMANCE OF ISOLATORS

- A. General: Comply with the minimum static deflections recommended by ASHRAE, including the definitions of critical and non-critical locations, for the selection and application of vibration isolation materials and units as indicated.
- B. Manufacturer's Recommendations: Except as otherwise indicated, comply with manufacturer's recommendations for selection and application of vibration isolation materials and units.

3.2 APPLICATIONS

- A. General: Apply the types of vibration isolation materials and units indicated at the locations shown or scheduled. Selection is Contractor's option where more than one type is indicated.

- B. Provide Neoprene Pads at the following locations/items of equipment:
 - 1. Where shown on drawings.
- C. Provide Vibration Isolation Springs for the following items of equipment:
 - 1. Where shown on drawings.
- D. Provide Spring Isolator, housed at the following items of equipment:
 - 1. Where shown on drawings.
- E. Provide Isolation Hangers for the following:
 - 1. Piping connected to machinery.

3.3 INSTALLATION

- A. General:
 - 1. Except as otherwise indicated, comply with manufacturer's instructions for the installation and load application to vibration isolation materials and units.
 - 2. Adjust to ensure that units do not exceed rated operating deflections or bottom out under loading, and are not short-circuited by other contacts or bearing points.
 - 3. Remove spacer blocks and similar devices (if any) intended for temporary protection during shipping or against overloading during installation.
 - 4. Anchor and attach units to substrate and equipment as required for secure operation and to prevent displacement by normal forces, and as indicated.
 - 5. Adjust leveling devices as required to distribute loading uniformly onto isolators. Shim units as required where leveling devices cannot be used to distribute loading properly.
 - 6. Install inertia base frames on isolator units as indicated, so that a minimum of 2" clearance below base will result when frame is filled with concrete and supported equipment has been installed and loaded for operation.
 - 7. Locate isolation hangers as near the overhead support structure as possible.
 - 8. Weld riser isolator units in place as required preventing displacement from loading and operations.

3.4 EXAMINATION OF RELATED WORK

- A. Installer of vibration isolation work shall observe the installation of other work related to vibration isolation work, including work connected to vibration isolation work; and, after completion of other related work (but before equipment startup), shall furnish a written report to the Contractor listing observed inadequacies for proper operation and performance of vibration isolation work. Report shall cover, but not necessarily be limited to the following:
 - 1. Equipment installations (performed as work of other sections) on vibration isolators.
 - 2. Piping connections including flexible connections.
 - 3. Passage of piping which is to be isolated through walls and floors.
- B. Do not start-up equipment until inadequacies have been corrected in a manner acceptable to the vibration isolation Installer.

3.5 DEFLECTION MEASUREMENTS

- A. Upon completion of vibration isolation work, take measurements and prepare a report showing measured equipment deflections for each item of equipment.

END OF SECTION

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SECTION 23 05 53 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. The Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to the Work in this Section.

1.2 SCOPE

- A. Provide all equipment, materials, labor, supervision, and services necessary for or incidental to the installation of all necessary identification items as indicated on the drawings and as specified.
- B. Work included:
 - 1. Valve tagging
 - 2. Pipe marking
 - 3. Equipment marking

- C. Submittals: **Provide submittals as required in Section 23 05 00, "Common Work Results for HVAC".**

1.3 QUALITY ASSURANCE

- A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.
- B. Without additional cost to the Owner, provide such other labor and materials as are required to complete the work of this Section in accordance with the requirements of governmental agencies having jurisdiction, regardless of whether such materials and associated labor are called for elsewhere in these Contract Documents.
- C. When requested, provide the Architect with manufacturer's certificate that materials meet or exceed minimum requirements as specified. Marking system shall conform to ASME 13.1, latest edition and OSHA 29 CFR 1910.261 requirements.

PART 2 - PRODUCTS**2.1 VALVE TAGS**

- A. Provide a tag for each valve in main and branch piping of natural gas and refrigerant piping systems.
 - 1. Tags shall be 1-1/2" diameter of solid brass with blacked filled stamped characters of 1/4" height above and 1/2" height below.
 - 2. Provide 8" long meter seals for use with valve tags.
- B. Provide a valve chart with a schedule and location plans for all identified equipment, both in a frame with an acrylic cover to be located as directed by the Architect.

2.2 PIPE MARKERS

- A. Provide pipe markers for pipes that provide 360 degree visibility with ANSI approved color coded background, color of legend in relation to background color, legend letter size, and length of color field. Additionally, direction of flow arrows shall be printed on the same markers, and words shall be repeated and reversed for use with flow in either direction.
 - 1. Each marker shall be formed with a clear acrylic covering suitable for use outdoors.
 - 2. For diameters 3/4" to 6", marker shall be formed in order to snap on and completely surround the pipe. For diameters 6" and larger, provide radius formed markers of same material.

2.3 EQUIPMENT PLATES

- A. Plate shall be black with white letters that appear when the plate is engraved.
- B. Plate material shall be specifically suited for conditions surrounding the equipment. Outdoor equipment shall require special plate material for outdoor use.
- C. Plate size shall be as required with lettering size appropriate for the information shown but in no case less than 1/8" high. Lettering style shall match existing facility standards.
- D. Nomenclature for plates shall be based on the equipment designations shown on the equipment schedules and as approved by the Architect.

2.4 CONCEALED DEVICES

- A. Operable devices and equipment located above ceilings shall be marked with color coded W. H. Brady "Tack" type markers.

2.5 MANUFACTURERS

- A. Provide marking system as manufactured by W. H. Brady Company, Seton, Craftmark, or approved equal.

PART 3 - EXECUTION

3.1 GENERAL

- A. Place all markers and plates in such locations that they are easily read by a person without assuming awkward or hazardous positions.

3.2 VALVE TAGS

- A. Secure one valve tag to each valve.

3.3 PIPE MARKERS

- A. For diameters 3/4" to 6", markers shall snap around the pipe, completely surrounding the pipe. Markers shall not require taping or the use of any adhesive material or fasteners to permanently secure them to the pipe. For diameters 6" and larger, secure with stainless steel spring fasteners.

- B. Install sufficient quantities of markers that tracing of pipe systems can be readily accomplished. Install within three feet before and/or after penetrations through walls, floors, ceilings, underground or other non-accessible enclosures; at access doors, manholes or other access points which permit view of concealed piping; and when there is a change in direction of the concealed pipe. Locations in major mechanical rooms shall be labeled at a maximum spacing of every 20 feet. Other piping shall have labels at a maximum spacing of every 30 feet and at least once in every area that the pipe passes over or through. Install additional markers where directed by the Architect.

3.4 EQUIPMENT PLATES

- A. Provide engraved plates for all HVAC equipment and all remote mounted starter/disconnects.
- B. Secure all plates with two self-tapping metal screws with round heads. Alternately, plates may be fastened with "pop" rivets provided no cracking or injury occurs to the plate. Plates attached with adhesives shall not be permitted.

END OF SECTION

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SECTION 23 05 93 - TESTING, ADJUSTING, AND BALANCING FOR HVAC**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. The Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to the Work in this Section.

1.2 SUMMARY**A. Testing and Balancing Agency Qualifications**

1. The testing, adjusting, and balancing of the heating, ventilating and air conditioning systems shall be performed by a technical firm or balancing agency certified in Air and Hydronic TAB and system commissioning by the Associated Air Balance Council (AABC) or National Environmental Balancing Bureau (NEBB). The TAB agency shall also employ a permanent full time Registered Professional Engineer on staff with a minimum of five years specialized experience in testing and balancing. The testing and balancing agency shall possess calibrated instruments, qualified engineers, and skilled technicians to perform required tests in accordance with the AABC or NEBB National Standards.
2. The testing and balancing agency shall be an independent firm separate and distinct from; not to be associated with, or be subsidiary of a firm performing work under other Sections of Division 22 & 23 and shall be under contract directly to the Owner.

B. Testing and Balancing Agency Responsibilities**1. Submittals**

- a. Engineer and Technicians Data: Submit proof that the agency, the Test and Balance Engineer assigned to supervise the procedures, and the technicians proposed to perform the procedures meet the qualifications specified.
 - b. Sample Form: Submit sample forms, proposed for use on this project, for approval.
 - c. Certified Reports: Submit testing, adjusting, and balancing reports bearing the seal and signature of the Certified Agency.
2. Review the construction documents, submittal, and shop drawings for balance ability. Submit a list of suggestions or recommendations to the Architect/Engineer for consideration.
 3. Perform a job site observation prior to the ceiling installation to verify that ductwork, piping, dampers, valves, and air terminal devices have been installed per the contract documents. Submit in writing to the Architect/Engineer a list of any discrepancies noted.
 4. Test, adjust and balance the heating, ventilating, and air conditioning systems in accordance with AABC or NEBB National Standards for field measurement.
 5. Verify the operation, calibration, and set points of all heating, ventilating, and air conditioning systems controls.
 6. Functional performance tests of the control and smoke purge system and its components.
 7. Submit in writing to the Architect/Engineer a list of deficiencies for correction by the installing contractor. In the event a deficiency remains after being reported as corrected, the balancing agency may submit an itemized request for its lost time for payment by the installing contractor. All deficiencies that prevent proper T&B work from being completed shall be corrected prior to submittal of the Final T&B Report.

8. Measure and record space temperature readings after occupancy for a period of two consecutive eight hour periods. Make adjustments if necessary to achieve an even temperature distribution.
9. Submit three copies of a certified, bound, typewritten report for approval by the Owner and Architect/Engineer including all test report data, instrument calibration, and schematic drawings of the HVAC layout.
10. Make a total of three inspections within 90 days after occupancy of the building to insure that satisfactory conditions are being maintained. Submit a report of the findings to the Owner and Architect/Engineer.
11. Make an inspection in the building during the opposite season from which the initial adjustments were made. At that time, make any necessary modifications to the initial adjustments required to produce optimum operation of the system for all seasons. Submit a report of the findings to the Owner and Engineer.

C. Contractor Responsibilities

1. The Contractor shall provide the T&B firm with copies of all Drawings, Specifications, Shop Drawings, Submittal Data, Up-to-Date Revisions, Change Orders, and other data required for planning, preparation and execution of the T&B work.
2. Coordinate the HVAC installation and start up schedule with the T&B Agency and General Contractor to allow sufficient time prior to the completion date for testing and balancing to be conducted and deficiency items corrected and retested. Provide sufficient personnel and utilities to operate the HVAC systems during normal and overtime hours to meet the completion date and testing and balancing schedule.
3. The Mechanical Contractor shall install all systems complete and provide balancing valves, test plugs, thermometer wells, flow measurement orifices, volume dampers, splitter dampers, etc. necessary for T&B work. All equipment shall be operated at the Contractor's expense for a minimum of three consecutive days prior to balancing in order to make certain the equipment is free from mechanical defects, runs smoothly and quietly, and performs satisfactorily to meet the requirements set forth in the contract documents.
4. Provide written notification to the T&B agency and General Contractor the systems are ready for balancing. Should the systems not be ready for balancing, it shall be the Contractor's responsibility to compensate the T&B Agency for time lost.
5. Correct any deficiency items noted during testing and balancing including controls calibration, installation of balancing devices, sheave replacements, and motor replacements at no additional cost to the Owner. Provide written notification to the Testing and Balancing Agency and General Contractor when systems are ready for retesting. Should the systems not be ready for retesting it shall be the Contractors responsibility to compensate the T&B Agency for time lost.
6. It shall be the responsibility of the Contractor to install all valves, dampers, and other adjustment devices in a manner that will leave them accessible and readily adjustable.
7. The Control Contractor shall provide and install the control system, complete with all temperature, pressure and humidity sensors installed and calibrated for accurate control.
8. Perform all tests of plumbing and piping systems and equipment as specified herein and as required to obtain approvals from all authorities having jurisdiction.
9. Provide all instruments, materials and labor to perform the testing and to obtain and record all measurements.

10. The Contractor is to perform duct leakage testing in accordance with the latest edition of the SMACNA - HVAC Air Duct Leakage Test Manual and maintain a log book on site indicating the area tested, date tested, leakage amount, and personnel performing the test. At the end of the project submit a final type written report with the results. The test and balance agency is to be notified one week prior to duct leakage testing and at their option witness the testing to confirm the testing is being performed in accordance with these specifications.

PART 2 - PRODUCTS

2.1 EQUIPMENT

- A. The balancing agency shall have a complete set of instruments as required by AABC or NEBB standards.
- B. Calibration histories for each instrument used for measurement shall be available for examination. Calibration, accuracy, and maintenance of all instruments shall be in accordance with AABC standards.

PART 3 - EXECUTION

3.1 CLEANING AND ADJUSTING

- A. Equipment, piping, valves, fittings and fixtures shall be cleaned of grease, metal cuttings and foreign matter that may have accumulated from operation of the system during the test. Any stoppage, discoloration or other damage to the finish, furnishings or parts of the building, due to the Contractor's failure to properly protect such items shall be repaired by the Contractor without additional cost to the Owner.
- B. When the work is complete, the water systems shall be adjusted for all required flows. Flush valves and automatic control devices shall be adjusted for proper operation. Hot water heaters shall be tested for proper operation of all safety and operating controls as recommended by the manufacturer. Demonstrate that supply and recirculation systems are balanced for specified flows and temperatures and as shown on the drawings.
- C. Sterilization: After pressure tests have been made, the entire domestic water distribution system shall be thoroughly flushed with water until all entrained dirt and mud have been removed, and shall be sterilized by chlorinating material. The chlorinating material shall be either liquid chlorine conforming to Federal Specification BB-C-120 or hypochlorite conforming to Federal Specification O-C-114, Type II, Grade B, or Federal Specification O-S-602, Grade A or B. The chlorinating material shall provide a dosage of not less than 50 parts per million and shall be introduced into the system in an approved manner. The treatment water shall be retained in the pipe long enough to destroy all non-spore forming bacteria. Except where a shorter period is approved, the retention time shall be at least 24 hours and shall produce not less than 10 ppm of residual chlorine at the extreme end of the system at the end of the retention period.
- D. All valves and faucets in the system being sterilized shall be opened and closed several times during the contact period. The system shall then be flushed with clean water until the residual chlorine is reduced to less than 1.0 ppm. Samples of water shall be taken from several points in the system in properly sterilized containers for bacterial examination. The sterilizing shall be repeated until tests indicate the absence of pollution for at least two full days. The system will not be accepted until satisfactory bacteriological results have been obtained.

3.2 EQUIPMENT AND SYSTEM TESTS

- A. General: The Test and Balance firm shall test all HVAC equipment and systems and make final adjustments and corrections necessary to place the systems in proper operating condition.
 - 1. After testing and balancing, patch insulation, ductwork, and housings, using materials identical to those removed. Air test drilled openings shall be sealed with plastic plugs to allow future access. Seal insulation to re-establish integrity of the vapor barrier.
 - 2. Mark equipment settings, including damper control positions, valve indicators, fan speed control levers, and similar controls and devices to show final settings.
- B. Air Distribution Devices:
 - 1. Proportion each air handling unit, damper, register, diffuser and grille so that air distribution will be as scheduled, with tests showing air quantities indicated for each inlet and outlet that do not vary by more than plus or minus 10 percent from those indicated on the drawings.
- C. Ductwork:
 - 1. The contractor shall perform duct leakage testing on 25% of the supply, return and exhaust ductwork in accordance with SMACNA - HVAC Air Duct Leakage Test Manual. Seal any ductwork not meeting the following acceptable leakage rates and retest until test is successful.

<u>Duct System</u>	<u>Allowable % Leakage</u>
Low Pressure Supply	2% @ construction pressure class
Low Pres. Return/Exhaust	2% @ construction pressure class
Smoke Exhaust	2% @ construction pressure class

- D. Fan Balancing:
 - 1. Provide proper fan design and balance fans and drives to limit vibration (displacement in mils) at operating speed to the values in the following table unless specified elsewhere. Measure vibration at each fan bearing, in all three planes.

FAN VIBRATION CRITERIA

Fan RPM (peak-to peak)	Mils (in each plane)
500	4.2
800	3.0
1200	2.0
1700	1.5
2000 and greater	1.3

3.3 SYSTEM OPERATING TESTS

- A. After the successful completion of all equipment start-up and test requirements, the following formal testing and balancing shall be performed on the complete mechanical system:

1. Temperature Controls - The balancing agency shall be assisted by the contractor in the commissioning of the operation and calibration of all temperature control systems. The following tests are required:
 - a. Verify all controlling devices are calibrated and set for design operating conditions.
 - b. Verify all components are installed and functional.
 - c. Verify the accuracy of each temperature sensor by temperature measurement.
 - d. Check the sequence of operation for all control modes to ensure that they are in accordance with the contract documents.
 - e. Verify that default setpoints are correct if different from the normal operating set points.
 - f. Verify all interlock systems function.
 - g. Perform all system verifications to assure the safety of the system and its components.
 - h. Verify changeover from heating to cooling occurs as specified.
 - i. Calibrate and adjust all thermostats and other controlling devices.
 - j. Replace defective controllers at no cost to the Owner.
2. Mechanical Contractor Responsibility
 - a. Final Operating Test: An operating test shall be performed by the Contractor to the satisfaction of the Architect and the Owner for a period of not less than 8 hours. Should any element of the system not perform properly, the Contractor shall make all required corrections, and the test shall be repeated until successfully performed

3.4 AIR SYSTEM PROCEDURES

- A. The balancing agency shall perform the following testing and balancing functions in accordance with the AABC or NEBB National Standards for TAB.
 1. Diffusers and Grilles - Determine air velocity at outlets with a velometer or anemometer and using air device manufacturer's data, calculate the delivery cfm, or determine cubic feet per minute flow with a test hood.
 2. Fans - Test supply, return, exhaust fans and adjust fan blower speeds to achieve specified CFM.
 3. Current and Voltage - Measure and record motor full load amperage and voltage. Actual amperages higher than nameplate full load amps are not acceptable. Verify heater sizes.
 4. Pitot-tube Traverse - Perform a Pitot-tube traverse (minimum of 16 points) on main supply and return ducts to obtain design CFM. If a Pitot-tube traverse is not practical, the summation of the outlets or inlets may be used with an explanation why a traverse was not conducted.
 5. Outside Air - Test and adjust system minimum outside air by Pitot-tube traverse. If a Pitot-tube traverse is not practical, the percentage of outside air may be determined by calculations from the return air, outside air, and mixed air temperatures when the temperature differential between the return and outside air is greater than 20°F.
 6. Static Pressure - Test and record system static pressures, including entering and leaving static pressures of each fan, coil section, and filter section. For VAV systems, establish and record the minimum operating static pressure setpoint required for the air handling unit to achieve design airflow at the last terminal box in the system.
 7. Air Temperature - Take wet bulb and dry bulb air temperatures on the entering and leaving side of each cooling coil. Dry bulb temperature shall be taken on the entering and leaving side of each heating coil.
 8. Main Ducts - Adjust main ducts to within design CFM requirements and traverse for total CFM quantities.

9. Branch Ducts - Adjust branch ducts to within design CFM requirements. Multi-diffuser branch ducts shall have at least one volume damper completely open.
10. Tolerances
 - a. Test and balance each diffuser, grille and register to within 10% of design requirements.
 - b. Test and balance each fan and air-handling unit to within plus 10% and minus 5% of design requirements. Test and balance units having filters with clean filters in place.
11. Minimizing Drafts - Adjust all diffusers, grilles, and registers to minimize drafts in all areas.
12. If inspections or tests reveal defects, such defective work or material shall be replaced or repaired as necessary and inspections and tests shall be repeated. Repairs to piping shall be made with new materials. Patching of screwed joints or holes shall not be acceptable.

3.5 TEST AND BALANCE REPORT

- A. The Final TAB Report shall be typewritten on 8.5 x 11 inch white bond paper, in bound form with an index and tabs to segregate the data into logical sections. The summary shall include information on special testing conditions and results. A listing of the TAB Agency, Contractor, Owner, and Engineer shall be included.
- B. The report shall present data entered on AABC or NEBB standard forms (modified as necessary to include additional data hereinafter required) or pre-approved acceptable equivalent thereof.
- C. The report shall contain copies of fan curves, field test reports and as-built plans (size 11 x 17 inches) of the HVAC systems.
- D. Include a certification sheet containing the seal and name, corporate address, telephone number, and signature of the Certified Test and Balance Engineer.
- E. Include a listing of the instrumentation's used for the procedures along with the proof of calibration.
- F. System Identification - Each supply, return, and exhaust opening shall be identified and numbered on reduced plans no larger than 11 x 17 inches to correspond to the numbers used on the report data sheets.
- G. Air Outlet Test Report Forms - Each grille, diffuser, and register shall be identified as to location (room number) and area served. Record the size, type, and manufacturer of each diffuser, grille, and register.
- H. Air Handling Unit Test Report Forms - Record the manufacturer, model number and motor nameplate data and all design and manufacturer-rated data including supply, return, and outside airflows, fan rpm, sp, and bhp. Report the following.
 1. Total actual CFM by traverse. Include duct traverse form. If not practical, the sum of the outlets may be used, or a combination of each of these procedures.
 2. Inlet and outlet static pressures at the fan, coil and filter sections.
 3. Actual outside air and return air total CFM.
 4. Actual operating current, voltage, and brake horsepower of each fan motor.
 5. Final RPM of the fan and motor.
 6. Fan and motor sheave sizes and center distance. Belt size and quantity.

7. For VAV air handling systems, report the minimum static pressure set point required to achieve design CFM to the last terminal box in the system while maintaining design airflow at the air handler.
8. Coil EAT and LAT (db/wb), EWT, LWT, and air pressure drops.
9. Outside air temperature (DB/WB).

3.6 FINAL JOB MEETING

- A. At job completion, all Division 21, 22, 23, 26, and 28 representatives shall meet at the job site and shall demonstrate the operation of all equipment and systems. The Owner shall be advised in writing 10 days prior to the time and date of this inspection.

3.7 SYSTEM PERFORMANCE VERIFICATION:

- A. Testing and Balancing Agency
 1. At the time of final inspection, the Test and Balance Agency may be required to recheck, in the presence of the Owner's representative, specific and random selections of data, air quantities, and air motion recorded in the Certified Report.
 2. Points and areas for recheck shall be selected by the Owner's representative.
 3. Measurement and test procedures shall be the same as approved for work forming basis of Certified Report.
 4. If random tests elicit a measured flow deviation of 10% or more from that recorded in the Certified Report the report will be rejected, all systems shall be retested, new data recorded, new Certified Report submitted, and new inspection tests made, at no additional cost to Owner.

END OF SECTION

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SECTION 23 07 00 - HVAC INSULATION**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. The Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to the Work in this Section.

1.2 SUMMARY

- A. Provide all equipment, materials, labor, supervision, and services necessary for or incidental to the insulation of the mechanical systems as indicated on the drawings and as specified herein.
- B. Factory insulated equipment is excluded from this section of the specifications except that the insulating material characteristics shall equal or exceed those of specified materials for similar service.
- C. Work Included:
 - 1. Piping:
 - a. Cooling coil condensate drain lines.
 - b. All refrigerant lines.
 - 2. Ductwork:
 - a. Supply air:
 - 1) Insulate externally with thermal duct wrap.
 - b. Return air:
 - 1) Insulate externally with thermal duct wrap.
 - c. Make-up air duct:
 - 1) Insulated externally.
 - d. All round ductwork exposed to view shall be double wall factory internally insulated with 1" thick glass fiber duct and fittings.
- D. **Submittals:** Provide submittals as required in Section 23 05 00, "Common Work Results for HVAC".

1.3 QUALITY ASSURANCE

- A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.
- B. Without additional cost to the Owner, provide such other labor and materials as are required to complete the work of this Section in accordance with the requirements of governmental agencies having jurisdiction, regardless of whether such materials and associated labor are called for elsewhere in these Contract Documents.
- C. When requested, provide the Architect with manufacturer's certificate that materials meet or exceed minimum requirements as specified.

- D. Acceptable Manufacturers:
1. Fiberglass Insulation:
 - a. Owens-Corning Fiberglas
 - b. Manville
 - c. Certain Teed
 2. Urethane Insulation:
 - a. Armstrong (Armalok)
 - b. Thermacor
 3. Mastics:
 - a. Benjamin Foster
 - b. Insul-Coustic
 - c. Chicago Mastic
 - d. Childers Products
 4. High Temperature Bonding Cements: Ryder Thermocote
 5. PVC Fittings: Zeston, Inc.

1.4 GENERAL

- A. All materials shall be applied by workmen skilled in this trade. Mechanical fasteners shall be used whenever possible to assure permanent construction. Unsightly work shall be cause for rejection.
- B. Materials will be applied only after all surfaces have been tested and cleaned.
- C. All material, jacket, coverings, sealers, mastics and adhesives shall not exceed flame spread rating of 25 and smoke developed of 50 in accordance with ASTM Method E84, UL Standard 723 and NFPA Bulletins 255 and 90A.
- D. Insulation shall be vermin resistant.
- E. Non-compressible insulation material shall be installed at hangers of cold piping to eliminate through metal conductance.
- F. Sizing, paint, pipe shield or saddle, and internal duct insulation shall be provided under other sections of Division 23.
- G. Insulation of cold surfaces shall be vapor sealed.
- H. Minimum thickness of insulation shall be as listed or energy code as adopted by authority having jurisdiction. However, sufficient insulation shall be provided to eliminate condensation on the cold surfaces and to maintain a maximum exterior insulation surface of 125°F. (OSHA Standard) on the hot surfaces.

PART 2 - PRODUCTS

2.1 PIPING SYSTEMS

- A. Pipe Insulation:
1. Above ground-Johns Manville AP-T preformed one-piece fiberglass with reinforced craft paper and aluminum foil jacket. Include vapor barrier where required.
 - a. Use pre-formed PVC fitting covers with fiberglass inserts. Fiberglass shall be same density as pipe insulation.

- b. Where insulation is exposed to weather, use Manville Flame-Safe ML, or approved equal, Metal-Jacketed Fiberglass pipe insulation. Attachment shall be made by 1/2" 0.020 aluminum bands with approved closure system.
- 2. **1" Armstrong SOLID CORE** Armaflex or equal for all refrigerant lines. Split Armaflex is not approved in refrigeration applications.
- 3. Condensate drain lines shall be insulated from AC unit to indirect waste termination points and first 10'-0" of horizontal drain line at floor drains receiving condensate. Material shall be closed cell type with 3/4" thick molded pipe covering with a density of 7 lbs. thermal conductivity at 0.28 at 75°F. Do not split the insulation. All joints shall be glued with manufacturer's adhesive.

2.2 DUCTWORK SYSTEMS

- A. External insulation for metal ductwork (flexible blanket): Johns Manville Microlite fiberglass duct wrap with FSK reinforced craft paper and aluminum foil facing, conforming to the requirements of NFPA 90A and 90B.
- B. High velocity ductwork with external insulation shall be insulated with blanket wrap fiberglass insulation, 1-1/2 inches thick, one (1) pound density or minimum thermal resistance of 6.0, complete with scrim kraft jacket. Facing overlapping joints shall be at least two (2) inches and held in place with outward clinching staples on approximately four (4) inch centers. Underside of ducts exceeding 24 inches in diameter shall be spot cemented and finally secured with sheet metal screws and washers.
- C. High velocity flexible ductwork shall be UL 181, Class I, with rating to meet or exceed NFPA 90A-90B and reinforced with a perforated sheet metal inner jacket.
- D. High velocity ductwork located in non-conditioned spaces shall be insulated with 2" thick fiberglass board insulation with vapor barrier jacket.
- E. Other manufacturers are CertainTeed, Knauf, and Owens Corning or approved equal.
- F. Fibrous-Glass Duct Liner: Comply with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
 - 1. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. CertainTeed Corporation; Insulation Group.
 - b. Johns Manville.
 - c. Knauf Insulation.
 - d. Owens Corning.
 - 2. Maximum Thermal Conductivity: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
 - 3. All duct liner products shall avoid air erosion up to velocities of 4,000 feet per minute.
- G. Solvent-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.

2.3 ADHESIVES

- A. Water based, polymeric, UL classified lagging adhesive for applying canvas and glass cloth; Foster 30-36 or Childers CP-50.
- B. A fast setting, rubber based, UL classified, vapor barrier lap and attachment adhesive; Foster 85-15 or Childers CP-85.

- C. Same adhesive, except non-flammable when wet; Foster 85-20 or Childers CP-82.
- D. A rubber based, UL classified, fast setting contact adhesive for adhering flexible cellular insulation; Foster 82-40 or Armstrong 520.

2.4 INSULATION THICKNESS

- A. Piping insulation thickness based on a maximum k value of 0.23 Btu in/hr ft² °F at a mean temperature of 75°F.

Pipe Sizes			
System	Runouts To 12 ft. Max.	1 1/2" and Less	1 1/2" Up
Refrigerant piping	1"	1"	2"
Condensate drain piping	1"	1"	1"

- B. Exterior Duct Insulation: All supply, return and outside air ductwork, shall be insulation 2" thick, with a minimum installed R value of 6.0.

2.5 DUCT SEALANTS

- A. A fast setting, rubber based, UL classified, high velocity duct sealer; Foster 32-14 or 3M EC-800.
- B. Same sealer, except non-flammable when wet; Foster 30-02.

2.6 EXPANSION AND BALL JOINT INSULATION COVERS

- A. Furnish and install removable and reusable insulation covers.
- B. Insulation and jacketing material shall be as required for service temperatures.
- C. Covers shall have hook and loop fasteners and draw cords.

PART 3 - EXECUTION

3.1 GENERAL

- A. The installation of all insulation shall be made by experienced craftsmen in a neat, workmanlike manner and shall be in accordance with the manufacturer's published recommendations for service intended, as interpreted by the Architect.
- B. All adhesives used in conjunction with insulation shall be compatible with the insulation and vapor barrier used and be vermin-proof and mildew resistant.

3.2 APPLICATION

- A. Install materials in accordance with manufacturer's instructions.

- B. Ductwork:
1. External Duct Insulation: All external duct shall be installed without sagging or loose fitting sections. Outer jacket shall be sealed with mastic to form a continuous vapor barrier. Install as recommended by the insulation manufacturer.
 2. Flexible fiberglass insulation shall be wrapped around ducts and secured with outward clinching staples. Ducts 24" wide and larger shall have the insulation additionally secured with stick clips on 18" centers or with 4" wide bands of adhesive applied on 18" centers. Insulation shall be lapped a minimum of 4" and all seams and penetrations shall be sealed with an approved mastic reinforced with 3" glass mesh reinforcement. Where insulation terminates, all raw glass shall be sealed to duct.
- C. Insulation shall be the full specified thickness, continuous through walls, floors, ceilings, etc. Reducing thickness or cutting back of insulation to pass obstructions or through sleeves will not be permitted.
- D. Valve and fitting insulation shall be built up to the thickness of the adjacent pipe insulation or may be factory prefabricated units at the Contractor's option.
- E. Any painting of pipe insulation shall be accomplished under the Painting Section. After finish painting, any insulation showing splits or other signs of poor workmanship shall be replaced.
- F. No part of any system shall be insulated until all required tests have been completed.
- G. All insulation shall be installed so that it does not interfere with the functions of thermometer wells, gage connections and/or cocks, unions, access panels, hand holes, manholes, sight glasses, etc., or obscure serial numbers or other nameplate data.
- H. Insulation shall be extended to include stiff leg supports as required to prevent sweating.
- I. Complete vapor barriers to prevent sweating shall be installed on all cold systems and equipment. If a single tape adhesive system or staples are used for closure of the longitudinal lap, a vapor barrier mastic must be used to ensure a vaporproof closure. All edges and abutments shall be sealed, waterproof and vaporproof. Supplier of jacket materials shall certify that the material proposed is approved for use in return air plenums, where applicable.
- J. Where necessary, the application of insulation shall be arranged to accommodate movement of piping due to thermal expansion and/or contraction.
- K. **Exterior Piping: All pipe and fittings specified herein to be insulated when installed exposed to weather, shall be insulated, and wrapped with an 0.016" smooth or corrugated aluminum jacket with proper closure system positioned to shed water to make a waterproof assembly.** Fittings shall be insulated with molded insulation fittings or pipe insulation carved and mitered to fit properly. Insulation shall be butted together and adhered in place with contact cement. Where possible tubing shall be slipped on without slitting. Where insulation terminates, it shall be neatly beveled and finished. No portion of this insulation shall be concealed prior to approval by the Architect.

- L. Below Grade Piping: All pipe and fittings specified herein to be insulated, when installed below grade shall be insulated and spirally wrapped with open mesh glass tape embedded in asphaltic mastic and then completely covered with waterproof asphaltic mastic so as to make a waterproof assembly. Fittings shall be insulated with molded insulation fittings or pipe insulation carved and mitered to fit properly. Insulation shall be butted together and adhered in place with contact cement. Where possible tubing shall be slipped on without slitting. Where insulation terminates, it shall be neatly beveled and finished. No portion of this insulation shall be concealed before the Architect has checked and approved same.
- M. Piping supports shall pass completely around the exterior of the finished insulation. Rigid blocks of insulation material shall be provided at all support points. In addition, sheet metal saddles shall be provided at support points in accordance with the following table:

Pipe Size	Gauge Metal	Saddle Length
Up to 2-1/2"	18	6"
3" - 5"	16	10"
6" - 8"	16	14"
10" and Over	16	18"

- N. Saddles shall cover the bottom of the insulation, and saddle edges shall be hemmed or suitably covered to prevent damage to the insulation material.
- O. The vapor barrier and finish shall be continuous at all support points.
- P. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-19, "Flexible Duct Liner Installation."
1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
 2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
 3. Butt transverse joints without gaps, and coat joint with adhesive.
 4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
 5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
 6. Apply adhesive coating on longitudinal seams in ducts.
 7. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
 8. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
 - a. Fan discharges.
 - b. Intervals of lined duct preceding unlined duct.
 - c. Upstream edges of transverse joints in ducts where air velocities are higher than 2000 fpm or where indicated.
 9. Secure insulation between perforated sheet metal inner duct of same thickness as specified for outer shell. Use mechanical fasteners that maintain inner duct at uniform distance from outer shell without compressing insulation.
 - a. Sheet Metal Inner Duct Perforations: 3/32-inch diameter, with an overall open area of 23 percent.

- Q. Lined exterior ductwork shall be treated with an acid etch bath and two coats of UV resistant paint. Color shall be approved by Architect.
- R. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

END OF SECTION

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SECTION 23 23 00 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to the Work in this Section.

1.2 SUMMARY

- A. The Contractor shall furnish and install items as shown on the drawings or as necessary to provide a complete working system in accordance with the intent of the drawings and specifications, including all valves as indicated or as necessary to completely control the entire piping system. The piping drawings are diagrammatic and indicate the general routing, locations, and connections. The piping may require be offsetting, lowering or rising as needed to avoid interferences or as directed at the site. This does not relieve the Contractor from responsibility for the proper installation of piping systems.
- B. Work Included:
 - 1. Refrigerant piping and accessories.
- C. Submittals: Provide submittals as required in Section 23 0500, "Common Work Results for HVAC".

1.3 QUALITY ASSURANCE

- A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.
- B. Without additional cost to the Owner, provide such other labor and materials as are required to complete the work of this Section in accordance with the requirements of governmental agencies having jurisdiction, regardless of whether such materials and associated labor are called for elsewhere in these Contract Documents.
- C. When requested, provide the Architect with manufacturer's certificate that materials meet or exceed minimum requirements to comply with ANSI, ASTM, ASME, CISPI, IAPMO, PDI, and AWWA and all other applicable standards.
- D. Copies of each welder's certification documents shall be furnished to the Architect prior to them performing work.
- E. All pipes, valves, and fittings shall be manufactured in the United States. Mill Test reports and manufacturer's certifications shall be submitted to the Engineer on all such materials used.

1.4 SUBMITTALS

- A. Provide submittals as required in section 23 05 00, "Common Work Results for HVAC"

PART 2 - PRODUCTS

2.1 PIPE AND PIPE FITTINGS

A. Refrigerant Piping:

1. Seamless ACR copper tubing, Type L, hard drawn with wrought or bronze solder joint fittings.

2.2 VALVES, COCKS AND SPECIALTIES

A. Materials: Bronze, or copper only

B. Valve locations:

1. Provide a valve on inlet and outlet of each piece of equipment. **(all refrigeration lines)**
 - a. **Locate at condenser**
 - b. **Locate at fan coil unit.**
 - c. **Locate at inlet and outlet of all refrigeration selector boxes**
2. Provide valves to isolate individual or a group of equipment on branch runouts from piping mains. This is in addition to valves at each fixture and equipment.
3. Provide valves as indicated and where required to adequately service parts of systems and equipment.

C. Refrigerant Valves:

1. Globe and Angle Valves: Forged brass or bronze alloy with packed stem and seal cap.
2. Check Valves: Spring-loaded, forged brass or bronze alloy body with solder connections.
3. Relief Valves: Forged brass bodies with nonferrous corrosion resistant internal working parts. Valves shall be in accordance with ANSI B9.1.
4. Solenoid Valves: Two-position, direct acting or pilot operated type, UL listed, with manual opening stem and constructed for servicing without removal from lines. Valves shall have coil housing, stainless steel enclosing tube, replaceable seat, and proper inlet and outlet connections for the type of pipe containing the valve.

2.3 PIPE HANGERS AND SUPPORTS

A. Supports, hangers, anchors, guides and supplementary steel shall be provided for horizontal and vertical piping and shall meet or exceed the ASA Code for Pressure Piping.

B. Rod sizes noted are minimum sizes. The structural integrity of the supports is the responsibility of the Contractor.

C. Hangers Supporting and Contacting Copper:

1. 3" and Smaller: Grinnell Fig. CT-109, copper plated, split-ring hanger with adjusters.

D. Hangers Supporting Insulated Lines:

1. **All hangers must support outside of insulation and not on pipe directly.**

E. Supports for Vertical Riser Piping:

1. Brass or copper pipe shall be isolated from support with sheet polyethylene, minimum 1/8" thick.

F. Supports for Vertical and Horizontal Piping in Chases and Partitions:

1. Provide securely anchored supports for pipes serving plumbing fixtures and equipment near the area the pipe penetrates the wall.
2. Supports shall be steel plate, angles or unistruts mounted vertically or horizontally with unistrut clamps P2426, P2008 or P1109.
3. Attach supports to wall or floor construction with clip angles, brackets or other approved anchoring devices.
4. Brass and copper pipe shall be isolated from support with sheet polyethylene, minimum 1/8" thick.

2.4 SLEEVES

- A. Provide sleeves where pipes penetrate floors, walls, foundations, fireproofing, etc.
- B. Size sleeves large enough to allow for movement due to expansion and to provide for continuous movement. Provide a bead of sealant in space between pipe and sleeve.

2.5 TRAPEZES

- A. Trapezes of Kindorf, Elcen or approved equal may be provided where multiple lines run horizontally at the same elevation.

2.6 STRAP HANGERS

- A. **Under no circumstances will perforated strap iron, zip ties, tape, fabric strap or wire be acceptable for hangers or supports on this project.**

2.7 BRAZING ROD

- A. **Refrigerant piping shall be brazed with no less than silver solder "Sil-Fos"#15.**

PART 3 - EXECUTION

3.1 GENERAL

- A. All work shall be performed by workmen skilled in the trade required for the work. All materials and equipment shall be installed in accordance with the approved recommendations of the manufacturer and the best practices of the trade in conformance with the contract documents.
- B. **Contractor shall consider all refrigeration piping materials are subject to change in temperature and will expand and contract with this change. Installation techniques must allow for expansion and contraction changes, this will prevent stress that will buckle and rupture the copper tubing or joint. Consider components, pipe type, length, hanger type, and rapid temperature differences within the piping system when calculating expansion. It is the contractor's responsibility to ensure that the pipe has adequate room for expansion and contraction without putting undue stress on the VRF components such as "Y" branches, changeover boxes, headers, and indoor units. Contractor shall follow the recommendations found in the most recent issue of *The Piping Handbook*, for expansion loops, expansion joints, pipe offsets and other methods to allow the refrigerant pipe to expand and contract based on the temperature ranges within each refrigerant pipe in the system. Failure to follow this procedure can cause a tendency for lines to bow, and possibly buckle or rupture, particularly on smaller pipe sizes.**

3.2 INSTALLATION

- A. Refer to Section 23 0500, "Common Work Results for HVAC" for general installation requirements.
- B. Erection of Pipe above Grade: Piping shall be properly supported and adequate provisions shall be made for flashing, expansion, contraction, slope and anchorage. All piping shall be cut accurately for fabrication to measurements established at the construction site. Pipe shall be worked into place without springing and/or forcing, properly clearing all structural elements, finished rooms, windows, doors, and other openings and equipment. Cutting or other weakening of the building structure to facilitate installation will not be permitted.
- C. All changes in direction shall be made with fittings, except that bending of pipe will be permitted providing a hydraulic pipe bender is used. Bent pipe showing kinks, wrinkles or other malformation will not be acceptable.
- D. Copper tubing shall be joined by the following method:
1. The tubing shall be reamed to remove all burrs from the inside diameter of the pipe.
 2. The tubing and fitting shall be sanded or brushed to a uniform bright finish.
 3. The tubing shall be brazed with silver solder no less than #15 sil-fos.
- E. Provide sleeves around all pipes passing through walls, floors, ceiling, partitions, structural members or other building parts.
- F. Refrigerant Piping:
1. Refrigerant piping shall not be run concealed in walls or partitions nor underground or under the floor except as indicated on the drawings. Where pipe passes through building structure, pipe joints shall not be concealed, but shall be located where they may be readily inspected.
 2. **Refrigerant piping shall be brazed with silver solder "Sil-Fos" #15.** The inside of tubing and fittings shall be free of flux. The parts to be joined shall be cleaned bright with emery cloth and shall be heated to a temperature slightly greater than the solder flow point, and shall be kept hot until the solder has penetrated the full depth of the fitting. Joints shall be cooled in the air after which flame marks and traces of flux shall be removed. **During the brazing operation, the tubing shall be protected from forming an oxide film on the inside by slowly flowing dry nitrogen to expel the air.** Installation of the piping shall comply with ANSI B31.5.
 3. Refrigerant lines shall be installed so that the gas velocity in the evaporator suction line is sufficient to move the oil along with the gas to the compressor. Where equipment location requires a vertical riser, the line size shall be as shown and installed to provide sufficient gas velocity or a double riser shall be installed as shown on the drawings. The larger riser shall have a trap, of minimum volume, formed by the use of 90 degree and 45 degree ells. The small riser shall be located with its inlet just upstream of the trap and shall connect to the top of the horizontal line. Valves shall not be installed in risers except as shown on the drawings.
 4. Refrigerant driers, sight glass liquid and moisture indicators, and strainers shall be provided in refrigerant piping for remote installations when not furnished by the manufacturer as part of the equipment. Driers shall be installed in liquid line with service valves and a valved bypass line which are the same size as liquid line in which the drier is installed. Driers of 50 cubic inches and larger shall be installed with the cover and the full cartridge being easily removable.

5. Sight glass liquid and moisture indicators shall be installed in the liquid line downstream of the drier. Connections shall be the same size as the liquid line in which it is installed, up to 7/8"; 1-1/8" and larger shall have a 1/4" indicator installed in the "By-pass" position.
6. Strainers shall be located close to equipment they are to protect. A strainer shall be provided in the refrigerant liquid supply to expansion valves. Strainers shall be installed with screen down and in direction of flow as indicated on the strainer's body.
7. Refrigerant Charging Valve: A valved refrigerant charging connection shall be provided for each field piped refrigeration system when not provided as part of the condensing unit. The valve shall be located on the reducing outlet of a full size tee in the liquid line, upstream from the refrigerant drier and sight glass moisture indicator. Valves shall be of the seal cap type, 1/2" min. port size.

3.3 INSTALLATION OF SUPPORTS

- A. All pipe supports shall be designed and installed to avoid interferences with other piping, hangers, ducts, electrical conduit, supports, building structure, equipment, etc. All piping shall be installed with due regard to expansion and contraction. The type of hanger, method of support, location of support, etc., shall be governed in part by this specification.
- B. Pipe hangers shall be attached to the structure as follows:
 1. Poured-in-Place Concrete: Each hanger rod shall be fitted with a nut at its upper end, which nut shall be set into an Underwriters' Laboratories, Inc., listed universal concrete insert placed in the formwork before concrete is poured.
 2. Steel Bar Joists: Where pipes and loads are supported under bar joists, hanger rods shall be run through the space between the bottom angles and secured with a washer and two nuts. Where larger lines are supported beneath bar joists, hanger rods shall be secured to angle irons of adequate size. Each angle shall span across two or more joists as required to distribute the weight properly and shall be welded to the joists or otherwise permanently affixed thereto.
 3. Steel Beams: Pipes and loads supported under steel beams shall be installed using approved beam clamps.

3.4 SPACING

- A. Install hangers for steel piping with the following maximum spacing and minimum rod sizes according to MSS SP 69 Tables 3 and 4:
 1. NPS 3/4: Maximum span, 7 feet; minimum rod size, 3/8 inch.
 2. NPS 1: Maximum span, 7 feet; minimum rod size, 3/8 inch.
 3. NPS 1-1/4: Maximum span, 7 feet; minimum rod size, 3/8 inch.
 4. NPS 1-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
 5. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.
- B. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:
 1. NPS 1/2: Maximum span, 5 feet; minimum rod size, 3/8 inch.
 2. NPS 5/8: Maximum span, 5 feet; minimum rod size, 3/8 inch.
 3. NPS 1: Maximum span, 6 feet; minimum rod size, 3/8 inch.
 4. NPS 1-1/4: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 5. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
- C. Spacing and rod sizes for other piping materials shall be as recommended by the manufacturer.

3.5 TRAPEZES

- A. Trapeze members, including suspension rods, shall be properly sized for the number, size and loaded weight of the lines they are to support. Install as noted above.

3.6 MISCELLANEOUS

- A. Install any other special foundations, hangers and supports indicated on the drawings, specified elsewhere, or required by installation conditions.

END OF SECTION

SECTION 23 31 13 - METAL DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to the Work in this Section.

1.2 SUMMARY

- A. Provide all equipment, materials, labor, supervision and services necessary for or incidental to the installation of all air distribution items as indicated on the drawings and as specified.
- B. Work Included:
 - 1. Ductwork.
 - 2. Access Doors.
- C. Submittals: Provide submittals as required in Section 23 0500, "Common Work Results for HVAC".

1.3 QUALITY ASSURANCE

- A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.
- B. Without additional cost to the Owner, provide such other labor and materials as are required to complete the work of this Section in accordance with the requirements of governmental agencies having jurisdiction, regardless of whether such materials and associated labor are called for elsewhere in these Contract Documents.
- C. When requested, provide the Architect with manufacturer's certificate that materials and methods meet or exceed minimum requirements as specified.

1.4 SUBMITTALS

- A. **Provide submittals as required in section 23 05 00, "Common Work Results for HVAC."**

PART 2 - PRODUCTS

2.1 SHEET METAL DUCTWORK

- A. Ducts shall be constructed of new-galvanized steel sheets and erected in a first class manner, straight and smooth, with joints neatly finished, anchored securely to the building and free from vibration.
- B. All ducts penetrating fire walls shall be minimum **26-gauge** galvanized steel regardless of SMACNA Standards.
- C. All elbows shall be curved elbows with a centerline radius equal to 1-1/2 times the width of the duct. Air turns consisting of curved metal vanes, arranged to permit the air to follow abrupt turns without appreciable turbulence shall be installed in square elbows, only where approved by the

engineer. Air turns shall be the manufacturer's standard products, and shall be quiet and free from vibration.

- D. All ductwork shall be fabricated in accordance with the Sheet Metal and Air Conditioning Contractor's National Association, Inc. (SMACNA) "HVAC Duct Construction Standards, Metal and Flexible, Second Edition, 1998". The duct static pressure rating for this duct shall be two times the external static pressure of the system fan. The requirements for the seal class corresponding to the above static pressure shall be met.
- E. Longitudinal joints shall be Pittsburgh lock or Acme grooved seam. Side panels greater than 10 inches in depth shall be cross-broken for added stiffness.
- F. Transverse joints shall be Ductmate, TDC or types fabricated according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" Figure 1-4, "Transverse (Girth) Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- G. **Round steel duct shall be spiral duct construction in all commercial applications. Snap lock round duct is acceptable in residential construction only.**
- H. Splitter damper shall have end bearings and consist of a blade constructed of 20 gauge-galvanized steel securely riveted or welded to a square operating rod. The length of the splitter blade shall be 1-1/2 times the width of the split in the main duct, but in no case less than 12". Multi-blade adjustable pickup shall be as manufactured by Titus Model AG-45 or approved equal with operator adjustable from the duct exterior.
- I. Volume dampers shall have end bearings and be multi-blade type with opposed acting blades linked together and controlled by a single operator. Multi-blade dampers shall be not less than No. 16-gauge galvanized steel mounted to plenum or ductwork per SMACNA requirements.
- J. Regulators shall be stamped galvanized steel, lever type with locking screw mounted on face of ductwork or concealed type with adjustable cover plate as manufactured by Young Regulator Model No. 315 with 2-1/4" diameter cover plate or approved equal.
- K. Damper quadrants, volume dampers and other duct flow control quadrants shall be as manufactured by Young Regulator or approved equal.
- L. Cable shall consist of Bowden cable 0.054" stainless steel control wire encapsulated with 1/16" flexible galvanized spiral wire sheath. Control kit shall consist of 270-896 bracket with a 7/8" diameter cold rolled steel zinc plated threaded cap suitable for painting, and 14 gauge steel rack and pinion gear drive converting rotary motion to push-pull motion. Control shafts shall be D-style flattened 1/4" diameter with 265 degree rotation providing graduations for positive locking and control, and 1-1/2" linear travel capability. Control kit shall be manually operated using Young Regulator Model 030-12 wrench. Provide a wrench for each cable control system installed. Control kit shall be Young Regulator Model 270-896P with tamper proof screws or prior approval equal.

2.2 FLEXIBLE DUCTWORK

- A. Core material shall be a PVC Coated Fiberglass reinforced fabric supported by helically wound galvanized steel. The fabric shall be mechanically fastened to the steel helix without the use of adhesive.
- B. The internal working pressure rating shall be at least as follows with a bursting pressure of at least 2-1/2 times the working pressure.

- C. The duct shall be rated for a velocity of at least 5500 feet per minute.
- D. Suitable for operating temperatures of at least 250 degrees F.
- E. Factory insulate the flexible duct with flexible fiberglass insulation. The R value shall be at least 5.0 at a mean temperature of 75 degrees F. (R4.2 not acceptable)
- F. Cover the insulation with a reinforced aluminum pigmented vapor barrier jacket having a permeance of not greater than 0.05 perms when tested in accordance with ASTM E 96, procedure A.
- G. The ductwork shall be UL 181 listed, Class 1 Air Duct and comply with NFPA 90A and NFPA 90B.
- H. Duct shall be secured with metal bands.
- I. Duct shall be Flexmaster Type 8M or pre-approved equal

2.3 ACCESS DOORS

- A. Provide access doors equal to Nailor-Hart Ind., Inc. Series 0800.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. All ductwork shall be installed as recommended by SMACNA and as shown or indicated on the drawings. Coordinate ductwork with all other trades and elements of the building construction.
- B. All ductwork accessories shall be provided as specified or shown or indicated on the drawings, install as recommended by SMACNA and the manufacturer.
- C. Ductwork shall be installed in a neat, workmanlike manner with ducts generally parallel to structure and tops of ducts as high as possible against building construction. Provide offsets as necessary to avoid obstructions, piping, or structural members.
- D. Flexible ductwork shall be installed and supported as recommended by SMACNA and the manufacturer.
- E. At each major branch from a primary rectangular or square trunk duct, and where shown on the drawings, install a splitter damper or multi-blade adjustable air pickup.
- F. Each individual air supply duct tap shall be equipped with a volume control device for the manual adjustment of airflow in each tap. Face bars, blanks, and equalizing grids shall not be used to regulate airflow.
- G. Volume dampers shall be installed within ducts or plenums where shown on the drawings and on all supply/return/exhaust taps for balancing of system.
- H. Round or oval ductwork shall be fastened together with a minimum of three sheet metal screws equally spaced around the perimeter of the duct and taped with an approved duct sealing tape. Ductwork shall be furnished complete with all factory fabricated starting collars, Y shaped branch takeoffs, adjustable elbows, etc.

- I. Where ducts are in mechanical rooms or unfinished areas, or where dampers occur above lift out ceilings, regulators shall be stamped galvanized steel, lever type with locking screw mounted on face of ductwork. For all other areas, where damper adjustments cannot be accessed through the ceiling, regulators shall be the concealed type with adjustable cover plate.
- J. For all detention areas and other areas where damper adjustments cannot be accessed through the ceiling, Bowden cable controls shall be used. Damper controller and cable shall be concealed above the ceiling. Control kit shall be imbedded in the ceiling flush with the finished surface. Control kit shall not be located within detention living areas, exact location shall be approved by the architect prior to installation.
- K. On the inlet and outlet of each piece of air moving equipment, unless noted otherwise, install a flexible connection made with sufficient slack to render it flexible.
- L. Where air intakes and/or discharges are indicated on the drawings and no air device is indicated, install 1/4" bird screens over each duct opening set in galvanized steel frames and securely attach to the openings.
- M. Furnish and install 26 gauge galvanized steel counter flashings for all ducts penetrating roofs and for all roof mounted equipment unless directed otherwise by the Architect.
- N. Provide concentric taps on all connections from the main duct to branch ducts.
- O. Provide stamped steel access doors at each fire damper, fire and smoke damper, where control devices occur within ductwork, and as indicated on the drawings. Access doors shall be fully insulated where duct is lined internally. Provide with mounting flange, double thickness door with cam latch, gasket and retaining wire. No tools shall be required to open the access door.
- P. The minimum size of each access door shall be sufficient to provide adequate access for the intended purpose of installation.

END OF SECTION

SECTION 23 81 49 - VARIABLE REFRIGERANT AIR CONDITIONING SYSTEMS**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. The Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to the Work in this Section.

1.2 SUMMARY

- A. Provide all equipment, materials, labor, supervision and services necessary for or incidental to the installation of a complete and operating refrigeration and air handling system as indicated on the drawings and as specified.
- B. Contractor Qualifications:
1. The contractor installing this system shall have installed a minimum of five (5) VRF systems of similar size or larger within the past three (3) years. Installation of one-to-one mini-splits is not considered equal to the experience of installing multi-zone VRV systems.
 2. A list of projects, year project was installed and commissioned, installed tonnage (indoor units and outdoor unit), and reference contact information shall be provided in the submittal.
- C. Work included:
1. Variable Refrigerant Flow System
- D. Submittals: Provide submittals as required in Section 23 0500, "Common Work Results for HVAC". IN ADDITION, and specifically related to the VRV/VRF portion of work:
1. Equipment and total system capacities shall show the actual Total And Sensible capacities of all equipment after the following design considerations have been taken into account:
 - a. Outdoor Ambient Conditions
 - b. Altitude
 - c. Entering Air Temperature into the FCU
 - d. Refrigerant line diameters and length
 - e. Refrigerant line diameters and length
- E. Installation and Commissioning
1. Manufacturer software shall be used to produce piping tree and shall be submitted (1) before ordering material, (2) confirmed/revised for actual field dimensions before welding/pressure testing, and (3) submitted after pressure testing to document final pipe sizes and lengths and shall be included as "As-Builts".

3. After the final piping connection is made, confirm that all valves within the refrigerant circuit are open, date/time stamped photos of the pressure gauge(s) at both the beginning and ending of a successful pressure test OR documented observation by a 3rd party along with ambient temperatures for the same period shall be submitted. The subcontractor shall be knowledgeable of the Ideal Gas Law to be able to judge a successful pressure test while ambient conditions vary. A pressure test shall be considered "successful" when it has held the manufacturer's stated PSI for the manufacturer's stated minimum duration. Additionally, the refrigerant circuit shall remain under pressure until the refrigerant circuit is prepared for start-up at which point it shall be measured and documented to match that of the original successful pressure test. **THE INSTALLER IS CHARGED WITH NOTIFYING THE JOBSITE OF SAFETY REQUIREMENTS CONCERNING WORKING NEAR PIPING UNDER PRESSURE.**
4. BEFORE START-UP, the installer shall purge the refrigerant circuit of nitrogen and pull a vacuum on the entire open circuit down to 500 microns and shall hold for 1 hour. It shall be measured and documented by Factory Authorized Commissioning Agent.
5. WARRANTY: VRF equipment shall come with a 5 year parts warranty and a 7 year compressor warranty. This warranty includes all the components that are factory installed within the VRF condensing units, fan coil units, branch selector boxes and wall mounted controllers. To ensure viability of the warranty it shall be supplied, in writing, by the equipment manufacturer and not the local sale representative. Warranty is parts only and does not include troubleshooting or labor. Other items shall have a 1 year parts warranty.

1.3 QUALITY ASSURANCE

- A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.
- B. Without additional cost to the Owner, provide such other labor and materials as are required to complete the work of this Section in accordance with the requirements of governmental agencies having jurisdiction, regardless of whether such materials and associated labor are called for elsewhere in these Contract Documents.
- C. When requested, provide the Architect with manufacturer's certificate that the equipment meets or exceeds minimum requirements as specified.
- D. All equipment shall have a minimum EER in accordance with ASHRAE 90.1 unless specified otherwise.
- E. The units shall be listed by Electrical Laboratories (ETL) and bear the ETL label.
- F. All wiring shall be in accordance with the National Electric Code (NEC).
- G. The system will be produced in an ISO 9001 and ISO 14001 facility, which are standards set by the International Standard Organization (ISO). The system shall be factory tested for safety and function.
- H. All VRF equipment shall be stored protected from weather, extreme temperature, etc. as suggested by the manufacturer. All VRF equipment shall be moved, lifted, etc. as suggested by the manufacturer.

PART 2 - PRODUCTS

2.1 VARIABLE CAPACITY, VARIABLE REFRIGERANT VOLUME/VARIABLE REFRIGERANT FLOW SERIES

- A. System Description: The variable capacity, heat recovery air conditioning system shall be a Variable Refrigerant Flow Series (simultaneous heat/cool model) system or equal as approved by Architect. The system shall have all components required by the plans and specifications so that once properly installed will create an operational Heat Pump (HP) or Heat Recovery (HR) as required by plans and specifications to operate in accordance with manufacturers listed performance. If required to meet capacities scheduled the system shall include multiple evaporators using PID control. The system shall consist of the following from the same manufacturer:
- a. R410A condensing units with inverter driven compressor(s)
 - b. Multiple evaporator Fan Coil Units (FCUs) for use in VRF systems
 - c. Refrigerant piping network "Y" branches as required.
 - d. Refrigerant heat/cool change over boxes, as required
 - e. DDC Control boards with PID loop, wall mounted FCU controllers, centralized touchscreen controller, as required.
 - f. The system may connect up to 150% the nameplate tonnage of FCUs to condensing unit nameplate tonnages without effecting the ability for the system to operate as scheduled.
 - g. For Heat Recovery systems, every indoor unit shall be independently capable of operating in either heating or cooling mode regardless of the mode of other indoor units. The system shall be capable of changing mode of individual indoor units (cooling to heating or heating to cooling) within a maximum time of 5 minutes to ensure indoor temperature can be properly maintained.
- B. The outdoor unit shall be interconnected to indoor units in accordance with the manufacturer's engineering data book detailing each available indoor unit. The indoor units shall be connected to the outdoor utilizing the manufacturers specified piping joints and headers.
- C. Heat Pump systems shall consist of one (1) liquid refrigerant line and one (1) gas refrigerant line.
- D. Heat Recovery system shall consist of (1) liquid refrigerant line and one (1) gas refrigerant line and (1) medium pressure gas line. System that attempt to use only 2 refrigerant lines in heat recovery mode shall provide heating scheduled in the units at the design conditions listed in ASHRAE for project location even if this requires an increase in quantity or size condensing units.
- E. Units shall be as manufactured by Carrier or pre-approved equal.

2.2 CONDENSING (OUTDOOR) HEAT RECOVERY UNIT

- A. General: Factory assembled, single piece, air-cooled outdoor unit. Contained within the unit enclosure shall be all factory wiring, piping, controls, and the multiple inverter driven twin rotary compressors.

1. The maximum sound pressure rating for a single module shall not exceed 63.5dBa sound pressure in cooling and 65.5dBa in heating. For twinned systems the sound pressure numbers should not exceed 66.5 dBa and 68.5 dBa.
2. The outdoor unit shall include an oversized accumulator and a liquid tank for proper heating performance while allowing the indoor unit PMV valve (metering device) to shut off completely when a zone is satisfied.
3. The outdoor unit shall be protected by a High-pressure switch, High-pressure sensor, Low-pressure sensor, Fusible plug, PC board fuse, and an inverter overload protector.
4. The outdoor unit shall be capable of operating in cooling mode down to 14°F ambient air temperature and down to -4°F WB ambient air temperature in heating. For simultaneous heating and cooling the unit shall be capable of operating between 14°F and 60°F ambient air temperature.
5. The outdoor unit shall include a total oil management system that balances oil between compressors within a module, replenishes compressor oil to the compressors in a module from the oil separator if required, and allows to move oil and refrigerant between twinned units if required even if one of the units is not running.

B. Unit Cabinet:

1. Unit cabinet shall be constructed of pre-coated steel, finished on both inside and outside.
2. Unit access panels shall be removable with minimal screws and shall provide full access to the compressors, fan, and control components.
3. Compressors shall be isolated in a compartment and have an acoustic wrap to assure quiet operation.
4. The outdoor unit control panel shall include a sliding window to access adjustable controls and an LED display for setup and diagnostics.
5. Unit cabinet shall be capable of withstanding 500-hour salt spray test per Federal Test Standard No. 141 (method 6061).

C. Fans:

1. Outdoor fan shall discharge air vertically and be driven by a DC inverter variable speed motor with 64 steps that is capable of running down to 60 RPM.
2. Outdoor fan motor shall be totally-enclosed with permanently-lubricated bearings.
3. Motor shall be protected by internal thermal overload protection.
4. Fan blade shall be non metallic and shall be statically and dynamically balanced.
5. Outdoor fan shall be protected by a raised non metallic protective grille.

D. Compressors:

1. Each outdoor unit module shall be equipped with two or three inverter driven twin rotary compressors with full range control to a level of 0.1 Hz.
2. Compressor shall be totally enclosed in the machine compartment.
3. Compressors shall be equipped with factory mounted crankcase heaters.
4. Internal overloads shall protect the compressor from over-temperature operation.
5. Motor shall be suitable for operation in an R-410A refrigerant atmosphere.
6. Compressor assembly shall be installed on rubber vibration isolators.
7. To maximize compressor reliability, multiple compressors, within a module, shall be started and operated in variable patterns to ensure equal run time on all compressors.
8. To ensure maximum efficiency throughout the system operation range, no compressor is required to run at maximum speed under any condition.

- E. Outdoor Coil:
1. Coil shall be constructed of aluminum fins mechanically bonded to seamless copper tubes, which are cleaned, dehydrated, and sealed.
 2. The coil configuration shall be 4 sided and fully separated from the machine compartment for more effective heat transfer and sound isolation.
 3. The coil fins shall have a factory applied corrosion resistant blue-fin finish.
- F. Electrical Requirements:
1. All sizes shall utilize 208/230-3-60 or 460-3-60 field power supply.
 2. Twinned systems shall have separate field power supply to each module.
 3. Two core shielded low voltage cable is shall be required for communication between outdoor and indoor unit.
 4. All power and control wiring must be installed per NEC and all local electrical codes.
- G. Controls and Safeties: Operating controls and safeties shall be factory selected, assembled, and tested. The minimum control functions shall include the following:
1. Controls: Compressor speed to match the refrigerant flow and capacity with the system requirements.
 - a. Outdoor fan motor speed for higher efficiency and lower sound.
 - b. Oil control for improved system reliability and comfort
 - c. Pulse modulating valve control for precise control of the refrigerant distribution and accurate capacity management to avoid starving any units.
 - d. Control of compressor staging to maximize reliability and minimum run time on all compressors.
 - e. Module control of compressor operation, compressor speed, and outdoor heat exchange surface to maximize efficiency and sound level and reliability across the entire operating range of the system.
 - f. Control of the outdoor heat exchanger surface (main vs. sub heat exchangers) for maximum efficiency and comfort.
 2. Safeties: The following safety devices shall be part of the condensing unit:
 - a. High pressure switch
 - b. Fuses
 - c. Crankcase heater
 - d. Fusible plug
 - e. Over current relay for the compressor
 - f. Thermal protectors for compressor and fan motor
 - g. Compressor time delay
 - h. Oil Recovery system
 - i. Oil level sensor
 - j. Over-current sensor
 - k. Compressor suction and discharge temperature sensor
 - l. Compressor suction and discharge pressure sensor
- H. Refrigerant Piping and Line Lengths:
1. Piping connections shall be from the front or the bottom of the unit.
 2. The unit shall be capable of operating with maximum connected refrigerant line lengths of 985 ft.
 3. The outdoor unit should have the ability to operate with a maximum height of 165 ft. between the outdoor and the lowest indoor unit.

4. The maximum distance between the outdoor unit and the furthest fan coil shall not exceed 575 ft. No line size changes or oil traps shall be required.
 5. The system should be capable of operating when the height difference between the upper and the lower fan coil is 130 ft.
- I. Auxiliary Refrigerant Components:
1. All field supplied copper tubing connecting the outdoor unit to the indoor unit shall use factory supplied branching kits consisting of either Y joints or headers to ensure even refrigerant flow.
 2. To ensure piping flexibility the system shall allow having Y joints or headers downstream of another header.
 3. When twinning two modules, and in order to maximize efficiency and comfort, a 3/8" oil balance line shall be used to allow the flow oil and refrigerant between the two units even when one of the units is not running.
 4. A flow selector box will be required regulate the flow of high pressure hot gas or high pressure liquid to the fan coil requiring heating or cooling.
 5. Up to 8 fan coils, all requiring same duty cycle, maybe connected to a single flow selector box.
 6. A fan coil that runs in cooling only will not be required to connect to a flow selector box.
 7. The flow selector box can be installed up to 49 feet away from the indoor unit.
 8. The flow selector box shall be wired from the indoor unit using a factory supplied power and control wire harness.
 9. The flow selector box shall not require a drain connection.
 10. The flow selector box shall include a galvanized steel enclosure, full interior insulation, and shall be tested prior to shipment.

2.3 4-WAY CEILING CASSETTE INDOOR UNIT

- A. General: Indoor, direct-expansion, low profile (10.1") in-ceiling fan coil. Unit shall be complete with a coil, fan, DC inverter driven fan motor, PMV valve, piping connectors, electrical controls, microprocessor control system, integral temperature sensing, condensate pump with a lift capability of 26" (661 mm), and hanging brackets.
- B. Unit Cabinet: Cabinet shall be constructed of zinc-coated steel. Fully insulated discharge and inlet grilles shall be attractively styled, high-impact non-metallic material. The inlet grille shall have hinges and can be opened to obtain access to the cleanable filters, indoor fan motor and control box. Fresh air can be introduced in two ways:
1. Use an auxiliary fresh air intake flange to condition the outside air before it is introduced into the space.
 2. Use a fresh air inlet and filter chamber to introduce unconditioned outside into the space.
- C. Fans:
1. Fan shall be centrifugal direct-drive blower type with air intake in the center of the unit and discharge at the perimeter. Automatic, motor-driven vertical air sweep shall be provided standard. Automatic motor-driven louvers shall be provided standard and shall be adjustable for 2, 3 or 4-way discharge.
 2. Air sweep operation shall provide three user selectable modes.

- D. Coil: Coil shall be copper tube with aluminum fins and galvanized steel tube sheets. Fins shall be bonded to the tubes by mechanical expansion and specially coated for enhanced wet-ability. A drip pan under the coil shall have a factory installed condensate pump and drain connection for hose attachment to remove condensate. A replaceable element in the condensate disposal system provides antibacterial protection.
- E. Motors: Motors shall be totally enclosed, permanently lubricated ball bearing with inherent overload protection. Fan motors shall be inverter controlled variable speed.
- F. Controls: The system shall be microprocessor controlled to maintain precise room temperature and minimum power consumption. The controls system shall employ a genetic algorithm for temperature control, and shall have an accuracy of 0.9 °F (\pm 0.5 °C). Any of the following user interface accessories shall be compatible with the unit.
1. Local Controller: Either a wired or a wireless controller can be used to control the system. The wireless kits shall have a remote receiver not integral to the unit. Wired remote controller shall communicate over two core shielded wire up to 1640ft/500m. It shall be capable of controlling groups of up to 8 indoor units. It shall be able to operate as a primary or secondary controller when two remote controllers are connected to a single indoor unit or group. The system shall be able to be configured so that the return air (TA) can be sensed at the unit, at the remote controller or through a remote sensor. The local controller shall minimally be able to control On-OFF, set point, mode, and be able to display system generated error codes.
 2. Central Controller: Central controller shall communicate over two core shielded wire up to 6562ft/2000m and use existing Indoor – Outdoor communication protocol to communicate. A Single Central Controller shall be capable of controlling up to 128 Indoor Units individually. It shall be able to create 4 Zones without any extra wiring. The Central Controller shall be equipped with digital input points for Force-OFF. It shall provide operation monitoring, and generate a digital output signal in response to an alarm. It shall be capable of restricting Local Remote Control operation. It shall be able to facilitate Indoor operation without local remote controller(s).
 3. Advance Central Controller: The Advanced Central Controller shall be able to control up to 128 Indoor Units Individually. It shall also be able to create up to 128 Zones without any extra wiring. The Controller shall be equipped with digital input points for Force-OFF & External ON-OFF. It shall provide operation monitoring, and generate a digital output signal in response to an alarm. It shall be able to restrict Local Remote Control operation and allow Set Back temperature. It shall provide a web interface for remote monitoring, control, and scheduling. It shall be able to create up to 10 programs per day. It shall facilitate Indoor operation without local remote controller(s). It shall be capable of monitoring energy consumption for each tenant and generate monthly billing reports.
 4. Building Management Systems
 - a. The system shall be able to be controlled by BACnet, or Lon Works either directly or through an external gateway.
 - b. BACnet and Lon Works shall be able to control: On / OFF, Operation mode, Fan speed, Louver, Set temperature, Permit / Prohibit of Local Operation
 - c. BACnet and Lon Works shall be able to monitor: On / OFF, Operation mode, Fan speed, Louver, Set temperature, Permit / Prohibit of Local Operation, Room temperature, Error status, Error code.

- G. The unit shall have the following functions as a minimum:
1. Selectable automatic restart, after power failure the system will restart at the same operating conditions as before the failure.
 2. Temperature-sensing controls shall sense return air temperature at the unit or at the remote control
 3. Indoor coil freeze protection in both cooling and heating (reversing valve failure) modes.
 4. Automatic air sweep control to provide multiple operating modes of the air sweep louvers.
 5. Dehumidification mode shall provide increased latent removal through total system modulation.
 6. Fan-only operation to provide room air circulation when no cooling is required.
 7. Fan speed control shall be user-selectable: high, medium, low, or microprocessor determined (Auto) based on the differential between the room temperature and the set point during all modes of operations.
 8. Indoor coil high temperature protection shall be provided to detect excessive indoor discharge temperature in heating.
 9. Cold blow prevention in heating.
 10. Adjustable compensation for air stratification in heating.
- H. Filters: Unit shall have factory-supplied resin net (cleanable) type filters. The return air filter material shall have the following characteristics:
1. Odorless
 2. Temperature resistant to 185°F (85°C)
 3. Humidity resistant up to 95% RH
- I. Electrical Requirements:
1. Indoor units are 208/230-1-60.

2.5 HIGH STATIC CEILING-CONCEALED DUCTED INDOOR UNIT

- A. General: Indoor, direct expansion, high static ducted fan coils. Unit shall be complete with a coil, fan, AC induction fan motor, PMV valve, piping connectors, electrical controls, microprocessor control system, integral temperature sensing, and hanging brackets.
- B. Unit Cabinet: Cabinet shall be constructed of zinc-coated steel and configured for rear return.
- C. Fans: The fan shall be of the multi-blade type with its performance designed to match the coil performance. The fan shall be statically and dynamically balanced to ensure low noise and vibration and capable of up to 1.18 In. WG external static pressure.
- D. Coil:Coil shall be copper tube with aluminum fins and galvanized steel tube sheets. Fins shall be bonded to the tubes by mechanical expansion and specially coated for enhanced wet-ability. A drip pan under the coil shall have a drain connection for hose attachment to remove condensate.
- E. Motors: Motors shall be totally enclosed, permanently lubricated ball bearing with inherent overload protection.

- F. Controls: The system shall be microprocessor controlled to maintain precise room temperature and minimum power consumption. The controls system shall employ a genetic algorithm for temperature control, and shall have an accuracy of 0.9 °F (± 0.5 °C). Any of the following user interface accessories shall be compatible with the unit.
1. Local Controller: Either a wired or a wireless controller can be used to control the system. The wireless kits shall have a remote receiver not integral to the unit. Wired remote controller shall communicate over two core shielded wire up to 1640ft/500m. It shall be capable of controlling groups of up to 8 indoor units. It shall be able to operate as a primary or secondary controller when two remote controllers are connected to a single indoor unit or group. The system shall be able to be configured so that the return air (TA) can be sensed at the unit, at the remote controller or through a remote sensor. The local controller shall minimally be able to control On-OFF, set point, mode, and be able to display system generated error codes.
 2. Central Controller: Central controller shall communicate over two core shielded wire up to 6562ft/2000m and use existing Indoor – Outdoor communication protocol to communicate. A Single Central Controller shall be capable of controlling up to 128 Indoor Units individually. It shall be able to create 4 Zones without any extra wiring. The Central Controller shall be equipped with digital input points for Force-OFF. It shall provide operation monitoring, and generate a digital output signal in response to an alarm. It shall be capable of restricting Local Remote Control operation. It shall be able to facilitate Indoor operation without local remote controller(s).
 3. Advance Central Controller: The Advanced Central Controller shall be able to control up to 128 Indoor Units Individually. It shall also be able to create up to 128 Zones without any extra wiring. The Controller shall be equipped with digital input points for Force-OFF & External ON-OFF. It shall provide operation monitoring, and generate a digital output signal in response to an alarm. It shall be able to restrict Local Remote Control operation and allow Set Back temperature. It shall provide a web interface for remote monitoring, control, and scheduling. It shall be able to create up to 10 programs per day. It shall facilitate Indoor operation without local remote controller(s). It shall be capable of monitoring energy consumption for each tenant and generate monthly billing reports.
 4. Building Management Systems
 - a. The system shall be able to be controlled by BACnet, or Lon Works either directly or through an external gateway.
 - b. BACnet and Lon Works shall be able to control: On / OFF, Operation mode, Fan speed, Louver, Set temperature, Permit / Prohibit of Local Operation
 - c. BACnet and Lon Works shall be able to monitor: On / OFF, Operation mode, Fan speed, Louver, Set temperature, Permit / Prohibit of Local Operation, Room temperature, Error status, Error code.
- G. The unit shall have the following functions as a minimum:
1. Selectable automatic restart, after power failure the system will restart at the same operating conditions as before the failure.
 2. Temperature-sensing controls shall sense return air temperature at the unit or at the remote control
 3. Indoor coil freeze protection in both cooling and heating (reversing valve failure) modes.
 4. Dehumidification mode shall provide increased latent removal through total system modulation.
 5. Fan-only operation to provide room air circulation when no cooling is required.
 6. Fan speed control shall be user set to one of three speeds by using the taps on the motor.

7. Indoor coil high temperature protection shall be provided to detect excessive indoor discharge temperature in heating.
 8. Cold blow prevention in heating.
 9. Adjustable compensation for air stratification in heating.
- H. Condensate Pump:
1. The unit shall include a factory installed condensate pump that will be able to raise drain water a minimum of 20 inches above the ceiling cassette face.
- I. Electrical:
1. The unit electrical power shall be 208/230 volts, 1-phase, 60 Hz.
 2. The indoor unit shall be capable of operation within voltage limits of +/-10% rated voltage.

2.4 WALL-MOUNTED INDOOR UNIT

- A. General: Indoor, direct-expansion, wall-mounted fan coil. Unit shall be complete with coil, fan, DC inverter driven fan motor, PMV valve, piping connectors, electrical controls, microprocessor control system, and integral temperature sensing. Unit shall be furnished with integral wall mounting bracket and mounting hardware.
- B. Unit Cabinet: Cabinet discharge and inlet grilles shall be attractively styled, high-impact non metallic material.
- C. Fans:
1. Fan shall be tangential direct-drive blower type with air intake at the top of the unit and discharge at the bottom front. Automatic, motor-driven vertical air sweep shall be standard.
 2. Vertical air sweep operation shall be user selectable using the remote control and the horizontal air direction may be set manually.
- D. Coil: Coil shall be copper tube with aluminum fins and galvanized steel tube sheets. Fins shall be bonded to the tubes by mechanical expansion and specially coated for enhanced wet-ability. A drip pan under the coil shall have a factory installed drain connection (on both ends) for hose attachment to remove condensate.
- E. Motors: Motors shall be totally enclosed, permanently lubricated ball bearing with inherent overload protection. Fan motors shall be inverter controlled variable speed.
- F. Controls: The system shall be microprocessor controlled to maintain precise room temperature and minimum power consumption. The controls system shall employ a genetic algorithm for temperature control, and shall have an accuracy of 0.9 °F (± 0.5 °C). Any of the following user interface accessories shall be compatible with the unit.

1. Local Controller: Either a wired or a wireless controller can be used to control the system. The wireless kits shall have a remote receiver not integral to the unit. Wired remote controller shall communicate over two core shielded wire up to 1640ft/500m. It shall be capable of controlling groups of up to 8 indoor units. It shall be able to operate as a primary or secondary controller when two remote controllers are connected to a single indoor unit or group. The system shall be able to be configured so that the return air (TA) can be sensed at the unit, at the remote controller or through a remote sensor. The local controller shall minimally be able to control On-OFF, set point, mode, and be able to display system generated error codes.
2. Central Controller: Central controller shall communicate over two core shielded wire up to 6562ft/2000m and use existing Indoor – Outdoor communication protocol to communicate. A Single Central Controller shall be capable of controlling up to 128 Indoor Units individually. It shall be able to create 4 Zones without any extra wiring. The Central Controller shall be equipped with digital input points for Force-OFF. It shall provide operation monitoring, and generate a digital output signal in response to an alarm. It shall be capable of restricting Local Remote Control operation. It shall be able to facilitate Indoor operation without local remote controller(s).
3. Advance Central Controller: The Advanced Central Controller shall be able to control up to 128 Indoor Units Individually. It shall also be able to create up to 128 Zones without any extra wiring. The Controller shall be equipped with digital input points for Force-OFF & External ON-OFF. It shall provide operation monitoring, and generate a digital output signal in response to an alarm. It shall be able to restrict Local Remote Control operation and allow Set Back temperature. It shall provide a web interface for remote monitoring, control, and scheduling. It shall be able to create up to 10 programs per day. It shall facilitate Indoor operation without local remote controller(s). It shall be capable of monitoring energy consumption for each tenant and generate monthly billing reports.
4. Building Management Systems
 - a. The system shall be able to be controlled by BACnet, or Lon Works either directly or through an external gateway.
 - b. BACnet and Lon Works shall be able to control: On / OFF, Operation mode, Fan speed, Louver, Set temperature, Permit / Prohibit of Local Operation
 - c. BACnet and Lon Works shall be able to monitor: On / OFF, Operation mode, Fan speed, Louver, Set temperature, Permit / Prohibit of Local Operation, Room temperature, Error status, Error code.

G. Electrical:

1. The unit electrical power shall be 208/230 volts, 1-phase, 60 Hz.
2. The indoor unit shall be capable of operation within voltage limits of +/-10% rated voltage.

H. The unit shall have the following functions as a minimum:

1. Selectable automatic restart, after power failure the system will restart at the same operating conditions as before the failure.
2. Temperature-sensing controls shall sense return air temperature at the unit or at the remote control
3. Indoor coil freeze protection in both cooling and heating (reversing valve failure) modes.
4. Automatic air sweep control to provide multiple operating modes of the air sweep louvers.
5. Dehumidification mode shall provide increased latent removal through total system modulation.

6. Fan-only operation to provide room air circulation when no cooling is required.
7. Fan speed control shall be user-selectable: high, medium, low, or microprocessor determined (Auto) based on the differential between the room temperature and the set point during all modes of operations.
8. Indoor coil high temperature protection shall be provided to detect excessive indoor discharge temperature in heating.
9. Cold blow prevention in heating.
10. Adjustable compensation for air stratification in heating.

I. Accessories:

1. A condensate pump.
2. Programmable wired remote control
3. Refrigeration Lines
 - a. All refrigeration lines must be hidden
 1. Through the wall entering through the back of the unit.
 2. Covered by a refrigeration wall escutcheon.

2.5 CONTROLS

A. General

1. Communication daisy chain wiring to be 2-conductor, twisted pair shielded cable throughout the system

B. Central Control

1. The building shall be installed with a web-enabled factory native central controller. The controller shall provide web users to manipulate the following functions:
 - a. On/Off Control
 - b. Schedule-Adjustment
 - c. Mode Selection
 - d. Setpoint Control (Independent heating and cooling setpoints available)
 - e. Operational Status and Alarm Notifications
 - f. Provide with battery backup and USB port for software updates
 - g. User and Administrator Levels with password protection.
 - h. Customize groups and zones
2. The manufacturer or authorized agent shall commission the central controller to provide a dedicated login and password so that each resident is capable of web access to their A/C system and the building maintenance staff shall have access to the entire HVAC system. (Provide multiple Central Controllers as required for the number of fan coil units.)
3. The owner shall provide the manufacturer's agent with an IP address for each central controller.
4. CONTROL FOR NON-VRF EQUIPMENT – The VRF Central controller shall provide a fully integrated connection to the 100% OA units. If the 100% OA units are not compatible with the VRF Central controller, then a BACnet interface shall be provided for both VRF and OA units and the VRF supplier shall provide a web based central control interface with user interface to control the system. The central controller shall be capable of controlling the following functions of the 100% OA unit:
 - a. Manual Start/Stop
 - b. Setting of operation schedule
 - c. Alarm notification and display of alarms
 - d. Status

- C. Individual Indoor Unit Controller - Wired Wall Mounted Controller (Thermostat)– Each zone/FCU shall include a 7-Day Programmable controller with the following features.
1. Backlit LCD display. Display information shall be selectable from English, French, or Spanish. Day of the week as well as time of day configurable for 12/24 hour clock shall be displayed. Display of temperature information shall be Fahrenheit. The controller shall be able to display and adjust room temperature in one degree increments.
 2. Room temperature sensing Thermistor shall be included in the Zone Controller
 3. The controller shall have COOL, HEAT, FAN ONLY, DRY (dehumidification), and AUTO-CHANGE-OVER modes.
 4. For AUTO change over mode, the controller shall allow independent setpoints for heating and cooling to eliminate wide swings in temperature and unnecessary change over.
 5. Setback function shall be included with adjustable setback temperature override.
 6. The programmable controller shall have the capability of individually disabling the following buttons:
 - a. Menu/OK
 - b. ON/OFF
 - c. Mode
 - d. Fan Speed
 - e. Setpoint Adjustment (Up/Down Keys)
 7. The controller shall allow for a local (controller-level) adjustable limitation of user setpoint range.
 8. SCHEDULING: The following scheduling capability shall be available:
 - a. 7-Day, Weekday/Weekend, or Weekday/Saturday/Sunday schedule formats
 - b. 5 Schedule events per day with independent heat/cool setpoints and/or setback.
 - c. Off-Timer override function that will turn off the system at a set interval when scheduled to be off and a user enables the system
 9. The Remote Controller shall display error codes on the screen in the event of a system error.
 10. The following Fan Coil Unit sensor values shall be available at the wall mounted remote controller:
 - a. Controller thermister temp
 - b. (Refrigerant) Liquid line temperature
 - c. (Refrigerant) Gas line temperature
 11. 48 Hour battery back up of clock/date. All other settings shall be stored in non-volatile memory to ensure that settings are not lost upon power failure.

2.6 REFRIGERANT PIPING:

- A. Refrigerant piping shall comply with all other project specifications.
- B. Refrigerant piping shall be installed in a neat and orderly fashion taking care to avoid to unnecessary traps, bends, elbows, kinks, etc.
- C. Refrigerant piping shall be supported and secured at proper intervals as determined by code and saddled or otherwise installed such that the pipe insulation is protected from compressing by more than 50% of its original dimension.
- D. The installer is responsible for strictly following the manufacturer's guidelines for piping; including the angle and direction of manufacturer supplied fittings, observing rules pertaining to bends before and after manufacturer supplied fittings, and keeping within line length limitations between all equipment and manufacturer supplied fittings.

- E. Pipe sizes, lengths, and elbows shall match exactly to the final piping tree produced by the manufacturer's software and provided in approved submittals and shop drawings.
- F. Piping shall be brazed while maintaining at least 2 psi of flowing nitrogen.
- G. Flaring shall be performed as stated by the manufacturer and produced with tools recommended by the manufacturer.
- H. Pipe insulation shall be a thickness as determined by the applicable code, but never less than the manufacturer's stated guideline and shall be installed completely and without air gaps. Insulation shall be installed on ALL refrigerant pipes. Insulation on pipes exposed to weather shall be protected against UV radiation by coating or jacketing.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Equipment shall be installed as shown or indicated on the drawings and as recommended by the manufacturer.
- B. Variable Refrigerant Flow (VRF) systems use a high pressure refrigerant and have unique installation procedures and requirements. It is imperative that the installation of these systems meet factory specifications in order for the systems to meet the expected performance and efficiency.
 - 1. Factory training for installing technicians. – Prior to installation, the installing mechanical contractor must provide written proof that all installing technicians have received adequate training by the equipment manufacturer or approved alternate. Approved contractors who are awarded this project may contact the manufacturer to arrange training prior to installation for any unqualified technicians. The mechanical contractor's installation price shall be inclusive of the manufacturer's installation requirements including the cost of training, specialty tools, and cost charged by the manufacturer for technical assistance.
 - 2. Job installation support and certification. – In order to assure properly installed system components and approved installation procedures, the specified manufacturer or approved alternate must provide installation technical support for the installing contractor via telephone and the internet, and job site supervision. Upon completion of installation and prior to factory startup, a factory authorized commissioning agent must inspect the installation of each system to verify proper installation. Upon verification of proper installation, the manufacturer is to submit a letter of certification approving the installation of their respective systems.
 - 3. Factory Startup and Warranty Approval – Upon verification and written receipt of proper installation, a factory authorized commissioning agent is to perform a factory approved initial startup of all system components. Such that the requirements to receive the maximum manufacturer's warranty are met and confirmed with the manufacturer.

3.2 PRODUCT SUPPORT

- A. Maintain a fully staffed service office within 400 miles (1 day drive) of the job site. Fully staffed means a full time secretary, complete service library, at least 2 factory trained service technicians and the factory recommended spare parts inventory.

- B. Provide a 24 hour/7 day technical support phone number to factory service office. Support shall be for all components including controls, mechanical components, system operation and alarm codes, etc.
- C. The Manufacturer or local representative shall maintain a complete parts inventory for all systems that will allow for 24 hour receipt of any necessary part.
- D. Provide owner/operator and service training both on line and at designated training centers.

3.3 EQUIPMENT START-UP

- A. The VRF system must be installed by a factory trained contractor/dealer.
- B. The VRF manufacturer's rep shall witness and record 15% of the piping pressure tests. This shall include the first system installed. The contractor is responsible for recording all pressure tests and submitting in the O&M manual.
- C. Equipment start up shall be by factory trained personnel. The startup shall be attended by the controls contractor and Test and Balance contractor.

3.4 PIPING SCHEMATIC

- A. The VRF piping system must be installed by a factory trained contractor/dealer.
- B. The VRF piping system must be installed by a factory trained contractor/dealer based on the manufacturers sizing recommendations.
- C. Heat Recovery shall have full port refrigerant valves on each side of the refrigerant box

END OF SECTION

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