

**PITTSBURG UNIFIED SCHOOL DISTRICT
ADMINISTRATION CENTER**

ADDENDUM NO. ONE

PROJECT: Administration Center
2000 Railroad Avenue, Pittsburg, CA 94565

DATE: January 23, 2023

OWNER: Pittsburg Unified School District
2000 Railroad Avenue
Pittsburg, CA 94565

GENERAL INFORMATION

1. **ITEM NO. G1-1** See attached Agenda and list of attendees to the pre-construction conference.
2. **ITEM NO. G1-2** See attached list of Pre-Qualified PUSD CUPCAA contractors.

DRAWINGS

1. **ITEM NO. D1-1**
Reference: P2.1 PLUMBING FLOOR PLAN
Description: Revise piping layout. Note piping layout is diagrammatic.

PROJECT MANUAL

1. **ITEM NO. PM1-1**
Reference: 230500 Common Work Results For HVAC
Description: Section 230500 Common Work Results For HVAC is included in this addendum. See attached section.
2. **ITEM NO. PM1-2**
Reference: 230593 Testing, Adjusting And Balancing HVAC
Description: Section 230593 Testing, Adjusting And Balancing HVAC is included in this addendum. See attached section.
3. **ITEM NO. PM1-3**
Reference: 230713 Duct Insulation
Description: Section 230713 Duct Insulation is included in this addendum. See attached section.
4. **ITEM NO. PM1-4**
Reference: 233113 Metal Ducts
Description: Section 233113 Metal Ducts is in this addendum. See attached section.
5. **ITEM NO. PM1-5**
Reference: 233300 Air Duct Accessories
Description: Section 233300 Air Duct Accessories is included in this addendum. See attached section.

6. ITEM NO. PM1-6

Reference: 233713 Diffusers, Registers and Grilles

Description: Section 233713 Diffusers, Registers and Grilles is included in this addendum. See attached section.

END OF ADDENDUM NO. ONE



Pre-Bid Conference & Walkthrough

Thursday, 01/19/2023 @ 2:00 PM (PST) at District Admin. Offices Site
Pittsburg USD – District Admin. Offices Portable Project

CONFERENCE AGENDA –

I. Introduction of Project Team Members:

Larry Scott – PUSD Director of Facilities Management & IT
Keith Holtlander – PUSD Project Manager
Donna Fentanes – PUSD Facilities Specialist
Kati Mejia – PUSD Special Projects Accountant
Matthew Belasco – PUSD Director of MO&T Dept.
Mike Barros – PUSD Supervisor of M&O Dept.
Benjamin Trotter – PUSD Supervisor of M&O Dept.
George Barrall, Carl Horner, Daniel Del Moral – PUSD Project Inspectors
Chad Hamilton – Architect/Owner at H+A Architects

II. Schedule:

- A. Thursday, January 26, 2023: Pre-Bid RFI's due by 5:00 PM (PST). Pre-Bid RFI's are to be submitted in writing to Chad Hamilton at c.hamilton@haarchs.com with a copy to Keith Holtlander at kholtlander@pittsburgusd.net.
- B. Tuesday, January 31, 2023 @ 2:00 PM (PST): Bids Due**
- C. February 09, 2023: Notice of Award
- D. February 09, 2023: Notice to Proceed
- E. February 20, 2023: On-Site Construction Work Start
- F. June 02, 2023: On-Site Construction Work Completion
- G. July 07, 2023: Contract Completion

III. Requirements of the Bid:

- A. Preparation of Bid Forms – Complete all bid forms; the bids must be signed in the name of the bidder, and submitted in a sealed envelope bearing the name of the bidder and the name of the Project.
- B. Bid Security – Each bid shall be accompanied by a Bid Bond, a Certified Check, or a Cashier's Check payable to the District as described in the Contract Documents.
- C. Designated Subcontractors List, Site Visit Certification and Non-Collusion Declaration are required to accompany Bid.
- D. Delivery of Bids – **2:00 PM (PST) on Tuesday, January 31, 2023.** Bids will be received at the **District Site Support Services Center, 3200 Loveridge Road, Pittsburg, CA 94565.**
- E. Insurance Requirements – See General Conditions 00 72 13 Article 13 for Insurance and Bonds, and Special Conditions, 00 73 13, Article 6 for Insurance Policy Limits.
- F. Fingerprinting Requirements – See Special Conditions, Article 9 for the specifics.

IV. Site Walk:

A. Area of Work and Site Access

V. Questions and Answers:

PUSD - CUPCAA CONTRACTORS - 2022 (PROJECTS UNDER \$200,000)

Vendor Name	Vendor Type	Type of Work Performed with own forces	Email	ADDRESS	PHONE	License Type	CSLB LICENCE	DIR NUMBER
99 North Construction	General Building & Specialty Contractor	Plumbing	climovdenis@icloud.com	4651 Melody Dr., Apt A, Concord, CA 94521	415-650-6503 p	B, C-36	1044733	1000862728
AAA Fence Company, Inc.	Specialty Contractor	Fencing & Gates	keith@aaafenceco.com	2746 Scott Blvd., Santa Clara, CA 95050	408-200-1720 p 408-970-8680 f	C-13	522762	1000002526
Agbayani Construction Corporation	General Building & Specialty Contractor	General Engineering, Building & Specialty Contractor	vince.agbayani@agbayani.com	88 Dixon Court, Daly City, CA 94014	650-994-9380 p 415-999-0926 m	A, B, C-10, C-20, C-36	650472	1000012612
All County Flooring	Specialty Contractor	Flooring	carl@allcounty-flooring.com	PO Box 965, Benicia, CA 94510	707-205-4229 p 707-280-4100 m 866-321-2909 f	C-15	988380	1000004884
Alten Construction	General Engineering & Building Contractor	Earthwork, Demolition, Concrete, Framing, Rough Carpentry, Masonry	bids@altenconstruction.com	1141 Marina Way South, Richmond, CA 94804	510-234-4200	A, B	705713	1000000530
Ams.Net, Inc.	Specialty Contractor	Sound and Communications	ordertracking@ams.net	502 Commerce Way, Livermore, CA 94551	925-245-6100 p 925-245-6150 f	C-7	763508	1000001046
Arntz Builders, Inc.	General Engineering & Building Contractor	Demolition, Concrete, Rough & Finish Carpentry	bid@arntzbuilders.com kelsey@arntzbuilders.com	431 Payran St., Petaluma, CA 94952	707-835-2900 p 707-835-2993 f	A, B	856393	1000003147
Athens Painting & Commerical Coatings, Inc.	Specialty Contractor	Exterior & Interior Painting	athenspainting@comcast.net	4291 Suzanne Dr., Pittsburg, CA 94565	925-232-4446 p 510-754-3343 m 925-526-4620 f	C-33	1007231	1000032497
August-Jaye Construction	General Building Contractor	General Construction	info@augustjaye.com	P.O. Box 1425, Rohnert Park, CA 94927	707-766-0927 p 707-217-9341 m 707-634-1418 f	B	987876	1000041753
Avidex Industries LLC	Specialty Contractor	Low Voltage/ Audio Visual/ Electrical	biddesk@avidex.com	20382 Hermana Circle, Lake Forest, CA 92630-8701	949-428-6333 p 949-428-6334 f	C-7, C-10	981651	1000004292
Bailey Fence	Specialty Contractor	Fencing	tony@baileyfenceco.com	3205 Baumberg, Hayward, CA 94545	510-783-2980 p 510-783-2989 f	C-13	498661	1000005722
Bay Cities Fire Protection, Inc.	General Building & Specialty Contractor	Fire Protection	bcfp@sbcglobal.net	51 Foley St., Santa Rosa, CA 95401	707-579-8694 p 707-579-8920 f	B, C16	731222	1000045613
B.E.A.M Construction Enterprises, Inc.	General Building Contractor	General Construction	info@beamconstructioninc.com	2127 25th Ave., San Francisco, CA 94116	650-302-8600 p	B	1079434	1000812763
Beals Martin, Inc.	General Engineering & Building Contractor	General Construction & Site Work	dwight@bealsmartin.com	2596 Bay Road, Redwood City, CA 945063	650-364-8141 p 650-367-7645 f	A, B	396189	1000000570
Bel Air Mechanical, Inc.	General Building & Specialty Contractor	HVAC & Sheet Metal	bruce@belairmechanical.com	4100 Alhambra Ave., #2680 Martinez, CA 94553	925-609-9655 p 925-719-0444 m 925-372-0680 f	B, C-10, C-20	844161	1000005475
Bell Products, Inc.	General Engineering, Building & Specialty Contractor	Mechanical, HVAC, Sheet Metal, Plumbing	bids@bellproducts.com	722 Soscol (Mailing P.O. Box 396), Napa, CA 94559	707-255-1811 p 707-266-8782 m 707-255-1908 f	A, B, C-4, C20, C36, C43	171534	1000000656
Best Contracting Services, Inc.	General Engineering, Building & Specialty Contractor	Roofing, Waterproofing, Sheet Metal, Glazing, Wall Panels	estimating@bestcontracting.com	19027 S. Hamilton Avenue, Gardena, CA 90248	310-328-6969 p 310-328-9176 f	A, B, C17, C39, C43	456263	1000000563
BHM Construction Inc.	General Engineering & Building Contractor	Demolition, Masonry, Carpentry	bids@bhmconstruction.com	221 Gateway Road W, Ste. 405, Napa, CA 94558	707-643-4580	A, B	900404	1000000064
Bockmon & Woody Electric Co. Inc.	Specialty Contractor	General Electrical, High Voltage, Solar	garym@bockmonwoody.com arlene@bockmonwoody.com	1528 El Pinal Drive Stockton, CA. 95205	209-464-4878	C10	588308	1000002789
BuildCorp, Inc.	General Building Contractor	General Construction	buildcorpinc@gmail.com	236 West Portal Ave., #787, San Francisco, CA 94127	415-349-1676	B	1066717	1000652541
Cal Coast Telecom (Radonich Corp)	Specialty Contractor	Low Voltage/ Audio Visual/ Electrical	estimating@ccctcom.net	886 Faulstich Court, San Jose, CA 95112	408-275-8888x212 408-640-9704 m 408-275-8895 f	C-7	732886	1000000317

PUSD - CUPCAA CONTRACTORS - 2022 (PROJECTS UNDER \$200,000)

Vendor Name	Vendor Type	Type of Work Performed with own forces	Email	ADDRESS	PHONE	License Type	CSLB LICENCE	DIR NUMBER
C & J Painting	Specialty Contractor	Painting	candjpainting@comcast.net	257 Walnut St., Suite F, Napa CA 94559	707-226-5510 p 707-332-9163 m	C-33	700342	1000002131
C. Overaa & Co.	General Engineering & Building Contractor	Demoliton, Site Grading & Preperation, Excavation, Concrete, Framing, Rough & Finish Carpentry, Cabinetry & Millwork, Mechanical & Piping	carl@overaa.com	200 Parr Blvd., Richmond, CA 94801	510-234-0926	A, B	106793	1000000871
CAL, Inc.	General Building & Specialty Contractor	Abatement, Demo, Paint/Coatings, Environmental & Safety Training	tvargas@cal-inc.com	2040 Peabody Rd., Vacaville, CA 95687	707-446-7996 p 707-450-6177 m 707-446-4906 f	A, B, C21, 22, 33, 39	657754	1000003209
Collins Electrical Company, Inc.	General Engineering, Building & Specialty Contractor	General Electrical	dplaster@collinselectric.com atorres@collinselectric.com	3412 Metro Drive, Stockton, CA 95215	209-466-3691 p 209-466-3146 f	A, B, C10, C31	115427	1000000184
Color New Co.	General Building & Specialty Contractor	Painting & General Building Contractor	colornewco@yahoo.com	22855 Califa St., Woodland Hills, CA 94367	818-884-0856 p 323-854-9845 m 818-884-0217 f	B, C-33	818650	1000001623
Construction West Services, Inc.	General Building Contractor	General Construction	bids@cw-si.com	837 Arnold Dr., Martinez, CA 94553	925-387-8177 p 925-383-4867 c	B	964217	1000002197
CWS Construction Group, Inc.	General Engineering & Building Contractor	General Building and General Engineering	charliejr.cws@gmail.com	42 Digital Drive, Suite 1, Novato, CA 94949	415-599-6545 p 415-209-0228 f	A, B	811153	1000020287
DDK Mechanical, Inc.	General Building & Specialty Contractor	HVAC, Sheet Metal, Plumbing	office3ddk@sbcglobal.net	5761 Florin Perkins Rod., #9, Sacramento, CA 95828	916-383-5190	B, C20, C36, C43	855723	1000002411
DecoTech Systems, Inc.	General Building & Specialty Contractor	Electrical, Communications, Data, Voice, Low Voltage	davidd@decotech.com	1180 Mt. Diablo Blvd., Walnut Creek, CA 94596	925-954-1520 p	B, C-7, C-10	862324	1000003634
Don Lawley Company, Inc.	Specialty Contractor	Demolition	stevehay@donlawleyco.com	PO Box 31807, Stockton, CA 95213	209-466-8088 p 209-456-1185 m 209-780-1972 f	C-21	621509	1000003843
Dowdle & Sons Mechanical Inc.	General Engineering, Building & Specialty Contractor	Mechanical, HVAC, Plumbing	alyssa@dowdleandsonsmech.com	100 Tower Road, American Canyon, CA 94503	707-224-6968	A, B, C-4, C-20, C36	542743	1000000606
Dryco Construction , Inc.	Asphalt, Concrete, Seal Coat, Striping, Tennis Courts, Fence & Iron	Specialty Contractor Daren Young - President Sandra Young - Secretary	aland@dryco.com	42745 Boscell Rd., Fremont, CA 94538	510-438-6500 p 510-719-6573 m	A, & C-13	540379	1000003241
Dynamic Security Technologies, Inc.	Specialty Contractor	Security System/Camera Installation	management@dystinc.com	28301 Industrial Blvd., Suite B, Hayward, CA 94545	510-786-1121 p 510-921-2349 m 510-786-1122 f	C-7	902667	1000043982
Edgeworth Integration LLC	Specialty Contractor	Low Voltage/ Audio Visual/ Electrical	dhaddad@edgeworthsecurity.com	1048 Serpentine Lane, Suite 302, Pleasanton, CA 94566	925-968-2632 p 925-577-2856 m	C-7, C-10	1034768	1000055181
Edward W. Scott Electric Co.	General Building & Specialty Contractor	Electrical	aagrawal@scottelectric.com	500 W. Ohio Ave., Richmond, CA 94804	415-206-7120 p 765-430-0664 m 510-965-9554 f	A, B, C-10	190426	1000005701
E. F. Brett & Company, Inc.	General Engineering & Building Contractor	Sewer, Carpentry, General Labor, Concrete, Misc. Specialities	estimator@efbree.com	1 Commercial Blvd., Suite 203, Novato, CA 94949	415-524-8951 p 707-303-5392 m	A, B	924636	1000000490
EIDIM Group, Inc. dba EIDIM AV Technology	General Building, Specialty Contractor	Audio Visual Systems, Low Voltage Electrical work	estimate@eidim.com	6905 Oslo Cir., Suite J, Buena Park, CA 90621	562-777-1009 p/m 562-777-9120 f	B, C-7, C-10, C-33	824410	1000010711
Fertado Heating & Air, Inc.	Specialty Contractor	HVAC, Architectural Sheet Metal	becky@fertadoheatandair.com	2504 Verne Roberts Circle #101, Antioch CA	925-754-2730 p 925-584-4682 m	C-20, C-43	792474	1000016505
Fix Painting Co.	General Building & Specialty Contractor	Painting & General Building Contractor	aloizu@hotmail.com	23003 Ventura Blvd., Woodland Hills, CA 91364	818-225-0633 p 818-266-4695 m 818-225-0284 f	B, C-33	467787	1000001299

PUSD - CUPCAA CONTRACTORS - 2022 (PROJECTS UNDER \$200,000)

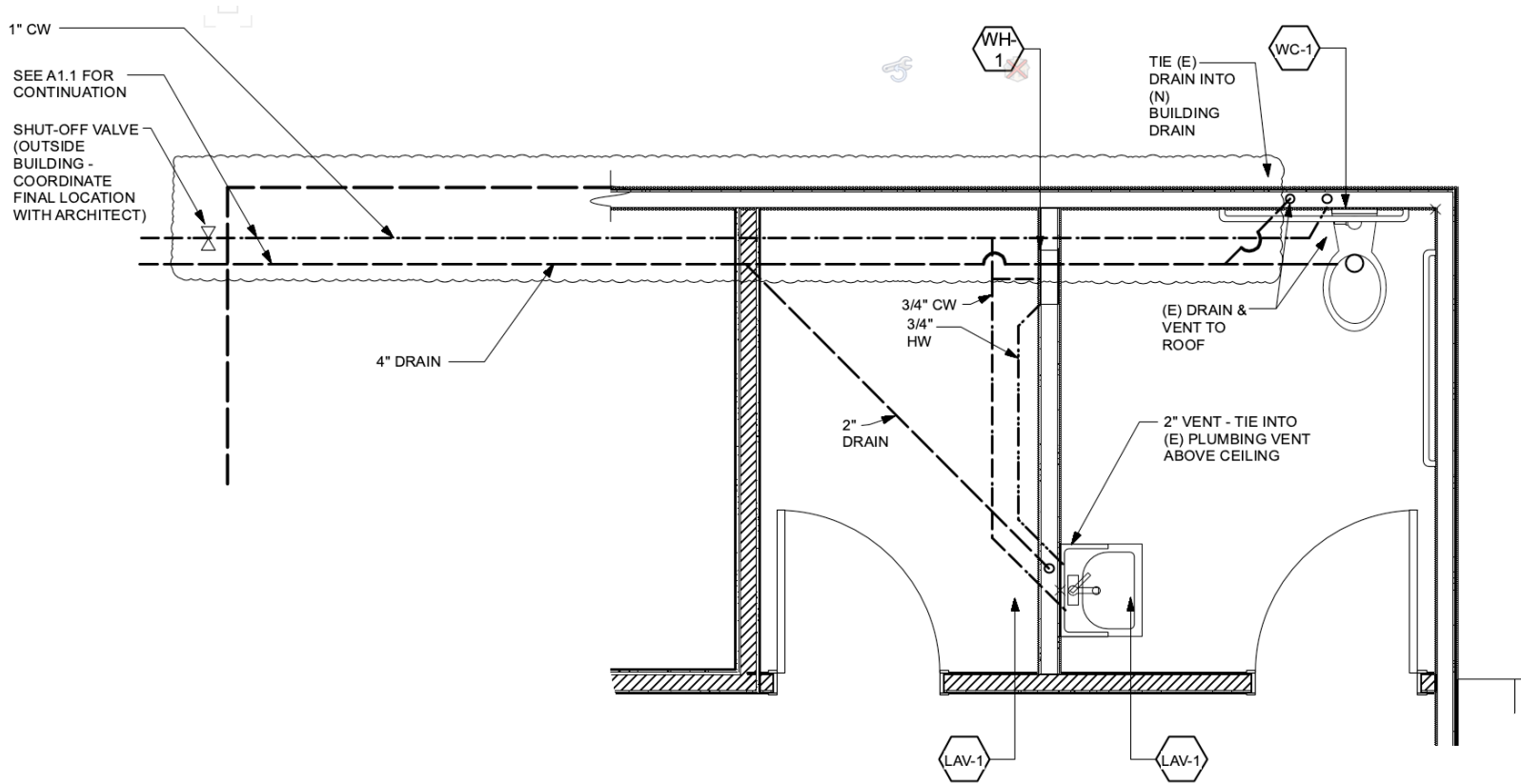
Vendor Name	Vendor Type	Type of Work Performed with own forces	Email	ADDRESS	PHONE	License Type	CSLB LICENCE	DIR NUMBER
Flint Builders Inc.	General Engineering & Building Contractor	General Carpentry, Doors, Frames & Hardware	rtognetti@flintbuilders.com	52 S. First St., Unit 320, San Jose, CA 95113	916-757-1000 p 916-825-4682 m	A, B, C-17	982487	1000000005
FRC, Inc.	General Building Contractor	General Contractor	bids@frcinc.biz	9680 Old Redwood Highway, Windsor, CA 95492	707-837-5065 p 707-369-5509 m 707-837-5623 f	B	715667	1000002179
Freedom Alarm, Inc.	Specialty Contractor	Intrusion Alarm	freedomalarm@yahoo.com	3700 Delta Fair Blvd., Suite 203, Antioch, CA 94509	925-779-1820 p 925-206-9285 m 925-757-7227 f	TBD	AC07698	1000457749
G&S Paving	Specialty Contractor	Asphalt, Grading, Paving, Crack seal, Striping, Coating, Potholes	gnspace@pacbell.net	13 Gold Run Ct., Oakley, CA 94561	925-679-1940 p 925-766-2234 m 925-625-8032 f	C-12	961703	1000004524
George E. Masker Inc.	Specialty Contractor	Painting, Specialty Coatings, Wallcovering, Intumescent Fireproofing	stefanie@maskerpainting.com	7699 Edgewater Drive Oakland CA. 94621	510-568-1206 p 510-760-2123 m	C33	219160	1000000521
Golden Bay Fence Plus Iron Works, Inc.	General Building & Specialty Contractor	Fencing, Gates, Bollards, Security and Wrought Iron	smadrigal@goldenbayfence.com	4104 South B Street, Stockton, CA 95206	209-944-9754 p 209-944-5812 f	A, B, C-10, C-13, C-20	664905	1000000720
Granite Rock Company	General Contractor	Earthwork, Grading, AC Paving, Concrete Work, Structures & Underground.	estimating@graniterock.com	5225 Hellyer Avenue, Suite 220, San Jose CA 95138	408-574-1400 p 408-365-9548 f	A, B, C-12, w/HAZ	22	1000000239
H2I Group	Specialty Contractor	Athletic Equipment, Scoreboards, Bleachers, Lockers and Lab Equipment	mkurnik@h2igroup.com	1679 Placentia Ave., Costa Mesa, CA 92627	714-503-0326 p 949-236-5145 m	C6, C61/D24, C61/D34	1060739	1000537618
Joe's Landscaping & Concrete, Inc.	General Building & Specialty Contractor	Commercial/Residential Landscape	joe@joesic.com janet@joesic.com	802 Inyo Ave., Newman, CA 95360	209-862-2004 p 209-597-2135 m 209-862-3331 f	C27, C8, C61, D49, C13, B	853867	1000047632
J-Walt Construction, Inc.	General Engineering & Building Contractor	General Construction, Modernization, Remodel, Drywall, Painting, Rough/Finish Carpentry, Masonry, Demolition, Concrete, Flooring, Insulation, HVAC, Lathing & Plastering	office@jwaltconstruction.com	1787 E. Main St, Unit 12, Woodland, CA 95776	(530) 406-2278 p (530) 662-1903 f	B	981420	1000032729
Kerex Engineering	General Engineering Contractor	Concrete, Sewer, Underground, Earthwork	patrick@kerexengineering.com	4941 Pacheco Blvd., Martinez, CA 94553	925-387-8913 p 347-613-5788 m 925-387-0853 f	A	1002913	1000033698
K.S. Kruse Plumbing Company	Specialty Contractor	General Plumbing	kriskruse@comcast.net	151 W. Trident Drive Pittsburg CA. 94565	925-427-5547	C36	512710	1000000600
KYA Services LLC	General Contractor & Specialty Contractor	General Building and Flooring Contractor	info@theyagroup.com	1800 E. McFadden Ave., Santa Ana, CA 92705	714-659-6477 p	B, C15, C61/D12	984827	1000003379
Lathrop Construction Associates Inc.	General Engineering & Building Contractor	Carpentry, Concrete Foundations, Specialties	aed@lathropconstruction.com	4001 Park Rd. Benicia, CA 94510	707-746-8000	A, B	415981	1000000073
Lloyd F. McKinney Associates, Inc.	Specialty Contractor	Sound Audio Visual Systems-PA/Clocks, Public Address & Assisted Listening Systems	debbie.smith@mckinneyassoc.com	25350 Cypress Ave., Hayward, CA 94544	510-783-8043	C-7, C10	248851	1000007927
Martinez Sheet Metal	Specialty Contractor	HVAC, Sheet Metal, Plumbing	ap@martinezsheetmetal.com	4040 Pacheco Blvd., Martinez, CA 94553	925-228-3380 p 925-628-2014 m 925-228-3382 f	B, C4, C20, C36, C38, C43	222277	1000004071
MBC Enterprises, Inc.	General Building Contractor	General Construction	admin@mbcenterprises.net	8631 Universe Avenue, Westminster, CA 92683	714-709-6565 m	A, B	1050671	1000064318

PUSD - CUPCAA CONTRACTORS - 2022 (PROJECTS UNDER \$200,000)

Vendor Name	Vendor Type	Type of Work Performed with own forces	Email	ADDRESS	PHONE	License Type	CSLB LICENCE	DIR NUMBER
McGuire & Hester	General Engineering, Building & Specialty Contractor	Grading, Paving, Concrete, Underground & Landscaping	estimating@mcguireandhester.com	2810 Harbor Bay Parkway, Alameda CA 94502	510-632-7676	A, B, C21, C27, C31, HAZ	95879	100000033
Modular Solutions, Inc.	General Building Contractor	Portable Building Moving and Repair	ridenourstan@aol.com	PO Box 231, Atwater, CA 95301	559-431-1559 p 559-978-7080 m	B	826531	1000009328
Opening Technologies, Inc.	Specialty Contractor	Doors, Door Hardware, Key Systems, Access Control	matthewr@openingtech.com	2050 Commerce Ave., Concord, CA 94520	925-674-6900 p 925-348-5683 m 925-674-6995 f	C-28	835076	1000002569
NetXperts, Inc.	Specialty Contractor	Cisco Systems Hardware/Software, Low Voltage	gnordine@netxperts.com	1777 Botelho Drive, Suite 102, Walnut Creek, CA 94596	925-806-0800 p 925-382-9724 m 925-806-0899 f	C-7, C10	869161	1000003207
Pacific Coast General Engineering	General Engineering & Specialty Contractor	Grading, Paving, Underground Concrete, Hazardous Materials Removal	info@pcge.biz ; sam@pcge.biz ;	12 Industry Road Pittsburg CA,94565	925-252-0214	A, HAZ	894723	1000003642
Pacific Power & Systems, Inc.	Specialty Contractor	Electrical, Low Voltage	projects.admin@pacificpowersystemc.com	4970 Peabody Rd., Fairfield, CA 94533	707-437-2300 p 707-437-2388 f	C-7, C-10	458315	1000000158
PCD	Audio Visual Systems	Audio Visual Systems	cvelasquez@pcdinc.net	1032 Maxwell Drive, Santa Rosa CA 95401	707-546-3633	C-10, C-7	527657	1000000341
Pinguelo Const., Inc.	General & Glazing	General & Glazing	pingueloconstruction@yahoo.com	2288 Rockville Road, STE B Fairfield, CA 94534	OFC 707-864-3003 FAX 707-864-1661 CELL 707-580-6644	B, C-17	610938	1000002874
Point 1 Electrical Systems, Inc	General Building & Specialty Contractor	General Electrical, Low Voltage	kirsten.jones@legac-group.com ;	6751 Southfront Road Livermore, CA. 94551	925-667-2950 p 510-876-2061 m 925-667-2901 f	B, C-7, C10	745827	1000000897
Presidential Fire Protection, Inc.	Specialty Contractor	Fire Protection	fabian@presidentialfireprotection.com	4517 Harlin Dr. Sacramento, CA 95826	916-379-9199 p 916-379-9099 f	C-16	847133	1000003447
Professional Asbestos & Lead Serv (PALS)	General Building & Specialty Contractor	Hazardous Materials Abatement & Soft Interior Demolition	steve@palscorp.com	PO Box 31986, Stockton, CA 95213	510-750-7543 p/m	B, ASB, HAZ, C-21, C-22	700658	1000003350
RCM Fire Protection, Inc.	General Building & Specialty Contractor	Fire Protection	dstoffel@rcmfire.com	350 Enterprise Place, Tracy, CA 95304	209-833-8228 p 209-833-8221 f	B, C-16	793205	1000006192
Rodan Builders, Inc.	Carpentry, Demolition, Underground Utilities, Drywal	Carpentry, Demolition, Underground Utilities, Drywal	mlacues@rodanbuilders.com	3486 Investment Blvd., Suite B, Hayward, CA 94545	650-508-1700 p 650-576-1720 f	A, B, C-21	858119	1000003240
Roebelen Contracting, Inc.	General Engineering, Building & Specialty Contractor	General Engineering, Building & Specialty Contractor	estimating@roebelen.com	1241 Hawks Flight Court, El Dorado Hills, CA 95762	916-939-4000 p	A, B, C-8, C-13	734124	1000001469
Russell Sigler, Inc.	Specialty Contractor	HVAC	jmyers@siglers.com	205 South Puente Street, Brea, CA 92821	714-421-2455 m	C-20	960159	1000005440
S&H Construction, Inc.	General Contractor	General Contractor	shcalifornia@yahoo.com	5560 Boscell Common, Fremont, CA 94538	510-579-7352	B, C-20, C-10, C-9	786358	1000000362
Saboo Inc.	General Building & Specialty Contractor	Underground, Electrical, Plumbing, HVAC, Glazing & Concrete	tasghar@sbcglobal.net	415 Beatrice Court, Ste. H, Brentwood, CA 94513	925-418-4447 t 626-260-2849 m	A, B, C-10, C-20, C-17	896479	1000020822
Sausal Corporation	General Contractor	General Construction	josh@sausal.net	3550 Willow Pass Road, Concord, CA 94519	925-568-2200 t 925-568-2525 f	B	281425	1000001877
Smart City Electric Group	Specialty Contractor	Electrical	infosmartcity@yahoo.com	23003 Ventura Blvd., Woodland Hills, CA 91364	818-225-0633 p 510-504-9744 m 818-225-0284 f	C-10	1081062	1000823353
Smith & Sons Electric Inc.	Specialty Contractor	General Electrical	charleen@smithandsonselectric.com ;	44255 Old Warm Springs Blvd. Fremont, CA 94538	510-651-4994	C10	437138	1000000480
Stronger Building Services	General Building & Specialty Contractor	Roofing & General Contracting	strongerbuilding@yahoo.com	580 Harlan St., San Leandro, CA 94577	510-487-8363	B, C-39	955618	1000002136

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Vendor Name	Vendor Type	Type of Work Performed with own forces	Email	ADDRESS	PHONE	License Type	CSLB LICENCE	DIR NUMBER
Sturdisteel Company	Specialty Contractor	Grandstands, Stadium Seating, bleachers, press boxes, banners	rlopez@sturdisteel.net	131 Ava Dr., Hewitt, TX 76643	800-433-3116 t	A	727715	1000001982
Trahan Mechanical, Inc.	Specialty Contractor	HVAC & Sheet Metal	kimberly@trahaninc.com	PO Box 10462, San Rafael, CA 94912	415-457-5541 p/m	C-20, C43	774154	1000006155
VLA Construction, Inc.	General Building & Specialty Contractor	Painting & General Building Contractor	vlainc@hotmail.com	22815 Ventura Blvd., #157, Woodland Hills, CA 91364	818-225-1800 p 818-451-7377 m 818-225-8112 f	B, C-33	1040399	1000060242
Walker Telecomm Inc.	Specialty Contractor	Communications , Voice & Data, Low Voltage	angel@walkertelecomm.com	412 Main St., Wheatland, CA 95692	530-652-4169 p 916-833-3099 m 530-641-1258 f	C-7, C10	953866	1000000137



Item D1-1 Part of P2.1 Plumbing

SECTION 23 05 00 - COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The General Conditions, Supplementary General Conditions, and Division 1 - General Requirements, are hereby made a part of this Section as if repeated herein.
- B. These General Provisions apply to the entire Division 23, Heating Ventilating and Air Conditioning (HVAC).

1.2 DESCRIPTION

- A. Work Included: Furnish all labor, materials, equipment and pay all fees required to complete all HVAC work shown on the drawings and specified herein.

1.3 RELATED WORK ELSEWHERE

- A. Section 00 70 00, Special Condition.
- B. Section 07 92 00, Joint Sealants.
- C. Section 08 31 13, Access Doors and Frames.
- D. Section 09 91 00, Painting.
- E. Division 26, Electrical.
- F. Related work included in other sections:
 - 1. Landscape Irrigation.
 - 2. Site Work.
 - 3. All work in every Section must also comply with such general conditions of the specifications as are applicable, including, but not limited to
 - a. Instructions to Bidders
 - b. General Conditions
 - c. Special Conditions
 - d. Supplementary Conditions
 - e. Division 1 General Requirements
 - 4. Consult all other Sections, determine the extent and character of related work and properly coordinate work specified herein with that specified elsewhere to produce a complete and operable installation. This section is provided to assist Contractor in coordination of work scope but shall not be construed to limit Contractor's scope of work encompassed by the contract documents.

1.4 INCORPORATED DOCUMENTS

- A. Published specifications, standards, tests or recommended methods of trade, industry or governmental organizations apply to work of this Section, including those noted below:
1. Associated Air Balance Council (AABC).
 2. American Gas Standard (AGA).
 3. Air Moving and Conditioning Association (AMCA).
 4. American National Standards Institute (ANSI).
 5. Adhesive and Sealant Council (ASC),
 6. American Society of Mechanical Engineers (ASME).
 7. American Society for Testing and Materials (ASTM).
 8. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE).
 9. National Environmental Balancing Standards (NEBB)
 10. National Electrical Manufacturers Association (NEMA).
 11. National Fire Protection Association (NFPA).
 12. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).
 13. Underwriters' Laboratories, Inc. (UL).
 14. Air Moving and Conditioning Association (AMCA).
 15. Air Diffusion Council (ADC).

1.5 LEGAL REQUIREMENTS AND STANDARDS

- A. General: Comply with applicable sections of state and local codes, laws ordinances, rules and regulations of authorities having jurisdiction.
- B. Codes and Standards: Conform to applicable sections of codes and standards, including:
1. California Energy Conservation Code, Title 24.
 2. Occupational Safety and Health Administration (OSHA).
 3. State Fire Marshal requirements.
 4. California Electric Code (CEC).
 5. California Building Code (CBC).
 6. California Mechanical Code (CMC).
 7. California Plumbing Code (CPC).
- C. Minimum Requirements:
1. Comply with requirements of authorities as minimum acceptable work.
 2. The drawings and specifications take precedence when they call for materials or construction of better quality or larger size than required by codes, laws, rules and regulations.

1.6 QUALITY ASSURANCE

- A. Products Criteria:
1. Supply all equipment and accessories new, free from defects.
 2. Supply all equipment and accessories in compliance with the applicable standards listed in Article 1.4 of this sections and with all applicable national, state, and local codes.
 3. Electrical Equipment: Listed by UL and shall bear their label.

4. Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least 3 years. See other specification sections for any exceptions.
 5. Products shall be supported by a service organization that maintains a complete inventory of repair parts and is located reasonably close to the site.
 6. When two or more units of materials or equipment of the same type or class are required. These units shall be products of one manufacturer.
 7. Manufacturers of equipment assemblies, which use components made by others, assume complete responsibility for the final assembled product.
 8. Nameplate bearing manufacturer's name or identifiable trademark shall be securely affixed in a conspicuous place on equipment, or name or trademark cast integrally with equipment, stamped, or otherwise permanently marked on each item of equipment.
 9. Asbestos products, equipment or materials containing asbestos shall not be used.
 10. Where installation procedures or any part thereof are required to be in accordance with the recommendations of the manufacturer of the material being installed, printed copies of these recommendations shall be furnished to the Owner prior to installation. Installation of the item will not be allowed to proceed until the recommendations are received. Failure to furnish these recommendations can be cause for rejection of the material.
- B. Qualifications of Installers: For the actual fabrication, installation and testing of work under this Section, use only thoroughly trained and experienced workmen completely familiar with the items required and the manufacturer' current recommended methods of installation.
- C. Before any welding is performed, submit a copy of the Welding Procedure Specification (WPS) together with the Procedure Qualification Record as required by Section 9 of the ASME Boiler and Pressure Vessel Code.
1. Before any welder performs any welding, submit a copy of the Manufacturer's Record of Welder or Welding Operator Qualification Tests as required by Section 9 of The ASME Boiler and Pressure Vessel Code. The letter or symbol (as shown on the qualification test form) shall be used to identify the work of that welder and shall be affixed in accordance with appropriate construction code, to each completed weld.
 2. The types and extent of non-destructive examinations required for pipe welds are shown in Table 136.4 if the Code for Pressure Piping, ANSI/ASME.
- D. Requirements of Regulatory Agencies and Standards:
1. Permits: All fees, permits and inspections are owner's responsibility. Deliver all certificates of inspection to Architect.
 2. Arrange and pay all costs for utilities required to complete all work of this Division. Connection to all utility company or on-site services, payment of service charges and provision for and installation of temporary utilities is included.
 3. The requirements of authorities shall be minimum acceptable requirements for the work. When contract drawings or specifications call for materials or construction of better quality for larger size than required by codes, laws, rules and regulations, the drawings and specifications take precedence.

E. Drawings:

1. Because of the small-scale drawings, it is not possible to indicate all offsets, fittings, and accessories that may be required. All scaled and figured dimensions are approximate and are given for estimating purposes only. The Contractor shall carefully investigate the conditions surrounding installation of his work, furnishing the necessary piping, fittings, valves, traps, and other devices that may be required to complete the installation. Before proceeding with any work, carefully check and verify all dimensions and sizes.
2. As far as possible the work has been indicated on the drawings in such position as to suit and adapt to the work of other trades, but the work as indicated is largely diagrammatic and shown primarily for clarity. The general arrangement indicated on the drawings shall be followed as closely as possible. Coordinate with the work of all other trades prior to installation of piping fixtures and equipment to verify adequate space available for installation of the work shown.
3. When apparatus and equipment have been indicated on the drawings, dimensions have been taken from typical equipment of the class indicated. The locations of apparatus, piping, and equipment indicated on the drawings are approximate. Piping and equipment shall be installed in such a manner as to avoid all obstruction, preserve headroom, and keep openings and passages clear. The locations of and mounting heights of all fixtures shall be coordinated with the architectural plans and room elevations.
4. Where equipment is furnished by others, verify dimensions and the correct locations of this equipment before proceeding with the rough-in of connections.
5. Be responsible for any cooperative work which must be altered due to lack of proper supervision or failure to make proper provision in time. Such changes shall be directly supervised by the Architect and made to his satisfaction.
6. Special Note: Should the Contractor make changes in the installation differing from what is indicated on the contract drawings and not necessitated due to field conditions as indicated hereinabove, the Contractor shall be required to re-install the work to comply with what has been indicated on the contract drawings. Should it be impossible to re-install the work and the installation is in accordance with all governing authorities, the architect may permit the installation to remain. However, all costs incurred to revise the contract drawings by the engineer for submittal to the building department indicating the as-installed condition shall become the responsibility of the Contractor.

1.7 COORDINATION

- A. Coordinate size and location of structural-steel support members.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided.
- C. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.
- D. Refer to §1.12 for Submittal Requirements.

1.8 DEFINITIONS

- A. Exposed: Piping, ductwork, and equipment exposed to view in finished rooms, or completed work.
- B. Option or Optional: Contractor's choice of an alternate material or method.
- C. Install: To physically erect, mount and connect complete with related accessories.
- D. Supply: To purchase, procure, acquire, and deliver complete with related accessories.
- E. Furnish or Provide: To supply, install, complete connections, and ready for safe and regular operation of work referred to, unless specifically noted otherwise.
- F. Work: Labor, materials, equipment, apparatus, controls, accessories, and other items required for proper and complete installation.
- G. Wiring: Raceway, conduit, fittings, wire, boxes, and related items.
- H. Concealed: Embedded in masonry or other construction, installed in furred spaces, within double partitions or hung ceilings, in trenches, in crawl spaces, or in enclosures, and not exposed to view in the completed work.
- I. Reviewed, Satisfactory, Accepted, or Directed: As reviewed, satisfactory, accepted or directed, by or to Engineer.
- J. Motor Controllers: Manual or magnetic starters (with or without switches), individual pushbuttons or hand (HOA) switches controlling the operation of motors.
- K. Control or Actuating Devices: Automatic sensing and switching devices such as thermostats, pressure, switches, and relays, etc., controlling operation of equipment.
- L. Indicated, as Shown, or Noted: As indicated, shown, or noted on Drawings or Specifications.
- M. Similar or Equal: Of base bid manufacturer, equal in materials, weight, size, design, and efficiency of specified product.
- N. Engineer: Mechanical Engineer of Record.
- O. Accessible: Capable of being reached without the use of ladders, or without climbing or crawling under or over obstacles such as motors, fans, pumps, belt guards, transformers, high voltage lines, piping, and ductwork.

1.9 SITE EXAMINATION

- A. Before bidding on this work, Contractors shall make a careful examination of the premises and shall thoroughly familiarize themselves with the requirement of the contract. Compare site and existing conditions to the mechanical, electrical, architectural, structural, civil, and other drawings and specifications. Call any discrepancies to the attention of the Architect during bidding period. Make allowances for them in preparing the bid.

1.10 ELECTRICAL WORK

- A. Quality: Work shall comply with requirements of Division 16 and applicable codes.
- B. Wiring: all wiring shall be in electrical conduit or as indicated on drawings.
- C. HVAC Control Wiring: Provide control wiring for starter holding coils, relays, interlock, and temperature controls.
- D. Provide controls, controllers, relays, transformers, switches, time clocks, etc., required by work of this Division. Install duct mounted smoke detectors furnished by Fire Alarm products.

1.11 SUBSTITUTION OF MATERIALS:

- A. The design has been based on the manufacturer's name and product listed on the drawings or named first in these specifications. Other manufacturers' names or same manufacturer but different product line listed in these specifications may be selected and considered "as equal" for quality only; however, they must match the performance, construction, fit and features of those selected for design. The acceptance of these does not relieve the Contractor for responsibility of providing the required materials and providing a workable system.
 - 1. In addition to the Submittal Requirements for labeling listed above, product data sheets for the specified item shall be clearly labeled "SPECIFIED ITEM, NOT SUBMITTED". Product data sheets for the corresponding proposed substitution item shall be clearly labeled "PROPOSED SUBSTITUTION".
 - 2. It shall be the Contractor's responsibility to provide sufficient information to allow the Engineer to analyze any proposed alternate. If inadequate information is provided, the proposal will not be reviewed, and the submittal will not be allowed.
- B. Should the contractor wish to substitute equipment or material other than those considered for the basis of design, the contractor shall submit information as called for in "Submittal of Materials and Equipment" for both the specified or scheduled item and the substitute item. These submittals will show that both the specified and the substitute material match in quality, performance, construction, fit and features of those selected for design. Any equipment or material submitted for substitution without the comparison information will not be reviewed or acceptable.
- C. Liability of Substitutions:
 - 1. Performance of substitutions must be equal to the item specified. If the substituted item fails to perform according to the specifications, replace with the originally specified item without extra compensation on request of the Architect any time within the guarantee period.
 - 2. The contractor is responsible for the cost of any changes to other trades and additional Architectural and Consulting fees resulting from approved substitutions in mechanical equipment.
 - 3. The Contractor assumes full responsibility that alternate items and procedures will meet the job requirements and is responsible for cost of redesign and of modifications to this and other parts of work caused by alternate items furnished under work in this Section. In view of these responsibilities, it is the purpose of

these specifications to establish procedures to ensure that the Contractor has considered all the ramifications of proposed alternates before submitting them for review. Submittals which do not comply with the requirements of these specifications or which indicate proposed alternates that were selected without proper regard to the requirements of the job will not be approved. No more than one proposed alternate will be considered for each item.

4. Alternate items installed without Engineer's approval will be replaced with specified items at Contractor's expense.

1.12 SUBMITTAL OF MATERIALS AND EQUIPMENT

A. Submittal:

1. Submittals for a product or material or area of work must be complete. **PIECEMEAL SUBMITTAL WILL NOT BE ACCEPTABLE.** All submittals shall be factory or manufacturer certified. Vendor's submittal data not acceptable.
2. Have all product data sheets clearly labeled to indicate the individual items being submitted. In addition, all required options and accessories shall be clearly marked.
 - a. Product data sheets corresponding to items indicated on plans shall be clearly labeled with the corresponding fixture or equipment tag number.
 - b. Product data sheets corresponding to items indicated in specifications shall be clearly labeled with the specification section, page, and item numbers.
3. Identify submittal with Architect's project name, number and with item designation as indicated on drawings, and referenced to applicable paragraphs of the specification. Submit in brochure form.

- ### B. Review of Submittal:
- These will be reviewed for general design only, and not for method of assembly, erection, construction, or detailed compliance with contract documents. All submittals shall be factory or manufacturer certified. Submittal technical data and dimensions by Vendor are not acceptable.

C. Manufacturer's Data:

1. Include data for all material and equipment that will be installed.
2. Include complete catalog information such as construction, capacities, types, fan curves, pump curves, sizes, etc. Also include dimensional data, and sufficient information to illustrate compliance with the specifications and list labeling and/or approving agencies and standards of design employed in manufacturer data.

D. Shop Drawings:

1. Prepare dimensionally accurate floor plans and Sections in tight conditions as required of all equipment rooms and all floor plans. Show all equipment, complete ductwork, piping (including plumbing and sprinkler pipes), accessories, and clearances for operating servicing and coordination with other systems. Indicate bottom elevation for both pipes and ductwork.
2. Automatic temperature control systems, wiring diagrams, control panel boards. Include in wiring diagrams all low and line voltage wiring and equipment.
3. Drawings clearly identified with the Architect's project name and number, and a sheet title identifying its contents.
4. Show location of thermostat(s) and sensors.

1.13 SHOP, OFFICE, AND STORAGE

- A. Provide temporary shop, office, and storage space on site only at locations approved by Architect, as required for execution of work. Remove these facilities upon completion of work.

1.14 JOB CONDITIONS

- A. Where new pipes are to be connected to an existing pipe, verify location, size, elevation, and all other information necessary for connection. This verification shall be done prior to installation of the new pipe. Should there be a problem, contact the Architect immediately to resolve the problem.
- B. Interruption of Services:
 - 1. Before making any connections or doing any work which interrupts services to existing buildings, notify Owner in writing at least 72 hours in advance; and such work performed as quickly as possible and only at such times as designated by Owner.
 - 2. Length of time existing services is shutdown to be approved by Owner.
- C. Restoration of Damage: Repair or replace, as directed by Architect, materials and parts of premises which become damaged because of installation of work of this Division. Remove replaced parts from premises. Keep accumulation of dust and debris to a minimum. Remove and dispose of debris in a legal manner. Burning and/or selling material at the site is prohibited.
- D. Storing Mechanical material in Premises:
 - 1. Duct and mechanical equipment on site must be covered before installation.
- E. Cleaning Equipment and Premises:
 - 1. Clean equipment and materials: Remove all dirt, grease, splashed paint, plaster and similar foreign materials. Restore damaged finishes to original condition.
 - 2. Site Cleaning: Remove from site all packing cartons, scrap materials and other rubbish resulting from operations.

1.15 REVIEW OF CONSTRUCTION

- A. Work may be reviewed at any time by representatives of Owner or representatives of Architect.
- B. Advise Architect that work is ready for review at following times:
 - 1. Prior to backfilling buried work.
 - 2. Prior to concealment of contract have been completed.
 - 3. When requirements of contract have been completed.
 - 4. Do not backfill or conceal work without Architect's consent.
- C. Maintain on job a set of specifications and drawings for use by Architect's representative.

- D. Noncompliance: Should any of the work be covered up or enclosed prior to all required inspections and approvals, uncover the work as required and, after it has been completely inspected and approved, make all repairs and replacements with such materials as are necessary to the approval of the Architect and at no additional cost to the Owner.

1.16 MATERIALS

- A. In addition to material and equipment specified, also provide incidental materials required to effect complete installation. Such incidental materials and equipment shall be uniform throughout the installation. Equipment or fixtures of the same type shall be of same manufacturer.
- B. Protection of Materials:
 - 1. Protect materials, equipment and apparatus provided under this Division from damage, water, dust, or similar impairment, both in storage and installation until Notice of Completion has been filed. Materials, equipment, or apparatus damaged because of improper storage or protection will be rejected and must be removed from the site.
 - 2. Cap openings in pipes and ends of valves with manufactured caps and fittings. Do not use taped caps.
 - 3. Protect premises and work of other Divisions from damage arising out of installation of work of this Division.

1.17 TESTING

- A. Provide tests specified hereinafter, where applicable. Provide written verification that the tests have been successfully completed.

1.18 RECORD DRAWINGS (AS-BUILT DRAWINGS)

- A. Contractor shall provide and keep up to date a complete and accurate "as-built" record set of blue line prints which shall show every change from the original drawings and the exact "as-built" locations and sizes of the work provided under this Section of the specifications. This set shall include locations, dimensions, depth of buried piping, ts, shut-off valves, etc. This record shall be kept up to date on blue line prints as the job always progresses and made available for inspection. Submit completed drawings to Architect in compliance with Division 1.
- B. Include on as-built drawings:
 - 1. Main shut-off valves plainly marked and identified.
 - 2. Position of all buried or concealed mains accurately dimensioned, both horizontally and vertically.
 - 3. Changes in location of piping, duct, or equipment from construction documents. Bottom elevations of each duct and pipe.
 - 4. Ceiling and duct access panel locations.
 - 5. Location of temperature control devices including static pressure control probe, stats, selected zones, etc.

6. Location of all equipment.

1.19 OPERATING AND MAINTENANCE DATA

- A. General: Submit to the Architect before acceptance of the installation, complete and at one time. Partial or separate data will not be accepted. Data shall consist of the following minimum submissions:
 1. Piping Identification Schedule: Copy of charts as specified under valve tags and charts.
 2. Simplified and consolidated control drawings.
 3. Equipment: List of nameplates, including nameplate data and system served.
 4. Manufacturer's Literature: 3 copies of manufacturer's instructions for operation and maintenance of all mechanical equipment, including replacement parts list.
 5. Written Instructions: Typewritten instructions for operation and maintenance of these systems composed of Operating Instructions and Maintenance Schedule. 4 copies submitted to the Engineer for approval.
 6. Operating Instructions: A brief description of the system indicating proper setting of switches and other equipment furnished for providing control of the system and its components by the operator. Do not include adjustments requiring the technical knowledge of the service agency personnel.
 7. Maintenance Instructions: A list of each item of equipment requiring inspection or lubrication, describing the performance of such maintenance, and the month of the year when each item of equipment should be inspected, serviced, or lubricated.
 8. Maintenance Schedule: A list of each item of equipment requiring maintenance, showing the exact type of bearing on every component of each item of equipment, and the frequency when each item of equipment should be inspected or serviced.
 9. Verbal Instructions: Upon completion of the work, and at a time designated by the Architect, instruct the Owner's representative in the operation and maintenance of the equipment supplied by his company.
 10. Binders: Four complete sets of the above data in loose ring binders with permanent covers, with permanent identification on back and index.

1.20 COMPLETION

- A. Before Final Review: The work hereunder will not be reviewed for final acceptance until Operating and Maintenance Data, Manufacturer's Literature, Valve Directories, Piping Identification Code Directory, and nameplates specified herein have been approved and properly posted in the building and final cleaning has been completed.
- B. Demonstration of Operations: When the installation is complete and adjustments specified herein have been made, operate the systems for one week, during which time demonstrate to the Architect that systems are completed and operating in conformance with these specifications.

1.21 GUARANTEE

- A. General: Conform to the GENERAL CONDITIONS of the specifications.
- B. Contractor shall guarantee the entire plumbing and piping systems unconditionally for a period of one (2) year after final acceptance. If, during this period, any materials, equipment, or any part of the systems fail to function properly, the Contractor shall make good the defects promptly and without any expense to the Owner.
- C. Contractor shall be responsible for all damage to any part of the premises caused by leaks in pipelines or equipment furnished and installed under this Section for a period of two (2) years after date of acceptance of his work.
- D. Parts Warranty: Provide standard warranty of manufacturer for replacement of parts to apply after expiration of above period. Furnish replacement parts to Owner or to his service agency as directed. Furnish Owner printed manufacturer's warranties' complete with material included and expiration dates upon completion of project.
- E. Warranty also applies to services including instructions, adjusting, testing, noise, balancing, etc.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Beyond material and equipment specified, also provide incidental materials required to effect complete installation. Such incidental materials include solders, tapes, caulking, mastic, gaskets, and similar items.
- B. Materials and equipment shall be uniform throughout the installation. Equipment of the same type shall be of same manufacturer.
- C. Products from other manufacturers not listed shall submit specifically in accordance with Specification Section 01630 – Product Substitution Procedures.

2.2 HANGERS AND SUPPORTS

- A. All required seismic bracing shall be installed as per Title 24, Part 2, 2019 CBC for total lateral forces prescribed in ASCE 7 Section 13.3 as defined in ASCE 7-16.
- B. Installation shall be as published by SMACNA for non-seismic support or OSHPD anchorage pre-approved seismic restraint system see section 2.4. All hanger material to be electroplated zinc or hot-dipped galvanized. No plain (black) finish allowed.
- C. Trapeze suspension (trapeze hangers may be used for parallel lines if pipes pitch same direction): Size channel assembly in accordance with manufacturer's published load ratings. No deflections shall exceed 1/360 of span (refer to Superstrut load tables).
- D. Support and laterally brace all ducts, pipes, and equipment per latest SMACNA Manual Standards.

- E. Do not support weight of piping from mechanical equipment, i.e., coil connections.
- F. Do not cut or weld to any structural steel without permission of Architect.
- G. Provide Semco, Trisolator, or equal pipe isolator at all hangers for non-insulated pipes.
- H. Schedule of hangers and supports:

INDIVIDUAL PIPE HANGERS		
Pipe Size - inches	Hanger	Minimum Rod Size - inches
½" thru 2"	Superstrut C711	3/8"
2½" thru 3"	Superstrut C711	½"
4" and 5"	Superstrut C711	5/8"
6"	Superstrut C711	¾"
8"	Superstrut C711	7/8"

TRAPEZE HANGERS	
Single or Double 12 Gauge Channel	Superstrut A1200 or A1202
Straps	Superstrut 70 or 702 series
Pipe Isolators	Superstrut 1-716 Cush-A-Clamp

WALL SUPPORT	
Individual pipe sizes up to 3"	Superstrut S250
Individual pipe sizes 4" thru 8"	Superstrut S251

2.3 ROOF, WALL, AND FLOOR PENETRATIONS

- A. All pipe penetration through poured concrete wall or floor shall be sealed with Metra-seal as shown on drawings. All other pipe penetration holes shall be sealed with a product that will seal against the spread of flame, smoke, gases and water, for up to a 3-hour rating. Product shall be as manufactured by 3M Brand (Fire Barrier Penetration Sealing Systems) or equal. Product must have been tested and classified by Underwriters' Laboratories and listed in the UL Building Materials Directory; "Through-Penetration Fire stop Systems (XHEZ)," and "Fill, Void or Cavity Materials (XHHW)." Submittal shall reflect product and manufacturers Spec-Data sheet reflecting approvals.
- B. Provide pipe sleeves as follows:

SLEEVE LOCATION	SLEEVE MATERIAL
Floor membrane waterproof	Duco cast iron body with floor and roof construction flashing device, under deck clamp as required, J.R. Smith 1720 or approved equal. Non membrane floor and Standard weight black steel exterior wall pipe with a

SLEEVE LOCATION	SLEEVE MATERIAL
	continuously welded water stop of 1/4" steel plate extending from outside of sleeve a minimum of 2" all around.
Non membrane floor and continuously exterior wall construction.	Standard weight black steel pipe with a welded water stop from outside of a sleeve, a minimum of 2" all around

C. Length of sleeves as follows:

SLEEVE LOCATION	SLEEVE LENGTH
Floors	Equal to depth of floor construction including finish. Extend minimum 2" above floor level in unfinished area, and in pipe chases.

D. Escutcheons: Provide 1" wide chrome or nickel plated plates on all pipes exposed to view, passing through floors, walls, partitions, etc. Escutcheons sized to fit pipe and pipe covering and give a finished appearance. Escutcheons held in place by set screws. Provide plates on pipes extending through sleeves.

2.4 SEISMIC RESTRAINTS

- A. General Requirements: Seismic restraints shall be provided for all vibration isolated equipment, both supported and suspended, and all vibration isolated piping.
- B. Where anchorage details are not shown on the drawings, the field installation shall be subject to the approval of the mechanical engineer and the project inspector.
- C. All mechanical equipment shall be braced or anchorage to resist horizontal force acting in any direction using the following criteria:
- The total design lateral seismic force shall be determined from ASCE 7 Section 13.3.1, California Building Code (CBC) 2019. Forces shall be applied in their horizontal directions, which result in the most critical loadings for design. The value of a_p (component amplification factor) and R_p (component of modification factor) of Section 13.3.1 shall be selected from Table 13.6-1, ASCE 7. The value of I_p (seismic importance factor) and S_{DS} (special acceleration) shall be selected from Section 13.1.3 and Section 11.4.4, ASCE 7, respectively.
- D. For Supported Equipment:
- Pre-approved isolator restraint system by the State of California OSHPD and bear approval number.
 - Submittal shall include load versus deflection curves up to 1/2" in the x, y, and z planes. Tests shall be conducted in an independent laboratory or under the signed supervision of an independent registered engineer. The snubber assemblies shall be bolted to the test machine as the snubber is normally installed. Test reports shall certify that neither the bridge bearing neoprene elements, nor the snubber body has sustained any obvious deformation after release from the load.

3. Submit calculations for each seismic restraint and vibration isolation signed by structural Registered Engineer.
- E. Seismic Restraint Systems for Ductwork and Piping:
1. Piping, ductwork, and electrical distribution systems shall be braced to comply with the forces and displacements prescribed in ASCE 7-10 Section 13.3 as defined in ASCE 7-16 Section 13.6.8, 13.6.7, 13.6.5.6, and 2019 CBC Section 1616A.1.23, 16A.1.24, 1616A.1.25 and 1616A.1.26.
 2. The bracing and attachments to the structure shall be detailed on the approved drawings or they shall comply with one of the OSHPD pre-approval of manufacturer's certifications (OPM) as modified to satisfy anchorage requirements of ACI 318-14 Chapter 17.
 3. Copies of the OPM manual(s) shall be on the jobsite prior to the start of hanging and bracing of the ductwork and pipe distribution systems.

2.5 IDENTIFICATIONS

- A. Equipment: Each piece of motor-driven equipment shall be identified by engraved plastic-laminate signs. Signs shall be a minimum of 4½" x 1½" with minimum of ½" high white letters on a black background, mounted permanently on equipment. The names shall correspond to those given on the control panels be identified as to the area or space served by the equipment. Automatically started motors shall have warning sign: "THIS MOTOR MAY START AT ANY TIME." The equipment shall be further identified with the electrical panel and circuit.

2.6 TOOLS AND LUBRICANTS

- A. Furnish and turn over to the owner special tools, 2 sets minimum, for each type or size of tool not readily available commercially, that are required for disassembly or adjustment of equipment and machinery furnished.
- B. Grease guns with attachments for applicable fittings: one for each type of grease required for each motor or other equipment.
- C. Tool containers: Hardwood or metal, permanently identified for intended service and mounted, or located where directed by the owner.
- D. Lubricants: A minimum of one quart of oil and one pound of grease of equipment manufacturer's recommended grade and type in unopened containers and properly identified as to use for each different application.

PART 3 - EXECUTION

3.1 REVIEW OF CONSTRUCTION

- A. Work may be reviewed any time by representative of Architect.
- B. Advise Architect that work is ready for review at following times:

1. Before concealment of work in walls and above ceilings.
2. When requirements of Contract have been completed.

C. Do not conceal work without Architect's consent.

D. Maintain on project site a set of specifications and drawings for use by Architect's representative.

3.2 NOISE AND VIBRATION

A. Correct conditions at no cost to the Owner if noise or vibrations because of improper material or installation occurs in the building.

3.3 GENERAL INSTALLATION METHODS

A. Where pipe passes through seismic joint: install flexible connection as manufactured by Metraflex to allow vertical and horizontal movement during an earthquake.

B. Where ductwork passes through seismic joint: install a minimum of 12" flexible connector, compressed by half for flexible movement of buildings.

C. Carpentry, Cutting, Patching and Core Drilling:

1. Provide carpentry, cutting, patching, and core drilling required for installation of material and equipment specified in this Division.
2. Do not cut, core or drill structural members without consent of Architect.
3. All asphalt and concrete sawing shall not have any outside corners cut.

D. Waterproof Construction:

1. Maintain waterproof integrity of penetration of materials intended to be waterproof. Caulk penetrations of foundation walls and floors watertight. Provide membrane clamps at penetrations of waterproof membranes.
2. Provide weatherproof NEMA 3R enclosures for all equipment or devices mounted outside or otherwise exposed to the weather.

E. Sleeves, Chases, and Concrete Inserts:

1. Provide all required sleeves, chases, concrete inserts, anchor bolts, etc., and be responsible for correct location, installation of same.
2. Sleeves and chases are prohibited in structural members, except where approved in writing.
3. Locating and sizing of openings for ductwork through walls, etc., under this Division.
4. Provide sleeves for each pipe passing through walls, partitions, floors, and roofs.
5. Set all pipe sleeves and inserts in place before concrete is poured. Coordinate the placing of these items to avoid delaying concrete placing operations.
6. Locate all chases, shafts, and openings required for the installation of the mechanical work during framing of the structure. Do any additional cutting and boring required due to improperly located or omitted openings without cost of the Owner under the supervision of the Architect.

7. Sleeves for un-insulated pipe shall be two pipe sizes larger than pipe passing through or a minimum of 1/2" clearance between inside of sleeve and outside of pipe.
8. Sleeves for insulated piping of adequate size to accommodate the full thickness of pipe covering with clearance for packing and caulking.
9. Caulk space between sleeve and pipe or pipe covering with an incombustible, permanently plastic, water-proof non-staining compound leaving a finished, smooth appearance or pack with incombustible fibrous glass to within 1/2" of both wall faces and provide plastic, water-proof caulking compound.
10. Finish and Plates: Smooth up rough edges around sleeve with plaster.

F. Mechanical Equipment:

1. Where not otherwise indicated, basis for equipment and material installation is published recommendations of respective manufacturer.
2. Equipment:
 - a. Accurately set and level with supports neatly placed and properly fastened. No allowance of any kind will be made for negligence on part of Contractor to foresee means of bringing in, installing equipment into position inside building.
 - b. All equipment shall be installed accessible on all sides with operable areas having a minimum space clearance as recommended by the manufacturer.
 - c. Where the School District determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance, equipment shall be removed, and reinstalled or remedial action performed as directed at no additional cost to the Owner.

G. Piping and/or Ductwork Systems:

1. Work into complete integrated arrangement, with like elements to make work neat appearing finish.
2. Run concealed, except as shown otherwise.
3. Exposed pipes and ductwork to run parallel with walls or structural element. Do not install any exposed pipe or ductwork without prior approval of Architect.
4. Install with adequate passageways free from obstructions, as high as practicable to maintain adequate head room, as shown or as required. Coordinate with work of other Divisions to achieve proper head room as specified in this Division.
5. Clearance: Do not obstruct spaces required by code in front of electrical equipment, access doors, etc.

3.4 TESTING AND ADJUSTING

- A. General: All defects disclosed as result of the following or other tests or operations shall be promptly repaired by and at expense of Contractor and to Architect's satisfaction. Test shall comply with all necessary codes, rules, and regulations as noted herein before. Contractor shall supply all instruments, labor and tools required by tests. Any defective material and/or equipment shall be repaired, adjusted, and replace by new, like materials and equipment, and retested before acceptance.
- B. Clean and purge equipment and piping before each test.

- C. Test various mechanical systems in portions as work progresses. Any system or portion previously tested to become part of any repeated test when it becomes part of distribution or collection system.
- D. Maintain test pressures for periods stated, or as directed, without loss in pressure except that due to change in temperature or authorities having jurisdiction.
- E. Operational Tests: Operational tests shall be made on all machinery and devices to determine proper compliance with specifications. All equipment shall function quietly and efficiently; any undue noise or vibration caused by malfunctioning of piping and equipment shall be promptly repaired and/or corrected before acceptance.
- F. Timing of Tests: Two weeks before expected completion date, the Contractor shall put all systems and equipment into operation and shall continue operation of same during each working day, but not less than five 8-hour periods, until all adjusting, balancing, testing, demonstrations, instructions, and cleaning of systems have been completed. Instructions and demonstrations required shall be given simultaneously with this operation.
- G. Duct Leakage Tests: All ductwork with 2" W.C. or higher static pressure shall be tested for leaks, using necessary instruments. Conduct tests as recommended in SMACNA balancing manual. Ductwork handling air pressure less than 2" W.C. static pressure shall be sealed wherever visible or tactile observations reveal leakage.
- H. After completion of testing and adjustment, operate the different systems and equipment under normal working conditions for two days and show specified performance. If, in the opinion of the Architect, performance of equipment or systems is not according to specifications or submitted data, alter, or replace equipment at no increase in contract sum. Contractor, at his option, may order tests from an independent approved laboratory to prove compliance. All such tests shall be at no increase in contract sum.

3.5 INSTALLATION OF PIPING AND EQUIPMENT

- A. Closing-In of un-inspected Work: Do not allow or cause any of the work to be covered up or enclosed until it has been inspected, tested, and approved by the Architect. Any work enclosed or covered prior to such inspection and test shall be uncovered and, after it has been inspected, tested, and approved, make all repairs with such materials as may be necessary to restore all work, including that of other trades, to its original and proper condition.
- B. Before laying of any pipe or digging of any trenches, Contractor shall determine by actual excavation and measurement exact locations and depth of existing utility and service lines to which he is going to connect. In event depth of existing sewer main or storm drain is not sufficient to permit installation of piping as detailed on drawings or to make connection in manner indicated; Contractor shall confer with the Architect, Owner's representative and Engineer for Direction.
- C. Conceal all piping within finished rooms, unless otherwise noted on drawings.

- D. Cut pipe accurately to measurements established at the building; work into place without springing or forcing; properly clear all windows, doors and other openings. Excessive cutting or other weakening of the building structure to facilitate piping installation will not be permitted.
- E. Make all changes in direction with fittings and changes in main sizes through eccentric reducing fittings. Unless otherwise noted, install water supply and return piping with straight side of eccentric fittings at top of pipe.
- F. Provide sufficient swing joints, ball joints, expansion loops, and devices necessary for a flexible piping system.
- G. Provide union and isolating valves on piping at all equipment or apparatus. Locate valves so that the equipment can be removed without dismantling any branch lines.
- H. Install drain valves at all low points of each system to enable complete drainage, and air vents at all high points in the piping system to enable complete air venting. Install automatic air vent at all high points in the main piping systems.
- I. Support piping independently at pumps, coils, tanks, and the like so that its weight will not be supported by the equipment.
- J. Pipe all drains from pump glands, drip pans, relief valves, air vents, etc., to spill over an open sight drain, floor drain or other acceptable discharge points, and terminate with a plain end unthreaded pipe, 2" above the drain.
- K. Securely bolt in place to building structures, all equipment, isolators, hangers, etc.
- L. Pitch pipeline as required for proper drainage and elimination of air.
- M. Wire for hanging or strapping pipes not permitted.
- N. Support each run of piping independently from all other piping.
- O. Install spring vibration isolation in mechanical rooms and penthouse for all pipes' elbows and within 40 feet of pipe length.
- P. Equipment Access
 - 1. Install all piping, equipment, and accessories to permit access for maintenance. Relocate piping, equipment and accessories required to provide maintenance access at no additional cost.
 - 2. Furnish access doors where any valves and equipment requiring access for servicing, repairs or maintenance located in walls, chases, or above ceilings. Coordinate the location of access doors of access doors with and install by the applicable Contractor installing walls or ceilings.
- Q. Install gauges, thermometers, valves and other devices with due regard for ease in reading or operating and maintaining said devices. Locate and position thermometers and gauges to be easily read by operator or staff standing on floor or walkway provided. Servicing shall not require dismantling adjacent equipment or pipe work.

3.6 PIPE JOINTS

A. Copper Tubing:

1. Cut square, remove burrs, and clean pipe and inside of female fitting to a bright finish with steel wool, wire brush, sandpaper or emery cloths. Apply solder flux with brush to tubing. Remove internal parts of solder-end valves prior to soldering.
2. Provide dielectric unions at points of connection of all copper tubing and any ferrous piping and equipment.
3. Joining of Copper Pipes:
 - a. Piping 1 1/2" and smaller: 95-5 solder
 - b. Piping larger than 1-1/2": Sil-Fos brazing 1000°F minimum.
 - c. All solder shall be lead free.

3.7 HANGERS AND SUPPORTS:

A. Piping:

1. Space hangers and supports for horizontal copper tubing according to the following schedule:

TUBE SIZE - inches	MAXIMUM SPACING
1" and smaller	6 feet on center
1 1/4" and 1 1/2"	7 feet on center
2" and 2 1/2"	8 feet on center
3" and larger	10 feet on center

2. Space hangers and supports for horizontal iron pipes according to the following schedule:

PIPE SIZE - inches	MAXIMUM SPACING
1 1/4" and smaller	8 feet on center
1 1/2" thru 3"	10 feet on center
4" and larger	14 feet on center
All cast iron	5 feet on center*

- a. * Locate hangers within 18" of each joint per Uniform Building Code.

3. Safety Hanger Wires:

- a. For air diffusers and other mechanical units to be mounted on suspended grid ceiling systems and weighing less than 20 pounds may be supported directly on the runners of a heavy-duty grid system but, in addition, they must have a minimum of two (2) #12 gage slack safety wires attached to the fixture at diagonal corners and anchored to the structure above.
- b. In advance of ceiling hanger-wire work, provide to job site layouts and/or instruction necessary for proper installation of safety wires.
- c. Connect safety wires to mechanical diffusers and equipment.
- d. For diffusers and equipment units weighing 20 pounds or more must be independently supported by not less than four (4) taut #12 gage wires, each attached to the fixture and to the structure above. The four (4) taut

#12 gage wires, including their attachment to the structure above, must be capable of supporting four (4) times the weight of the unit.

3.8 IDENTIFICATION OF VALVES

- A. Provide 3 typewritten charts assembled in 3-ring binders showing the valve numbers together with their locations and use. Mount on metal frames and installed as directed the Architect.

3.9 VIBRATION ISOLATION

- A. The entire system, including equipment, air ducts, pipes, motors, and all other parts must be noiseless and free of vibration transmission.
- B. The Contractor shall not install any equipment or pipe which makes rigid contact with the "building" unless it is approved in this specification or by the Architect. "Building" includes slabs, beams, studs, walls, lath, etc.
- C. The installation or use of vibration isolators must not cause any change of position of equipment or piping which would result in stresses in piping connections or misalignment of shafts or bearings. To meet this objective, equipment and piping shall be maintained in a rigid position during installation. The load shall not be transferred to the isolator until the installation is complete and under full operational load.
- D. The Contractor shall correct, at no additional cost, all installations which are deemed defective in workmanship or materials by the Architect.

3.10 PROTECTION, CARE, AND CLEANING

- A. Provide adequate means for, and fully protect, all finished parts of the materials and equipment against physical damage from whatever cause during the progress of this work and until final completion.
- B. During construction, properly cap all lines and equipment nozzles to prevent the entrance of sand, dirt, etc. Protect equipment against moisture, plaster, cement, paint, or other work of other trades by covering it with polyethylene sheets.
- C. After installation has been completed, clean all systems.
- D. Piping, Ductwork and Equipment to be insulated: Clean exterior thoroughly to remove rust, plaster, cement, and dirt before insulation is applied.
- E. Piping, Ductwork and Equipment to be painted: Clean exterior of piping, ductwork and equipment, exposed in completed structure, removing rust, plaster cement, and dirt by wire brushing. Remove grease, oil, and similar materials by wiping with clean rags and suitable solvents. Touch up primer coat as required.
- F. Motors, Pumps and Other Items with Factory Finish: Remove grease and oil and leave surfaces clean and polished.

- G. Plumbing Fixtures: Clean and polish fixtures immediately prior to final inspection or Owner's occupancy. Clean floor drain grates: check each fixture to insure against trap stoppage.

3.11 LUBRICATION

- A. Upon completion of the work and before turning over to the Owner, clean and lubricate all bearings except sealed and permanently lubricated bearings. Use only lubricant recommended by the manufacturer.

3.12 PAINTING

- A. Properly prepare work under this Division to be finish painted under SECTION 09 91 00, "PAINTING".
- B. Paint duct black behind grilles and diffusers where duct is visible.

3.13 COMPLETION

- A. Before Final Review: The work hereunder will not be reviewed for final acceptance until Operating and Maintenance Data, Manufacturer's Literature, Valve Directories, Piping Identification Code Directory and name plates specified herein have been approved and properly posted in the building and final cleaning has been completed.
- B. Demonstration of Operations: When the installation is complete and adjustments specified herein have been made, operate the systems for a period of one week, during which time demonstrate to the Architect that systems are completed and operating in conformance with these specifications.

3.14 ALTERATION WORK

- A. Existing installations are to be altered in the areas indicated. Disconnect, remove, or relocate material and equipment required by removal of or changes to existing construction. Where the work of this trade or the work of other trades interrupts or interferes with existing services, all such service to be re-established in the manner directed by the Architect. Existing installations, and similar work, have been indicated on the drawings as accurately as possible. Accuracy of such information is not guaranteed and the Contractor to determine exact requirements as work progresses. Provide all alterations, extensions, additions, and related work required providing the finished project. Existing materials removed and not required for re-installation to remain the property of the Owner and to be delivered to the Owner. Materials which the Owner does not wish to retain shall become the property of the Contractor and to be removed from the site.
- B. At completion of alteration work, any existing work not required for proper operation of the completed system shall be removed.

END OF SECTION

SECTION 23 05 93 - TEST, ADJUSTING & BALANCING HVAC

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Balancing Air Systems:
 - a. Constant-volume air systems.

1.2 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. ASHRAE: American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.
- C. NEBB: National Environmental Balancing Bureau.
- D. TAB: Testing, adjusting, and balancing.
- E. TABB: Testing, Adjusting, and Balancing Bureau.
- F. TAB Specialist: An entity engaged to perform TAB Work.

1.3 SUBMITTALS

- A. Submittal:
 - 1. Air-Balance Report: Documentation of work performed for ASHRAE 111-2008, "Balancing."
 - B. Strategies and Procedures Plan: Within 90 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.
 - C. Certified TAB reports.

1.4 QUALITY ASSURANCE

- A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC, NEBB or TABB.
 - 1. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC, NEBB or TABB.
 - 2. TAB Technician: Employee of the TAB contractor and who is certified by AABC, NEBB, or TABB as a TAB technician.

- B. Certify TAB field data reports and perform the following:
 - 1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
 - 2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.
- C. TAB Report Forms: Use standard TAB contractor's forms approved by Architect.
- D. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
- B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.
- C. Examine the approved submittals for HVAC systems and equipment.
- D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.
- E. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they meet the leakage class of connected ducts as specified in Division 23 Section "Metal Ducts" and are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.
- F. Examine equipment performance data including fan and pump curves.
 - 1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
 - 2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

- G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- H. Examine test reports specified in individual system and equipment Sections.
- I. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
- J. Examine system pumps to ensure absence of entrained air in the suction piping.
- K. Examine operating safety interlocks and controls on HVAC equipment.
- L. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

- A. Prepare a TAB plan that includes strategies and step-by-step procedures.
 - 1. Minimum procedures shall include coordination and documentation for the Title 24 2016 NRCA-MCH forms as indicated on the Title 24 compliance documents.
 - 2. Such documentation shall include the necessary coordination with the control's contractor.
- B. Complete system-readiness checks and prepare reports. Verify the following:
 - 1. Permanent electrical-power wiring is complete.
 - 2. Automatic temperature-control systems are operational.
 - 3. Equipment and duct access doors are securely closed.
 - 4. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
 - 5. Windows and doors can be closed so indicated conditions for system operations can be met.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in ASHRAE 111-2008, or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems", or SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing" and in this Section.
 - 1. Comply with requirements in ASHRAE 62.1-2010, Section 7.2.2, "Air Balancing."
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
 - 1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.

2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Division 23 Section "HVAC Insulation."
- C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
- D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' "as-built" duct layouts.
- C. For variable-air-volume systems (DOAS), develop a plan to simulate diversity.
- D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.
- F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- G. Verify that motor starters are equipped with properly sized thermal protection.
- H. Check dampers for proper position to achieve desired airflow path.
- I. Check for airflow blockages.
- J. Check condensate drains for proper connections and functioning.
- K. Check for proper sealing of air-handling-unit components.
- L. Verify that air duct system is sealed as specified in Division 23 Section "Metal Ducts."

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
 1. Measure total airflow.
 - a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.

2. Measure fan static pressures as follows to determine actual static pressure:
 - a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
 - b. Measure static pressure directly at the fan outlet or through the flexible connection.
 - c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
 - d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
 3. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
 4. Obtain approval from Architect for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in Division 23 Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
 5. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
- B. Measure air outlets and inlets without making adjustments.
1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.
- C. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.
1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
 2. Adjust patterns of adjustable outlets for proper distribution without drafts.
- D. Motorized dampers shall initially be fully open when in the unoccupied and occupied modes. Dampers shall close upon command from controls when the space(s) or are unoccupied during scheduled occupied hours. DOAS variable speed drive shall maintain constant static pressure within the ductwork. Air balancer shall witness proper operation of damper sequencing and provide statement of operation in commissioning report. Balance air distribution devices with all motorized dampers fully open.
- 3.6 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS
- A. Perform a preconstruction inspection of existing equipment that is to remain and be reused.

1. Measure and record the operating speed, airflow, and static pressure of each fan.
2. Measure motor voltage and amperage. Compare the values to motor nameplate information.
3. Check the operation of the drain pan and condensate-drain trap.
4. Check bearings and other lubricated parts for proper lubrication.
5. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.

B. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.

1. Compare the indicated airflow of the renovated work to the measured fan airflows, and determine the new fan speed and the face velocity of filters and coils.
2. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.
3. If calculations increase or decrease the air flow rates and water flow rates by more than 5 percent, make equipment adjustments to achieve the calculated rates. If increase or decrease is 5 percent or less, equipment adjustments are not required.
4. Balance each air outlet.

3.7 TOLERANCES

A. Set HVAC system's air flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
2. Air Outlets and Inlets: Plus or minus 10 percent.

3.8 REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

B. Status Reports: Prepare at 75% completion of construction progress report to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.9 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
 2. Include a list of instruments used for procedures, along with proof of calibration.
- B. Final Report Contents: In addition to certified field-report data, include the following:
1. Fan curves.
 2. Manufacturers' test data.
 3. Field test reports prepared by system and equipment installers.
 4. Other information relative to equipment performance; do not include Shop Drawings and product data.
- C. General Report Data: In addition to form titles and entries, include the following data:
1. Title page.
 2. Name and address of the TAB contractor.
 3. Project name.
 4. Project location.
 5. Architect's name and address.
 6. Engineer's name and address.
 7. Contractor's name and address.
 8. Report date.
 9. Signature of TAB supervisor who certifies the report.
 10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
 11. Summary of contents including the following:
 - a. Indicated versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
 12. Nomenclature sheets for each item of equipment.
 13. Data for terminal units, including manufacturer's name, type, size, and fittings.
 14. Notes to explain why certain final data in the body of reports vary from indicated values.
 15. Test conditions for fans and pump performance forms including the following:
 - a. Settings for outdoor-, return-, and exhaust-air dampers.
 - b. Conditions of filters.
 - c. Cooling coil, wet- and dry-bulb conditions.
 - d. Fan drive settings including settings and percentage of maximum pitch diameter.
 - e. Settings for supply-air, static-pressure controller.
 - f. Other system operating conditions that affect performance.
- D. System Diagrams: Include schematic layouts of air distribution systems. Present each system with single-line diagram and include the following:
1. Quantities of outdoor, supply, return, and exhaust airflows.
 2. Duct, outlet, and inlet sizes.

3. Terminal units.
 4. Balancing stations.
 5. Position of balancing devices.
- E. Air-Handling (Fan coils) Test Reports: For air-handling units with coils, include the following (as applicable):
1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and unit size.
 - e. Manufacturer's serial number.
 - f. Unit arrangement and class.
 - g. Discharge arrangement.
 - h. Sheave make, size in inches, and bore.
 - i. Center-to-center dimensions of sheave, and amount of adjustments in inches.
 - j. Number, make, and size of belts.
 - k. Number, type, and size of filters.
 2. Motor Data:
 - a. Motor make, and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches, and bore.
 - f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
 3. Test Data (Indicated and Actual Values):
 - a. Total air flow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Filter static-pressure differential in inches wg.
 - f. Preheat-coil static-pressure differential in inches wg.
 - g. Cooling-coil static-pressure differential in inches wg.
 - h. Heating-coil static-pressure differential in inches wg.
 - i. Outdoor airflow in cfm.
 - j. Return airflow in cfm.
 - k. Outdoor-air damper position.
 - l. Return-air damper position.
- F. Fan Test Reports: For supply, return, and exhaust fans, include the following:
1. Fan Data:

- a. System identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and size.
 - e. Manufacturer's serial number.
 - f. Arrangement and class.
 - g. Sheave make, size in inches, and bore.
 - h. Center-to-center dimensions of sheave, and amount of adjustments in inches.
2. Motor Data:
- a. Motor make, and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches, and bore.
 - f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
 - g. Number, make, and size of belts.
3. Test Data (Indicated and Actual Values):
- a. Total airflow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Suction static pressure in inches wg.

3.10 INSPECTIONS

A. Initial Inspection:

1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.
2. Check the following for each system:
 - a. Measure airflow of at least 10 percent of air outlets.
 - b. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
 - c. Verify that balancing devices are marked with final balance position.
 - d. Note deviations from the Contract Documents in the final report.

B. Final Inspection:

1. After initial inspection is complete and documentation by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Commissioning Authority.

2. The TAB contractor's test and balance engineer shall conduct the inspection in the presence of the Commissioning Authority.
 3. Commissioning Authority shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
 4. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
 5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.
- C. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:
1. Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
 2. If the second final inspection also fails, Owner may contract the services of another TAB contractor to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB contractor's final payment.
- D. Prepare test and inspection reports.

END OF SECTION

01/07/16

SECTION 23 07 13 - DUCT INSULATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes insulating the following duct services:
 - 1. Indoor, concealed supply and outdoor air.
 - 2. Indoor, concealed return located in unconditioned space.
- B. Items Not Insulated:
 - 1. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
 - 2. Factory-insulated flexible ducts.
 - 3. Factory-insulated plenums and casings.
 - 4. Flexible connectors.
 - 5. Vibration-control devices.
 - 6. Factory-insulated access panels and doors.
- C. Related Sections:
 - 1. Division 23 Section "HVAC Piping Insulation."
 - 2. Division 23 Section "Noise & Vibration" for duct liners.

1.2 DESCRIPTION

- A. Field applied insulation for thermal efficiency and condensation control for HVAC, piping systems (HVAC), ductwork and equipment.
- B. Definitions:
 - 1. Air-conditioned space: Space directly supplied with heated or cooled air.
 - 2. ASJ+: All service jacket, white finish facing or jacket.
 - 3. Cold: Equipment, ductwork or piping handling media at design temperature of 60°F or below.
 - 4. Concealed: Ductwork and piping above ceilings and in chases, interstitial space, and pipe spaces.
 - 5. Conditioned Space: A room area which is heated or cooled.
 - 6. Exhaust Duct: A duct transporting air from one or more rooms only to the outdoors.
 - 7. Exposed: Piping, ductwork, and equipment exposed to view in finished areas including mechanical and electrical equipment rooms. Attics and crawl spaces where air handling units are located are considered to be mechanical rooms. Shafts, chases, interstitial spaces, unfinished attics, crawl spaces and pipe basements are not considered finished areas.
 - 8. FSK: Foil-scrim-kraft facing.
 - 9. Hot: Ductwork handling air at design temperature above 60°F; equipment or piping handling media above 105°F.
 - 10. Return Duct: A duct transporting air from one or more rooms toward fan if such air can be, at any time, circulated back to any rooms.
 - 11. Thermal conductance: Heat flow rate through materials.
 - a. Flat surface: BTU per hour per square foot.

- b. Pipe or cylinder: BTU per hour per linear foot.
- 12. Thermal conductivity ('k'): BTU per inch thickness, per hour, per square foot, per degree Fahrenheit temperature difference.
- 13. Transfer duct: A duct transporting air from one or more rooms to another room or rooms.
- 14. Unconditioned Space: A room or area which is neither heated nor cooled.

1.3 REFERENCES

- A. ASTM C518 - Steady State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
- B. ASTM C553 - Mineral Fiber Blanket and Felt Insulation.
- C. ASTM C612 - Mineral Fiber Block and Board Thermal Insulation.
- D. ASTM E84 - Surface Burning Characteristics of Building Materials.
- E. ASTM E96 - Water vapor Transmission of Materials.
- F. CMC – California Mechanical Code.
- G. NFPA 90A - Installation of Warm Air Heating and Air Conditioning Systems.
- H. NFPA 255/UL 723 - Surface Burning Characteristics of Building Materials.
- I. USGBC – U.S. Green Building Council.

1.4 CRITERIA

- A. Comply with NFPA 90A, particularly paragraphs 2-1.3; 2-2; and 3-3.8, parts of which are quoted as follows:
 - 1. "2-1.3.1 Duct coverings, duct linings, vapor barrier facings, tapes, and core materials in panels used in duct system shall have a flame spread rating not over 25 without evidence of continued progressive combustion and a smoke developed rating not higher than 50. If coverings and linings are to be applied with adhesives, they shall be tested as applied with such adhesives, or the adhesives used shall have a flame spread rating not over 25 and a smoke developed rating no higher than 50 when in the final dry state."
 - 2. "2-1.3.6 Pipe insulation and coverings shall meet the requirements of 2-2.1.2(a) when installed in ducts, plenums, or concealed spaces used as part of the air distribution system."
 - 3. "2-2.1.2(a) All materials exposed to the air flow shall have smoke developed ratings not greater than 50 and be non-combustible or limited combustible."
 - 4. "3-3.8.1 Where ducts pass through walls, floors, or partitions required to have a fire resistance rating and fire dampers are not required, the opening in the construction around the duct shall not exceed one inch (2.54 cm) average clearance on all sides and shall be filled solidly with an approved material capable of preventing the passage of flame and hot gases sufficient to ignite cotton waste when subjected to the same NFPA 255 time-temperature fire conditions required for fire barrier penetration." (Note: By NFPA 101, 6-2.3.4

and 6-3.6, this requirement applies to pipe penetrations of fire or smoke barriers also.)

- B. Test methods: ASTM E84-2010b, ASTM E 2231-2009, and UL 723-2008.
- C. Specified 'k' factors are at 75°F mean temperature unless stated otherwise. Where optional thermal insulation material is used, select thickness to provide thermal conductance no greater than that for the specified material. For pipe, use insulation manufacturer's published heat flow tables. For domestic hot water supply and return, run out insulation and condensation control insulation, no thickness adjustment need be made.
- D. All materials shall be compatible and suitable for service temperature and shall not contribute to corrosion or otherwise attack surface to which applied in either the wet or dry state.
- E. Underwriters Laboratories, Inc., label or listing, or satisfactory certified test report from an approved testing laboratory will be required to show that surface burning characteristics for materials to be used do not exceed specified ratings.
- F. Lining materials installed within ducts shall have mold, humidity and erosion resistant surface that meet the requirements of CMC 604.0, ASTM C 411-2005.
- G. General: All insulating material required for piping, mechanical equipment and duct work etc., shall be furnished and installed under this Section of the specifications. The execution of the work shall be in strict accordance with Title 24, Energy Conservation Standards and the best practice of the trade and the intent of this specification. All insulation shall be UL listed and shall meet all code requirements.
- H. Surface burning characteristics:
 - 1. Flame spread.....25
 - 2. Smoke developed.....50
- I. Every package or standard container of insulation or accessories delivered to the job site for use must have a manufacturer's stamp or label giving the name of the manufacturer and description of the material.
- J. Acceptable Manufacturers:
 - 1. Fiberglass Insulation: Owens-Corning Fiberglas, CertainTeed, Knauf.
 - 2. Flexible Elastomeric: Armstrong, Halstead, IMOCA, or Rubatex.
 - 3. Fiberglass Premolded Pipe Fitting Covers: Insul-Coustic/Birma Corp., Childers, Speedline, or Zeston.
 - 4. Adhesives and Cements: Armaflex Low VOC Spray Contact Adhesive by Armacell.
 - 5. Weld Pins: Nelson Stud Welding Div. TRW Inc. Duro Dyne Corp., Tuff-Weld, or Grip Nail.

1.5 ENVIRONMENTAL REQUIREMENTS

- A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.

- B. Maintain temperature during and after installation for minimum period of 24 hours.
- C. Manufacturer's products for insulation, adhesives and caulk shall be listed by the USGBC.

1.6 SUBMITTALS

- A. Product Data: For each type of product indicated.
- A. Manufacturer's Literature and Data:
 - 1. Insulation materials: Each type used. State surface burning characteristics.
 - 2. Insulation listings for all required Standards Listing.
 - 3. Insulation facings and jackets: Each type used. Make it clear that white finish will be furnished for exposed ductwork, casings and equipment.
 - 4. Insulation accessory materials: Each type used.
 - 5. Manufacturer's installation and fitting fabrication instructions for flexible unicellular insulation.
 - 6. Make reference to applicable specification paragraph numbers for coordination.
- B. Submittals:
 - 1. Laboratory Test Reports for Credit EQ 4: For adhesives and sealants, documentation indicating that product complies with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers," including 2004 Addenda.
 - 2. Duct Liner Manufacturer's Literature and Data:
 - a. Insulation materials: State surface burning characteristics, or each type used.
 - b. Insulation facings and jackets: each type used. Make it clear that white finish will be furnished for exposed ductwork, casings, and equipment.
 - c. Insulation accessory materials: Each type used.
 - d. Manufacturer's installation and fitting fabrication instruction for flexible unicellular insulation.
 - e. Make reference to applicable specification paragraph numbers for coordination

1.7 QUALITY ASSURANCE

- A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in "Duct Insulation Schedule, General," "Indoor Duct and Plenum Insulation Schedule," and "Aboveground, Outdoor Duct and Plenum Insulation Schedule" articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article. Thickness – 2".
 - 1. Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:
 - a. CertainTeed Corp.; SoftTouch Duct Wrap.
 - b. Johns Manville; Microlite.
 - c. Knauf Insulation; Friendly Feel Duct Wrap.
 - d. Manson Insulation Inc.; Alley Wrap.
 - e. Owens Corning; SOFTR All-Service Duct Wrap.

2.2 ACOUSTICAL DUCT LINING AND INSULATION BOARD

- A. All acoustical duct lining shall incorporate means to prevent fiber entrainment in the air stream.
- B. Acceptable product for lining rectangular section ducts and plenums: Owens Corning "Fiberglass Duct Liner Board".
- C. Minimum sound-absorbing duct lining material:

	Octave Band Center Frequency, Hz					
	125	250	500	1000	2000	4000
1.0" thickness lining, 2-3.0 pcf density	.03	.22	.60	.84	.98	.97
1.5" thickness lining, 2-3.0 pcf density	.16	.22	.91	1.01	1.01	1.01
2.0" thickness lining, 2-3.0 pcf density	.24	.79	1.13	1.13	1.04	1.05

- D. Acceptable product for lining circular duct: Casco Circliner, Johns Manville Spiracoustic.

- E. Where acoustically lined circular or oval duct is required, (except underground) lining shall be positively retained in place. Acceptable manufacturers of prefabricated, internally lined duct include United McGill and Sheet Metal Products.
- F. Installation
 - 1. Internal acoustical lining may be substituted at contractor's option where external thermal insulation wrapping is specified.
 - 2. Insulate acoustical duct plenums and the inside perimeter of ductwork as indicated on the drawings, otherwise insulate according to the Ductwork Liner Schedule, see §3.3.

2.3 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 - 1. Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
 - b. Eagle Bridges - Marathon Industries; 225.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.
 - d. Mon-Eco Industries, Inc.; 22-25.
 - 2. Use adhesive that complies with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers," including 2004 Addenda.
- C. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
 - b. Eagle Bridges - Marathon Industries; 225.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.
 - d. Mon-Eco Industries, Inc.; 22-25.
 - 2. Use adhesive that complies with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers," including 2004 Addenda.

2.4 TAPES

- A. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. ABI, Ideal Tape Division; 491 AWF FSK.

- b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
 - c. Compac Corporation; 110 and 111.
 - d. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.
2. Width: 3 inches.
 3. Thickness: 6.5 mils.
 4. Adhesion: 90 ounces force/inch in width.
 5. Elongation: 2 percent.
 6. Tensile Strength: 40 lbf/inch in width.
 7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

2.5 SECUREMENTS

- A. Aluminum Bands: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal or closed seal.
 1. Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:
 - a. ITW Insulation Systems; Gerrard Strapping and Seals.
 - b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.
- B. Insulation Pins and Hangers:
 1. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:
 - 1) AGM Industries, Inc.; Tactoo Perforated Base Insul-Hangers.
 - 2) GEMCO; Perforated Base.
 - 3) Midwest Fasteners, Inc.; Spindle.
 - b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 - c. Spindle: Aluminum, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
 - d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
 2. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:
 - 1) AGM Industries, Inc.; Tactoo Self-Adhering Insul-Hangers.
 - 2) GEMCO; Peel & Press.
 - 3) Midwest Fasteners, Inc.; Self Stick.
 - b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.

- c. Spindle: Aluminum, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
 - d. Adhesive-backed base with a peel-off protective cover.
 3. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, galvanized-steel or aluminum sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
 - a. Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) AGM Industries, Inc.; RC-150.
 - 2) GEMCO; R-150.
 - 3) Midwest Fasteners, Inc.; WA-150.
 - 4) Nelson Stud Welding; Speed Clips.
 4. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
- C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

2.6 CORNER ANGLES

- A. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14.

2.7 JACKETS

- A. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Metal Jacketing Systems.
 - b. ITW Insulation Systems; Aluminum and Stainless Steel Jacketing.
 - c. RPR Products, Inc.; Insul-Mate.
 - d. Or equal
 2. Finish and thickness are indicated in field-applied jacket schedules.
 3. Moisture Barrier for Indoor Applications: 1-mil thick, heat-bonded polyethylene and kraft paper.
 4. Moisture Barrier for Outdoor Applications: 2.5-mil thick polysurlyn.
 5. Factory-Fabricated Fitting Covers:
 - a. Same material, finish, and thickness as jacket.
 - b. Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
 - c. Tee covers.
 - d. End caps.
- B. Self-Adhesive Outdoor Jacket: 60-mil thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a cross-laminated polyethylene film covered with white aluminum-foil facing.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Polyguard Products, Inc.; Alumaguard 60.

- b. Or equal.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Required pressure tests and connections shall be completed and the work approved by the owner or owner's representative before application of insulation. Surface shall be clean and dry with all foreign materials, such as dirt, oil, loose scale and rust removed.
- B. Apply covering (jackets) after ducts and equipment have been tested and proven tight.
- C. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.
- D. Install insulation materials, vapor barriers or retarders, and thicknesses required for each item of duct system as specified in insulation system schedules.
- E. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation in either wet or dry state.
- F. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- G. Install multiple layers of insulation with longitudinal and end seams staggered.
- H. Keep insulation materials dry during application and finishing.
- I. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- J. Install insulation with least number of joints practical.
- K. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 1. Install insulation continuously through hangers and around anchor attachments.
 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
- L. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches like butt joints.
- A. External Ductwork Insulation:
 - 1. Secure with 4" strips of adhesive, 8" on center.
 - 2. For rectangular ducts 24" and wider, secure to bottom of duct with mechanical fasteners 18" on center.
 - 3. Wrap with 18-gauge galvanized wire, 18" on center.
 - 4. Adhesive requirements same as for duct liner.
 - 5. Provide insulated ductwork conveying air below ambient temperature with vapor barrier jacket. Finish with tape. Seal vapor barrier penetrations with vapor barrier adhesive.
 - 6. Provide insulated ductwork conveying air above ambient temperature with or without standard vapor barrier jacket. Where service access is required, bevel and seal ends of insulation.
 - 7. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
 - 8. Install without sag on underside of ductwork. Use adhesive or mechanical fasteners where necessary to prevent sagging.
 - 9. For ductwork exposed in mechanical equipment rooms or in finished spaces, finish with aluminum jacket.
 - 10. For exterior ductwork exposed to weather, with external insulation, provide aluminum jacket sealed watertight with caulk.
- B. Duct Liner:
 - 1. Secure liner with adhesive for 100% coverage, anchor pins and speed washers. Refer to SMACNA Duct Liner Application Standards for installation.
 - 2. Seal liner surface penetrations with adhesive.
 - 3. Duct dimensions indicated are net inside dimensions required for air flow. Increase duct size to allow for liner thickness.
 - 4. Surface adjacent to air flow, including at joints, shall be uniformly flat.
 - 5. Seal butt joint edges of liner to prevent erosion. For rectangular ducts provide sheet metal end caps to cover liner edges at entering and leaving edges of lined duct section; for round ducts use low velocity duct sealant. For plenum lining, provide sheet metal caps at exposed edges, e.g., where liner terminates at access door.

3.3 DUCTWORK INSULATION SCHEDULE

SERVICE	SUPPLY	RETURN	EXHAUST
In Mechanical and Fan Rooms	DL, 1"	DL, 1"	DL, 1"
Within 10' or 10 duct diameters of fan, whichever is greater	DL, 1"	DL, 1"	DL, 1"
Concealed between roof and ceiling	WV, 2"	W, 2"	--
Outdoors unless otherwise noted	DL, 2"	DL, 2"	--

Concealed in shaft adjacent To unconditioned space or building exterior	WV, 2"	W, 2"	--
Other concealed	WV, 2"	--	--
Exposed within space	--	--	--
Return and exhaust stub ducts from ceiling plenum into shafts	--	--	--

A. Notes for Insulation Schedule

1. Abbreviations:
 - a. DL Duct Lining
 - a. W Flexible Glass Fiber Duct wrap without vapor barrier
 - b. WV Flexible Glass Fiber Duct wrap with vapor barrier
2. Where lining is specified, other insulation is not required.
3. Where lining is specified in ducts or shafts constructed of architectural materials, apply plenum lining to such materials.
4. Where round ducts are specified to be lined, use one of the following methods:
 - a. Line ducts as specified.
 - b. Provide pre-insulated duct or approved equal.
 - c. Where space permits and where permitted by Architect, provide equivalent size lined rectangular ducts (based on equal friction) in lieu of lined round ducts.

3.4 PENETRATIONS

- A. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- B. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.
 1. Comply with requirements in Division 07 Section "Penetration Firestopping" for firestopping and fire-resistive joint sealers.
- C. Insulation Installation at Floor Penetrations:
 1. Duct: For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
 2. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."

3.5 INSTALLATION OF MINERAL-FIBER INSULATION

- A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
 1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50 percent coverage of duct and plenum surfaces.
 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.

3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
 - b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not over compress insulation during installation.
 - e. Impale insulation over pins and attach speed washers.
 - f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
 - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.
5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.6 FIELD-APPLIED OUTDOOR JACKET INSTALLATION

- A. Where FSK jackets are indicated for outdoor supply and return air ductwork, install as follows:
 1. Per manufacturers installation instructions.
 2. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

3.7 FIRE-RATED INSULATION SYSTEM INSTALLATION

- A. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.
- B. Insulate duct access panels and doors to achieve same fire rating as duct.
- C. Install firestopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in Division 07 Section "Penetration Firestopping."

END OF SECTION

SECTION 23 31 13 - METAL DUCTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Rectangular ducts and fittings.
2. Round ducts and fittings.
3. Sheet metal materials.
4. Sealants and gaskets.
5. Hangers and supports.
6. Seismic-restraint devices.

B. Related Sections:

1. Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Division 23 Section "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.2 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA-2006 "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article. All supply, return and exhaust ductwork shall be constructed to 2" pressure classification.

B. Structural Performance: Duct hangers and supports and seismic restraints shall withstand the effects of gravity and seismic loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and ASCE/SEI 7-10, SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical - OSHPD."

C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Submittals:

1. Product Data for Prerequisite EQ 1: Documentation indicating that duct system complies with ASHRAE 62.1, Section 5 - "Systems and Equipment."
2. Documentation indicating that duct system complies with ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

3. Documentation of work performed for compliance with ASHRAE 62.1, Section 7.2.4 - "Ventilation System Start-Up."
 4. For adhesives and sealants, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- C. Delegated-Design Submittal:
1. Sheet metal thicknesses.
 2. Joint and seam construction and sealing.
 3. Reinforcement details and spacing.
 4. Materials, fabrication, assembly, and spacing of hangers and supports.

1.4 QUALITY ASSURANCE

- A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."
- B. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

PART 2 - PRODUCTS

2.1 RECTANGULAR DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA-2020 "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA-2006 "HVAC Duct Construction Standards - Metal and Flexible."
- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," 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."
- D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," 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."

2.2 ROUND DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA-2020 "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
 - 1. Manufacturers: Subject to compliance with requirements, [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
 - a. McGill AirFlow LLC.
 - b. SEMCO Incorporated.
 - c. Sheet Metal Connectors, Inc.
 - d. Spiral Manufacturing Co., Inc.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse 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."
- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," 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."
- D. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," using 45° lateral taps and Figure 3-6, "Conical Tees," 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."

2.3 SHEET METAL MATERIALS

- A. General Material Requirements: Comply with SMACNA-2020 "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 - 1. Galvanized Coating Designation: G60.
 - 2. Finishes for Surfaces Exposed to View: Mill phosphatized.
- C. Stainless Steel: ASTM A480.
- D. Aluminum Sheets: ASTM B209, alloy 3003, temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.
- E. Extruded Aluminum: ASTM B221, alloy 6063, temper T6.

- F. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
 - 1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.
- G. Tie Rods: Galvanized steel, quantity and size according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.4 SEALANT AND GASKETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
- B. Two-Part Tape Sealing System:
 - 1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
 - 2. Tape Width: 3 inches.
 - 3. Sealant: Modified styrene acrylic.
 - 4. Water resistant.
 - 5. Mold and mildew resistant.
 - 6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
 - 7. Service: Indoor and outdoor.
 - 8. Service Temperature: Minus 40 to plus 200 deg F.
 - 9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
 - 10. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- C. Water-Based Joint and Seam Sealant:
 - 1. Application Method: Brush on.
 - 2. Solids Content: Minimum 65 percent.
 - 3. Shore A Hardness: Minimum 20.
 - 4. Water resistant.
 - 5. Mold and mildew resistant.
 - 6. VOC: Maximum 75 g/L (less water).
 - 7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
 - 8. Service: Indoor or outdoor.
 - 9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

2.5 HANGERS AND SUPPORTS

- A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

- B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
- C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."
- D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.
- E. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
- F. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- G. Trapeze and Riser Supports:
 - 1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.

2.6 SEISMIC-RESTRAINT DEVICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cooper B-Line, Inc.; a division of Cooper Industries.
 - 2. Ductmate Industries, Inc.
 - 3. Hilti Corp.
 - 4. Kinetics Noise Control.
 - 5. Mason Industries.
 - 6. TOLCO; a brand of NIBCO INC.
 - 7. Unistrut Corporation; Tyco International, Ltd.
- B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an evaluation service member of the ICC Evaluation Service or the Office of Statewide Health Planning and Development for the State of California or an agency acceptable to authorities having jurisdiction.
 - 1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.
- C. Channel Support System: Shop- or field-fabricated support assembly made of slotted steel channels rated in tension, compression, and torsion forces and with accessories for attachment to braced component at one end and to building structure at the other end. Include matching components and corrosion-resistant coating.
- D. Restraint Cables: ASTM A 603, galvanized-steel cables with end connections made of cadmium-plated steel assemblies with brackets, swivel, and bolts designed for restraining cable service; and with an automatic-locking and clamping device or double-cable clips.

- E. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections, or reinforcing steel angle clamped] to hanger rod.
- F. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.
- B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- C. Install round ducts in maximum practical lengths.
- D. Install ducts with fewest possible joints.
- E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
- I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
- J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.
- K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Division 23 Section "Air Duct Accessories" for fire and smoke dampers.
- L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

3.2 INSTALLATION OF EXPOSED DUCTWORK

- A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
- B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.
- C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.
- D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
- E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 DUCT SEALING

- A. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":
 - 1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - 2. Outdoor, Supply-Air Ducts: Seal Class A.
 - 3. Outdoor, Exhaust Ducts: Seal Class C.
 - 4. Outdoor, Return-Air Ducts: Seal Class C.
 - 5. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class B.
 - 6. Unconditioned Space, Exhaust Ducts: Seal Class C.
 - 7. Unconditioned Space, Return-Air Ducts: Seal Class B.
 - 8. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class C.
 - 9. Conditioned Space, Exhaust Ducts: Seal Class B.
 - 10. Conditioned Space, Return-Air Ducts: Seal Class C.

3.4 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
 - 1. Where practical, install concrete inserts before placing concrete.
 - 2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
 - 3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
 - 4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.

5. Do not use powder-actuated concrete fasteners for seismic restraints.
- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
- D. Hangers Exposed to View: Threaded rod and angle or channel supports.
- E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum interval of 16 feet.
- F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.5 SEISMIC-RESTRAINT-DEVICE INSTALLATION

- A. Install ducts with hangers and braces designed to support the duct and to restrain against seismic forces required by applicable building codes. Comply with SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems." And ASCE/SEI 7-10.
 1. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
 2. Brace a change of direction longer than 12 feet.
- B. Select seismic-restraint devices with capacities adequate to carry present and future static and seismic loads.
- C. Install cables so they do not bend across edges of adjacent equipment or building structure.
- D. Install cable restraints on ducts that are suspended with vibration isolators.
- E. Install seismic-restraint devices using methods approved by an evaluation service member of the ICC Evaluation Service, the Office of Statewide Health Planning and Development for the State of California or an agency acceptable to authorities having jurisdiction.
- F. Attachment to Structure: If specific attachment is not indicated, anchor bracing and restraints to structure, to flanges of beams, to upper truss chords of bar joists, or to concrete members.
- G. Drilling for and Setting Anchors:
 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcement or embedded items during drilling. Notify the Architect if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.

2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Set anchors to manufacturer's recommended torque, using a torque wrench.
5. Install zinc-coated steel anchors for interior applications and stainless-steel anchors for applications exposed to weather.

3.6 CONNECTIONS

- A. Make connections to equipment with flexible connectors complying with Division 23 Section "Air Duct Accessories."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.7 DUCT CLEANING

- A. Clean **new [new and existing]** duct system(s) before testing, adjusting, and balancing.
- B. Use service openings for entry and inspection.
 1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Division 23 Section "Air Duct Accessories" for access panels and doors.
 2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
 3. Remove and reinstall ceiling to gain access during the cleaning process.
- C. Particulate Collection and Odor Control:
 1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
 2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.
- D. Clean the following components by removing surface contaminants and deposits:
 1. Air outlets and inlets (registers, grilles, and diffusers).
 2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
 3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
 4. Coils and related components.
 5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.

6. Supply-air ducts, dampers, actuators, and turning vanes.
7. Dedicated exhaust and ventilation components and makeup air systems.

E. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
6. Provide drainage and cleanup for wash-down procedures.
7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

3.8 START UP

- A. Air Balance: Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing for HVAC."

3.9 DUCT SCHEDULE

- A. Fabricate ducts with galvanized sheet steel
- B. Intermediate Reinforcement:
 1. Galvanized-Steel Ducts: Galvanized steel.
- C. Elbow Configuration:
 1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
 - a. Velocity 1000 fpm or Lower:
 - 1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
 - 2) Mitered Type RE 4 without vanes.
 - b. Velocity 1000 to 1500 fpm:
 - 1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
 - 2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
 - 3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
 - c. Velocity 1500 fpm or Higher:

- 1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
 - 2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
 - 3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
 - a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
 - b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
 - c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
 3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."
 - a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
 - 1) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
 - 2) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
 - 3) Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
 - b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
 - c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam.
- D. Branch Configuration:
1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."
 - a. Rectangular Main to Rectangular Branch: 45-degree entry.
 - b. Rectangular Main to Round Branch: Spin in.
 2. Round: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.
 - a. Velocity 1000 fpm or Lower: 90-degree tap.
 - b. Velocity 1000 to 1500 fpm: Conical tap.
 - c. Velocity 1500 fpm or Higher: 45-degree lateral.
- E. General requirements:
1. Verify all dimensions at the site making all field measurements and shop drawings necessary for fabrication and erection of sheet metal work. Dimensions shown are net free areas. Lined ducts shall be fabricated so that new dimensions to inside of lining shall equal the sizes shown on drawings.
 2. Make allowances for beams, pipes or other obstructions in building construction and for work of other trades. Check plans showing work of other trades and consult with Architect in the event of any interference.

3. Fittings: Manufactured fittings for all exposed ductwork. Use slop fit couplings for all joints.
4. Low Pressure Ductwork: Sheet metal gauges, transverse joint type and spacing, reinforcing type and spacing, In accordance with latest ASHRAE and SMACNA Schedules for low-pressure ductwork. Figures below are from the SMACNA Manual
5. Size round ducts installed in place of rectangular ducts in accordance with ASHRAE table of equivalent rectangular and round ducts. No variation of duct configuration or sizes permitted except by written permission.
6. Elbows shall be standard radius or square with vanes as shown on Fig 4-2, 3 & 4. Single vanes with $\frac{3}{4}$ " trailing edge are preferred. Adjust the vanes so that the trailing edges are parallel with the downstream duct when entering and leaving duct sizes are not equal. Turning vanes used in acoustically lined duct shall use an acoustical noise reduction turning vane.
7. Offsets & transitions - Fig 4-7, branch connections as illustrated in - Fig 4-1 or as indicated on the plans.
8. Round laterals - Fig 3-5, straight tees are not acceptable.
9. Conical tees and wyes– Fig 3-6.
10. Junctions between ducts: Branch take-off with 45° or 90° tapered spin-in. No branch duct to intersect main duct on bottom.
11. Seal all longitudinal and transverse duct and plenum joints and field formed seams airtight (Seal Class B) with medium water based, low VOC, pressure duct sealant.
12. Joints between ducts: Make with beaded sleeve joints. Apply duct sealer to male end. Mechanically fasten with sheet metal screws or pop rivets. Over joint and screw or rivet heads, apply coating of duct sealer.
13. Supports for ducts and plenums shall be band iron supports according to Section 4.
14. All ductwork shall be concealed behind finished wall, ceilings or floors unless specifically noted "exposed" on the drawings. Ductwork shown to be exposed shall be installed to provide maximum headroom and/or floor space.
15. Increase duct sizes gradually, not exceeding 15° divergence wherever possible. Divergence upstream of equipment shall not exceed 30°; convergence downstream shall not exceed 45°.
16. Access Panels and Doors in Ductwork: Provide in ductwork as indicated and wherever necessary or required for proper access to all instruments, controls, fire and automatic dampers and equipment and for convenient inspection and maintenance. Size as approved by Architect.
17. Install ductwork of sizes, runs and connections as shown on drawings.
18. Fabricate ductwork in workman-like manner with airtight joints; presenting smooth surfaces on inside, neatly finished on outside; construct with curves, bends; turning vanes to aid in easy flow of air. Make internal ends of slip joints in directions of air flow.
19. Install ductwork to provide maximum headroom.
20. Adjust ducts to suit local conditions. Alter duct sizes on basis of equal friction where required to facilitate installation.
21. Provide ductwork connected to air-handling equipment or air inlet and outlet devices, with all necessary transformation pieces, flexible fabric connections as required. Secure fabric connectors tightly to fans, casings and ducts. Allow at least 1" slack in connections. Do not paint fabric connectors. Provide galvanized steel weather shield over exterior top and sides of exposed flexible connections.

22. Diagonally or transversely cross break all panels on metal rectangular ducts over 18" in either direction.
23. Avoid penetration of ducts. Provide airtight rubber grommets at unavoidable penetrations of hanger rods.
24. Duct Openings: Provide openings where required to accommodate thermometers, smoke detectors, controllers, etc.
25. Provide pitot tube openings where required for testing of systems: Complete with metal cap with spring device or screw to ensure against air leakage.
26. Where openings are provided in insulated ductwork, install insulation material inside metal ring.

3.10 EVAPORATIVE COOLER DUCT INSTALLATION

- A. Entire length stainless steel continuous welded watertight. Continuous soldered aluminum acceptable where permitted by code.
- B. Slope duct 1-inch per foot down toward drain
- C. Only if above slope is impossible due to structural or architectural space limitations, slope in direction of air flow to low-point drain. Provide 1-inch drain from all low points to nearest air gap waste. Drain to have S trap for water seal.
- D. Two coats bitumastic on interior. Patch scratches. No holidays.

3.11 GREASE EXHAUST DUCTS

- A. Construct as required with Section 510 of the 2019 California Mechanical Code.
- B. Ducts shall be constructed of and supported by carbon steel not less than 0.054 inches (16 gauge) in thickness or type 316 stainless steel not less than 0.043 inches (18 gauge) in thickness.
- C. Ductwork exposed to weather or view shall be of 316 stainless steel construction, no less than 18 gauge (0.043" thick).
- D. Seams, joints, penetrations, and duct-to-hood collar connections shall have a liquid-tight continuous external weld. Exceptions to weld as per Section 510.5.2 Exceptions.
- E. Construct and install so grease cannot become pocketed in any portion. Slope duct 1/4-inch per foot down toward hood if less than 75 feet of horizontal duct run. Slope of 1" per foot when more than 75 feet of horizontal duct run. Only if slope is impossible due to structural or architectural space limitations, slope in direction of air flow to low-point drain. Provide 1-inch drain from all low points to nearest air gap waste. Drain to have S trap for water seal.
- F. Do not cross break bottom panels of duct.
- G. Securely fasten in place at every change in direction. No penetration of any duct wall.
- H. Enclose ducts penetrating a ceiling, wall or floor from the point of penetration to the outside by the general contractor.

- I. Provide access doors in duct at maximum 10 feet intervals and at each change in direction.
- J. For cleanout openings located in ducts within a fire-resistive shaft or enclosure, provide access openings in shaft or enclosure at each cleanout point. These access openings shall provide direct access to duct with work platforms provided where required.

3.12 DISHWASHER EXHAUST AND SPECIALTY PLENUMS

- A. Entire length of dishwasher exhaust and 10-feet downstream of in-line humidifiers: continuously welded stainless steel, slopes and drains as for grease duct, or aluminum continuously soldered or welded.
- B. Slope duct 1/4-inch per foot down toward equipment if less than 75 feet of horizontal duct run. 1" per foot when more than 75 feet of horizontal duct run. Only if is impossible due to structural or architectural space limitations, slope in direction of air flow to low-point drain. Provide 1-inch drain from all low points to nearest air gap waste. Drain to have S trap for water seal.
- C. Do not cross break bottom panel of duct.

3.13 FUME HOOD EXHAUST

- A. Entire length stainless steel continuous welded liquid tight.
- B. Slope duct 1/4-inch per foot down toward equipment. Only if above slope is impossible due to structural or architectural space limitations, slope in direction of air flow to low-point drain. Provide 1-inch drain from all low points to nearest air gap waste. Drain to have S trap for water seal.
- C. Do not cross break bottom panel of duct.

3.14 ALUMINUM DUCTWORK

- A. One gauge heavier than galvanized steel.

END OF SECTION

SECTION 23 33 00 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Manual volume dampers.
 2. Turning vanes.
 3. Flexible connectors.
 4. Flexible ducts.
 5. Duct accessory hardware.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Submittals:
1. Documentation indicating that units comply with ASHRAE 62.1-2010, Section 5 - "Systems and Equipment."
 2. Documentation indicating that duct insulation R-values comply with tables in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air Conditioning."
- C. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.
1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
 - a. Special fittings.
 - b. Manual volume damper installations.
 - c. Control damper installations.
 - d. Fire-damper and smoke-damper installations, including sleeves; and duct-mounted access doors.
 - e. Wiring Diagrams: For power, signal, and control wiring.
- D. Operation and maintenance data.

1.3 QUALITY ASSURANCE

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- B. Comply with AMCA 500-D testing for damper rating.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 - 1. Galvanized Coating Designation: G60.
 - 2. Exposed-Surface Finish: Mill phosphatized.
- C. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts.
- D. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.2 MANUAL AND CONTROL VOLUME DAMPERS

- A. Standard, Steel, Manual Volume Dampers:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Air Balance Inc.; a division of Mestek, Inc.
 - b. American Warming and Ventilating; a division of Mestek, Inc.
 - c. Flexmaster U.S.A., Inc.
 - d. McGill AirFlow LLC.
 - e. METALAIRE, Inc.
 - f. Nailor Industries Inc.
 - g. Pottorff; a division of PCI Industries, Inc.
 - h. Ruskin Company.
 - i. Vent Products Company, Inc.
 - 2. Standard leakage rating, with linkage outside airstream.
 - 3. Suitable for horizontal or vertical applications.
 - 4. Frames:
 - a. Hat-shaped, galvanized-steel channels, 0.064-inch minimum thickness.
 - b. Mitered and welded corners.
 - c. Flanges for attaching to walls and flangeless frames for installing in ducts.
 - 5. Blades:
 - a. Multiple or single blade.
 - b. Parallel- or opposed-blade design.
 - c. Stiffen damper blades for stability.
 - d. Galvanized-steel, 0.064 inch thick.
 - 6. Blade Axles: Galvanized steel.
 - 7. Tie Bars and Brackets: Galvanized steel.
- B. Jackshaft:
 - 1. Size: 1-inch diameter.

2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

C. Damper Hardware:

1. Zinc-plated, die-cast core with dial and handle made of 3/32-inch- thick zinc-plated steel, and a 3/4-inch hexagon locking nut.
2. Include center hole to suit damper operating-rod size.
3. Include elevated platform for insulated duct mounting.

2.3 TURNING VANES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Ductmate Industries, Inc.
2. Duro Dyne Inc.
3. METALAIRE, Inc.
4. SEMCO Incorporated.

B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

C. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

D. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."

E. Vane Construction: Single.

2.4 FLEXIBLE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Ductmate Industries, Inc.
2. Duro Dyne Inc.
3. Ventfabrics, Inc.

B. Materials: Flame-retardant or noncombustible fabrics.

C. Coatings and Adhesives: Comply with UL 181, Class 1.

D. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to 2 strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized sheet. Provide metal compatible with connected ducts.

- E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
 - 1. Minimum Weight: 26 oz./sq. yd..
 - 2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
 - 3. Service Temperature: Minus 40 to plus 200°F.

- F. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
 - 1. Minimum Weight: 24 oz./sq. yd..
 - 2. Tensile Strength: 225 lbf/inch in the warp and 300 lbf/inch in the filling.
 - 3. Service Temperature: Minus 40 to plus 250°F.

2.5 FLEXIBLE DUCTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Flexmaster U.S.A., Inc.
 - 2. McGill AirFlow LLC.
 - 3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

- B. Noninsulated, Flexible Duct: UL 181, Class 1, black polymer film supported by helically wound, spring-steel wire.
 - 1. Pressure Rating: 4-inch wg positive and 0.5-inch wg negative.
 - 2. Maximum Air Velocity: 4000 fpm.
 - 3. Temperature Range: Minus 20 to plus 175°F.

- C. Insulated, Flexible Duct: UL 181, Class 1, black polymer film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene vapor-barrier film.
 - 1. Pressure Rating: 4-inch wg positive and 0.5-inch wg negative.
 - 2. Maximum Air Velocity: 4000 fpm.
 - 3. Temperature Range: Minus 20 to plus 17°F.
 - 4. Insulation R-Value: Comply with ASHRAE/IESNA 90.1-2004 tables titled "Minimum Duct Insulation R-Value, Cooling and Heating Only Supply Ducts and Return Ducts" and "Minimum Duct Insulation R-Value, Combined Heating and Cooling Supply Ducts and Return Ducts."

- D. Flexible Duct Connectors:
 - 1. Clamps: Nylon strap in sizes 3 through 18 inches, to suit duct size.

2.6 DUCT ACCESSORY HARDWARE

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

- B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts.
- B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized.
- C. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
- D. Set dampers to fully open position before testing, adjusting, and balancing.
- E. Install test holes at fan inlets and outlets and elsewhere as indicated.
- F. Install fire and/or smoke dampers according to UL listing.
- G. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
 - 1. On both sides of duct coils.
 - 2. Upstream from duct filters.
 - 3. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
 - 4. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors; and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
 - 5. Control devices requiring inspection.
 - 6. Elsewhere as indicated.
- H. Install access doors with swing against duct static pressure.
- I. Access Door Sizes:
 - 1. One-Hand or Inspection Access: 8 by 5 inches.
 - 2. Two-Hand Access: 12 by 6 inches.
 - 3. Head and Hand Access: 18 by 10 inches.
 - 4. Head and Shoulders Access: 21 by 14 inches.
 - 5. Body Access: 25 by 14 inches.
 - 6. Body plus Ladder Access: 25 by 17 inches.
- J. Label access doors according to Division 23 Section "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

- K. Install flexible connectors to connect ducts to equipment. Outdoor flexible connectors will be covered by a 6" wide galvanized sheet metal covering over the top and vertical sides.
- L. Flexible duct shall not be used as a fitting. All fitting shall be galvanized ductwork.
- M. Connect diffusers or grilles to ducts with maximum 60-inch lengths of flexible duct clamped or strapped in place.
- N. Connect flexible ducts to metal ducts with draw bands.
- O. Install duct test holes where required for testing and balancing purposes.

3.2 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Operate dampers to verify full range of movement.
 - 2. Inspect locations of access doors and verify that purpose of access door can be performed.
 - 3. Operate fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
 - 4. Inspect turning vanes for proper and secure installation.

END OF SECTION

SECTION 23 37 13 - DIFFUSERS, REGISTERS & GRILLES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Perforated diffusers.
- B. Related Sections:
 - 1. Division 23 Section "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.
 - 2. Division 23 Section "Noise & Vibration" for related sizing for acceptable noise levels.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated, include the following:
 - 1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
 - 2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Titus or comparable product by one of the following:
 - 1. Titus HVAC.
 - 2. METALAIRE, Inc.
 - 3. Price Industries.

2.2 CEILING DIFFUSERS

- A. Perforated Diffuser:
 - 1. Material: Steel backpan and pattern controllers, with steel face.
 - 2. Finish: Baked enamel, white.
 - 3. Face Size: 24 by 12 inches for return, 24 by 24 inches for supply and return see plan for detail.
 - 4. Duct Inlet: Round and Rectangular.
 - 5. Mounting: T-bar.
 - 6. Pattern Controller: Four louvered deflector patches for supply and none for return.
 - 7. Dampers: None
 - 8. Accessories:
 - a. Equalizing grid.
 - b. Plaster ring.
 - c. Safety chain.
 - d. Wire guard.

2.3 SOURCE QUALITY CONTROL

- A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install diffusers, registers, and grilles level and plumb.
- B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
- C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.2 ADJUSTING

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION