Project Name N&T Project #21942.10 / PCCD RFQ 19-20/12	
ADDENDUM #01	Date: 9/23/2020

NOLL & TAM ARCHITECTS

General: The following instructions, substitutions, alterations, changes, clarifications, additions, and/or deletions are hereby made a part of the RFQ 19-20/12 and modify the original Documents dated September 03, 2020.
The changes documented in this addendum have precedence over all previous documents and shall be taken into consideration in preparation of your bid. It is the responsibility of all bidders to notify all subcontractors of all changes contained in this addendum. All other conditions shall remain the same.

All bidders shall acknowledge receipt and acceptance of this addendum on the bid form.

Bid/Schedule Clarification:

1. Revisions to Architectural Documents:
    a. A2.32 attached and labeled Addendum No. 1 dated 9/23/2020
        i. Expand clear dimensions for generator to accommodate maximum potential size for future equipment.
2. Revisions to Civil Documents:
    a. C3.00 attached and labeled Addendum No. 1 dated 9/23/2020
        i. Widen limits of anticipated demolition for utility conduits at the new utility building
    b. C4.00 attached and labeled Addendum No. 1 dated 9/23/2020
        i. Added 5 ea. 2.5” electrical and spare conduits from the new utility building to the central utility plan
    c. C4.01 attached and labeled Addendum No. 1 dated 9/23/2020
        i. Added 5 ea. 2.5” electrical and spare conduits from the new utility building to the central utility plan
3. Revisions to Mechanical Documents:
    a. Section 23 00 00 Heating, Ventilation and Air Conditioning attached and labeled Addendum No. 1 dated 9/23/2020
        i. Added Paragraph 1.15C.1.o: Provide 4” chilled water supply and return connection from CHW main in Building E to point of connection (also in Building E) for future library. Underground piping by civil.
        ii. Added Paragraph 1.15C.2.k: Provide 2.5” hot water supply and return connection from HHW main in Building E to point of connection (also in Building E) for future library. Underground piping by civil.
4. Revisions to Electrical Documents:
    a. E0.01 attached and labeled Addendum No. 1 dated 9/23/2020
        i. Addition of some general notes
    b. E1.01 attached and labeled Addendum No. 1 dated 9/23/2020

i. Clarification of building designations
ii. Enlarge scale

c. E2.01 attached and labeled Addendum No. 1 dated 9/23/2020
i. Addition of notes
ii. Minor revisions to Mechanical Connection schedule including feeder designations
iii. Clarification of existing equipment

d. Section 26 00 00 Electrical Design Criteria attached and labeled Addendum No. 1 dated 9/23/2020
i. 1.2b Clarification of project description
ii. 2.5 Clarification of batter inverter
iii. 3.2 Formatting issue
iv. 4.3b Minor revision to HVAC equipment schedule
v. 4.3e.1 Power monitoring addition
vi. 4.3e.2 TCP clarification
vii. 4.4a Minor revision to Plumbing schedule
viii. 7.2 Minor clarification to Fire alarm Description.

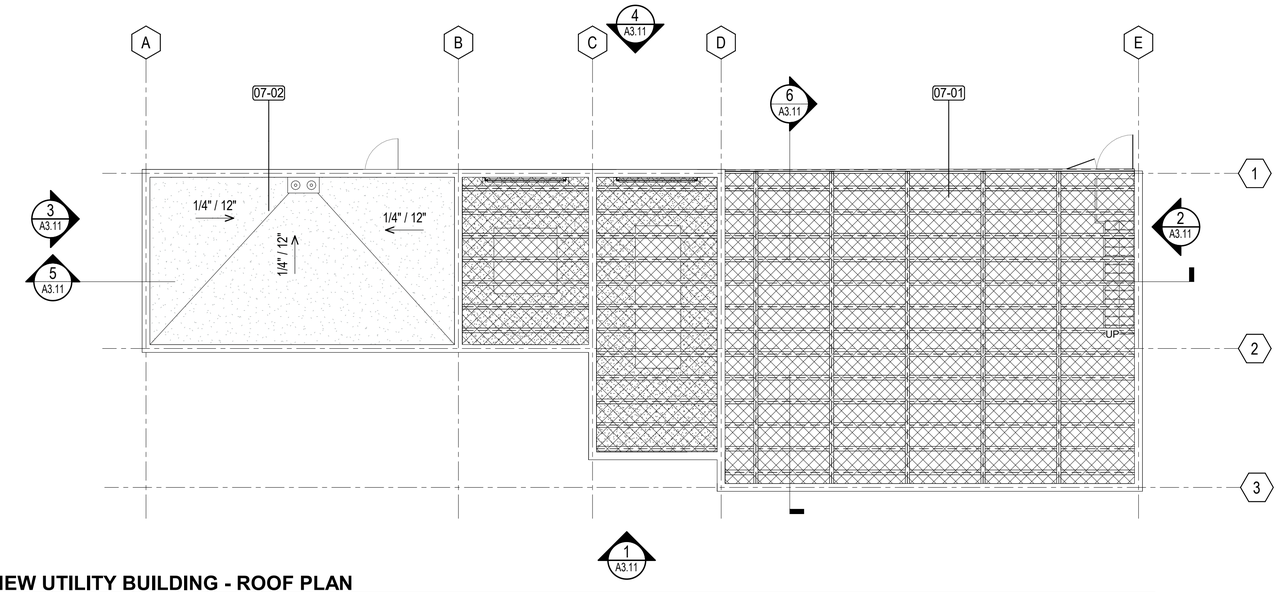
5. Waiver for Release of CAD files:
   a. Proposers to fill in pertinent information and sign document. An electronic link to the files will be provided on receipt of signed waiver.
6. For Reference:
   a. 50% Construction Documents for the Laney Library & Learning Resource Center, dated 08/24/2020.

Documents Issued / Attachments:

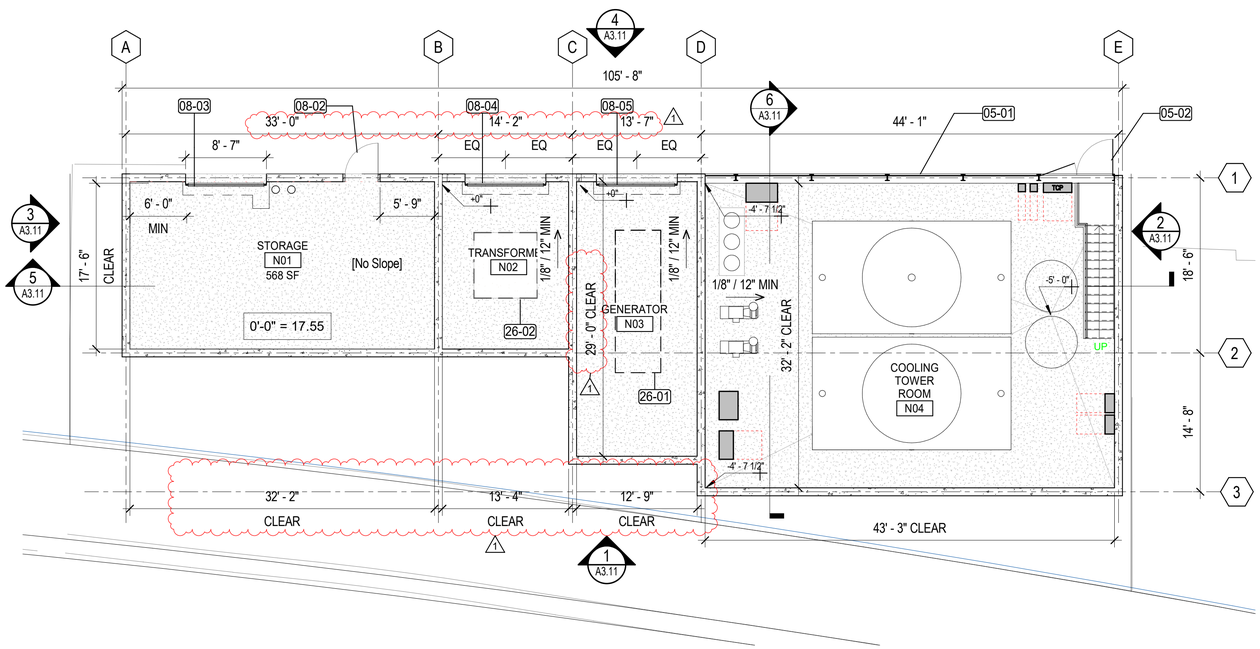
Item	Document
1	PCCD LANEY CUP ADDENDUM 01 - DRAWINGS.pdf
2	PCCD LANEY CUP ADDENDUM 01 - SPECS.pdf
3	PCCD LANEY CUP ADDENDUM 01 - CAD WAIVER.pdf
4	Laney-LLRC_CD50_FULL_DWG-SET.pdf

Issued By: Ned Reifenstein / Noll & Tam

Distributed to: Bill Krill / Swinterton



2 NEW UTILITY BUILDING - ROOF PLAN
A2.32 — 1/8" = 1'-0"



1 NEW UTILITY BUILDING - FLOOR PLAN
A2.32 — 1/8" = 1'-0"

SPACE REQUIREMENTS						
#	Name	AREA	FLOOR	WALLS	CEILINGS	COMMENTS
BUILDING E						
132	(E) CHILLER ROOM	EXISTING	CLEAN, REPAIR & SEAL (E) CONC	PAINT (E) WALLS		SEE MECH AND ELEC DRAWINGS
133	(E) BOILER ROOM	EXISTING	CLEAN, REPAIR & SEAL (E) CONC	PAINT (E) WALLS		SEE MECH AND ELEC DRAWINGS
131	(E) OFFICE	EXISTING	CLEAN, REPAIR & SEAL (E) CONC	PAINT (E) WALLS		SEE MECH AND ELEC DRAWINGS
134	(E) CHILLER ROOM	EXISTING	CLEAN, REPAIR & SEAL (E) CONC	PAINT (E) WALLS		SEE MECH AND ELEC DRAWINGS
135	(E) BOILER ROOM	EXISTING	CLEAN, REPAIR & SEAL (E) CONC	PAINT (E) WALLS		SEE MECH AND ELEC DRAWINGS
136	(E) OFFICE	EXISTING	CLEAN, REPAIR & SEAL (E) CONC	PAINT (E) WALLS		SEE MECH AND ELEC DRAWINGS
NEW UTILITY BUILDING						
N01	STORAGE	500 SF MIN.	SEALED CONC	SEALED CONC	EXPOSED STRUCTURE	WEATHER TIGHT, UNCONDITIONED
N02	TRANSFORMER	S.E.D	SEALED CONC, SLOPE TO DRAIN	SEALED CONC	WIRE MESH	SEE MECH AND ELEC DRAWINGS
N03	GENERATOR	S.E.D.	SEALED CONC, SLOPE TO DRAIN	SEALED CONC	WIRE MESH	SEE MECH AND ELEC DRAWINGS
N04	COOLING TOWER ROOM	S.M.D.	SEALED CONC, SLOPE TO DRAIN	SEALED CONC, WIRE MESH	WIRE MESH	SEE MECH AND ELEC DRAWINGS

KEYNOTES

NOTE	DESCRIPTION
05-01	WIRE MESH PARTITION
05-02	LOCKABLE WIRE MESH GATE, SEE SCHEDULE
07-01	WIRE MESH OVER STRUCTURE TO MATCH (E) UTILITY STRUCTURE (TBD)
07-02	TPO ROOF OVER TAPERED INSULATION OVER STEEL DECK
08-02	HOLLOW-METAL DOOR WITH LOUVER TRANSOM
08-03	OVERHEAD COILING DOOR, MOTORIZED, SOLID SLATS
08-04	OVERHEAD COILING DOOR, PUSH-UP OPERATION, VENITLATED SLATS
08-05	OVERHEAD COILING DOOR, PUSH-UP OPERATION, VENITLATED SLATS, SIZED FOR REMOVAL OF GENERATOR
26-01	FUTURE GENERATOR, N.I.C
26-02	FUTURE TRANSFORMER, N.I.C.

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SEAL

DRAFT! NOT FOR CONSTRUCTION

APPROVALS

PROJECT TITLE

PERALTA COMMUNITY COLLEGE DISTRICT
LANEY COLLEGE CENTRAL UTILITY PLANT

900 FALLON STREET,
OAKLAND, CA 94607

DESIGN CRITERIA DOCUMENTS

ISSUE DATE **SEPTEMBER 3, 2020**
N&T JOB NUMBER **21942.10**

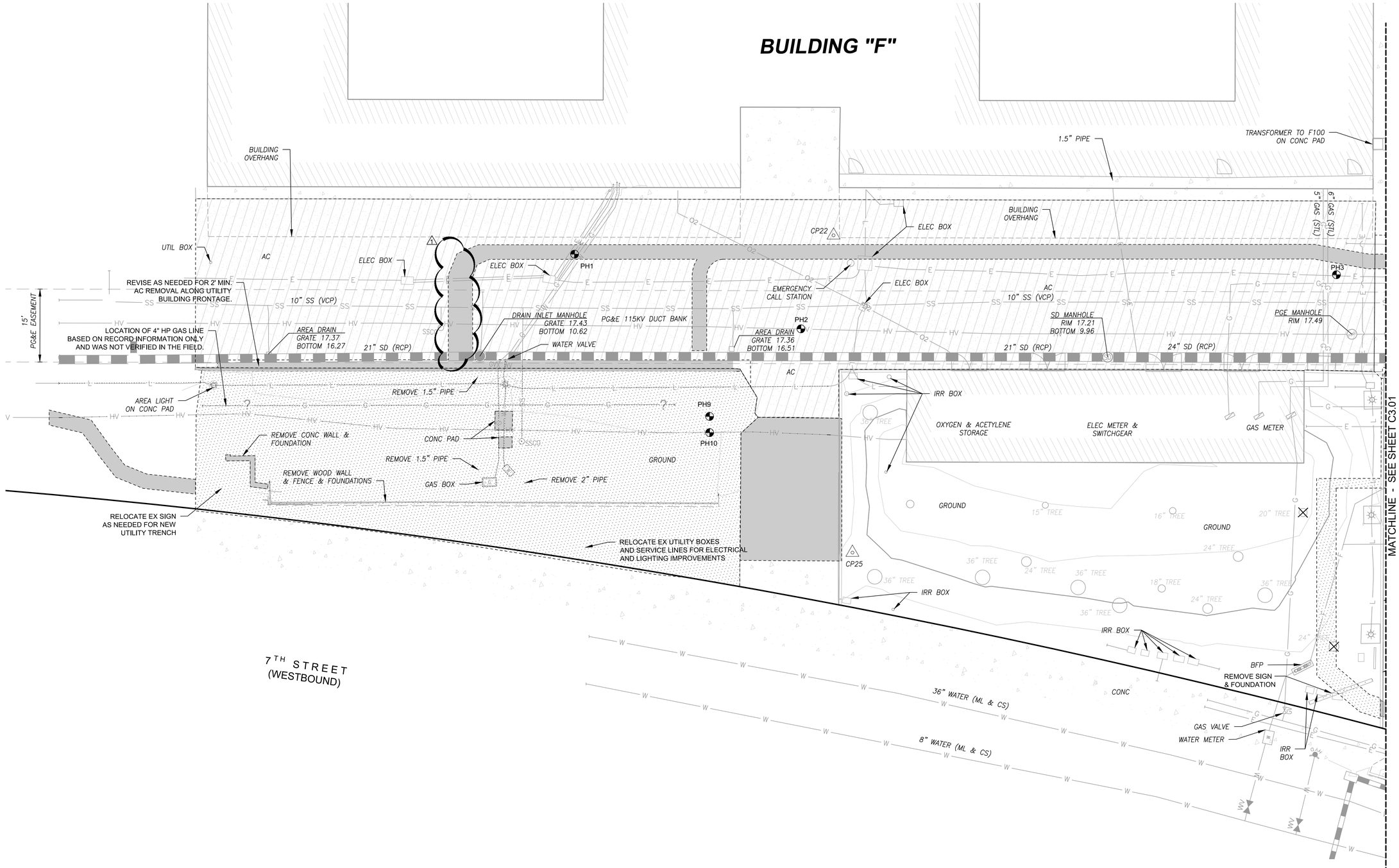
REVISIONS

	DATE	DESCRIPTION
1	09/23/2020	Addendum 01

DRAWN BY **Author** CHECKED BY **Checker**

SHEET TITLE
FLOOR & ROOF PLAN - NEW UTILITY BUILDING

SHEET NUMBER
A2.32



DEMOLITION LEGEND

- REMOVE AND DISPOSE EX. PAVEMENT (ASPHALT AND/OR CONCRETE CURB)
- GRIND/MILL 1.5" MIN AC PAVEMENT
- CLEAR AND GRUB
- REMOVE & DISPOSE OF TREE. GRIND ROOT 12-INCHES BELOW GRADE.
- REMOVE AND DISPOSE EXISTING UTILITY OR STRUCTURE AS INDICATED

NOTES

1. CONTRACTOR SHALL OBTAIN CITY ENCROACHMENT PERMIT FOR ANY WORK WITHIN THE CITY RIGHT-OF-WAY.
2. CONTRACTOR SHALL RELOCATE EXISTING SIGNS, TRASH CANS, IRRIGATION FACILITIES, AND OTHER SITE FEATURES NOT INDICATED IN PLANS FOR THE NEW UTILITY BUILDING AND SITE UTILITY IMPROVEMENTS.
3. ALL FACILITIES, UTILITIES, AND TREES OUTSIDE THE LIMIT OF DEMOLITION SHALL BE PROTECTED IN PLACE, UNLESS NOTED OTHERWISE.

Graphic Scale (in feet)

10 0 10 20

1 inch = 10 ft.

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45 Leveroni Court, Novato, CA 94949 — tel: 415.883.9850, fax: 415.883.9835

APPROVALS

PROJECT TITLE

Peralta Community College District

LANEY CENTRAL UTILITY PLANT

900 Fallon St
Oakland, CA 94607

Design Criteria Documents

ISSUE DATE	09.03.2020
N&T JOB NUMBER	21942.10

REVISIONS

	DATE	DESCRIPTION
2		
1	9/23/2020	ADDENDUM 01

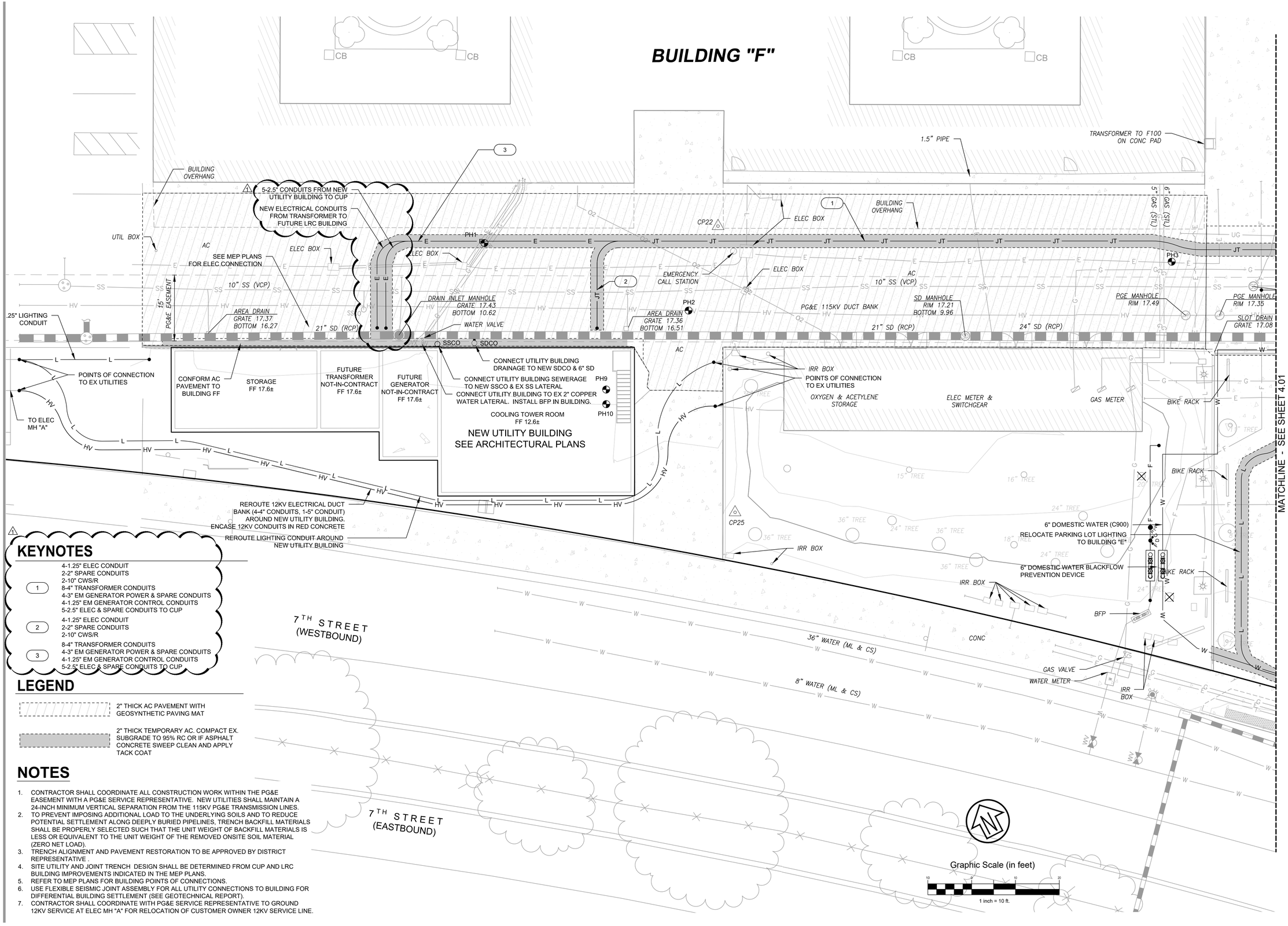
DRAWN BY RJS | CHECKED BY RJS

SHEET TITLE

DEMOLITION PLAN - WEST

SHEET NUMBER

C3.00



KEYNOTES

1. 4-1.25" ELEC CONDUIT
   2-2" SPARE CONDUITS
   2-10" CWS/R
   8-4" TRANSFORMER CONDUITS
   4-3" EM GENERATOR POWER & SPARE CONDUITS
   4-1.25" EM GENERATOR CONTROL CONDUITS
   5-2.5" ELEC & SPARE CONDUITS TO CUP
2. 4-1.25" ELEC CONDUIT
   2-2" SPARE CONDUITS
   2-10" CWS/R
3. 8-4" TRANSFORMER CONDUITS
   4-3" EM GENERATOR POWER & SPARE CONDUITS
   4-1.25" EM GENERATOR CONTROL CONDUITS
   5-2.5" ELEC & SPARE CONDUITS TO CUP

LEGEND

- 2" THICK AC PAVEMENT WITH GEOSYNTHETIC PAVING MAT
- 2" THICK TEMPORARY AC. COMPACT EX. SUBGRADE TO 95% RC OR IF ASPHALT CONCRETE SWEEP CLEAN AND APPLY TACK COAT

NOTES

1. CONTRACTOR SHALL COORDINATE ALL CONSTRUCTION WORK WITHIN THE PG&E EASEMENT WITH A PG&E SERVICE REPRESENTATIVE. NEW UTILITIES SHALL MAINTAIN A 24-INCH MINIMUM VERTICAL SEPARATION FROM THE 115KV PG&E TRANSMISSION LINES.
2. TO PREVENT IMPOSING ADDITIONAL LOAD TO THE UNDERLYING SOILS AND TO REDUCE POTENTIAL SETTLEMENT ALONG DEEPLY BURIED PIPELINES, TRENCH BACKFILL MATERIALS SHALL BE PROPERLY SELECTED SUCH THAT THE UNIT WEIGHT OF BACKFILL MATERIALS IS LESS OR EQUIVALENT TO THE UNIT WEIGHT OF THE REMOVED ONSITE SOIL MATERIAL (ZERO NET LOAD).
3. TRENCH ALIGNMENT AND PAVEMENT RESTORATION TO BE APPROVED BY DISTRICT REPRESENTATIVE.
4. SITE UTILITY AND JOINT TRENCH DESIGN SHALL BE DETERMINED FROM CUP AND LRC BUILDING IMPROVEMENTS INDICATED IN THE MEP PLANS.
5. REFER TO MEP PLANS FOR BUILDING POINTS OF CONNECTIONS.
6. USE FLEXIBLE SEISMIC JOINT ASSEMBLY FOR ALL UTILITY CONNECTIONS TO BUILDING FOR DIFFERENTIAL BUILDING SETTLEMENT (SEE GEOTECHNICAL REPORT).
7. CONTRACTOR SHALL COORDINATE WITH PG&E SERVICE REPRESENTATIVE TO GROUND 12KV SERVICE AT ELEC MH "A" FOR RELOCATION OF CUSTOMER OWNER 12KV SERVICE LINE.

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45 Leveroni Court, Novato, CA 94949 tel: 415.883.9850 fax: 415.883.9835

APPROVALS

PROJECT TITLE

Peralta Community College District

LANEY CENTRAL UTILITY PLANT

900 Fallon St
Oakland, CA 94607

Design Criteria Documents

ISSUE DATE	09.03.2020
N&T JOB NUMBER	21942.10

REVISIONS

	DATE	DESCRIPTION
2		
1	9/23/2020	ADDENDUM 01

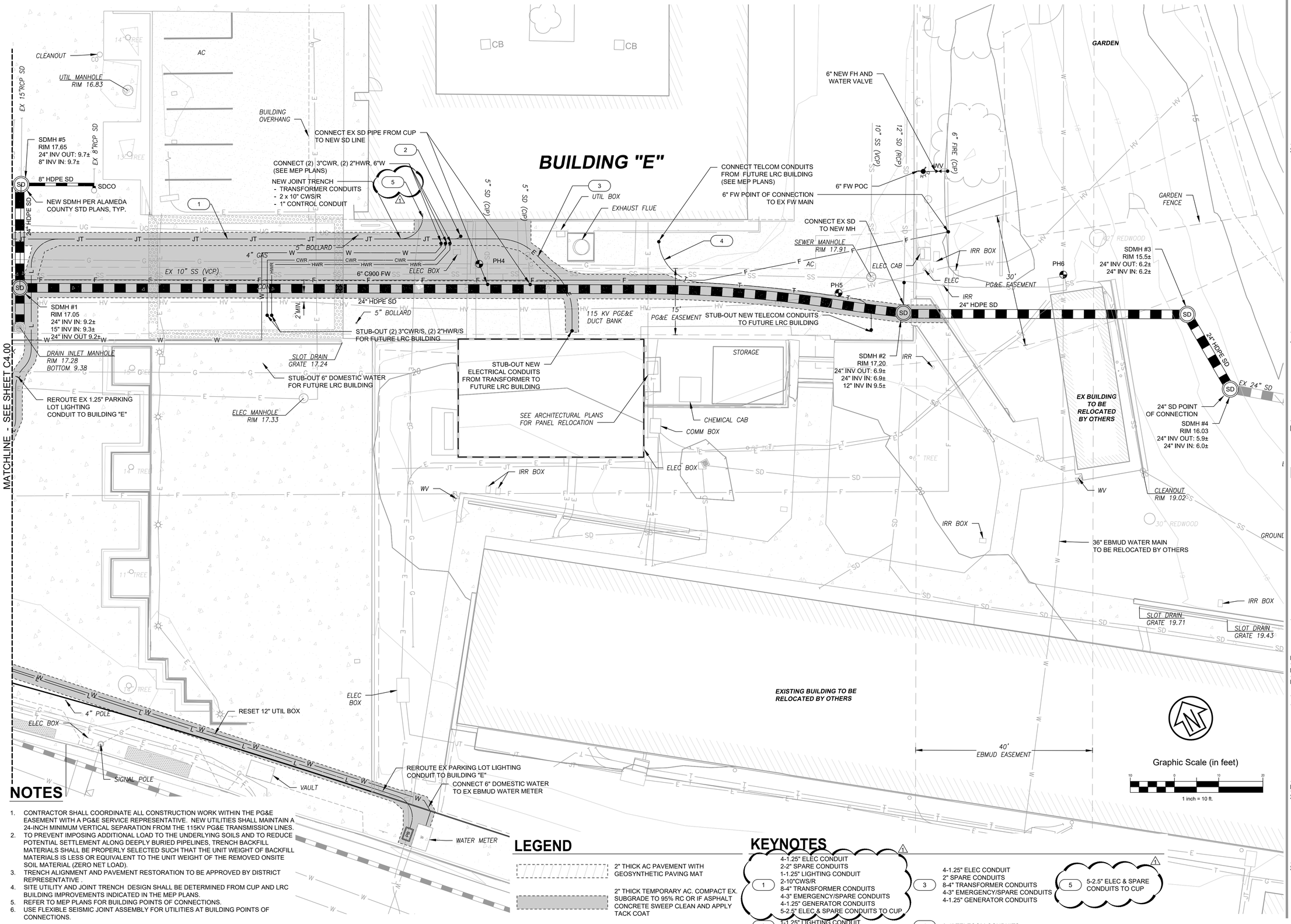
DRAWN BY RJS CHECKED BY RJS

SHEET TITLE

COMPOSITE CIVIL PLAN - WEST

SHEET NUMBER

C4.00



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2. TO PREVENT IMPOSING ADDITIONAL LOAD TO THE UNDERLYING SOILS AND TO REDUCE POTENTIAL SETTLEMENT ALONG DEEPLY BURIED PIPELINES, TRENCH BACKFILL MATERIALS SHALL BE PROPERLY SELECTED SUCH THAT THE UNIT WEIGHT OF BACKFILL MATERIALS IS LESS OR EQUIVALENT TO THE UNIT WEIGHT OF THE REMOVED ONSITE SOIL MATERIAL (ZERO NET LOAD).
3. TRENCH ALIGNMENT AND PAVEMENT RESTORATION TO BE APPROVED BY DISTRICT REPRESENTATIVE
4. SITE UTILITY AND JOINT TRENCH DESIGN SHALL BE DETERMINED FROM CUP AND LRC BUILDING IMPROVEMENTS INDICATED IN THE MEP PLANS.
5. REFER TO MEP PLANS FOR BUILDING POINTS OF CONNECTIONS.
6. USE FLEXIBLE SEISMIC JOINT ASSEMBLY FOR UTILITIES AT BUILDING POINTS OF CONNECTIONS.

LEGEND

- 2" THICK AC PAVEMENT WITH GEOSYNTHETIC PAVING MAT
- 2" THICK TEMPORARY AC. COMPACT EX. SUBGRADE TO 95% RC OR IF ASPHALT CONCRETE SWEEP CLEAN AND APPLY TACK COAT

KEYNOTES

1. 4-1.25" ELEC CONDUIT
   2-2" SPARE CONDUITS
   1-1.25" LIGHTING CONDUIT
   2-10"CWS/R
   8-4" TRANSFORMER CONDUITS
   4-3" EMERGENCY/SPARE CONDUITS
   4-1.25" GENERATOR CONDUITS
   5-2.5" ELEC & SPARE CONDUITS TO CUP
2. 1-1.25" LIGHTING CONDUIT
   2-10" CWS/R
3. 4-1.25" ELEC CONDUIT
   2" SPARE CONDUITS
   8-4" TRANSFORMER CONDUITS
   4-3" EMERGENCY/SPARE CONDUITS
   4-1.25" GENERATOR CONDUITS
4. 2-4" TELECOM CONDUITS
5. 5-2.5" ELEC & SPARE CONDUITS TO CUP

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APPROVALS

PROJECT TITLE

Peralta Community College District

LANEY CENTRAL UTILITY PLANT

900 Fallon St
Oakland, CA 94607

Design Criteria Documents

ISSUE DATE	09.03.2020
N&T JOB NUMBER	21942.10

REVISIONS

	DATE	DESCRIPTION
2		
1	9/23/2020	ADDENDUM 01

DRAWN BY RJS CHECKED BY RJS

SHEET TITLE

COMPOSITE CIVIL PLAN - EAST

SHEET NUMBER

C4.01

SYMBOLS LIST

SOME OF THESE SYMBOLS SHOWN MAY NOT BE USED ON THIS PROJECT

POWER DISTRIBUTION

- SWITCHBOARD, DISTRIBUTION BOARD, SUBSTATION OR MOTOR CONTROL CENTER, FLOOR MOUNTED.
- PANELBOARD, 277/480V, SURFACE MOUNTED ON WALL.
- PANELBOARD, 277/480V, FLUSH MOUNTED IN WALL.
- PANELBOARD, 120/208V, SURFACE MOUNTED ON WALL.
- PANELBOARD, 120/208V, FLUSH MOUNTED IN WALL.
- DRY-TYPE STEP-DOWN TRANSFORMER, FLOOR MOUNTED 3Ø,480-120/208V, UON.
- ELECTRIC MOTOR, NIEC. MAKE POWER CONNECTIONS ONLY AS NOTED ON PLANS.
- (F) INDOOR EXHAUST FAN MOTOR, SINGLE PHASE. MAKE POWER CONNECTIONS TO INCLUDE JUNCTION BOX MOUNTED MANUAL MOTOR STARTER AND DISCONNECT ADJACENT TO FAN WITH 2 #12 CONDUCTORS PLUS GROUND IN 1/2" FLEXIBLE CONDUIT BETWEEN STARTER AND MOTOR.
- (V) INDOOR FAN POWERED VAV BOX MOTOR, SINGLE PHASE, MOUNTED FROM STRUCTURE ABOVE, NIEC. MAKE POWER CONNECTIONS TO INCLUDE JUNCTION BOX MOUNTED MANUAL MOTOR STARTER AND DISCONNECT ADJACENT TO VAV BOX WITH 2 #12 CONDUCTORS PLUS GROUND IN 1/2" FLEXIBLE CONDUIT BETWEEN STARTER AND MOTOR.
- P PULLBOX OR HANDHOLE, SIZE AND TYPE AS NOTED ON PLANS.
- AF AF SAFETY DISCONNECT SWITCH, 3 POLE, UON. ADJACENT NUMBER INDICATES FUSE SIZE WHEN APPLICABLE. LABELING CONVENTION AS FOLLOWS:

A: 30A, NON-FUSED	AF: 30A, FUSED
B: 60A, NON-FUSED	BF: 60A, FUSED
C: 100A, NON-FUSED	CF: 100A, FUSED
D: 200A, NON-FUSED	DF: 200A, FUSED
E: 400A, NON-FUSED	EF: 400A, FUSED
F: 600A, NON-FUSED	FF: 600A, FUSED
G: 800A, NON-FUSED	GF: 800A, FUSED

- 1 MAGNETIC MOTOR STARTER. ADJACENT NUMBER INDICATES NEMA SIZE OF STARTER.
- 1 COMBINATION MAGNETIC MOTOR STARTER/SAFETY DISCONNECT SWITCH. ADJACENT NUMBER INDICATES NEMA SIZE OF STARTER.
- PACKAGE MOTOR CONTROLLER OR STARTER FURNISHED AND INSTALLED UNDER ANOTHER DIVISION WITH EQUIPMENT CONTROLLED. PROVIDE SINGLE-POINT POWER SERVICE CONNECTION UNDER THIS DIVISION AS NOTED ON PLANS.
- VFD VARIABLE FREQUENCY DRIVE FURNISHED AND INSTALLED UNDER ANOTHER DIVISION. PROVIDE POWER SERVICE CONNECTION UNDER THIS DIVISION AS NOTED ON PLANS.
- VFD VARIABLE FREQUENCY DRIVE WITH INTEGRAL DISCONNECT FURNISHED AND INSTALLED UNDER ANOTHER DIVISION. PROVIDE POWER SERVICE CONNECTION UNDER THIS DIVISION AS NOTED ON PLANS.
- INDICATES CABLE TERMINATION LUGS AT EQUIPMENT BUS.
- GROUP MOUNTED MOLDED CASE CIRCUIT BREAKER.
- G INDICATES INTEGRAL GROUND FAULT RELAY WHEN ASSOCIATED WITH CIRCUIT BREAKER.
- M UTILITY METER.
- TRANSFORMER.
- CONNECTION TO GROUND.
- CURRENT TRANSFORMERS.
- V AUTOMATIC OR MANUAL TRANSFER SWITCH.
- G EMERGENCY GENERATOR.
- NEUTRAL SERVICE DISCONNECT LINK.

CONVENTIONS

- NUMBERED SHEET NOTE, APPLIES TO DRAWING CONTAINING NOTES ONLY.
- (NAME) EQUIPMENT IDENTIFICATION TAG: ITEM FURNISHED AND INSTALLED UNDER ANOTHER SECTION AND WIRED UNDER THIS SECTION.
- FEEDER SIZE. REFER TO FEEDER SCHEDULE.
- DETAIL REFERENCE:
  - SHEET NUMBER
  - DETAIL DESIGNATION
- FIXTURE IDENTIFICATION TAG:
  - FIXTURE TYPE
  - QUANTITY

RACEWAYS

- CONDUIT RUN EXPOSED ON WALL OR CEILING.
- CONDUIT RUN CONCEALED IN SLAB, UNDER SLAB OR UNDERGROUND.
- CONDUIT RUN CONCEALED IN WALL OR ABOVE CEILING.
- CONDUIT HOMERUN, CONTINUOUS RUN TO PANEL OR EQUIPMENT CABINET.
- FLEXIBLE METALLIC CONDUIT.
- CONDUIT TURNED UP
- CONDUIT TURNED DOWN.

GENERAL NOTES

1. EXISTING BUILDING AND SITE DOCUMENTATION IS BASED ON AVAILABLE DOCUMENTATION PROVIDED BY THE OWNER AND LIMITED SITE OBSERVATION INVESTIGATIONS. AS-BUILT CONDITIONS MAY VARY. CONTRACTOR IS TO USE CAUTION IN DEMOLITION AND IS TO NOTIFY ARCHITECT IMMEDIATELY IF ANY VARIATIONS OR DISCREPANCIES ARE UNCOVERED.
2. FOR CUP ROUTE CONDUITS TO LOCATIONS NOTED ON SINGLE LINE, MECHANICAL SCHEDULE AND BASIS OF DESIGN.
3. FOR LRC BUILDING ROUTE CONDUITS TO LOCATIONS NOTED ON CIVIL DRAWINGS. INSTALL PULLSTRINGS FOR USE BY LRC PROJECT

ABBREVIATIONS

A	AMPERES
AFC	ABOVE FINISHED CEILING
AFI	ARC FAULT CIRCUIT INTERRUPTER
AF	AMPERE OVERCURRENT FRAME SIZE (WHEN APPLIED TO CIRCUIT BREAKERS) OR AMPERE FUSE SIZE (WHEN APPLIED TO FUSES)
AFF	ABOVE FINISHED FLOOR
AIC	ASYMMETRIC INTERRUPTING CURRENT
AL	ALUMINUM
AT	AMPERE OVERCURRENT TRIP (WHEN APPLIED TO CIRCUIT BREAKERS)
ATS	AUTOMATIC TRANSFER SWITCH
BPS	BOLTED PRESSURE CONTACT SWITCH
BFC	BELOW FINISHED CEILING
C	CONDUIT
CKT	CIRCUIT
CS	CHARGING STATION (BULLROOMS)
CT	CURRENT TRANSFORMER
CU	COPPER
DF	DRINKING FOUNTAIN
DW	DISH WASHER
(E)	EXISTING TO REMAIN
EC	ELECTRICAL CONTRACTOR
EF	EXHAUST FAN
EMT	ELECTRICAL METALLIC TUBING
F	FUSED
(F)	FUTURE
FACP	FIRE ALARM CONTROL PANEL
FLA	FULL LOAD AMPERES
FMC	FLEXIBLE METAL CONDUIT
G	GROUND
GB	GROUND BUS
GD	GARBAGE DISPOSAL
GFCI	GROUND FAULT CIRCUIT INTERRUPTER
GND	GROUND
HD	HAND DRYER
HPC	HIGH PRESSURE CONTACT SWITCH
HVAC	HEATING,VENTING AND AIR CONDITIONING
IWH	INSTANTANEOUS OR POINT OF USE WATER HEATER
JB	JUNCTION BOX
LCP	LIGHTING CONTROL PANEL
MLO	MAIN LUGS ONLY
MTC	EMPTY CONDUIT
MW	MICROWAVE
(N)	NEW
NIEC	NOT IN ELECTRICAL CONTRACT
NTS	NOT TO SCALE
OFCI	OWNER FURNISHED CONTRACTOR INSTALLED
PDZ	PRIMARY DAYLIGHT ZONE
PNL	PANEL
PR	PRINTER/PLOTTER/COPIER
PVC	POLYVINYL CHLORIDE
RF	REFRIGERATOR
(R)	EXISTING TO BE REMOVED
(RL)	RELOCATED
(RR)	REMOVE AND REPLACE
RSC	RIGID STEEL CONDUIT
SAD	SEE ARCHITECTURAL DRAWINGS
SB	SHRED BIN
SDZ	SECONDARY DAYLIGHT ZONE
TX	TRANSFORMER
TYP	TYPICAL
UON	UNLESS OTHERWISE NOTED
UPS	UNINTERRUPTIBLE POWER SUPPLY
UR	UNDERCOUNTER REFRIGERATOR
V	VOLTS
VA	VOLTS-AMPS
VAV	VARIABLE AIR VOLUME
VFD	VARIABLE FREQUENCY DRIVE
VM	VENDING MACHINE
W	WATTS
WAP	WIRELESS ACCESS POINT
WH	WATER HEATER
1Ø	1 PHASE
3Ø	3 PHASE
1P	1 POLE
2P	2 POLE
3P	3 POLE
3W	3 WIRE
4W	4 WIRE

DRAWING INDEX

DWG. No.	DRAWING TITLE	ISSUE TITLE: DESIGN CRITERIA (DATE: 08.24.2020)	ISSUE TITLE: BID ADDENDUM #1 (DATE: 09.22.2020)
E0.01	SYMBOLS LIST, NOTES AND DRAWING INDEX	●	●
E1.01	ELECTRICAL SITE PLAN	●	●
E2.01	POWER SINGLE LINE DIAGRAM AND LOAD CALCULATIONS	●	●

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ALAMEDA, CA. 94501
(510) 769-7600 JOB #20161

SEAL

DRAFT! NOT FOR CONSTRUCTION

APPROVALS

PROJECT TITLE

PERALTA COMMUNITY COLLEGE DISTRICT

LANEY COLLEGE CENTRAL UTILITY PLANT

900 FALLON STREET,
OAKLAND, CA 94607

CRITERIA DOCUMENTS

ISSUE DATE **AUGUST 10, 2020**

N&T JOB NUMBER **21942.10**

REVISIONS

	DATE	DESCRIPTION

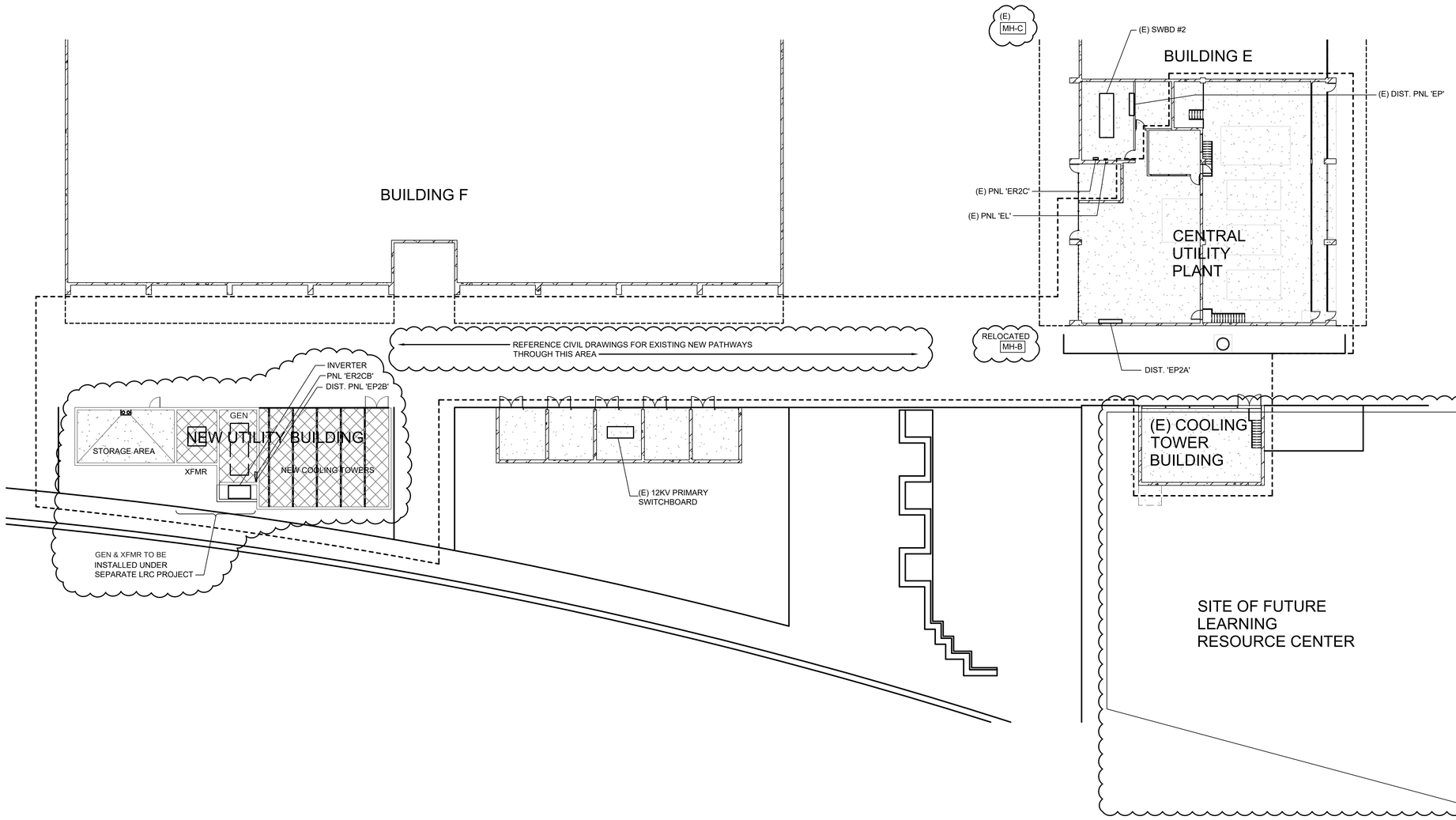
DRAWN BY **Author** CHECKED BY **Checker**

SHEET TITLE

SYMBOLS LIST AND DRAWING INDEX

SHEET NUMBER

E0.01



A E1.01 ELECTRICAL SITE PLAN

SCALE: 1" = 20'-0"

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THE POWER HOUSE
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ALAMEDA, CA. 94501
(510) 769-7600 JOB #20161

SEAL

DRAFT! NOT FOR CONSTRUCTION

APPROVALS

PROJECT TITLE

PERALTA COMMUNITY COLLEGE DISTRICT

LANEY COLLEGE CENTRAL UTILITY PLANT

900 FALLON STREET,
OAKLAND, CA 94607

CRITERIA DOCUMENTS

ISSUE DATE	**AUGUST 10, 2020**
N&T JOB NUMBER	**21942.10**

REVISIONS

	DATE	DESCRIPTION

DRAWN BY **Author** CHECKED BY **Checker**

SHEET TITLE

ELECTRICAL SITE PLAN

SHEET NUMBER

E1.01

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MECHANICAL AND PLUMBING CONNECTION SCHEDULE

ITEM	DESCRIPTION	LOCATION	SERVING	VOLTS / PHASE	LOAD		MOCP	WIRE / CONDUIT	EMERGENCY POWER	CIRCUIT	NOTES
CH-1	CHILLER	CUP	CAMPUS	460/3	381	A	600	5003		EP-1	
CH-2	CHILLER	CUP	CAMPUS	460/3	381	A	600	5003		EP-2	
CT-1	COOLING TOWER	UTILITY BUILDING	CAMPUS	460/3	15	HP	40	303		EP2B-1	
CT-2	COOLING TOWER	UTILITY BUILDING	CAMPUS	460/3	15	HP	40	303		EP2B-2	
FC-1	FAN COIL	CUP	CAMPUS	208/3	1/4	HP	15	203		ER2C-7,9,11	
FC-2 (ALTERNATE)	FAN COIL	CUP	CAMPUS	208/3	1/6	HP	15	203		ER2C-7,9,11	
TF-1	TRANSFER FAN	CUP	CAMPUS	208/3	1	HP	15	203		ER2C-13,15,17	
B-1	BOILER	CUP	CAMPUS	208/3	18	A	25	303		ER2C-19,21,23	
B-2	BOILER	CUP	CAMPUS	208/3	18	A	25	303		ER2C-25,27,29	
B-3	BOILER	CUP	CAMPUS	208/3	18	A	25	303		ER2C-31,33,35	
B-4	BOILER	CUP	CAMPUS	208/3	18	A	25	303		ER2C-37,39,41	
PCHP-1	PUMP	CUP	CAMPUS	460/3	10	HP	25	203		EP2A-1	
PCHP-2	PUMP	CUP	CAMPUS	460/3	10	HP	25	203		EP2A-2	
SCHP-1	PUMP	CUP	CAMPUS	460/3	50	HP	100	903		EP2A-3	
SCHP-2	PUMP	CUP	CAMPUS	460/3	50	HP	100	903		EP2A-4	
PHWP-1	PUMP	CUP	CAMPUS	460/3	7.5	HP	20	203		EP2A-5	
PHWP-2	PUMP	CUP	CAMPUS	460/3	7.5	HP	20	203		EP2A-6	
PHWP-3	PUMP	CUP	CAMPUS	460/3	7.5	HP	20	203		EP2A-7	
PHWP-4	PUMP	CUP	CAMPUS	460/3	7.5	HP	20	203		EP2A-8	
SHWP-1	PUMP	CUP	CAMPUS	460/3	20	HP	50	403		EP2A-9	
SHWP-2	PUMP	CUP	CAMPUS	460/3	20	HP	50	403		EP2A-10	
THWP-1	PUMP	CUP	CAMPUS	460/3	5	HP	15	203		EP2A-11	
THWP-2	PUMP	CUP	CAMPUS	460/3	5	HP	15	203		EP2A-12	
CW-1	PUMP	CUP	CAMPUS	460/3	20	HP	50	403		EP2A-13	
CW-2	PUMP	CUP	CAMPUS	460/3	20	HP	50	403		EP2A-14	
WTS-1	WATER TREATMENT	CUP	CAMPUS	120/1	15.00	A	20	202		ER2C-16	
AC-1	AIR CONDITIONING UNIT	CUP	CAMPUS	460/3	25.00	HP	60	503		EP2A-15	
D-1	CONDENSER WATER LOOP	CUP	CAMPUS	120/1	15.00	A	20	202		ER2C-18	
TCP -3	SOLENOID VALVE	CUP	CAMPUS	120/1	15.00	A	20	202		ER2C-20	
SE-1	SEWER EJECTOR PUMP	UTILITY BUILDING	UTILITY BUILDING	460/3	3.00	HP	15	203	INVERTER	EP2B-3	1
				460/3	3.00	HP	15	203	INVERTER	EP2B-4	1
SDP-1	STORM DRAIN PUMP	UTILITY BUILDING	UTILITY BUILDING	460/3	2.00	HP	15	203	INVERTER	EP2B-5	1
				460/3	2.00	HP	15	203	INVERTER	EP2B-6	1

	Total KVA	(A@480V)
Total Normal	1016	1221

GENERAL MECHANICAL EQUIPMENT CONNECTION SCHEDULE NOTES

A. THE ABOVE INFORMATION IS FOR A SPECIFIC MANUFACTURER. ACTUAL MANUFACTURER FOR EQUIPMENT MAY BE DIFFERENT. COORDINATE WITH MECHANICAL EQUIPMENT SUBMITTALS FOR LOADS AND OVER CURRENT PROTECTION REQUIREMENTS PRIOR TO INSTALLATION OF WIRING.

B. MOCP = MAXIMUM OVER CURRENT PROTECTION
MCA = MINIMUM CIRCUIT AMPACITY

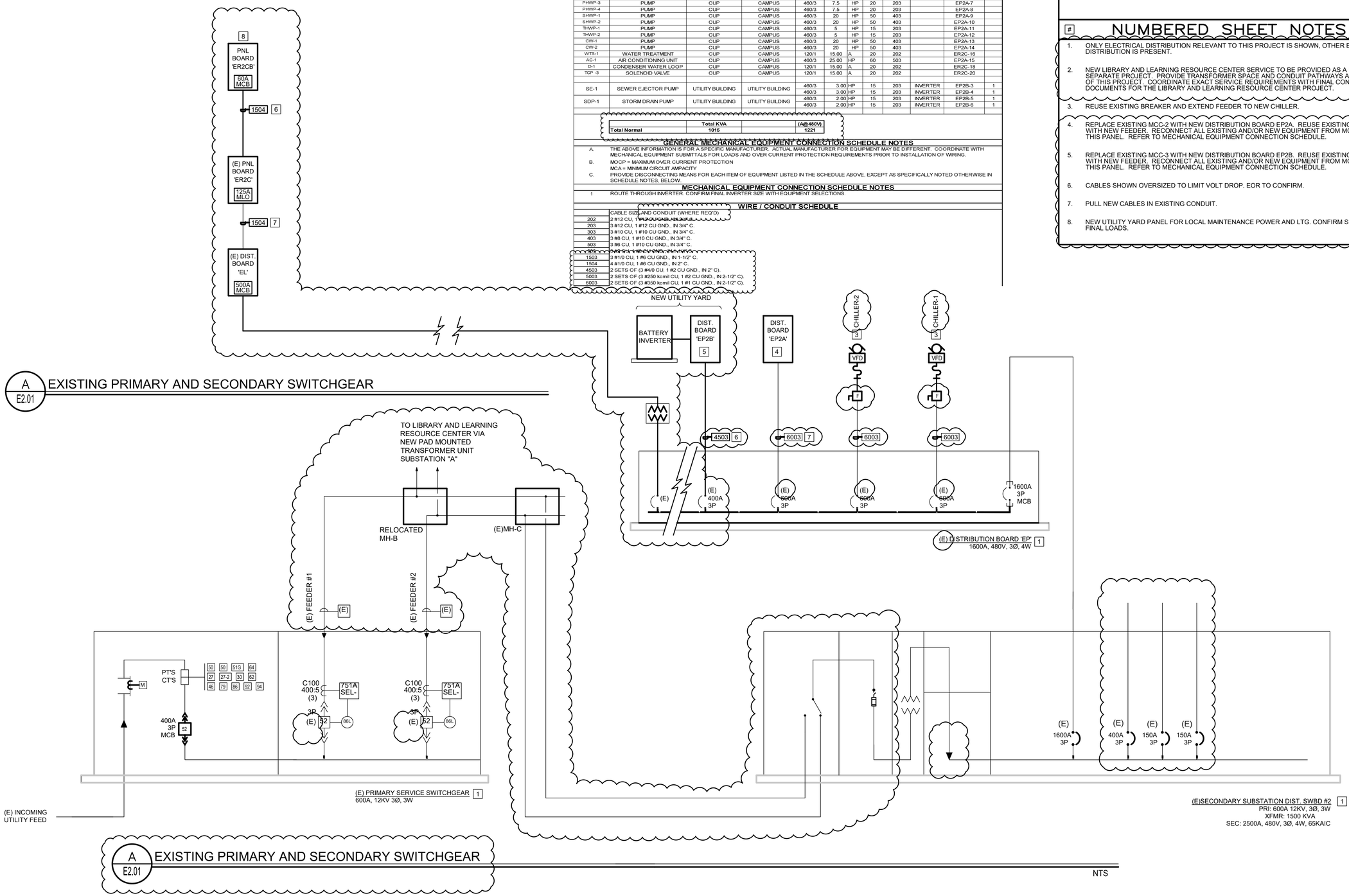
C. PROVIDE DISCONNECTING MEANS FOR EACH ITEM OF EQUIPMENT LISTED IN THE SCHEDULE ABOVE, EXCEPT AS SPECIFICALLY NOTED OTHERWISE IN SCHEDULE NOTES, BELOW.

MECHANICAL EQUIPMENT CONNECTION SCHEDULE NOTES

1 ROUTE THROUGH INVERTER. CONFIRM FINAL INVERTER SIZE WITH EQUIPMENT SELECTIONS.

WIRE / CONDUIT SCHEDULE

	CABLE SIZE AND CONDUIT (WHERE REQ'D)
202	2 #12 CU, 1 #12 GROUND, IN 3/4" C.
203	3 #12 CU, 1 #12 CU GND., IN 3/4" C.
303	3 #10 CU, 1 #10 CU GND., IN 3/4" C.
403	3 #8 CU, 1 #10 CU GND., IN 3/4" C.
503	3 #6 CU, 1 #10 CU GND., IN 3/4" C.
903	3 #2 CU, 1 #6 CU GND., IN 1-1/4" C.
1503	3 #1/0 CU, 1 #6 CU GND., IN 1-1/2" C.
1504	4 #1/0 CU, 1 #6 CU GND., IN 2" C.
4503	2 SETS OF (3 #4/0 CU, 1 #2 CU GND., IN 2" C).
5003	2 SETS OF (3 #250 kcmil CU, 1 #2 CU GND., IN 2-1/2" C).
6003	2 SETS OF (3 #350 kcmil CU, 1 #1 CU GND., IN 2-1/2" C).



A E2.01 EXISTING PRIMARY AND SECONDARY SWITCHGEAR

A E2.01 EXISTING PRIMARY AND SECONDARY SWITCHGEAR

NTS

GENERAL NOTES

A. SINGLE LINE DRAWING IS AT SCHEMATIC DESIGN LEVEL AND PROVIDED FOR REFERENCE ONLY TO COMPLIMENT THE ELECTRICAL DESIGN NARRATIVE.

NUMBERED SHEET NOTES

1. ONLY ELECTRICAL DISTRIBUTION RELEVANT TO THIS PROJECT IS SHOWN, OTHER EXISTING DISTRIBUTION IS PRESENT.
2. NEW LIBRARY AND LEARNING RESOURCE CENTER SERVICE TO BE PROVIDED AS A PART OF SEPARATE PROJECT. PROVIDE TRANSFORMER SPACE AND CONDUIT PATHWAYS AS A PART OF THIS PROJECT. COORDINATE EXACT SERVICE REQUIREMENTS WITH FINAL CONSTRUCTION DOCUMENTS FOR THE LIBRARY AND LEARNING RESOURCE CENTER PROJECT.
3. REUSE EXISTING BREAKER AND EXTEND FEEDER TO NEW CHILLER.
4. REPLACE EXISTING MCC-2 WITH NEW DISTRIBUTION BOARD EP2A. REUSE EXISTING BREAKER WITH NEW FEEDER. RECONNECT ALL EXISTING AND/OR NEW EQUIPMENT FROM MCC-2 TO THIS PANEL. REFER TO MECHANICAL EQUIPMENT CONNECTION SCHEDULE.
5. REPLACE EXISTING MCC-3 WITH NEW DISTRIBUTION BOARD EP2B. REUSE EXISTING BREAKER WITH NEW FEEDER. RECONNECT ALL EXISTING AND/OR NEW EQUIPMENT FROM MCC-3 TO THIS PANEL. REFER TO MECHANICAL EQUIPMENT CONNECTION SCHEDULE.
6. CABLES SHOWN OVERSIZED TO LIMIT VOLT DROP. EOR TO CONFIRM.
7. PULL NEW CABLES IN EXISTING CONDUIT.
8. NEW UTILITY YARD PANEL FOR LOCAL MAINTENANCE POWER AND LTG. CONFIRM SIZE WITH FINAL LOADS.

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SHEET TITLE

POWER SINGLE LINE DIAGRAM AND LOAD CALCULATIONS

SHEET NUMBER

E2.01

SECTION 230000

HEATING VENTILATING & AIR CONDITIONING

PART 1 GENERAL

1.01 DESCRIPTION & SCOPE

A. Work included: Engineering, materials, equipment, fabrication, installation, starting, testing and commissioning of heating, ventilating and air conditioning systems

B. Project Scope Summary

1. The project consists of retrofitting the existing central utility plant at the Laney College Campus in Oakland, CA.
2. The scope of work for this bid includes the chilled and hot water plant equipment located in Building E that provides heating and cooling to all buildings on campus. In addition, the existing cooling towers will be demolished and relocated to a new enclosure south of Building F.

C. Excluded work

1. Building Automation Systems
   a. BAS will be bid after the HVAC design is further developed so that the scope is better defined.
   b. The BAS will be bid as Division 25 and may or may not be a subcontractor to Division 23. The Division 25 budget estimate is $500,000 and **should not** be included in the pricing for scope of work under Division 23.
2. See Paragraph 1.01E for scope of work coordination.

D. Design/Build Approach

1. The work for this project will be built using a “design/build” approach. The design/build mechanical contractor (“Contractor”) and Taylor Engineering (“Engineer”) shall share design responsibilities as indicated herein.
2. The table below indicates engineering responsibility assignments for the Contractor and the Engineer.

Item	Contractor	Engineer
Engineer-of-Record	P	–
Mechanical system program requirements	R	P
Equipment sizing	P	R
Primary equipment selection (see Paragraph 1.02B)	P	P
Other equipment selection	P	S
Hydronic distribution systems conceptual design	R	P
Hydronic distribution systems	P	R
Air distribution systems conceptual design	R	P

Item	Contractor	Engineer
Air distribution systems	P	R
Vibration and noise control	P	R
Control systems	N	P
Construction details (see note below)	P	R
Seismic restraints	P	R
Completion of permit drawings	P	R
Title 24 HVAC Compliance Documentation	P	R
Project construction management	P	N
Construction and all field work	P	R
Construction quality control	P	N
Start-up & TAB	P	R
Commissioning	S	S

3. Explanatory notes
   a. Primary (P) responsibility shall mean making all decisions and taking engineer/contractor-of-record responsibility for the item.
   b. Secondary (S) responsibility shall mean taking an active role assisting the party with primary responsibility for the item.
   c. Review (R) shall mean that the party shall review and comment on the work done by the party with primary responsibility for the item.
   d. No (N) responsibility shall mean the party will have no role with regard to the item.
   e. "Construction details" includes wall, roof, and floor penetration details, piping, ductwork, and equipment details and supports, vibration isolation details, housekeeping pad layouts and dimensioning, etc.
   f. Commissioning will be overseen by a 3rd party commissioning provider retained by the Owner.
4. The Contractor shall be the engineer-of-record as well as the contractor of record and responsible for all required work.

E. Scope of Work Coordination

1. Coordination with other Trades: The following table is intended to assist the Contractors in coordinating the scope of work between Division 23 HVAC (indicated as 23 in table), Division 25 Building Automation Systems (indicated as 25), and other Divisions as indicated. However, the General Contractor is ultimately responsible for coordination among his subcontractors regardless of what is listed in this Section.

INTERFACE / RESPONSIBILITY MATRIX					
System	Division under which the following is specified				Remarks
	Equipment	Installation	Power wiring (remark 1)	Control & interlock wiring (remark 1)	
A. FIRE SPRINKLER SYSTEM					
1. Flow switches	21	21	26	26	
2. Valve monitors	21	21	26	26	
3. Post indicating valves	21	21	26	26	
B. FIRE & LIFE SAFETY SYSTEMS					
1. Fire alarm controls	26	26	26	26	
2. Duct mounted & in-duct mounted smoke detectors	26	23	26	26	
3. Other smoke detectors	26	26	26	26	
4. Smoke control interlocks to HVAC fans	26	26	26	26	2
5. Smoke dampers with electric actuators	23	23	26	26	
6. Smoke damper end switches	23	23	26	26	
C. MECHANICAL EQUIPMENT					
1. Unitary mechanical equipment	23	23	26	25	3
2. Chillers	23	23	26	25	3, 7
3. Air compressors	23	23	26	25	3, 8
4. Variable speed drives, field mounted	23	26	26	25	
5. Motors, 3 phase	23	23	26	–	
6. Motor starters, 3 phase	26	26	26	25	4
7. Motors, 1 phase	23	23	26	26	5, 6
8. Other powered equipment	23	23	26	25	
9. Disconnects/circuit breakers	26/23	26/23	26	–	9
10. Refrigerant leak detector	25	25	26	25	10
11. Cooling tower vibration switch	23	23	–	25	
12. Cooling tower water treatment system	23	23	26	25	11
D. BUILDING AUTOMATION SYSTEM (BAS)					
1. Central control workstations & servers	25	25	26	25	
2. Control system network backbone	25	25	25	25	
3. Line voltage control devices to 120V motors	25	26	26	26	6
4. Control panels	25	25	26/25	25	12

INTERFACE / RESPONSIBILITY MATRIX					
System	Division under which the following is specified				Remarks
	Equipment	Installation	Power wiring (remark 1)	Control & interlock wiring (remark 1)	
5. Control devices	25	25	25	25	
E. ELECTRICAL SYSTEMS					
1. Lighting Control BACnet gateway	–	–	–	–	
2. Lighting relay panels and low voltage switches	26	26	26	26	
3. Lighting occupancy sensors	–	–	–	–	
4. Power monitoring sensors and gateway	26	26	26	26/25	13
F. PLUMBING SYSTEMS					
1. Air compressors	23	23	26	23/25	
2. Compressed air dryer, filter, PRV	23	23	26	23/25	
3. Condensate drains including traps, primers	22	22	–	–	14
4. Condensate pumps	23	23	23/26	–	15
5. Make-up water to hot/chilled/condenser water including backflow prevention	22	22	-	-	16
6. Natural gas connections, pressure reducing station, gages	22	22	–	–	17
7. Gas and water flow meters	25	22	25	25	
8. Pipe gauges, thermometers, test plugs	22	22	–	–	
9. Self-powered valves, pressure relief valves, liquid level controllers, etc.	22	22	–	–	
10. Sensor wells, meters and other pipe-mounted control devices	25	22	25	25	
11. Floor drains	22	22	–	–	18
G. HVAC HYDRONIC SYSTEMS					
1. Pipe gauges, thermometers, test plugs	23	23	–	–	
2. Self-powered valves, refrigerant powered head pressure control valves, pressure relief valves, liquid level controllers, etc.	23	23	–	–	
3. Relief valve vent piping, equipment drain piping, etc. from equipment to floor drains/sinks	23	23	-	-	
4. Automatic isolation and control valves	25	23	25	25	

INTERFACE / RESPONSIBILITY MATRIX					
System	Division under which the following is specified				Remarks
	Equipment	Installation	Power wiring (remark 1)	Control & interlock wiring (remark 1)	
5. Sensor wells, meters and other pipe-mounted control devices	25	23	25	25	
6. Underground piping	33	33	–	–	19
H. HVAC SHEET METAL					
1. Duct mounted sensors	25	23	25	25	
2. Filter gauges	25	25	–	–	
3. Control dampers	23	23	–	–	20
4. Control damper actuators	25	25	25	25	20, 21
I. MISCELLANEOUS					
1. Demolition and salvage	2	2	–	–	22
2. Trenching, backfilling, boring, soil compaction, saw-cutting, patching and paving for underground piping	31	31	–	–	
3. Utilities beyond building interior wall line	33	33	–	–	
4. Roofing, including cant strips and counterflashing at the sides of roof curbs	7	7	–	–	
5. Thermal and acoustical insulation in and on partitions and ceilings	7	7	–	–	23
6. Undercutting of doors and door louvers	8	8			
7. Louvers	8	8	–	–	
8. Concrete housekeeping pads, piers, pedestals and inertia base fill etc. for equipment.	3	3	–	–	24
9. Equipment, ductwork, and piping steel supports and frames	23	23	–	–	
10. Grates and railings protecting mechanical shaft and other floor openings	5	5	–	–	
11. Painting	9/23	9/23	–	–	25
12. Coring or cutting existing wall and floor openings for ductwork and piping	23	23	–	–	
13. Fire-stopping around pipe and duct penetrations in floors and walls	23	23	–	–	

INTERFACE / RESPONSIBILITY MATRIX					
System	Division under which the following is specified				Remarks
	Equipment	Installation	Power wiring (remark 1)	Control & interlock wiring (remark 1)	
14. Fire rated enclosures where shown around ducts	9	9			
15. Framing of walls and ceilings to accept air outlets, fire dampers, etc.	9	9	–	–	26
16. Ceiling and wall access doors and panels	8	8	–	–	27
17. Elevator shaft vents	–	–	–	–	
18. Architectural shafts and plenum walls	9	9	–	–	28

NUMBERED REMARKS:

1. Wiring includes raceway, fittings, wire, boxes and related items, all voltages.
2. Wiring and controls to start and stop fans based on smoke detector status and smoke control logic specified under Division 26 Electrical.
3. Factory installed starters and variable speed drives are specified under Division 23 HVAC. Prewired control panel is specified under Division 23 HVAC; single point power connection (unless otherwise noted on drawings) specified by Division 23 HVAC.
4. Applies to motors that are not covered by note 3. Integral starter control devices such as HOA switches, 120V control transformers and time delay relays (from high to low speed) for two speed motors specified under Division 26 Electrical.
5. Single phase 120V motors with integral motor overload protection specified under Division 23 HVAC.
6. Line voltage control device such as thermostat or switch specified under Division 25 BAS; wiring and conduit between control device and motor specified under Division 26 Electrical.
7. Factory installed and wired chilled and condenser water flow switches are specified under Division 23 HVAC; no work is required under Division 25 BAS. Bi-directional (read/write) factory installed BACnet gateway between the BAS and chiller control panel specified with chiller under Division 23 HVAC; control wiring specified under Division 25 BAS. Chiller vendor to provide all necessary technical assistance to Division 25 BAS Contractor in mapping across chiller points to the BAS.
8. Control air dryers and PRV stations for any pneumatically actuated control equipment specified under Division 25 BAS.
9. Disconnects or circuit breakers are specified under Division 23 HVAC where specifically called for in equipment schedules or specifications to be factory installed with equipment. Otherwise all disconnects are specified under Division 26 Electrical.
10. Emergency override switches, status lights and other refrigerant machinery room controls as required by CMC are specified under Division 25 BAS.

INTERFACE / RESPONSIBILITY MATRIX					
System	Division under which the following is specified				Remarks
	Equipment	Installation	Power wiring (remark 1)	Control & interlock wiring (remark 1)	

11. TDS controller, bleed valve, injector pump, make-up water flow meter, and all other water treatment system controls are specified under Division 23 HVAC. Field wiring of all components is specified under Division 25 BAS.
12. 120V power to BAS control panels is specified under Division 26 for the panels shown on Drawings. Power to all other control panels that may be required is specified under Division 25 BAS, coordinated with Division 26 contractor for available circuits.
13. Power measuring sensors, installation and wiring to a single central controller with BACnet/IP interface specified under Division 26 Electrical. BACnet/IP gateway and network connection from gateway to BAS specified under Division 25 BAS. Power monitoring control vendor to provide all necessary technical assistance to Division 25 BAS Contractor in mapping across power monitoring control points to the BAS.
14. Condensate piping from condensate pans to the sewer system including trap and final connections is specified under Division 22 Plumbing. Piping from auxiliary drain pans where provided at fan-coils is specified under Division 23 HVAC.
15. Condensate pumps scheduled to be an accessory to the cooling unit are powered off the cooling unit; no Division 26 work is required. Power for condensate pumps scheduled under Remarks as field installed is specified under Division 26.
16. Domestic make-up water, including shut-off valve, backflow prevention, rough-in and final connection to hot water, chilled water, condenser water and any other HVAC systems requiring make-up water is specified under Division 22 Plumbing. Pressure reducing valves with bypass valve and shut-off valves at each closed-system make-up water connection are specified under Division 23 HVAC.
17. Pressure reducing valves to deliver gas at the pressure required by mechanical equipment, including final connections and shut-off cock, is specified under Division 22 Plumbing. All other gas control and regulating devices provided under the Section providing the gas-fired equipment. Venting of gas regulating devices and other equipment gas-train devices where required is specified under Division 22 Plumbing.
18. Floor drains and sumps shall be provided under Division 22 Plumbing adjacent to each pair of chillers, towers, boilers, water treatment system, etc. Where drains are located in negative air plenums, trap primers are required.
19. Underground piping shall terminate just inside building envelope and include seals at wall/floor penetration. Piping from that point of connection inside the building is specified under Division 23 HVAC.

INTERFACE / RESPONSIBILITY MATRIX					
System	Division under which the following is specified				Remarks
	Equipment	Installation	Power wiring (remark 1)	Control & interlock wiring (remark 1)	
20. Duct access doors required for access to control devices where required specified under Division 23 HVAC.					
21. Actuators for motorized dampers supplied with fans or hoods where scheduled on HVAC drawings are specified under Division 23 HVAC, mounted but not wired.					
22. Division 23 HVAC Contractor shall identify all mechanical related equipment and appurtenances to be retained, if applicable. Demolition work is specified under Division 2 Existing Conditions					
23. Wall, roof, ceiling, and floor thermal insulation identified on architectural drawings is specified under Division 7. Any acoustical insulation required for HVAC systems, whether mounted on or in ducts or on walls (including mechanical room walls), shafts, roofs, ceilings, or floors, shall be provided by the HVAC Contractor.					
24. Shop drawings showing dimensions of all curbs, bases, etc. specified under Division 23 HVAC.					
25. Painting of exposed piping, HVAC equipment, etc. per Paragraph 3.10 specified under Division 23 HVAC. All other painting specified under Division 9.					
26. Additional T-bar or spline and cut ceiling tile as required to accept air outlets is specified under Division 9.					
27. Dimensioning of access doors to mechanical equipment and coordination with Architect and Division 8 specified under Division 23. It is the responsibility of the HVAC Contractor to review architectural drawings to be sure that all access doors required for HVAC systems are properly located and dimensioned. Those that are not identified by the HVAC Contractor prior to ceiling/drywall bids shall be the responsibility of the HVAC Contractor.					
28. The HVAC Contractor shall identify all architectural shafts and plenum walls and their construction and sealing requirements to the architect for inclusion in architectural contract documents. It is the responsibility of the HVAC Contractor to review architectural drawings to be sure that all architectural shafts, plenums, etc. required for HVAC systems are properly located and dimensioned. Such items not identified by the HVAC Contractor prior to Division 9 bids shall be the responsibility of the HVAC Contractor.					

1.02 BID INSTRUCTIONS

A. This specification is intended to

1. Specify system performance/design criteria. The HVAC Contractor's proposal shall not deviate from these Design Criteria without written approval. Questions regarding the appropriateness or correctness of requirements shall be directed to the General

Contractor in writing prior to bid. Any changes in design or performance criteria will be disseminated to all bidders.

2. Establish the desired level of quality, including suggested design options that the Engineer feels will meet the performance requirements and design intent. HVAC Contractors' proposals may be based on the suggested approaches or on any other design of similar quality. If there is a question as to the appropriateness of any alternative system ideas, the HVAC Contractor shall review the proposed design (in the strictest confidence) with Taylor Engineering prior to bid.

B. Stipulated Pricing for Primary Equipment

1. Primary equipment shall be included in bids using the prices stipulated below. This equipment will be bid after the contractor is selected with final pricing adjusted based on actual price vs. stipulated price adjusted for taxes and contractor markup. See this article for details and rationale: https://taylorengineers.com/wp-content/uploads/2020/04/ASHRAE_Journal_-_Value-Based_HVAC_Equipment_Selection.pdf.

2. All pricing below excludes:

   a. Taxes and fees: Taxes and fees will be applied to the cost of equipment at time of selection. Contractor does not include in bid.

   b. Storage: Contractor to include cost of storage in bid, as necessary, to meet project schedule requirements.

   c. Installation: Contractor to include installation cost in bid.

   d. Contractor overhead & profit: Contractor to include percentage markup that will be applied to equipment. See Paragraph 1.03A.1.

3. Primary Equipment Pricing

   a. Chillers

      1) Price: $575,000

      2) Includes the following equipment, materials, and systems:

         a) CH-1, CH-2

         b) All scheduled accessories

         c) Freight to jobsite

         d) One-year warranty on parts and labor

         e) Factory startup

         f) Owner training

   b. Non-condensing boilers

      1) Price: $230,000

      2) Includes the following equipment, materials, and systems:

         a) B-1, B-2, B-3, B-4

         b) All scheduled accessories

         c) Freight to jobsite

c. Cooling towers
   1) Price: $160,000
   2) Includes the following equipment, materials, and systems:
      a) CT-1, CT-2
      b) All scheduled accessories
      c) Freight to jobsite

C. Contractor proposals shall include the following
   1. A narrative of the proposed system design
   2. Any exceptions to these specifications
   3. Completed bid form
      a. Design and Construction Price; broken down as follows:
         1) Base scope price: The base scope shall include all work described herein including installation of all HVAC equipment, procurement of secondary equipment, piping, duct, and flue connections.
         2) Breakout prices: Where breakout prices are requested in bid form, include materials, taxes, freight, installation, and mark-up, as applicable.
            a) Breakout price to procure and install all new chilled water pipe.
            b) Breakout price to procure and install all new condenser water pipe.
            c) Breakout price to procure and install all new hot water pipe.
      b. Contractor markup; as specified herein
      c. Additive/deductive alternates: Alternates listed herein must be bid. Additional voluntary alternates are strongly encouraged.
      d. Unit prices, as specified herein

D. Contractors shall prepare the following for the interview with the design team (This information may also be provided with proposals, at contractor's option):
   1. A preliminary schedule or detailed list of equipment showing proposed manufacturers, models, sizes, etc. ***for secondary equipment (i.e. all equipment without stipulated pricing).***
   2. Sketches or drawings showing the locations and dimensions of major equipment such as chillers, boilers, cooling towers, pumps, etc.
   3. Description of plumbing requirements such as make-up water, floor drains, condensate, etc.; use coordination form provided with bid documents.
   4. Description of electrical requirements; use coordination form provided with bid documents.
   5. Proposed mechanical room requirements if other than what is shown on current architectural and mechanical plans
   6. Requirements for concrete and steel work such as equipment bases under cooling towers, chillers, boilers, pumps, etc.
   7. Resumes of personnel who will be assigned to the project, including:

a. Design Engineer
b. Construction Manager
c. Field Superintendent

E. Proposals will be evaluated by the Laney CUP Selection Committee including Taylor Engineering, the Architect, Owner, and Construction Manager based on value, price, space requirements and other architectural impacts, requirements of other trades, and quality and reputation of the proposed project personnel.

1.03 MARKUP, ALTERNATES, AND UNIT PRICES

A. Contractor Markup
1. Total percentage markup on equipment with stipulated pricing per Paragraph 1.02B.
2. Total percentage markup on the Division 25 Building Automation System (designed by the Engineer and to be bid during CD phase), if it is assigned as a subcontractor to Division 23.

B. Alternates
1. Provide **(3)** year warranty. See Paragraph 1.13D.
2. Provide **1-year maintenance** contract to service chilled and hot water plant. See Paragraph 1.14A.
3. Provide **3-year maintenance** contract to service chilled and hot water plant. See Paragraph 1.14B.
4. Refurbish existing primary chilled water pumps. See Paragraph 1.15C.1.e.2).
5. Provide and pipe one redundant primary chilled water pump. Provide additional VFD to be installed and wired by Division 26. See Paragraph 1.15C.1.e.3).
6. Refurbish existing secondary chilled water pumps. See Paragraph 1.15C.1.f.2).
7. Provide and pipe one redundant secondary chilled water pump. Provide additional VFD to be installed and wired by Division 26. See Paragraph 1.15C.1.f.3).
8. Provide cooling tower filtration system. See Paragraph 1.15C.1.i.
9. Provide and pipe one redundant condenser water pump. Provide additional VFD to be installed and wired by Division 26. See Paragraph 1.15C.1.j.3).
10. Engage testing firm to provide non-destructive testing (ultrasonic thickness testing) to verify condenser water pipe and chilled water pipe thickness meets acceptable limits described in Paragraph 2.17. Keep all chilled and condenser water piping in chiller room that meet acceptable wall thickness limits. See Paragraph 1.15C.1.m.3).
11. Refurbish existing secondary hot water pumps. See Paragraph 1.15C.2.g.2).
12. Provide and pipe one redundant secondary hot water pump. See Paragraph 1.15C.2.g.3).
13. Engage testing firm to provide non-destructive testing (ultrasonic thickness testing) to verify hot water pipe thickness meets acceptable limits described in Paragraph 2.17. Keep all hot water piping in chiller room that meet acceptable wall thickness limits. See Paragraph 1.15C.2.j.3).
14. Demolish existing boiler flue main and stack. Provide new boiler flue main and stack. See Paragraph **1.15C.2.n.3)**~~1.15C.2.m.3)~~.

15. Provide new chiller room exhaust fan. See Paragraph 1.15C.3.a.2).
16. Boiler and chiller room conditioning. See Paragraph 1.15C.4.a, Paragraph 1.16F and Paragraph 2.06.
17. Any proposed by HVAC Contractor at his option

C. Unit prices: Unit prices shall include all equipment, material, labor, design engineering, balancing, start-up and testing costs necessary to provide a complete operational system. Prices may be used to add or deduct items from the scope for 1 year from award of contract. Prices are based on construction during normal design and construction schedule. Prices will be used to determine complete contract amount by multiplying quantity of each item times unit prices; this will be the complete price unless unusual conditions apply or item does not correspond to unit price description.
   1. Provide unit price for the procurement and installation of a 2-pipe fan coil unit.

1.04 REFERENCE STANDARDS

A. Requirements of Regulatory Agencies
   1. Nothing in Drawings or Specifications shall be construed to permit Work not conforming to applicable laws, ordinances, rules, regulations.
   2. When drawings or Specifications exceed requirements of applicable laws, ordinances, rules and regulations, comply with documents establishing the more stringent requirement.
   3. Applicable codes include the current version of those listed below, in addition to others specified in individual sections
      a. CBC – California Building Code
      b. CMC – California Mechanical Code
      c. City of Oakland Codes, Ordinances, and Code Amendments
      d. The State of California Codes
   4. If any of above requirements is in conflict with one another, or with Specifications' requirements, the most stringent requirement shall govern. Where codes are silent on an issue, NFPA Standards shall apply.

B. Published specifications, standards, tests or recommended method of trade, industry or governmental organizations as listed below apply to all work in this Section
   1. AABC - Associated Air Balance Council
   2. ADC - Air Diffuser Balance Council
   3. AMCA - Air Moving and Conditioning Association
   4. ANSI - American National Standards Institute
   5. AHRI - Air Conditioning, Heating and Refrigeration Institute
   6. ASHRAE - American Society of Heating, Refrigeration and Air Conditioning Engineers
   7. ASME - American Society of Mechanical Engineers
   8. ASTM - American Society for Testing and Materials
   9. ETL - Intertek Semko (Formerly Electrical Testing Laboratories)
   10. IEEE - Institute of Electrical and Electronic Engineers

11. NEMA - National Electrical Manufacturer's Association
12. NFPA - National Fire Protection Association
13. SMACNA - Sheet Metal and Air Conditioning Contractors National Association
14. UL - Underwriters' Laboratories

C. Industry standards and manufacturers' recommendations, diagrams or requirements shall be strictly adhered to for installation of materials and equipment.

1.05 QUALITY ASSURANCE

A. All equipment and accessories to be the product of a manufacturer regularly engaged in its manufacture.

B. All items of a given type shall be the products of same manufacturer.

C. Supply all equipment and accessories new and free from defects.

D. Supply all equipment and accessories in compliance with the applicable standards listed in article 1.04 of this section with all applicable national, state and local codes.

1.06 DEFINITIONS

A. Definitions of term used in Division 23 Sections may differ from those given in general and supplementary conditions and take precedence over them.

B. “Provide": to supply, install and connect up complete and ready safe and regular operation of particular work referred to unless specifically noted.

C. "Install": to erect, mount and connect complete with related accessories.

D. "Supply": to purchase, procure, acquire and deliver complete with related accessories.

E. "Work": labor, materials, equipment, apparatus, controls, accessories, and other items required for proper and complete installation.

F. "Piping": pipe, tube, fittings, flanges, valves, controls, strainers, hangers, supports, unions, traps, drains, insulation, and related items.

G. "Wiring": raceway, 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.

I. "Exposed": not installed underground or "concealed" as defined above.

J. "Indicated," "shown" or "noted": as indicated, shown or noted on drawings or specifications.

K. "Similar" or "equal": of base bid manufacture, equal in materials, weight, size, design, and efficiency of specified product, conforming to PART 2 Materials.

L. "Reviewed," "satisfactory," or "directed": as reviewed, satisfactory, or directed by or to Architect.

M. "Motor Controllers": manual or magnetic starters (with or without switches), individual pushbuttons or hand-off-automatic (HOA) switches controlling the operation of motors.

N. "Control or Actuating Devices": automatic sensing and switching devices such as thermostats, pressure, float, electro-pneumatic switches and electrodes controlling operation of equipment.

1.07 JOB CONDITIONS

A. Examine site related work and surfaces before starting work of any Section.
   1. Contractors shall be responsible for any conditions that can be visually observed at jobsite and in unconcealed, accessible areas.
   2. Contractor shall not be responsible for any conditions in concealed areas that could not be reasonably anticipated at time of bid. Any additional work caused by these conditions shall be by change order.

B. Parking and special traffic requirements
   1. Contact General Contractor for information and constraints
   2. Obtain all City permits and clearances required for hoisting and rigging equipment

1.08 REVIEW OF CONSTRUCTION

A. Work may be reviewed at any time by Owner or Owner's representative.

B. Advise Owner or Owner's representative that work is ready for review at following times
   1. Prior to concealment of work in walls and above ceilings
   2. When all requirements of Contract have been completed

C. Do not conceal work without Owner's representative review.

D. Maintain a set of Specifications and Drawings including all change orders on the job for use by Owner's representatives.

1.09 DESIGN DOCUMENTS

A. An employee of the HVAC Contractor shall serve as Engineer-of-Record. (A third party consulting engineer is acceptable only if consultant has significant design/build experience and a record of working with the HVAC Contractor on past projects of this size and complexity.)

B. The HVAC Contractor/engineer shall maintain a design and detailing schedule consistent with those of the architect and other engineers to produce working drawings and shop drawings in a timely and professional manner, consistent with the project construction schedule.

C. All HVAC system design documents shall be prepared under the supervision of the Engineer-of-Record.

D. Calculations
   1. Heating and cooling load calculations and equipment selections shall be supervised and reviewed by a registered professional engineer.
   2. Provide all heating and cooling load calculations for review by the Owner.
   3. Provide calculations and documentation to demonstrate HVAC systems compliance with prescriptive Title 24 Energy Standards.

E. Design documents

1. All design drawings shall be created using Revit 2013 or higher as determined by the Architect.
    a. Detailed clash detection shall occur at the 50% CD issue.
    b. Final construction drawings shall be Level of Development 300.
2. Drawings, at a minimum, shall include the following
    a. Equipment schedules
    b. Floor plans: Scale to match architectural drawings or larger, minimum 1/8" scale
    c. Equipment rooms: ¼" scale
    d. Riser sections: ¼" scale
    e. Piping diagrams
    f. HVAC Title 24

F. Dimensioning and detailing. All design drawings shall include the following
1. Duct mains and all rectangular ductwork shall be drawn double line
2. Top and bottom elevations shall be indicated for all duct mains
3. Bottom or centerline elevations shall be indicated for all piping mains
4. Notes, tags, etc. shall be on plans next to designated items; sheet notes shall not be used.

G. Drawings shall be complete for use as on-going comprehensive service record drawings. Existing systems and equipment shall be shown with dashed lines. Drawings shall include
1. All new and existing equipment
    a. Tag all equipment
    b. Schedule all new and existing equipment located in the central utility plant and the cooling tower enclosure
2. All new and existing ducts and grilles
    a. Tag all ducts with duct sizes
    b. Tag all grilles with grille size and airflow
3. All new and existing piping
    a. Size all piping

1.10 SUBMITTALS & SHOP DRAWINGS

A. Schedule
1. Allow 10 working days for approval, unless Engineer agrees to accelerated schedule.

B. Submit drawings, product data, samples and certificates of compliance required as hereinafter specified in this Section.

C. Submission Procedure
1. Optional Pre-Submittals. At Contractor's option, electronic submittals indicated below may be submitted unofficially via email directly to the Engineer for review and comment prior to formal submission. Comments provided by the Engineer are not official and may

be changed or additional comments may be provided on the formal submittal. The intent of pre-submittals is to reduce paperwork and review time.

2. Initial submittal
   a. Each submittal shall have a unique serial number such as “SUBMITTAL 230000-01”.
   b. Submittals may be submitted non-concurrently if required by the schedule.
   c. Submit one electronic copy of product data in word-searchable format such as Adobe pdf. Provide separate files for each equipment type. Paper copies or scans of paper copies will not be accepted.
   d. Submittal will be reviewed and comments returned to Contractor.
3. Resubmission
   a. Each resubmittal shall have the original unique serial number plus unique revision number such as “SUBMITTAL 230000-01 REVISION 1”.
   b. Make any corrections or change in submittals as required.
   c. Resubmit for review in electronic format described above until no exceptions are taken.
   d. The cost of Taylor Engineering’s review of submittals after first resubmittal will be borne by Contractor at Taylor Engineering standard billing rates.
4. Final approval: Once submission is accepted, Contactor shall provide printed and/or electronic copies for coordination with other trades as required by the General Contractor. Taylor Engineering does not require or desire paper copies.

D. Contents of Submittals
   1. HVAC Equipment Submittals
      a. Manufacturer's name and model number
      b. All information required to completely describe materials and equipment and to indicate compliance with drawings and specifications, including, but not limited to
         1) A schedule, for all items of the same type shall be supplied. The schedule shall include the manufacturer, the model, size, specific information that makes that item unique, the service of the item, the system served by the item.
         2) Physical Data, as applicable
            a) Dimensions
            b) Weight
            c) Finishes and colors
         3) Performance Data, as applicable
            a) Rated capacities
            b) Performance curves
            c) Operating temperature and pressure
         4) Electrical and plumbing requirements
         5) Flow and wiring diagrams as applicable

6) Description of system operation

c. All other pertinent information requested in individual sections

2. Test, Adjust, and Balance (TAB) Submittal

a. All test and report forms that will be submitted for the final TAB report

b. A written description of the balance procedures

c. Submit at least 30 days prior to any TAB work.

E. Shop Drawings

1. Drawings shall be developed using 3D software such as Revit, CAD-Duct and CAD-Pipe that is compatible with Navisworks.

a. All rectangular ductwork

b. All round ductwork other than flexible ductwork

c. All piping larger than 3/4" inches

d. All equipment

e. All grilles, registers and diffusers

2. Provide coordination plans indicating layout of pads, curbs, penetrations, openings, and other items to be provided by other trades.

F. Operating Instructions & Maintenance Manuals

1. Before requesting acceptance of work, submit word-searchable electronic set for review by Engineer. Use bookmarks for each equipment type.

2. After review and making corrections noted, furnish word-searchable electronic set on flash drive and two printed and bound sets in heavy three-ring binder. Provide separate tabs for each equipment type.

3. O&M manual shall include all submittal data submitted herein above, as installed. The intent of this section is that a single document contains all relevant information about each piece of equipment.

4. In addition to the submittal data, the O&M manual shall also include the following information

a. Manufacturer's name, model number, service manual, spare-parts list, and descriptive literature for all components

b. Installation instructions

c. Maintenance instructions

d. Wiring diagrams

e. Listing of possible breakdown and repairs

f. Instruction for starting, operation and programming

g. Detailed and simplified one line, color coded flow and wiring diagram

h. Name, address and phone number of contractors equipment suppliers and service agencies

i. Guarantee period, including start and end period

j. Start up test readings, dated and signed by testing technician

G. Record Drawings
   1. Update design/shop drawings to "as- built" conditions
      a. Fully incorporate all revisions made by all HVAC crafts in course of work.
      b. Include all field changes, adjustments, variances, substitutions and deletions, including all Change Orders
      c. Exact location, type, and function of concealed valves, dampers, controllers, piping, air vents and piping drains
      d. Exact size, elevations, and horizontal location of piping and ducts
      e. Revise equipment schedules to reflect all substitutions
      f. Complete for all HVAC systems, both new and existing
   2. Submit in electronic format per Submittals above for approval.
   3. Once approved
      a. Provide one set of original Revit files on portable media (e.g. CD) including all referenced background models.
      b. Load pdf of complete set of as-built drawings onto the control system front end computer.
      c. Provide one full size set of drawings on bond paper.
      d. Provide pdf set loaded onto 1 flash drive.

1.11 COMPLETION REQUIREMENTS

A. Until the documents required in this section are submitted and approved, the system will not be considered “accepted” and final payment to contractor will not be made.

B. O&M Manual; see Paragraph 1.10F.

C. Record Drawings: See Paragraph 1.10G.

D. Test and Balance reports; see Paragraph 3.14D.

E. Inspection and permit: Provide one copy of inspection certificates signed and approved by the local code authorities.

F. Commissioning documentation and forms; see Paragraph 3.15.

G. Training; see Paragraph 3.15D.

H. Warranty: Provide written guarantee and warranty documents for all equipment and systems, including the start and end date for each.

1.12 SCHEDULE OF WORK

A. Arrange design and construction work to conform to schedules established by the General Contractor and Architect.

B. In scheduling, anticipate means of installing equipment through available openings in structure.

C. Schedule of Work Constraints

1. No system shutdown shall be permitted without the expressed written approval from the Owner's Representative. The Contractor shall submit requests for each shutdown at least two weeks in advance. The request shall state what system is to be shutdown, what areas will be affected, how long the period will be, and what contingency plan is provided if the work cannot be completed within the specified time.
2. The classrooms adjacent to the chiller and boiler room in Building E will remain in operation during construction. Changes to systems that affect these areas must be minimal in impact and time out-of-service as limited herein during normal business hours which are weekdays from 6am to 6pm.
3. Central Chilled and Hot Water Service During Construction
    a. The campus will remain operational during construction and building will require chilled and hot water service.
    b. The central utility plant shall provide a minimum of 200 tons of chilled water capacity and 7,200 KBTUH of hot water capacity to buildings connected to the central utility plant throughout the duration of construction during normal business hours.
    c. At present, (1) 200 ton chiller is operational and (1) 7,200 KBTUH output boiler is functional.
    d. Contractor may use a combination of existing and temporary equipment to provide service during construction.
4. Other Limitations
    a. The chiller plant may be shut down as follows:
        1) During normal business hours:
            a) For periods not exceeding 1 hour
            b) When the outdoor air temperature is less than 60°F
        2) Anytime during non-business hours
    b. The boiler plant may be shut down as follows:
        1) During normal business hours:
            a) For periods not exceeding 2 hours after 10am
            b) When the outdoor air temperature is greater than 70°F
        2) Anytime during non-business hours
    c. Domestic water systems shall be maintained fully functional during normal business hours.
5. Include any charges, including overtime wages, required to perform work in phases and to minimize downtime of operating areas.

D. Schedule test, balance, and acceptance testing of mechanical systems
1. This phase must occur after completion of mechanical systems, including all control calibration and adjustment, and requires substantial completion of the building, including closure, ceilings, lighting, partitioning, etc.

E. Schedule shall allow several days after installation of all furnishings but prior to occupancy for indoor air quality purging of construction area. See Paragraph 3.12.

1.13 GUARANTEE

A. The HVAC Contractor shall guarantee the following
   1. All new materials, new equipment, apparatus and workmanship shall be free of defective materials and faulty workmanship.
   2. All equipment and material will produce the results specified.
   3. All systems have been fully tested, adjusted, balanced, and commissioned.

B. The HVAC Contractor shall furnish written guarantee to replace all defective work, materials, and services furnished under this Section, at no additional cost to the Owner, for the warranty period.

C. The warranty period shall be one (1) year from date of filing of Notice of Completion or beneficial system usage, whichever comes first.

D. ALTERNATE 1 Warranty period shall be **(3)** years from date of filing of Notice of Completion or beneficial system usage, whichever comes first.

E. The Owner reserves the right to make temporary repairs as necessary to keep equipment in operating condition without voiding the guarantees or relieving responsibility during the guarantee period.

F. The warranty shall not include
   1. Standard maintenance items
   2. Repairs or replacement of equipment damaged as a result of misuse, abuse, or lack of proper maintenance.
   3. Existing equipment and materials not provided by this contract.

1.14 ONGOING MAINTENANCE SERVICE

A. ALTERNATE 2 Provide **1-year maintenance** contract to service chilled and hot water plant including:
   1. Quarterly maintenance as described by equipment operation manuals for the following equipment:
      a. Non-condensing boilers
      b. Pumps
      c. Air compressor and dryer
      d. Cooling towers
      e. Condenser water treatment
   2. Annual service for non-condensing boilers as described by equipment operation manual
   3. An allowance for 10 hours of additional service per quarter performed by a journeyman.

B. ALTERNATE 3 Provide **3-year maintenance** contract to service chilled and hot water plant including:
   1. Quarterly maintenance as described by equipment operation manuals for the following equipment:
      a. Non-condensing boilers

b. Pumps
c. Air compressor and dryer
d. Cooling towers
e. Condenser water treatment

2. Annual service for non-condensing boilers as described by equipment operation manual
3. An allowance for 10 hours of additional service per quarter performed by a journeyman.

1.15 SYSTEM DESIGN

A. General

1. The HVAC system shall be selected and designed by the contractor to provide the specified performance requirements in the most life cycle cost optimum fashion. Suggested design concepts are listed in this section. They may be used by the contractor, or an alternative approach of similar or better quality and performance may be selected. When there is doubt about the acceptability of an alternative design, the HVAC Contractor shall seek approval from the Engineer during the bid period. Any inquiries other than those regarding scope will be kept confidential.
2. The HVAC Equipment Coordination Schedule provided with the bid documents indicates preliminary equipment sizes for the purpose of coordinating with other trades.
3. **Laney College intends to convert the central plant to all-electric heating in the future (not part of this scope of work). The conversion will require additional, future equipment. Space in the chiller and boiler room shall be maintained clear as indicated on Drawing M2.01. Two alternatives for future conversion to all-electric heating are shown on drawings M2.02, M5.03, and M5.04. These drawings are for reference only. Conversion to all-electric heating is not contained in the scope of this work.**

B. Architectural bid drawings

1. Drawings show the clear space required to accommodate future equipment in Building E when the central utility plant is converted to all-electric operation. The HVAC Contractor is not required to use this exact clear space − space may be relocated as required by the proposed design − provided there is a cost or performance benefit and the square footage of the clear area can accommodate the same future equipment. But the review team will look favorably upon designs that require as little revision to architectural and structural plans as possible.
2. Cooling tower enclosure footprint: **Cooling tower enclosure geometry including the total depth as shown on drawings shall be considered a design constraint.** Designs that require changes to same shall be bid as alternates only. The cooling tower enclosure may be smaller than the footprint shown on architectural drawings provided that the necessary clearances for maintenance and proper airflow are maintained.

C. Suggested HVAC systems: These systems indicate the desired level of quality but the HVAC Contractor is not limited to them.

1. Central Cooling Plant
   a. Chilled water plant capacity shall be designed for a 50% increase in current capacity.

b. Install a water-cooled chilled water plant with primary-secondary distribution. Both primary and secondary loops shall be variable speed, variable flow.

c. Maintain minimum clear space requirements for ***future*** equipment to be installed when transitioning to an all-electric plant. See Drawing M2.01.

d. Chillers

1) Demolish existing three chillers. Refrigerant shall be recovered prior to demolition and shall become the property of the Contractor to be recycled or otherwise disposed of in a lawful manner.

2) Provide and install new chillers in accordance with the following:

a) 900 tons total capacity

b) Variable speed

c) Minimum two, equally sized

d) Evaporators and condensers are shown as 3-pass and piped in parallel. See Drawing M5.01. Evaporator and condenser construction and piping arrangement allow the chillers to be used in heat recovery mode in the future. Chillers are not required to be 3-pass provided they are able to produce a minimum condenser water return temperature of 125°F when operating in heat recovery.

e) Chillers shall be located where all code required and manufacturer recommended clearances are maintained

f) Relocate piping, conduits, ducts etc. as required to remove old equipment and install new equipment

g) See Paragraph 1.16A for design temperatures

3) Chillers will be selected in conjunction with the Contractor, Engineer, and Owner after bid using a value-based selection procedure. See Paragraph 1.02B.

e. Primary Chilled Water Pumps

1) BASE

a) Demolish existing primary chilled water pumps.

b) Provide and install new headered variable speed primary chilled water pumps, minimum 2.

2) ALTERNATE 4:

a) Refurbish existing primary chilled water pumps

1. Replace impeller, bearings, and seals

2. Provide new motors

b) Re-pipe pumps in a headered configuration

3) ALTERNATE 5: Provide and pipe one redundant primary chilled water pump. Provide additional VFD to be installed and wired by Division 26.

f. Secondary Chilled Water Pumps

1) BASE

a) Demolish existing secondary chilled water pumps.

b) Provide and install new headered variable speed secondary chilled water pumps, minimum 2 each sized for 50% of the load.

2) ALTERNATE 6: Refurbish existing secondary chilled water pumps

a) Replace impeller, bearings, and seals

b) Provide new motors

c) Pipe a new check valve for each pump

3) ALTERNATE 7: Provide and pipe one redundant variable speed secondary chilled water pump. Provide additional VFD to be installed and wired by Division 26.

g. Buffer Tank: Provide a new chilled water buffer tank to act as the common leg.

h. Cooling Towers

1) Demolish existing three-cell cooling tower

2) Provide and install new cooling towers in accordance with the following:

a) Variable speed

b) Minimum two cell (or two towers)

c) Cooling towers shall be located where all manufacturer's recommended clearances and intake air velocities are maintained. See Drawing M-2.01 for cooling tower enclosure dimensions.

d) Install structural support for cooling tower. Structural calculations shall be prepared and stamped by a registered professional structural engineer and included in tower submittal for review by Engineer.

e) See Paragraph 1.16A for design temperatures

3) Cooling towers will be selected in conjunction with the Contractor, Engineer, and Owner after bid using a value-based selection procedure. See Paragraph 1.02B.

i. ALTERNATE 8: Cooling tower filtration system

1) Procure packaged separator system completely factory assembled.

2) Size for filtration of one cell at a time.

3) Pipe and install filtration system.

4) See Drawing M5.01.

j. Condenser water pumps

1) Demolish existing three condenser water pumps.

2) Provide and install new headered variable speed condenser water pumps, minimum 2.

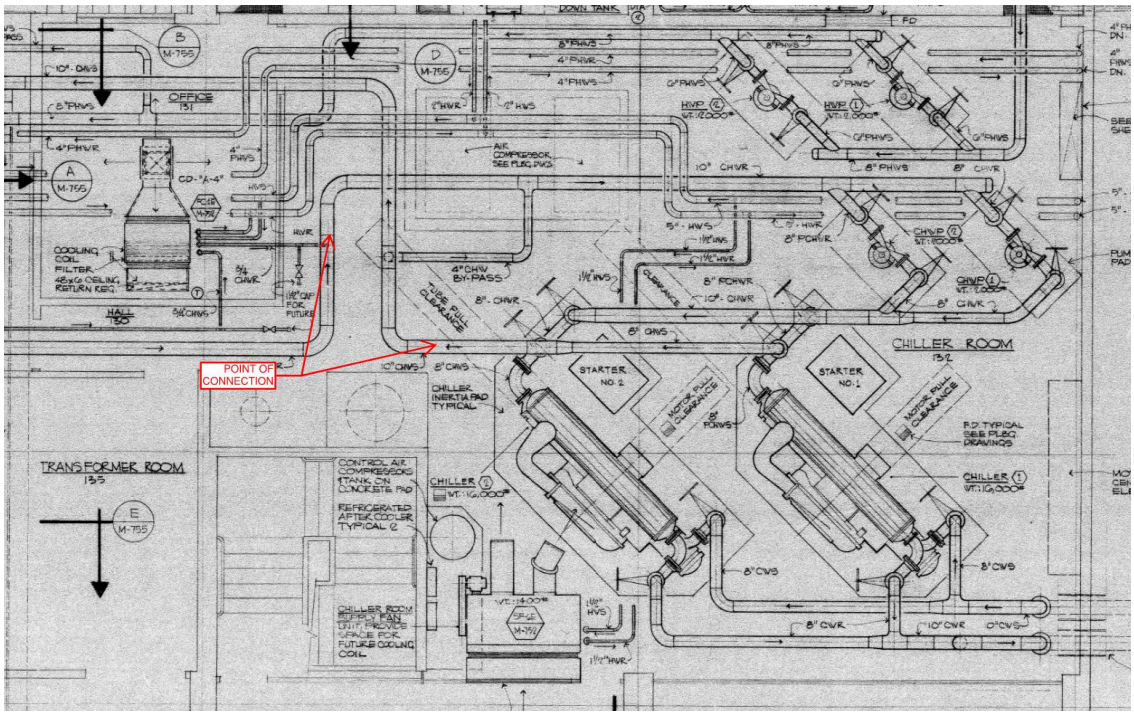
3) ALTERNATE 9: Provide and pipe one redundant condenser water pump. Provide additional VFD to be installed and wired by Division 26.

k. Condenser water treatment system

1) Demolish existing water treatment system.
2) Provide and install new water treatment system. Locate chemical tanks where they are readily accessible for refill without having to lift chemicals over piping or other obstructions.

l. Chilled Water Treatment System
1) Demolish existing pot feeder.
2) Provide and install new bypass pot feeder.

m. Piping
1) Note that results from a hazardous materials assessment will be provided as an addendum to the RFQ for contractor's reference.
2) BASE
a) Condenser Water Piping
1. Demolish all condenser water piping in existing cooling tower enclosure and chiller room. This excludes underground condenser water piping which is carried in the civil scope.
2. Provide new piping in accordance with Drawing M5.01.
b) Chilled Water Piping
1. Demolish all chilled water piping up to point of connection shown below. Note the drawing below is original piping. The plant layout has since been altered, but the chilled water at the point of connection remains the same.



2. Provide new piping in accordance with Drawing M5.01.

3) ALTERNATE 10:

a) Contractor shall retain a non-destructive testing firm to test condition of existing chilled and condenser water pipe in chiller room.

b) Demolish all condenser water piping in existing cooling tower enclosure. This excludes underground condenser water piping which is carried in the civil scope.

c) Demolish all chilled water piping and condenser water piping in the chiller room as required to install new equipment and all piping that will no longer be used. Install new piping to make equipment connections as required.

d) Demolish all chilled water piping and condenser water piping the has a pipe wall thickness loss of greater than 10% of original pipe wall thickness.

e) For the purpose of this alternate, assume 15% of the original CW and CHW pipe intended to be used to complete the scope of this work will require replacement. If alternate is selected, a price adjustment will be made if more than 15% of the original pipe requires replacement, but will not exceed the cost to replace all condenser and chilled water pipe as submitted per Paragraph 1.02C.3.a.2)a) and Paragraph 1.02C.3.a.2)b).

f) Reuse all other chilled water and condenser water piping in chiller room.

g) Final water piping shall be in accordance with Drawing M5.01.

n. Valves and Piping Accessories

1) Demolish all condenser water valves and chilled water valves and piping devices associated with the chiller, condenser water pumps, and primary and secondary chilled water pumps. This includes all shut off, check, and control valves, all strainers, and all other piping system devices.

2) All valves and piping accessories shall be new including expansion tank and air separator.

o. Library Chilled Water Connection

1) Provide and install 4" chilled water pipe supply and return in central plant for future library.

2) Connect chilled water supply to main chilled water loop downstream of central plant isolation valve.

3) Connect chilled water return pipe to main chilled water loop upstream of central plant isolation valve.

4) Connect to new underground pipe provided by Civil. Point of connection inside Building E.

~~o.~~**p.** Variable speed drives, disconnect switches, and all associated wiring

1) Demolish all variable speed drives, disconnect switches, and associated wiring

2) Provide new variable speed drives for primary chilled water pumps, secondary chilled water pumps, condenser water pumps, and cooling towers to be installed and wired by Division 26.

~~p.~~**q.** Housekeeping Pads and Inertia Bases

1) Demolish inertia bases.
2) Demolish housekeeping pads not required for final design.
3) Reuse, extend, or modify existing housekeeping pads where possible.
4) Provide new housekeeping pads where required.

~~q.~~**r.** Refrigerant detector along with manual switches for emergency shutdown and exhaust are provided under Division 25 BAS.

2. Central Boiler Plant
   a. Hot water plant shall be design within 10% of current capacity.
   b. Provide a gas-fired hot water plant with non-condensing boilers and primary-secondary distribution.
   c. Maintain minimum clear space requirements for future equipment to be installed when transitioning to an all-electric plant. See Drawing M2.01.
   d. Demolish all existing steam equipment and associated piping.
   e. Boilers
      1) Demolish existing three gas-fired hot water boilers (Cleaver Brooks FLX-900).
      2) Provide and install new boilers in accordance with the following:
         a) 20,000,000 BTUH total capacity
         b) Minimum three
         c) Equal sized
         d) Minimum total plant burner turndown of 12:1
         e) Boilers shall be located where all code required and manufacturer recommended clearances are maintained.
         f) Relocate piping, conduits, ducts etc. as required to remove old equipment and install new equipment.
         g) See Paragraph 1.16A for design temperatures
   f. Primary Hot Water Pumps
      1) BASE
         a) Demolish existing primary hot water pumps.
         b) Provide and install new dedicated constant speed primary hot water pumps, one for each boiler.
   g. Secondary Hot Water Pumps
      1) BASE
         a) Demolish existing secondary hot water pumps.

b) Provide and install new headered variable speed secondary hot water pumps located in the boiler room, each sized for 50% of the total design secondary waterflow.

2) ALTERNATE 11:

a) Refurbish existing secondary hot water pumps

1. Replace impeller, bearings, and seals
2. Provide new motors
3. Pipe a new check valve for each pump

b) Relocate headered secondary hot water pumps to boiler room.

3) ALTERNATE 12 Provide and pipe one redundant secondary hot water pump. Provide additional VFD to be installed and wired by Division 26.

h. Building E Tertiary Hot Water Pumps

1) Demolish existing Building E tertiary hot water pumps

2) Provide new Building E tertiary hot water pumps

~~2)~~

i. Hot Water Treatment System

1) Demolish existing pot feeder.

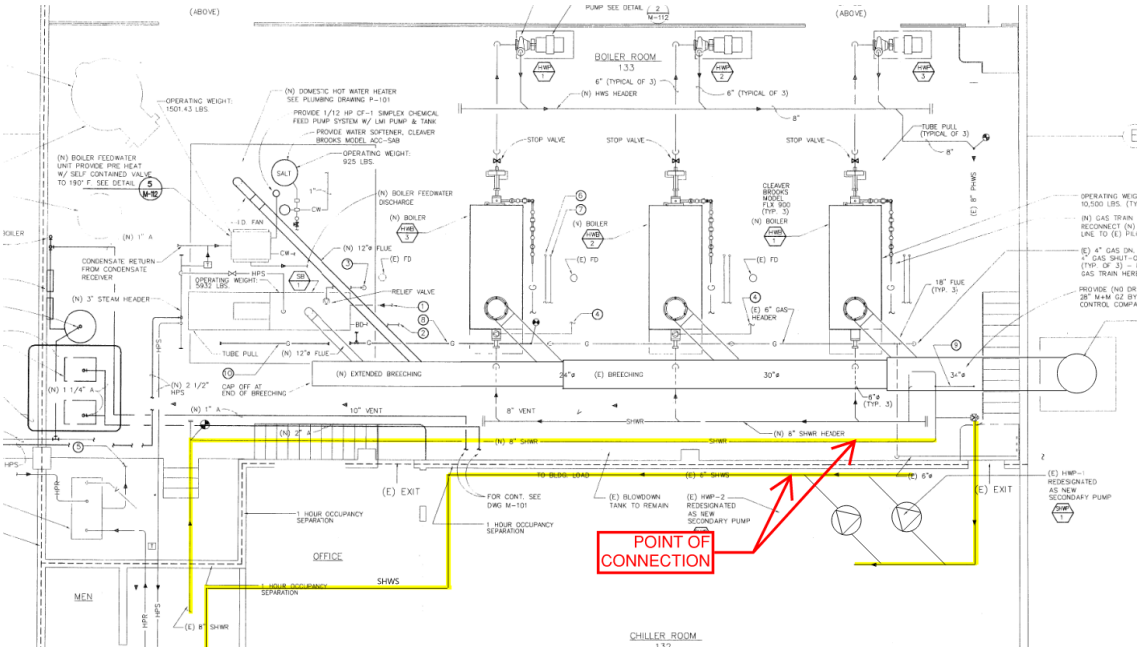
2) Provide and install new bypass pot feeder.

j. Hot Water Piping

1) Results from a hazardous materials assessment will be provided as an addendum to the RFQ for contractor's reference.

2) BASE

a) Demolish all hot water piping up to point of connection shown below



b) Provide new piping in accordance with Drawing M5.02.

3) ALTERNATE 13:

a) Contractor shall retain a non-destructive testing firm to test condition of existing hot water pipe located in the central plant.

b) Demolish all hot water piping water piping in the central plant as required to install new equipment and all piping that will no longer be used. Install new piping to make equipment connections as required.

c) Demolish all hot water piping the has a pipe wall thickness loss of greater than 10% of original pipe wall thickness.

d) For the purpose of this alternate, assume 15% of the original HW pipe intended to be used to complete the scope of this work will require replacement. If alternate is selected, a price adjustment will be made if more than 15% of the original pipe requires replacement, but will not exceed the cost to replace all hot water pipe as submitted per Paragraph 1.02C.3.a.2)c).

e) Reuse all other hot water piping in the central plant.

f) Final water piping shall be in accordance with Drawing M5.02.

k. Library Hot Water Connection

1) Provide and install 2.5” insulated hot water supply and return pipes in central plant for future library.

2) Connect hot water supply pipe to main hot water loop downstream of central plant isolation valve.

3) **Connect hot water return pipe to main hot water loop upstream of central plant isolation valve.**

4) **Connect to new underground pipe provided by Civil. Point of connection inside Building E.**

~~k.~~**l.** Natural Gas Piping

1) Connect natural gas piping to new gas trains for each new boiler.

~~l.~~**m.** Valves and Piping Accessories

1) Demolish all hot water valves and piping devices associated with the boiler and primary and secondary hot water pumps. This includes all shut off, check, and control valves, all strainers, and all other piping system devices.

2) All valves and piping accessories shall be new including expansion tank and air separator.

~~m.~~**n.** Boiler Flue

1) Contractor shall retain a non-destructive testing firm to test condition of existing flue located in the central plant. Wall thickness tests shall be conducted on both the horizontal main and the exterior stack.

2) BASE:

   a) Demolish existing boiler flue for each existing boiler up to boiler flue main and cap.

   b) Connect each new boiler into existing engineered flue. Contractor to verify flue requirements upon boiler selection.

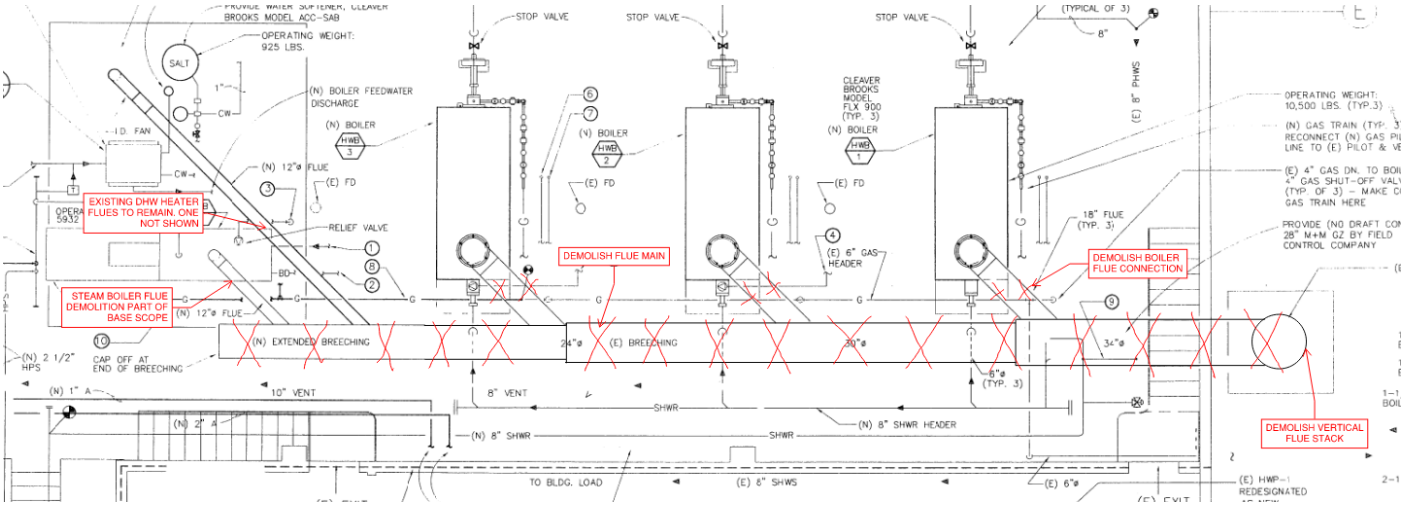
3) ALTERNATE 14

   a) Demolish existing boiler flue for each existing boiler back to boiler flue main, flue main, and exterior vertical flue stack.

   b) Provide and install new flue main and vertical flue stack extending from the boiler room. Maintain code-required clearances. Flue stack may be located on the interior or exterior of Building E. Fire-rated shaft provided by others, as necessary.

   c) Connect each new boiler into flue main.

   d) Reconnect existing equipment that will not be demolished into flue main.



~~n.~~**o.** Variable speed drives, disconnect switches, starters, and all associated wiring

1) Demolish all variable speed drives, disconnect switches, and associated wiring.
2) Provide new variable speed drives for secondary hot water pumps to be installed and wired by Division 26.

~~o.~~**p.** Housekeeping Pads

1) Demolish housekeeping pads not required for final design.
2) Reuse, extend, or modify existing housekeeping pads where possible.
3) Provide new housekeeping pads where required.

3. Fans
   a. Chiller Room Exhaust
      1) BASE
         a) Re-use existing chiller room exhaust fan.
         b) This requires that existing fan meets required exhaust airflow rate prescribed in UMC Chapter 11 for final mass of refrigerant in new chiller plant
      2) ALTERNATE 15: Provide and install new chiller room exhaust fan sized per UMC Chapter 11.
      3) Makeup from louver, by others, with inward facing backdraft damper by Division 23.
   b. Storage Room Ventilation
      1) Provide transfer fan for storage room with integral backdraft damper.
      2) Makeup from louver, by others, with inward facing backdraft damper by Division 23.
4. Miscellaneous HVAC
   a. Engineer's Office

1) Demolish existing fan coil unit.
2) Provide new fan coil unit with economizer mixing box serving the Engineer's office.
    a) Pipe chilled water to main secondary chilled water loop.
    b) Pipe hot water to main secondary hot water loop.
3) Provide outside air to fan coil via duct terminating at existing louver over the chiller room exterior door.
4) Provide new supply ductwork and air outlets.
5) Relief will be through existing wall louver.

b. ALTERNATE 16 Boiler and chiller room conditioning:
1) Demolish existing hot water fan coils serving the chiller and boiler room.
2) Boiler Room
    a) Provide and install new 3,000 CFM variable speed ventilation fan in boiler room. Connect outlet to existing louvers. Provide backdraft damper. Controls by Division 25.
    b) Duct outlet high to wall opposite combustion air intake.
    c) Provide screen over ducted outlet.
3) Chiller Room
    a) Provide and install new 1.5 ton, chilled water fan coil with economizer box in chiller room. Controls by Division 25.
    b) Provide plenum downstream of fan coil with tapped supply grille.
    c) Pipe chilled water to main secondary chilled water loop.

5. Pneumatic System
a. Demolish 2 LeROI compressors.
b. Provide new compressor with factory mounted tank to match existing compressor (Sullivan Palatek D4-25).
1) Compressor capacity of 95 CFM at 125 psi.
2) ASME tank capacity to match existing.
3) Install compressor and associated piping and pipe accessories in lead/standby arrangement.
c. Air dryer
1) Demolish existing Van Air compressed air dryer.
2) Procure and install new air dryer (200 SCFM at 100 psig, 100°F) to match existing.

6. Steam System Demolition
a. Demolish existing steam system including steam boiler, boiler feedwater unit, steam chemical feed pump system, water softener, condensate receiver, pumps, and blowdown tank.

b. Demolish all piping and piping accessories associated with steam system back to mains at utility corridor. This includes but is not limited to steam vent pipe, condensate pipe, high pressure steam pipe, and chemical feed lines.

D. Alternative Systems

1. HVAC contractors may propose any system for consideration.

1.16 DESIGN CRITERIA

A. Design Temperatures

Design Condition	Heating	Cooling
Outside air drybulb	31°F	89°F
Coincident outside air wetbulb	–	66°F
Outside air wetbulb for cooling tower sizing	–	67°F
Chiller Room		75°F
Boiler Room		80°F
Maximum design supply air (at outlet)	95°F	65°F
Minimum design supply air (at outlet)	–	57°F
Design hot/chilled water supply	180°F	42°F
Design hot/chilled water temperature difference (primary)	30°F	12°F
Design hot/chilled water temperature difference (secondary)	30°F	12°F
Future design hot/chilled water supply (All-electric)	130°F	42°F
Future design hot/chilled water temperature difference (All-electric)	25°F	23°F
Design condenser water, chillers	–	74°F
Minimum condenser water temperature difference	–	12°F
Maximum condenser water temperature difference	–	15°F

B. Design Relative Humidity

1. No active control.

C. Sound and Vibration Control:

1. Maximum noise levels shall be as indicated below. **The HVAC Contractor shall retain an acoustical consultant to approve the system design as meeting the specified NC requirement of NC 55 in equipment rooms and analyze acoustic performance of cooling towers at time of equipment selection.** Acoustical consultant shall determine the sound pressure level in dBA at 7th street sidewalk and Building F exterior stairs at grade for proposed tower selections.
2. The acoustical engineer's cooling tower related calculations shall be submitted to the Engineer for review and comment prior to cooling tower selection. All other calculations shall be submitted to the Engineer for review and comment at the end of the construction

documents phase. Vibration in walls and floors shall not be perceivable to the touch in any occupied space.

3. Final installation for the cooling tower shall comply with all applicable local noise ordinances.

D. Miscellaneous Design Constraints

1. Louvers: Louvers need not be as shown on architectural plans; size and position to be determined by HVAC Contractor
2. Location of ceiling mounted systems and equipment
    a. Equipment shall be located where readily accessed for maintenance, not over light fixtures, ceiling height partitions, or large, difficult-to-move furniture such as cabinets and desks. Where possible, locate in corridors or over entry doors to rooms where it is assured no furniture will be located below.
    b. Do not locate any equipment requiring access doors above drywall or other inaccessible ceilings in public areas, conference rooms, etc. (Ceiling access doors are acceptable in toilet rooms and other back-of-house type spaces.)
    c. Space shall be provided around all equipment for routine maintenance and inspection in strict accordance with recommendations of the manufacturer. Service and maintenance access space and access doors shall not be blocked by conduit, sprinkler lines, cable trays, ceiling hangers, etc.

E. Exhaust and make-up air systems

1. Chiller Room
    a. Provide refrigerant exhaust fan, as required by the CMC. (Refrigerant detector along with manual switches for emergency shutdown and exhaust are provided under Division 25 BAS.)
    b. Sound and energy efficiency are not issues in fan or outlet selection.
2. Boiler room gas flues and combustion air
    a. Contractor to verify existing flue duct construction is suitable for new boilers.
    b. Contractor to verify existing combustion air louvers are appropriately sized. Additional combustion air louvers shall be sized by Contractor and coordinated with architect, though additional combustion air openings are not expected to be required.

F. Air Distribution System Design

1. Duct Sizing
        1) Ductwork Downstream of Fan-Coils: Sheet metal ducts shall be sized for average friction rates below 0.1” per 100 feet.
        2) Refrigerant Exhaust Fan: limit velocity to 2,500 fpm
2. Ducts exposed to occupant view
    a. Avoid reducers
    b. Duct sealant shall be clear and concealed in the joint, invisible to occupants.
    c. Ducts shall not intersect wall corners or run parallel to and within a full height wall.

d. Materials shall be de-greased or otherwise ready to paint (paint by others).

e. Duct mounted grilles

1) Mount sidewall grilles/slots in taps that are sized for the outside dimension of the grille frame with flange turned in.

2) Grilles shall be mounted to discharge horizontally, not angled down.

f. Taps to grilles, tees, wyes, etc.: Have flanges at duct connection inside the duct concealed from view

3. Velocities and pressure drops through other air distribution devices shall be limited to the following:

Duct Component	Maximum velocity ft/min	Maximum pressure drop, "W.C.
Unducted control dampers	1000	0.03
Outside air intake louvers	As required to prevent rain entrainment	0.15
Exhaust air louvers	–	0.05
Filters (through face area)	500	–
Cooling coils	500	0.95
Heating coils	800	0.35
Transfer U-boot (no grilles)	900	–
Transfer boot/duct with one grille	475	–
Transfer boot/duct with two grilles	375	–

4. Layout

a. Ductwork shall not be run through electrical rooms, even where above ceilings, unless they serve the space and meet the restrictions in the Electrical Code.

b. Walls around all conference, IDF/MDF, and project rooms will be full height. Provide return air acoustical transfer ducts and grilles accordingly.

c. Return grilles and/or transfer ducts are not needed in the following situations. This assumes that the door has normal ¼" door undercuts; verify that there are undercuts – some doors will have acoustic threshold seals that will completely block airflow.

1) Rooms with full height walls or drywall ceilings: 45 cfm per door plus 30 cfm through wall and/or ceiling leakage.

2) Rooms with tee-bar ceilings and non-full height walls: 45 cfm per door plus 30 cfm or 0.15 cfm/ft2, whichever is larger, through wall and/or ceiling leakage.

d. Ductwork shall not be exposed on the roof unless absolutely necessary due to architectural constraints or acoustical requirements. Rectangular ducts located outdoors shall be sloped so that water does not accumulate.

5. Dampers: Mount so that actuators may be direct-coupled (not mounted to damper blade) one actuator per section.

6. Balancing:
   a. Balancing will be performed by adjusting the fan motor speed or with sheaves.
   b. Do not use splitters, extractors, or manual balance dampers for balancing.
7. Air Outlets
   a. Styles listed are Price. Equals by Titus, MetalAire, etc. are acceptable.
   b. Select diffusers for 5 NC less than maximum room NC.
   c. Styles
      1) General Office, tee-bar ceilings
         a) Interior supply
            1. Price PDSP star-pattern perforated (with black painted back pan and deflectors) or SPD plaque diffusers, maximum 350 cfm, at Contractor's option
            2. Maximum 12" neck size
         b) Return: 2x2 perforated, Price PDDR with light shield or equal
      2) No ceilings
         a) Supply on exposed duct: High duct elevation, bottom: Double deflection (Price 520-S) Adjust rear blades horizontal 22 degree upward and splay front blades in 45 degree pattern at each end gradually rotating to be almost straight at blades in center of grille.
   d. Borders and Frames: Use frames with concealed fasteners; no visible screw heads

G. Water Distribution Systems
1. Piping shall be sized using either the performance or prescriptive procedure described below.
   a. Performance Approach
      1) Optimize pipe using life cycle costs using this spreadsheet: http://www.taylor-engineering.com/Websites/taylorengineering/images/guides/Pipe_Size_Optimization_Tool.zip. Provide spreadsheets for TE review to confirm proper implementation.
   b. Prescriptive Approach
      1) Piping shall be designed in accordance with the table below. "Noise Sensitive" spaces are spaces designed for NC 40 and below.

Pipe Size	Secondary Hot and All Chilled Water		Primary Hot and Condenser Water to Chillers	
	Non-noise Sensitive	Noise Sensitive	Non-noise Sensitive	Noise Sensitive
½"	7.8	1.8	5.0	1.8
¾"	18	4.6	12	4.6
1"	29	8.9	19	8.9

Pipe Size	Secondary Hot and All Chilled Water		Primary Hot and Condenser Water to Chillers	
	Non-noise Sensitive	Noise Sensitive	Non-noise Sensitive	Noise Sensitive
1-1/4"	51	15	34	15
1-1/2"	88	24	57	24
2"	120	51	73	51
2-1/2"	160	81	100	81
3"	270	140	180	140
4"	480	280	320	280
5"	670	490	430	430
6"	1,100	770	700	700
8"	1,800	1,500	1,200	1,200
10"	2,900	2,700	1,900	1,900
12"	4,400	4,200	2,900	2,900
14"	6,000	5,400	4,000	4,000

c. Devices: Design pressure drop shall not exceed the following:

1) Coils: 15 feet

2. Pump head estimates for pumps are shown in schedules on Drawing M0.02. Pump heads shall be calculated using the spreadsheet specified in Paragraph 1.16G.1.a.1) regardless of how piping was sized.

3. Layout

a. Piping shall not be run above electronic equipment. Where absolutely necessary, provide drain pans to minimize damage due to leaks.

b. Piping shall not be run through electrical rooms, even where above ceilings.

c. Piping shall be inside building or cooling tower enclosure, no exposed piping acceptable. Piping may be suspended high along walls if tight to wall and over 7' above the adjacent walking surface.

4. Pump Types

a. Small pumps (<~75 gpm, ~2HP) where accessible mounted in-line with piping:

1) Close-coupled inline

b. Variable speed, <~2000 gpm:

1) ≤20HP: Close-coupled end-suction

2) >20HP: Flex-coupled end-suction with flexible polyurethane coupling

c. Constant speed, <~2000 gpm:

1) ≤15HP: Close-coupled end-suction

2) >15HP: Flex-coupled end-suction with EPDM coupling

d. >~2000 gpm:

1) Double suction, flex coupled

5. Balancing
   a. Variable flow systems (two-way modulating valves): No balancing required for two-way valve systems.
   b. Constant flow systems: For devices with a design pressure drop exceeding 2 psi, flow as indicated by coil pressure drop using test plugs may be used in lieu of balancing valves.
   c. Do not provide balancing valves at pumps (e.g. triple duty valves).
6. Hot water systems
   a. Systems shall be primary/secondary distribution with constant flow primary pumps and variable flow and variable speed secondary pumps.
7. Chilled water systems
   a. System shall be primary/secondary distribution with variable flow and variable speed.
   b. Provide a chilled water buffer tank
      1) Tank serves as the common leg between the primary and secondary loop.
      2) Tank sized for minimum cycle time of 45-minutes (22.5 minutes on, 22.5 minutes off) at 10% of a single chiller's load.
8. Condenser Water Systems
   a. Condenser water systems serving chillers shall be staged constant flow, constant speed when chiller compressor operates.
   b. Provide condenser water pumps with VFDs for variable flow during chiller "free cooling" operation.

H. Indoor Air Quality Measures
1. Coils: Individual finned-tube coils shall be meet Standard 62.1 requirement (no greater than 0.75" pressure drop when dry (no condensation) and rated at 500 fpm) to ensure coil cleanability. Multiple finned-tube coils in series shall also meet this constraint together unless 1.5 feet minimum width access sections with access doors are placed in between each coil.
2. Dehumidifying Cooling Coils: Field assembled and custom factory assembled dehumidifying cooling coils shall be selected for no more than negligible water droplet carryover beyond the drain pan at design conditions. Unitary dehumidifying cooling coils shall be designed so that no more than negligible water droplet carryover will occur at the standard rating conditions specified by the AHRI Standard appropriate for the equipment category. For the purpose of this section, negligible water droplet carryover is defined as 0.04 oz per ft^2 of coil area per hour. Drains and drain pans as specified below shall be provided under all dehumidifying cooling coils. Equipment and other obstructions in the air stream shall be located sufficiently downstream of the coil that it will not come in contact with water droplet carryover.
3. Drains and Drain Pans: Drain pans located in fan coil units, and other locations shall be designed and field tested to ensure proper slope and drainage and to prevent conditions

of water stagnation that result in microbial growth. Drainage shall be considered acceptable if after covering the entire pan with ½" water, the pan drains within 3 minutes with the fan system in operation to leave puddles no more than 2" in diameter and no more than 1/8" deep.

4. Access: Space shall be provided around all ventilation equipment as recommended by the manufacturer for routine maintenance and inspection including but not limited to filter replacement and fan belt adjustment and replacement. Access doors or panels shall be provided in ventilation equipment, ductwork and plenums as required for in-situ inspection and cleaning of the following:
    a. Outdoor air intake plenums
    b. Mixed air plenums
    c. Upstream of heating coils
    d. Upstream and downstream surface of cooling coils
    e. Filters
    f. Drain pans
    g. Fans
5. Filtration
    a. All fan systems shall have a filter to protect ductwork and coils from particulate accumulation.
    b. Minimum filter efficiency as rated by ASHRAE Standard 52.2: 4 inch pleat, MERV 13.
    c. MERV 8 prefilters in front of high efficiency filters shall be provided only during construction. The prefilters shall be discarded prior to final TAB tests.

I. Energy Conservation Measures
1. Motors
    a. All 3-phase motors shall be premium efficiency.
    b. All single phase motors shall be electrically commutated motors (ECMs).
    c. Motors driven by variable frequency drives shall meet the requirements of NEMA MG-1 part 31.40.4.2. No exceptions.
2. Pumps
    a. Variable flow systems shall have variable speed drives.
    b. Pumps in parallel shall be able to be staged with associated chiller/boiler/cooling tower using automatic isolation valves at associated devices.
3. Fans
    a. All fan-coils shall have variable speed drives or ECMs for single zone VAV control logic.
4. Cooling Towers
    a. Fans shall have variable speed drives.
    b. Tower internal distribution shall be selected for low flow so that all towers can operate at the same time when only one CW pump is operating.

c. Condenser water pumps will have variable speed drives to modulate water flow during chiller “free cooling” to maximize the number of “economizer” hours.

5. Equipment Efficiency: See specific equipment requirements under Materials below.

J. Redundancy and Reliability

1. Provide a minimum of two pumps for each service, sized for 50% of design
2. Provide a minimum of three boilers, sized for 33% of design
3. Provide a minimum of two chillers, sized for 50% of design
4. Provide a minimum of two cooling towers or one dual cell tower. Towers or cells shall be completely independent (separate basins, make-up, drain, supply, and return) and connected by an equalizer pipe that can be shut off to allow one tower/cell to operate alone.
5. All variable speed drives shall be located indoors in nearby mechanical or electrical rooms/closets unless the separation distance would be longer than manufacturer’s limits. Exterior VFDs shall be located in a NEMA 3R or 4X Enclosure.

PART 2 MATERIALS

2.01 CHILLERS

A. Chillers will be selected after bid. Include stipulated price in Paragraph 1.02B.3.a.

2.02 COOLING TOWERS

A. Cooling Towers will be selected after bid. Include stipulated price in Paragraph 1.02B.3.c.1).

2.03 **ALTERNATE 8** TOWER FILTRATION SYSTEM

A. Packaged separator system completely factory assembled.

1. Centrifugal vortex type separator
2. Pump
3. Controls
4. Interconnecting piping, schedule 80 PVC
5. Mounted on an epoxy coated steel skid

B. Separator

1. Tangential entry to ensure proper helical flow
2. Expected solids performance rating at or above 98 percent efficient at 74 microns and larger (with a specific gravity of 2.6 or greater) on a single pass
3. Inlet/outlet gauges to monitor pressure
4. Manual air relief valve at the top of the vessel
5. Fabricated of carbon steel, rated at 150 psi working pressure, tested at 1.5 times the design pressure
6. Finish: fusion bonded epoxy coating

C. Pump
   1. Close coupled, end suction type
   2. Cast iron construction, bronze fitted
   3. Standard efficiency, TEFC motor
   4. Cast iron pre-strainer with a perforated stainless steel basket
   5. Starter with HOA switch and overload short circuit protection

D. Purge
   1. Purging of the accumulation chamber shall be accomplished without interrupting flow or excessive loss of system fluid. Purge rate shall be low enough that it can be accommodated by a standard 3" floor sink.
   2. Include automatic controls consisting of an electrically actuated two-way brass ball valve with a HOA switch and solid state purge timer mounted in the control panel

E. Electrical and Controls
   1. Complete packaged control system
   2. NEMA 3R or 4X enclosure
   3. Single electrical connection point
   4. Dry contact for remote start/stop

2.04 HOT WATER BOILERS

A. Boilers will be selected after bid. Included stipulated price in Paragraph 1.02B.3.b.

2.05 PUMPS

A. Manufacturers: PACO, Bell and Gossett, equal

B. Construction
   1. Bronze or stainless steel impeller
   2. Mechanical seals
   3. Construction to permit complete servicing without breaking piping connections
   4. Pumps and flanges tested and rated to withstand 1-1/2 times specified working pressures based on both inlet pressures scheduled and pump shut-off head or 175 pounds per square inch working pressure at 250 degrees Fahrenheit, whichever is greater.
   5. Pumps to be suitable for handling fluids at scheduled temperatures
   6. Pressure taps on both inlet and outlet for gauge connection mounted in the pump casing (not in external piping).
   7. Factory tested
   8. Painted with at least one coat of high-grade machinery enamel

C. Pump characteristics
   1. Pump curve shall rise continuously from maximum capacity to shutoff
   2. Shutoff head approximately 10 percent greater than design head

3. Operation between 65% and 115% of GPM at best efficiency point (BEP) for the indicated impeller size, ideally between 85% and 105% of GPM at BEP.
4. For pumps serving variable flow (2-way valve) systems or where multiple pumps operate in parallel
    a. Pump shall be capable of operating at 40 percent beyond design flow rate without exceeding break off point
    b. Motors shall be selected for non-overloading operation at a flow rate 40 percent beyond design flow rate
5. Impeller diameter
    a. Minimum tip to cutwater clearance: 4%
    b. Constant speed pumps: Trim to duty
    c. Variable speed pumps: Trim to the maximum impeller size that does not cause an increase in motor size (so that maximum efficiency is achieved).
6. Flex-coupled
    a. Removable OSHA coupling guards
    b. Flexible couplings
        1) Constant speed: EPDM equal to Woods Sure-Flex
        2) Variable speed: Flexible polyurethane equal to Woods Dura-Flex or Dodge Para Flex

D. Motors
1. Premium efficiency
2. Motors exposed to outdoors shall be TEFC
3. For variable speed driven pumps, motors shall meet the requirements of NEMA MG-1 part 31.40.4.2.
4. 1800 rpm or less

2.06 FAN COIL UNIT

A. Price Industries, Envirotech/Johnson Controls/York, Trane, Carrier, Daikin, or equal

B. Comply with all Indoor Air Quality Measures and Energy Conservation Measures described above

C. Insulated housing with minimum 3/4”, 1.5 pound fiberglass or foam insulation

D. Include filters as scheduled

E. Hang unit with spring isolation

F. Motors: direct drive, ECM

G. Coils: Minimum 6 rows, 10 fpi

H. Units in electrical and electronic equipment rooms or over electrical or electronic equipment shall have auxiliary condensate drain pans and secondary condensate drain. All others shall have condensate high level switch factory wired to shut off fan.

2.07 COMPRESSORS

A. Sullivan Palatek

B. Direct drive compressor

C. Oversized air intake

D. Factory mounted separator tank

E. Factory installed 120 gallon ASME tank

F. Factory installed gauges
   1. Line pressure
   2. Discharge pressure
   3. Temperature
   4. Oil filter differential
   5. Separator element
   6. Run hour meter

G. Magnetic line voltage motor starter

2.08 COMPRESSED AIR DRYER

A. Equal to Van Air Systems RA-200

2.09 FANS (GENERAL)

A. Fans shall be tested and rated in accordance with AMCA Standards and shall bear AMCA Labels

B. Wheels shall be balanced statically and dynamically, free from vibration or noises

C. Bearings self-aligning, ball-bearing type, complete with grease fittings, extended to single point on drive side or to accessible location

D. Actual brake horsepower of fan and drive shall not exceed nameplate rating of motor driving fan

E. Provide adjustable sheaves for one-to-two-strand belt drives on motors 15 HP or less. Sheaves shall be selected to operate at mid-point of fan curve to allow adjustment in both directions. For belt drives with more than two strands serving motors over 15 HP, provide fixed sheaves. Replace fan sheaves as necessary to obtain desired results.

2.10 EXHAUST FANS

A. Cook, Greenheck, Twin City or equal

B. Provide back draft dampers on exhaust fans as required by code and Title 24.

2.11 MOTORS

A. General

1. In accordance with NEMA, IEEE, and ANSI C50 standards
2. Sized to operate driven devices under all conditions without overload
3. Minimum service factor: 1.15
4. Type
    a. 1/2 horsepower and smaller: AC motor single-phase, 60 hertz, NEMA rated for 110 volt, with built-in overload protection
    b. 3/4 horsepower and larger: AC motor 3 phase, 60 hertz, AC motor, NEMA rated for 460 volt or as available
    c. Motors 50 horsepower and over: Reduced voltage start, suitable for star-delta starting

B. Enclosure
1. Open drip-proof (ODP): Provide ODP motors unless otherwise indicated
2. Totally enclosed (TEFC):
    a. Non-ventilated: under ½ horsepower
    b. Fan-cooled: ½ horsepower and larger

C. Efficiency
1. Motors 1 horsepower and larger shall be NEMA Premium™ labeled and have guaranteed efficiencies equal to or exceeding NEMA Table 12-6D.

D. Motors driven by variable frequency drives
1. Shall meet the requirements of NEMA MG-1 part 31.40.4.2.
2. Where used for pumps or fans (variable torque), shall have minimum 10:1 turndown and be capable of operating at 10 percent speed indefinitely.

2.12 VARIABLE SPEED DRIVES

A. ABB, Danfoss, Cerus, equal

B. Electrical Characteristics
1. Efficiency shall be not less than 97% at rated voltage, current, and frequency and fundamental power factor shall not be less than 98% at all speeds and loads.
2. Provide as a minimum 5% impedance line reactors. The 5% impedance may be from dual (positive and negative DC bus) reactors or 5% AC line reactors. VSDs with only one DC reactor shall include AC line reactors.
3. VSD shall automatically mitigate harmonics throughout the effective load range using Swinging chokes or other devices designed to lower harmonics when VSD is at partial loads.
4. Include Ferrite Core EMI/RFI/Common mode filters. The onboard filters shall allow the VSD assembly to be CE Marked and the VSD shall meet product standard EN 61800-3 for the First Environment restricted level (Category C2).

C. Features and Accessories
1. Plain language LCD display (code numbers not acceptable); all set-up parameters, indications, faults, warnings, and other information must be displayed in words, not codes

2. Displays and meters for the following
    a. Output voltage
    b. Output frequency
    c. Motor rpm
    d. Motor current
    e. Motor watts
    f. Speed signal input
    g. Last three faults
3. HOA switch and speed potentiometer
4. Integral circuit breaker
5. Adjustable or multiple carrier frequencies up to 12 kHz. Include a carrier frequency control circuit that reduces the carrier frequency based on actual VSD temperature that allows the highest carrier frequency without derating the VSD or operating at high carrier frequency only at low speeds.
6. Isolated 4-20 mA or 0-10 Vdc speed signal input. If the input reference is lost the VSD shall, based on user selectable option, either (1) stopping and displaying a fault, (2) running at a programmable preset speed, (3) hold the speed based on the last good reference received, or (4) cause a warning to be issued.
7. Analog outputs for kW and speed; kW shall be accurate to ±3%
8. Digital outputs for alarm and motor on/off status; latter shall be based on field adjustable motor current that can indicate broken belt or coupling
9. Auto-restart after trip due to
    a. Overcurrent
    b. Under-voltage
    c. Over-voltage
    d. Over-temperature
    e. Auto-restart upon correction of causative condition
    f. Include a maximum of 3 restart attempts for over-current only, with VFD shutting down and requiring manual restart after the third attempt; the attempt counter shall reset after 10 minutes of successful operation
10. Automatic limit speed to prevent over-current on pumps or fans with overloading characteristics
11. Provide manual bypass as indicated in Energy Conservation Measures above
12. Controls
    a. Provide a minimum of three digital outputs that can be programmed for multiple purposes and also controlled through the BAS network interface device by the BAS independent of other VSD functions or status. Control sequence possibilities shall include:
        1) Contact to open fan discharge damper either with fan start or independent of fan operation, controlled via the BAS and wait for the damper end switch to make

before starting the drive; this shall function in the normal drive mode, bypass mode (if bypass is provided), and life safety mode (if part of smoke control system).

b. Provide built-in PID control loop, allowing connection of a pressure or flow signal to the VSD for closed loop control.

c. Provide factory installed BACnet/MSTP network interface that allows all VSD control points to be communicated to BAS. See Division 25 Building Automation Systems. At a minimum, the following points shall be provided:

1) Read only: Speed feedback, output speed, current, % torque, kW power, kilowatt hours (resettable), operating hours (resettable), drive temperature, digital input status, analog input values, all diagnostic warning and fault information, keypad “Hand” or “Auto” selected, bypass selected, deceleration rate, and acceleration rate

2) Read/write: On/off, output speed, digital output open/close, analog output values, remote fault reset, PID setpoint and gains, force the unit to bypass, maximum speed, and minimum speed.

D. Equipment Protection and Safeties

1. VFDs short-circuit interrupting rating shall equal or exceed the fault current available at the drive.
2. VFD shall protect itself against all normal transients and surges in incoming power line, any grounding or disconnecting of its output power, and any interruption or run away of incoming speed signal without time delay considerations. Protection is defined as normal shutdown with no component damage.
3. The VSD shall be capable of sensing a loss of load (broken belt / broken coupling) and signal the loss of load condition. The VSD shall be programmable to signal this condition via a keypad warning, relay output and/or over the serial communications bus. Relay output shall include programmable time delays that will allow for drive acceleration from zero speed without signaling a false underload condition.
4. VFD must protect itself against all phase-to-phase or phase-to-ground faults.
5. VFD shall be able to start into a rotating load at all speeds (forward or reverse) without trip.
6. Anti-regeneration circuit shall match the deceleration rate of the drive to that of the motor to prevent high bus voltage shutdown common to high inertia loads, such as fans.
7. VFD shall ride through an input power dip of 3 cycles without trip.
8. VSD shall operate properly at a -35% to +30% voltage fluctuation from rated voltage.
9. VSD shall operate properly at a 10 percent frequency variation from rated frequency.
10. VFD shall employ three current limit circuits to provide trip-free operation: slow current regulation, rapid current regulation, and current limit switch-off limit. VFD shall be designed so that overcurrent trip shall be at least 315% of the drive’s current rating.
11. VSD shall have the ability to set a maximum current available to the motor.
12. VSD shall withstand unlimited switching of the output under full load, without damage to the VSD. Operation of a disconnect switch between the motor and VSD shall not have an adverse effect on the VSD, whether the motor is operating or not. Controls conductors

between the disconnect and the VSD shall not be required for the safe and reliable operation of the VSD.

13. The VSD shall withstand switching of the input line power up to 20 times per hour without damage to the VSD.
14. The VSD shall be capable of operating continuously at full load in the following service conditions
    a. Ambient temp: 30 to 104 degrees Fahrenheit
    b. Relative humidity: 0 to 95 percent, non-condensing

E. Start-Up/Warranty
1. Certified factory start-up shall be provided. A certified start-up form shall be filled out for each drive with a copy to the owner and a copy kept on file by the manufacturer.
2. Warranty shall be 24-months from date of start-up certification including all parts, labor, travel time, and expenses.

2.13 CONDENSATE DRAIN PANS

A. Stainless steel for all drain pans including fan-coils but excluding auxiliary overflow pans

B. Comply with ASHRAE 62.1.

C. Minimum 16-gage

D. Condensate pan shall extend at least ½ of the coil height past the edge of the each cooling coil on the leaving air side. Drain pans shall be provided for intermediate coils in the bank as well as the bottom coil.

E. Pan must slope and drain connection must be installed for positive drainage to prevent standing water whether fan is off or on.

F. Intermediate pans shall drain into pan below with termination within 2” of pan.

G. Drain connection to meet code requirements.

2.14 AIR OUTLETS

A. Titus, Price, Krueger, Metal-Aire

B. See Paragraph 1.16F.7 for styles.

2.15 LOUVERS

A. Louver Design
1. Extruded aluminum
2. Primed for painting (painting by others)
3. Equal to Ruskin ELF375X for exhaust; ELF375DX for outside air intake
4. Combination louver/damper: Equal to Ruskin ELC6375, 6” frame

B. Screen
1. Aluminum wire screen

a. 14-gage
b. ½-inch mesh

2. Mounted on inside of louver

C. AMCA Certified Rating Seal: Tested in accordance with AMCA Standard 500

2.16 WATER TREATMENT SYSTEMS

A. General. Retain qualified water treatment specialist for complete water treatment service including

1. Prior to submitting any water treatment materials for approval, perform analysis of local makeup water including:
   a. Collect samples of local makeup water
   b. Conduct laboratory analysis of water samples.
   c. Provide a written report of local makeup water conditions and recommended methods and materials for initial and ongoing water treatment of all piping systems.
   d. For open cooling tower, determine Maximum Achievable Cycles of Concentration (COC) in accordance with:
      1) Title 24 Part 6 Section 110.2 (e) 2.
2. Recommend methods and materials required, including cleaning and passivation procedures as needed, to provide complete chemical treatment to protect all hydronic systems from scale formations, corrosion, algae and slime growth.
3. Furnish all water treatment chemicals and devices.
4. Supervise installation of water treatment chemicals and systems.
5. Relieve operating staff and contractor of all responsibility for chemical handling, water testing and adjusting water treatment equipment during warranty period including providing required maintenance of treatment equipment.
6. During warranty period, conduct monthly visits of qualified technical representative to provide the following at a minimum, summarized in a written report to the Owner:
   a. Collect samples from each treated system and provide laboratory analysis.
   b. Collect coupons for systems with coupon racks and provide laboratory analysis.
   c. Inspect and adjust water treatment controllers and devices.

B. Closed Systems

1. Pot feeder: size as appropriate to system size
2. Chemicals: Charge systems with a corrosion and scale inhibitor to a concentration recommended by the water treatment supplier

C. Open Systems

1. Scale control
   a. TDS (conductivity) controller

b. Conductivity sensor: Electrodeless temperature-compensating encapsulated toroidal non-contact type mounted in a PVC fitting. Contact-type probes will not be accepted.

c. Bleed valve, ball type with stainless steel ball and trim, spring-return normally-closed

d. Inhibitor tank with automatic feed pump

e. Test set to determine inhibitor concentration shall be included.

2. Microbial control

a. Time controller/alternator

b. Dual microbiocide tanks with automatic feed pumps

c. Two types of biocide shall be provided, at least one effective for *Legionella*.

3. Controllers shall be mounted in enclosures NEMA rated for outdoor installation where applicable.

1. Include Modbus/IP or BACnet/IP interface with read/write capability of all control points and setpoints; coordinate protocol with Division 25 Building Automation Systems. Assist BAS Contractor in mapping over all available data points. Minimum points, read-only:

a. Conductivity

b. Cycles of concentration

c. Conductivity setpoint

d. Conductivity low alarm setpoint

e. Conductivity low alarm

f. Conductivity high alarm setpoint

g. Conductivity high alarm

h. Timer 1 alarm

i. Timer 2 alarm

j. Flow status

k. Bleed valve status

l. Makeup water flow

m. Makeup water total

n. Bleed water flow

o. Bleed water total

2. Meters

a. Provide makeup water flow meter with pulse connection to feed controller.

b. Provide low pressure drop bleed water meter upstream of bleed valve.

c. Provide strainer at inlet to meters.

d. All meters to have dial face with totalizing counter reading in gallons.

3. Provide coupon rack, minimum of 3 coupons.

4. Chemical tanks shall be protected with spill container or double-wall tanks.

5. A sufficient supply of non-mix/non- dilute type chemicals shall be furnished for 90 days at 50% load.
6. Water treatment supplier shall provide supervisory service and instruction for installation, start-up and correct operation of the equipment in the system.
7. Manufacturer
    a. Chemtrol CT 2000 with Modbus option
    b. Walchem Webmaster One or WGI with Modbus option
    c. Equal

2.17 PIPE MATERIALS AND JOINING SYSTEMS

A. Piping materials shall be
    1. HW and CHW: Schedule 40 Black steel or Type "L" Copper at contractor's option.
    2. Open CW: Schedule 40 Galvanized steel or Type "L" Copper at contractor's option.

B. Joint System
    1. Steel: welded or grooved (Victaulic)
    2. Copper
        a. Hard temper
        b. Wrought-copper, solder joint fittings, ANSI B16.22
        c. 95/5 tin/antimony solder or 95.6 percent tin, 4 percent copper, 0.4 percent silver; lead free
        d. Or Press-Fit fittings and couplings equal to Viega ProPress

2.18 PIPE VALVES AND ACCESSORIES

A. Piping system components shall be selected for maximum design operating pressure based on static head, shutoff pump head, and pressure relief valve setting.

B. Gauges
    1. Fixed gauges
        a. Temperature gauges
        1) Self-powered via integral photovoltaic cells
        2) Weiss DVU or equal
        b. Pressure gauge: Weksler Model AA44 with valve
        c. Boilers to have factory mounted temperature and pressure gauge
    2. Pressure/Temperature Test Plugs: "Pete's Plug" fittings, solid brass with Nordel or EPDM valve core (or neoprene valve core for chilled water or condenser water) fitted with a color coded and marked cap with gasket.

C. Check Valves
    1. Nibco or equal
    2. Silent

3. Combination higher pressure drop check & balance (triple-duty) valves are not acceptable as a substitution for individual check and shut-off valve (due to high pressure drop and poor ease of use).

D. Shut-off Valves
   1. Nibco or equal
   2. Ball or butterfly valves only
   3. Valves used for balancing shall have infinite position handles with memory stop
   4. Ball valves
      a. Full Port 1/2 to 1 inch; Standard Port 1-1/4 and larger
      b. Stainless steel ball and stem
      c. Equal to Nibco 580-70-66
   5. Butterfly valves
      a. Removable seats
      b. Valve stem shall be fastened to the disc so that no liquid can reach the stem
      c. External fasteners such as roll pins, cotters, keys, or set screws will not be allowed
      d. Butterfly valves shall be lug type; no wafer type valves allowed
      e. Provide manual gear operator for butterfly valves 8" and larger
   6. Extended neck model for all insulated lines
   7. Provide chain operators on all valves located higher than 7 feet above access level

E. Pipe Supports
   1. Kin-line, Superstrut, or equal
   2. Where pipe is insulated, protect insulation at hangers by installing a 22 gauge shield and clamp sized to allow pipe insulation to pass continuously through the hanger. For piping 2" and larger, provide 360 degree high density calcium silicate insert within shield.

F. Expansion Tanks: Amtrol, B&G or Taco bladder type, stamped and certified constructed in accordance with ASME Code for Unfired Pressure Vessels for applicable working pressure.

G. Flexible Pipe Connectors: Not used

H. Balancing Valves: Not used

I. Air Separators
   1. Centrifugal type
      a. ASME construction
         1) 125 pounds per square inch operating pressure
      b. Steel tank
      c. Perforated stainless steel air collector
      d. Drain connection
      e. Equal to
         1) Up to 1.5”: Bell and Gossett model EAS.

2) 2” and above: Bell and Gossett "Rolairtrol" model RL

2. In-line type
   a. One piece
   b. Cast iron
   c. Rated for minimum 125 psig working pressure and minimum 250°F liquid temperature
   d. Expansion tank connection on bottom
   e. Air vent connection on top
   f. Equal to Bell and Gossett model IAS
3. Provide bronze, high capacity float operated automatic air vent.

J. Strainer
1. Nibco, Mueller, or equal
2. Cast iron or bronze "Y-pattern" body to match piping material
3. Perforated Monel, 304 or 316 stainless steel screen
4. Free area not less than 2-1/2 times inlet area
5. Perforations: 1/8 inch
6. Provide valve with hose bib adapter with cap for all strainers

2.19 VIBRATION ISOLATION & SUPPORTS

A. Manufacturers
1. Vibration Isolation
   a. Mason Industries, Inc.
   b. Kinetics Noise Control, Inc.
   c. M.L. Saussé & Co. (Vibrex).
   d. Or equal
2. Seismic Restraints
   a. Hangers and Snubbers: Any manufacturer who can verify compliance with SMACNA standards and the California Building Code
   b. Strut: Channel Framing: Any manufacturer who can verify compliance with the CBC standards
   c. Anchors: Drill in, wedge type: Any manufacturer within the ICBO standards approved for seismic
   d. Snubbers: Any manufacturer within the CBC standards

B. Vibration Isolator Types
1. Housed isolation
2. Size for weight of unit and associated items that hang from the springs
3. Spring isolators shall incorporate following:

a. All springs to be single coil steel with minimum spring coil outer diameter 0.8 of loaded operating height
b. Horizontal spring stiffness within 0.8 to 1.25 times rated vertical spring stiffness
c. Corrosion resistance where exposed to corrosive environment with:
    1) Springs neoprene coated
    2) Hardware cadmium plated
    3) All other metal parts hot dip galvanized
d. Reserve deflection (from loaded to solid height) of 50 percent of rated deflection
e. Minimum 6mm (1/4") thick neoprene acoustical base pad on underside, unless designated otherwise
f. Designed and installed so that ends of springs remain parallel; neoprene cups not acceptable
g. Noise pads of ½ inch or 1 inch thickness below the spring base to reduce the chance that the springs shall be resonant with equipment forcing frequencies or support structure natural frequencies
h. Leveling device
i. Where operating weight differs from installed weight provide built-in adjustable limit stops to prevent equipment rising when weight is removed. Stops shall not be in contact during normal operation

C. Anchors, Inserts and Fasteners
1. All anchors and inserts shall be installed according to the CBC standards
2. Do not use any anchor or insert in concrete which does not have a signed structurally engineered design value based on its installed application and one of the following:
    a. ICBO evaluation report
    b. Lab test report verifying compliance
3. Powder Actuated Anchors
    a. Not allowed on initial building construction; allowed only for revisions made after initial construction and with approval of Owner
    b. Hardened steel stud with threaded shank; size of shank to match hanger rod size
    c. Use only with non-shock loads
    d. Maximum load safety factors
        1) Maximum anchor load: 100 pounds
        2) Static loads - 5
        3) Vibratory loads - 8-10
    e. For concrete and steel; not to be used for light weight concrete, brick or concrete block
    f. 10% testing rate required, testing by contractor
4. All over-head concrete anchors or inserts shall be selected to comply with the ICBO report or CBC table for the anchor or insert

5. Torque testing of anchors shall be allowed to verify compliance of anchor installation. However, torque testing shall not justify usability of anchor. Only load or pull testing shall be allowed to justify usability of anchors. Failure of torque shall constitute failure of anchor.

2.20 DUCTWORK AND ACCESSORIES

A. Materials and joints
   1. Ductwork shall be galvanized sheet metal minimum G-60
   2. The gauge of metal, type of joints, hanging, reinforcing, and other details of construction shall conform to the SMACNA HVAC Duct Construction Standards.
   3. Static pressure classes shall be as required by the fan system and acoustical requirements with the following minimums:
      a. Low pressure downstream of fan coil units: 1”
      b. Low pressure return air and exhaust air: associated return/exhaust fan static pressure
      c. Transfer ducts and other ducts not connected to fans: 0.5”
      d. Outside air ductwork: 0.5”
   4. Joints
      a. Rectangular Duct
         1) Longitudinal seams shall be Pittsburgh.
         2) Transverse Joints:
            a) Low pressure ductwork (<2” pressure class) shall be TDC, TDF, Duct-Mate or "S" and drive as allowed by SMACNA
      b. Round and Oval Duct
         1) Spiral
      c. Snap-lock joints not allowed
   5. Fiberglass Duct: not allowed
   6. Flexible Duct
      a. Flexible duct shall be listed by UL under Class One air duct and UL 181. All flexible ducts, even low pressure ducts, shall be minimum 4” pressure class to increase longevity.
      b. Insulated Flexible Duct
         1) Chlorinated polyethylene (CPE) inner liner duct permanently bonded to a vinyl or zinc coated spring steel wire helix
         2) Fiberglass insulating blanket; minimum R-value
            a) Ducts outside the conditioned space and in conditioned envelope: 4.2
            b) Ducts outside conditioned space and conditioned envelope: 8.0
         3) Low permeability outer vapor barrier of fiberglass bi-directional reinforced metallized film laminate

4) Thermaflex M-KE or equal

c. Aluminum duct is also acceptable provided noise criteria can be met.

B. Duct Flexible Connectors

1. General
   a. Conform to NFPA 701 and NFPA 90A
   b. Flame spread rating: 25
   c. Smoke development rating: 50
   d. Airtight and waterproof to plus or minus 10 inches
2. Construction
   a. Metal collar at each end
   b. Galvanized steel G60
   c. Minimum thickness: No. 24 USSG
   d. Minimum length: 3”
   e. Double lock joint
3. Length of fabric
   a. Minimum: 4 inch
   b. Maximum: 10 inch
4. Materials
   a. Coated glass fabric
   b. Sewed and cemented seams
   c. Neoprene or woven nylon/polyester blend with vinyl coating
   d. 22 oz. per square yard minimum
5. Ventfabrics, Inc. Ventglas or equal

2.21 FLUES

A. General

1. Sizes of all flues (and combustion air ducts where used) shall be confirmed with boiler manufacturer prior to issuing submittals.

2. Flue design is considered design/build by the flue material supplier, who shall be responsible for code compliance and performance of the flue and its installation details.

B. Category I appliances

1. Type B, double wall, factory-built, UL 441 listed for Category I appliances burning natural gas for flue gases less than 550 degrees Fahrenheit.

2. The vent shall have an inner gas carrying pipe of aluminum alloy or stainless steel. The outer jacket shall be G-90 galvanized or aluminum coated steel. The space between the

inner and outer pipe, the thickness of materials, and construction of the modular sections and accessories shall be as specified by the terms of the product's UL Listing.

3. The stack system shall be from one manufacturer and shall be complete with caps, supports and seismic bracing.

4. Where exposed to weather, the outer closure band shall be sealed to prevent rainwater from entering the space between inner and outer walls.

5. Metal-Fab Model M, Selkirk Metalbestos RV, or equal

C. Category III appliances

1. Positive pressure, double wall, factory-built, UL 1738 listed for Category III appliances burning natural gas

2. The vent shall have an inner gas carrying pipe of Type 304 stainless steel. The outer jacket shall be aluminum coated steel. The space between the inner and outer pipe, the thickness of materials, and construction of the modular sections and accessories shall be as specified by the terms of the product's UL Listing.

3. The stack system shall be from one manufacturer and shall be complete with caps, supports and seismic bracing.

4. Where exposed to weather, the outer closure band shall be sealed to prevent rainwater from entering the space between inner and outer walls.

5. Metal-Fab Model PIC, Selkirk Metalbestos PS, or equal

2.22 FILTERS

A. Farr, Flanders, or equal

B. See Design Criteria for efficiency requirements. See Paragraph 1.16H.5.b

C. Construction Filters: Provide minimum 2" MERV 8 pleated filters

2.23 INSULATION

A. Certainteed, Owens Corning, Manville, Knauf or equal

B. Insulation shall:

1. Meet minimum thickness requirements of Section 120.4 of Title 24 and CMC 604.1
2. Meet mold, humidity, and erosion resistance requirements of CMC 605.0
3. Have flame spread not more than 25 and smoke density of not more than 50 when tested as a composite installation per CMC 602.2

C. Ductwork and Plenums

1. In concealed spaces, including ceiling plenum: Shall be insulated with 1-1/2" Fiberglas, 3/4 lb./cubic-foot faced Duct Wrap.

2. Where required for acoustical attenuation: Shall be internally lined with Certainteed Toughgard Duct Liner, 1-1/2 lb. density, 1" thick.

D. HW & CHW Piping
   1. Fiberglass molded pipe insulation with all service jacket.
   2. Thickness per Title 24 requirements.
   3. All piping and devices through which water flows in normal operation shall be insulated, including coil tube bends.
      a. Exception: Hot water piping, fittings, valves and accessories located between coils and isolation valves (for coils with 2-way valves) where located in the conditioned space the coil serves and exposed to occupant view.
   4. Fittings
      a. Hot water: Fittings on pipe over 1/2" shall be insulated with fiberglass and finished with one piece PVC fitting cover (Zeston). Valves, flanges and irregular surfaces shall be insulated with oversized pipe covering with ASJ jacket. Exposed ends shall be finished with four ounce canvas jacket saturated in Arabol.
      b. Chilled water: Elbows shall be insulated with PVC fitting covers (Zeston) with all joints and overlaps taped with Zeston PVC vapor barrier tape. Valves and fittings shall be insulated with fiberglass oversized insulation or molded fittings and shall be coated with two coats of Foster vapor barrier mastic reinforced with glass fabric. Butt ends of insulation shall be sealed off at 21 ft. intervals maximum or at fittings, with Foster 30- 35, or equal. Vapor barrier is to be continuous. Insulation is not required at coil headers where condensation will drip into coil drain pan.

E. Equipment
   1. Air separators, pumps, and other equipment in the piping circuit shall be fully insulated; thickness same as that for largest piping used.
   2. Do not insulate expansion tank, chemical feeder or other equipment not in the piping circuit.

PART 3 EXECUTION

3.01 RECORD DRAWINGS

A. Keep an accurate dimensional record of installed systems and equipment. Maintain a set of record (“as-built”) drawings up-to-date as construction progresses. Drawings shall be maintained at the jobsite and available for inspection by the general contractor, other subcontractors, the Engineer, and Owner’s representatives.

3.02 PROTECTION OF WORK DURING CONSTRUCTION

A. Protect from damage, water, dust, etc., material, equipment and apparatus provided under this Division, both in storage and installed, until Notice of Completion has been filed.

B. Provide protective covers, skids, plugs or caps to protect equipment and materials from damage and deterioration during construction. Protect exposed coils with plywood or other suitable rigid covers to avoid damage to fins.

C. Protect existing walls, doors, carpeting, etc. from damage. Any damage must be repaired at no cost to Owner.

D. Cover motors and other moving machinery to protect from dirt and water during construction.

E. During transport to and storage on the construction site, and during rough-in until final connections are made, all ductwork and other related air distribution component openings shall be covered with plastic to prevent contamination from dust, water, and debris.

F. Keep openings in piping closed to prevent entrance of foreign matter.

G. Material, Equipment or Apparatus

1. Material, equipment or apparatus damaged because of improper storage or protection will be rejected.
2. Remove damaged material, equipment or apparatus from site and provide new, duplicate, material, equipment or apparatus in replacement of that rejected.
3. Porous materials, such as insulation, shall be protected from weather. If such material becomes wet during construction, it shall be removed and replaced at no cost to Owner; drying is not sufficient due to possible microbial contamination.

3.03 INSTALLATION AND WORKMANSHIP

A. All equipment and material shall be installed in a neat and workmanlike manner.

B. Repair all damaged or temporarily removed walls, roofs, roofing, equipment, etc.

C. Follow manufacturer's installation instructions and recommendations.

D. All equipment must be anchored to the building.

3.04 PIPING

A. Install pipes and pipe fittings in accordance with recognized industry practices which will achieve permanently leak resistant piping systems, capable of performing each indicated service without piping failure. Install each run with minimum joints and couplings but with adequate and accessible unions for disassembly and maintenance/replacement of valves and equipment. Reduce sizes where indicated by use of reducing fittings. Align piping accurately at connections, within 1/16-inch misalignment tolerance.

B. Escutcheons: Provide stainless steel escutcheons at piping penetrations of walls where exposed to public view and required for proper appearance. Provide galvanized steel escutcheons at penetrations of masonry walls elsewhere. Escutcheons not generally required at drywall penetrations where not exposed to public view.

C. Sleeves

1. Provide sleeves where pipes pass through floors above grade, roofs, poured-in-place masonry walls, and exterior walls

2. Sleeves shall be standard weight steel pipe, except sleeves for concealed piping through floors not in structural members may be 25-gauge galvanized sheet metal
3. Floor sleeves for piping shall extend from the bottom of the slab to 2-inches above the finished floor
4. Seal between piping and sleeve with fire-rated caulk at all penetrations of fire-rated partitions and floors
5. Make sleeves through outside walls watertight. Caulk between uninsulated pipe and sleeve
6. Size sleeves for insulated pipes to allow full thickness insulation

D. Application of Piping Accessories
1. This section establishes minimum requirements for installation of valves and other piping accessories. Additional devices may be installed as deemed necessary by the Contractor.
2. Pressure gauges
   a. Single gauge at all pumps, piped to pump taps
3. Thermometers
   a. Heat exchanger inlet and outlet unless temperature readings are readily provided by unit controller.
4. Test plugs
   a. Inlet and outlet of all heat exchange devices including where fixed gauges are installed
   b. At piping temperature sensor wells (for sensor calibration)
5. Air Separators
   a. Hot water system: Centrifugal type
   b. Chilled water system: Not required
6. Strainers
   a. Inlet to all closed circuit pumps
   b. Inlet to open circuit heat exchange devices such as chiller condenser barrels
7. Coils, evaporators, condensers, boilers, and heat exchangers
   a. Isolation valves at inlet and outlet (individually at multi-coil banks)
   b. Test plugs at inlet and outlet (individually at multi-coil banks)
   c. Drains with ball valve and hose connection with cap
   d. Control valves (if required herein), with reducers as required
   e. Flow measurement (for testing and diagnostics), include one of the following:
      1) Calibrated balance valves. May double as isolation valves if valves are ball valves and have handles and memory stops.
      2) Test plugs on each side of a control valve. The valve pressure drop and Cv can be used for determining flow.

3) Test plugs on each side of a heat exchanger/coil with a design pressure drop exceeding 2 psi. The heat exchanger/coil pressure drop and manufacturer's data can be used for determining flow.

3.05 DUCTWORK

A. Install per SMACNA Standards.

B. Rectangular and medium pressure duct bends greater than 45 degrees shall be curved sections, the center line radius of which shall not be less than 1-1/2 times the width of the duct in the plane of the bend. Where required due to space constraints, short radius elbows with duct splitter(s) may be used. No capped "bullhead" tees or short-radius tees permitted. On low pressure ducts, square elbows with single width turning vanes may be used. Round duct elbows may be adjustable type on low pressure systems only, with gores sealed.

C. Flexible Duct
   1. Flexible duct length shall be not exceed 5 feet.
   2. Ducts shall be supported as required by the CMC.

D. Grille connections (except grilles exposed to occupant view)
   1. Provide flexible duct connections, minimum 5 feet.
   2. Provide at entry to diffuser collar either:
      a. Straight duct for 1 duct diameters or greater
      b. Full radius elbow
      c. Equal to Thermaflex FlexFlow Elbow
   3. Connections at grilles shall be insulated to the extent the duct is insulated including the final register box
   4. Seal connections at grilles per seal class of upstream ductwork

E. Ductwork Sealing
   1. Comply with
      a. Title 24 Energy Standards
      b. UL 181, 181A and 181B
   2. Ductwork shall be sealed per SMACNA sealing classes as follows
      a. Return air ducts and low pressure supply air ducts exposed in conditioned space: Seal Class C
      b. Transfer boots: None
   3. The gores of gored elbows and end caps shall be sealed.
   4. Seal using one of the following:
      a. Duct Sealing Compound
      b. Gasketed TDC or Duct-Mate
      c. Two-Part Hard-Setting Joint Tape
      d. Rolled Elastomeric Duct Sealant if and only if

1) Joint is not exposed to occupant view
2) Pressure class is less than 2 inches
3) Surface is clean, dry, and grease/oil-free
4) Extensive pressure is applied, working the tape into the duct surface using an application tool recommended by the Rolled Elastomeric Duct Sealant manufacturer.

5. Flexible ducts shall be connected using Panduit strap on the inner liner, sealed with tape, then the outer liner shall be sealed with tape.

3.06 SEISMIC CONTROL

A. Install seismic restraints for pipes, ducts and equipment per CBC and SMACNA or Mason Industries Guidelines for pipe and duct bracing.

B. Design and provide restraints to prevent permanent displacement in any direction caused by lateral motion, overturning, or uplift
   1. Calculations required for supports and bracing for situations not covered by referenced guidelines.
   2. Include horizontal and vertical reaction loads at connections to building structures for all seismic restraints, including those covered by referenced guidelines. Coordinate reaction loads and attachment details with structural engineer for building.
   3. Calculations made and signed by registered structural engineer knowledgeable in seismic design
      a. Hired under this Section of work
      b. Cost of calculations borne under this Section

C. Provide resilient restraining devices as required to prevent equipment motion in excess of 1/4 inch

D. Coordinate seismic bracing requirements with other sections to result in
   1. Vertical pipe and duct restraints to coincide with and take place of required hangers
   2. Longitudinal pipe bracing to coincide with required pipe anchors

E. Bracing shall not short circuit vibration isolation systems or transmit objectionable vibration or noise

3.07 VIBRATION ISOLATION

A. Vibration isolation requirements shall be as required to meet sound and vibration design constraints. See Section 1.16C.

B. Installation
   1. Install isolators and seismic restraints in accordance with manufacturer's written instructions
   2. Vibration isolators must not cause any change of position of equipment or piping resulting in piping stresses or misalignment

3. Make no rigid connections between equipment and building structure that degrade noise and vibration isolation system herein specified
    a. Electrical conduit connections to isolated equipment shall be flexible liquid tight conduit of sufficient length to incorporate a right angle bend, an offset of not less than 8 inches or a loop to allow free motion of isolated equipment.
    b. Coordinate work with other trades to avoid rigid contact with the building. Inform other trades following work, such as plastering or electrical, to avoid any contact which would reduce the vibration isolation.
4. Verify that all installed isolators and mounting systems permit equipment motion in all directions

3.08 CLEANING

A. Thoroughly clean all equipment, ducts, etc. free of dust, scale, filings, plaster, grease, oil, paint and other construction debris.

B. No construction materials, debris, dirt, etc. shall remain in any area planned for occupancy during construction during normal business hours. Clean up all areas prior to start of normal business hours.

C. Water systems
    1. Closed Circuit Piping Systems
        a. Open all valves (including control valves) in all legs so circulation goes through all sections.
        b. Install temporary filter bags or fine-mesh start-up strainer screen in all line strainers during cleaning.
        c. Fill with clean water.
        d. Keep return isolation valve separating the central plant from the campus loop closed to prevent startup debris from migrating from the plant out to the campus; crack open supply isolation valve to provide a thermal expansion/contraction path for the mass of water in the building loop (applies after each loop filling). Bypass startup valve shall be open throughout cleaning procedure and closed immediately thereafter.
        e. Start pumps and operate at design flow rate or greater.
        f. Simultaneously drain at low points and fill the loop until effluent is clear.
        g. Shut off makeup water.
        h. Circulate for a minimum of two 48-hour periods. For each period:
            1) Add 4 lb. trisodium phosphate for each 1000 lb. of water in the system via pot feeder.
            2) At end of period
                a) Shut the plant isolation valve.
                b) Remove and clean strainers.
                c) Drain at low points.

i. After last circulation period
   1) Shut off pumps.
   2) Shut the plant isolation valve.
   3) Completely drain out entire system of cleaning solution.
   4) Remove filters at strainers, or replace start-up screen with final strainer screen.
   5) Fill system with clean water.
   6) Start pumps, and simultaneously drain at low points for 8 hours.
   7) Test
      a) Alkalinity not more than 200 parts per million in excess of alkalinity of rinsing water
      b) Effluent visually clear; no visible particles or color
   8) Repeat flushing of water until tests are met.

j. Connect the central plant to the campus distribution network.
   1) Open both the supply and return isolation valves to place the plant into service.
   2) Coordinate start of service with campus engineering so that central plant chemical dosing can be adjusted, if needed, to account for the new fluid added to the central plant.
   3) Do NOT leave the system filled with untreated water for more than 4 hours.

2. All open circuit systems shall be flushed until water runs clean.
3. Cooling Tower Passivation
   a. Passivate all continuously wetted galvanized surfaces.
   b. Water treatment supplier shall be responsible for providing passivation procedures and supervising passivation.

D. Ducts
1. Duct openings shall be sealed with plastic during construction to prevent debris buildup.
2. Vacuum any visible debris from inside ducts, duct plenums and grille boxes.
3. Use connected fan(s) to blow air through all duct systems until they are free of all foreign materials.

3.09 EQUIPMENT AND PIPING IDENTIFICATION

A. Equipment
1. All mechanical equipment shall be identified by nameplates securely fastened in a clearly visible location to the equipment housing or frame. Nameplates shall include the equipment design plan tag and brief description of service. Where starters or variable speed drives are provided under Division 23, provide additional nameplate indicating equipment tag mounted on starter face.
2. Nameplates shall be 2-1/2" x 3/4" minimum, either 1/6" thick Bakelite with engraved white core letters and beveled edge, or aluminum with black enameled background and etched or engraved natural aluminum lettering.

3. Manufacturer's nameplate shall be clean and legible and installed in a clearly visible location.

B. Piping
1. Identify piping with symbol identification (e.g. CWS) and direction of flow arrows, complying with ANSI A 13.1 color standards.
2. Identify piping at approximately 25' centers where unconcealed Concealed piping above inaccessible ceilings shall be identified at each access panel. Concealed piping above accessible ceilings shall be identified within 10 feet of each wall penetration (both sides of walls).
3. Where capped piping is provided for future connections, provide legible and durable metal tags indicating symbol identification.
4. Printed labels with colored background and attaching strap: Seton, W. Brady, or equal.

C. Valves: Tags not required.

D. Warning Signs
1. Provide warning signs at all equipment driven by electric motors which are controlled by fully automatic starters, General Industry Safety Orders.
2. Provide refrigeration system labeling per code.

3.10 PAINTING

A. Painting under this Section
1. Black steel or PVC water piping exposed to outdoors
   a. One coat primer
   b. Two coat alkyd oil paint, color as indicated
2. Interior of ductwork at air outlets as far back as visible from occupied spaces
   a. Flat black
3. Marred surfaces of factory painted equipment
   a. Spot coat to match adjacent coat

B. Execution
1. Protect flooring and equipment with drip cloths
2. Paint and materials stored in location where directed
3. Oily rags and waste removed from building every night
4. Wire brush and clean off all oil, dirt and grease areas to be painted before paint if applied
5. Workmanship
   a. No painting or finishing shall be done with:
      1) Dust laden air
      2) Unsuitable weather conditions
      3) Space temperature below 60 degrees F
   b. Pipes painted containing no heat and remain cold until paint is dried

c. Paint spread with uniform and proper film thickness showing no runs, sags, crawls or other defects

d. Finished surfaces shall be uniform in sheen, color, and texture

e. All coats thoroughly dry before succeeding coats are applied, minimum 24 hours between coats

f. Priming undercoat of slightly different color for inspection purposes

6. Piping continuously painted in all exposed areas

C. Paint

1. High gloss medium or long alkyd paint
2. Best grade for its purpose
3. Deliver in original sealed containers
4. Apply in accordance with manufacturers instructions

D. Colors

1. Color coding as follows on Sherwin Williams, "Kem Lustral" or "Metalalistic II" name and figure numbers

a. Condenser water piping --- PALE GREEN, F65G42

2. Interior of ductwork as far back as visible from outside: flat black
3. Uncoated hangers, supports, rods and insets: dip in zinc chromate primer

E. Factory finish

1. Steel air outlets in ceilings: baked white enamel
2. Bare aluminum air outlets: anodized
3. Exposed fan coil units: baked enamel
4. Unit ventilators and unit heaters: baked enamel

F. Marred surfaces of prime coated equipment and piping: spot prime coat to match adjacent coat

3.11 LEAKAGE TESTING

A. Testing of hydronic systems: Pressure test piping at 1-1/2 times operating pressure, hold for one hour. No loss in pressure will be permitted. All leaks shall be repaired by tightening, rewelding or replacing pipe and fittings. Caulking of joints will not be permitted. Retest as required.

B. Duct leakage testing

1. Not required.

3.12 VARIABLE SPEED DRIVES

A. Certified factory start-up shall be provided. A certified start-up form shall be filled out for each VSD with a copy to the Owner's Representative and a copy kept on file by the manufacturer. Start-up technician shall configure the VSD as follows:

1. Set minimum speed for all applications in accordance with procedure indicated in Division 25 Building Automation Systems.

2. Enable current limit control and set maximum current limit setpoint to the motor to the motor's full load amps.
3. Enable flying start feature.
4. Set voltage to speed ratio (V/f) to "squared"
5. Enable Flux Optimization capability.
6. Set switching frequency:
    a. Set to 4 kHz then check for motor noise in nearby occupiable spaces.
    b. If motor noise is audible in occupied space, enable noise smoothing feature.
    c. If noise is still a problem, raise switching frequency to 8 kHz. Do not raise switching frequency above 8 kHz.
7. Configure status point to only indicate status when the drive detects a current above that which occurs when a belt is broken (fan), the rotor is locked, or a discharge damper or valve is fully closed.
8. Set VSD to automatically restart with shortest time period allowed by VSD
    a. After power is restored after a power interruption
    b. After alarms are cleared
9. For fans such as relief fans and cooling tower fans: Run fan through entire speed range and program out speeds that cause fan vibration.
10. For VSDs powered by emergency generators, disable Under-volt Control (to cause the Pre-Charge Contactor to open as quickly as possible and prior to transfer of power, avoiding current surge and possible VFD damage).

B. After VSD is fully configured and programmed, all settings shall be documented and included with commissioning documentation in electronic format per Section 230501 Basic Mechanical Materials and Methods. The intent is to allow replacement drive electronics to be readily configured.

C. See Section 250000 Building Automation Systems for points to be mapped from the drive controller to the BAS; coordinate information addresses and other information required with the Division 25 Building Automation Systems contractor.

3.13 OPERATION OF SYSTEMS AND POST-CONSTRUCTION PURGE

A. This section is provided to
1. Minimize the possibility that ducts and air plenums will be contaminated with construction debris.
2. Ensure that off-gassing volatile organic compounds (VOCs) are not transferred from one area to another.
3. Purge VOCs that have off-gassed from construction materials and furnishings prior to occupancy.

B. Construction Period
1. Fan systems shall not be operated during construction (e.g. to assist in drying walls, space conditioning, etc.) unless approved in writing by Owner's representative.

C. Test and Balance Period

1. Operation of fan systems for test and balance shall only occur after the area served by air systems and all air plenums have been thoroughly cleaned of dust and debris. No construction work that generates dirt and particles shall be occurring while fan systems are in operation.
2. Procedure
   a. Install temporary construction filters (prefilters) on all supply air systems. Do not install high efficiency final filters at this time.
   b. Adjust systems with economizer capability to supply 100% outdoor air, no recirculated air.
   c. Perform test and balance work per Testing, Adjusting and Balancing herein.
   d. Immediately prior to the start of the post-construction purge period (see below), remove and discard construction filters and install high efficiency final filters.
   e. Conduct test and balance work at supply air system. System may be temporarily converted from 100% outdoor air to minimum outdoor air as required for tests only; return to 100% outdoor air configuration after tests.

D. Post-Construction Purge Period

1. Schedule
   a. Start after
      1) All construction work that produces dust or VOCs is complete, except for minor touch-up painting work and installation of furnishings
      2) All test and balance work is complete on all air systems with 100% outdoor air capability
      3) Temperature control systems are operational
      4) Heating systems are fully operational
   b. End after a time period determined from the following equation, calculated for each fan system individually, where T is time in days, A is the floor area served by the system in ft2 and CFM is the outdoor air capacity of the system in cfm:

$$T = \frac{14000 * A}{CFM * 60 * 24}$$

   c. The space may only be occupied
      1) After the purge time period calculated above is complete; or
      2) After time T' calculated from the equation below provided the space is ventilated at minimum rate of 0.30 cfm/ft2 of outside air or the design minimum outside air rate, whichever is greater, a minimum of three hours prior to occupancy and during occupancy until the purge time period calculated above is compete.

$$T' = \frac{3500 * A}{CFM * 60 * 24}$$

2. Procedure

a. Adjust systems with economizer capability to supply 100% outdoor air, no recirculated air.
b. Ensure that high efficiency final filters are in place.
c. Run fan systems supplying 100% outdoor air during entire purge period.
d. Enable boilers and zone controls and set heating setpoints to 70oF.
e. Cooling systems may be enabled or disabled.

3. Because final filters will not be challenged with contaminants in the return air, they do not have to be replaced after the flush-out period.

3.14 TESTING, ADJUSTING, AND BALANCING

A. Test and adjust all items of heating, ventilating and air conditioning system to provide design conditions
   1. Testing, adjusting, and balancing shall be performed in complete accordance with AABC or NEBB National Standards for Field Measurements and Instrumentation as applicable to air distribution and hydronic systems.
   2. In general, systems shall be balanced so that one or more balancing valves/dampers remains wide open; if further flow reduction is required, fan or pump speed shall be reduced or impellers trimmed (in the case of pumps).

B. Hydronic Systems
   1. Prepare water systems for balancing in following manner
      a. Verify the following conditions
         1) Piping systems have been flushed and treated in accordance with Paragraph 3.08.
         2) Strainers have been cleaned
         3) Piping systems are completely full of water, all air properly vented
         4) All coil and heat exchanger shut-off, balance, and control valves are fully open
      b. Check pump
         1) Rotation
         2) Pump factory impeller trimming by comparing shut-off heads with pump curves from approved submittals
            a) Note that impellers on variable speed pumps should not be trimmed to design flow and head conditions.
            b) Report discrepancy in shut-off head to Owner's Representative and if impeller does not appear to be properly trimmed. Wait for direction before proceeding with pump test and balance.
      c. BAS and Central Plant Operability
      d. Do not proceed with any of the following balancing procedures until the BAS is capable of operating equipment such as fans, pumps, control valves, etc. in manual and automatic modes and capable of reading sensors such as differential pressure, flow rates, temperatures, etc. of air and hydronic systems to be tested and adjusted.

e. Do not proceed with fan-coil testing until chilled and hot water at design temperatures are available from the central plant.

2. Pumps
   a. Test and report for each pump at test conditions indicated in Paragraphs below.
      1) Tag
      2) Manufacturer and model of pump and motor
      3) Motor horsepower, volts, phase, full load amps
      4) Pump shut-off head from curves, measured shut-off head, and resulting impeller diameter from pump curve
      5) At test condition specified
         a) Volts and amps
         b) Calculated brake horsepower
         c) Entering and leaving gage pressure and difference in feet
         d) Flow rate deduced from pump curve
         e) For pump with variable speed drive
            1. Speed (Hz)
            2. Kilowatts
   b. Include pump curve from approved submittals in final report.
   c. Under no circumstances shall valves at pumps be used for balance. All balance shall be done using valves at coils, chillers, and other devices served by the pumps.
3. Chilled Water Distribution Variable Speed Drive Setpoint Determination
      1) Central Utility Plant secondary pumping system will use existing differential pressure setpoint as the Maximum Differential Pressure Setpoint.
      2) Verify BAS differential pressure reading matches handheld measurement when plant is enabled and chilled water pumps are in operation.
      3) Report at condition described above
         a) BAS differential pressure reading and concurrent reading of handheld measurement.
         b) Water flow rate through flow meter (where applicable), through BAS
4. Hot Water Distribution Variable Speed Drive Setpoint Determination
      1) Central Utility Plant secondary pumping system will use existing differential pressure setpoint as the Maximum Differential Pressure Setpoint.
      2) Verify BAS differential pressure reading matches handheld measurement when plant is enabled and hot water pumps are in operation.
      3) Report at condition described above
         a) BAS differential pressure reading and concurrent reading of handheld measurement.
         b) Water flow rate through flow meter (where applicable), through BAS

5. Fan Coil Test & Balance
    a. System is self-balancing. Two-way control valves at coils prevent each coil from being over-supplied with water, other than minor excursions during transients such as cool-down or warm-up. Conventional balancing (throttling of balancing valves) will increase pump energy use by not allowing aggressive differential pressure setpoint reset. Hence, do not adjust any valves on any coil or pump, except temporary adjustments where noted. Calibrated balancing valves may be provided for flow measurement and diagnostics but they shall not be modulated for flow balancing. Pressure independent valves shall be set to maximum flow rate of the valve, not the design flow rate. All manual valves at coils and pumps shall be wide open when test and balance work is complete.
    b. Report with all control valves open to coil and all pumps (except standby pumps, where applicable) operating at full speed
        1) See Air Balance below for coil temperature data where required
        2) See Pump test data above for pump data
        3) Terminal tag
        4) Control valve model number and serial number
        5) Pressure drop across coil
        6) Flow as measured by calibrated balancing valve (where applicable). Where a calibrated balancing valve is not provided, determine flow by either of the following:
            a) Use test plugs to measure pressure drop across the coil and estimate flow using coil manufacturer's submittal data of flow vs. pressure drop. This option shall only be used when design coil pressure exceeds 5 feet.
            b) Use test plugs to measure pressure drop across the control valve and calculate flow using valve manufacturer's submitted Cv.
6. Chilled Water Plant
    a. Condenser Water Balance
        1) Determine chiller condenser flow using design differential pressure drop across condenser and manufacturer's design pressure drop from equipment submittals (do not use data on schedules).
        2) For each chiller stage, test and balance flow to condensers
            a) Fully open valves at tower cells. (The towers will not be balanced.)
            b) Fully open isolation valves at condenser.
            c) Run appropriate number of CW pumps for the stage.
            d) Adjust pump speed until flow rate at condensers is within 5% of design flow rate (deduced from pressure drop).
            e) Do not adjust valve at pump discharge or isolation valve at chiller to balance flow.
        3) Report
            a) See Pump test data above for pump data

b) For each chiller condenser

1. Design flow rate and pressure drop.
2. Measured inlet and outlet pressure and pressure drop and flow rate deduced from pressure drop from manufacturer's data.
3. Condenser water pump speed (%)

b. Evaporator Water Balance

1) Determine chiller flow using design differential pressure drop across evaporator and manufacturer's design pressure drop from equipment submittals (do not use data on schedules).

2) Test and measure flow through chiller evaporators

a) Run all primary chilled water pumps (except stand-by pump, if any) at full speed.

b) Do not limit pump speed; it is acceptable if flow at 60 Hz exceeds design flow.

3) Minimum speed correlation to minimum flow determination

a) For each chiller

1. Open the control valve to the evaporator.
2. Run one primary chilled water pump at full speed.
3. Slowly lower the speed until the primary flowrate as measured by the primary loop flow meter equals the chiller's minimum flow rate.
4. Note the pump VFD speed.

b) Both chillers operating in series

1. Open the control valve to operate both chillers in series.
2. Run one primary chilled water pump at full speed.
3. Slowly lower the speed until the primary flowrate as measured by the primary loop flow meter equals the chillers' minimum flow rate.
4. Note the pump VFD speed.

c) Both chillers operating in parallel

1. Open the control valve to operate both chillers in parallel.
2. Run one primary chilled water pump at full speed.
3. Slowly lower the speed until the primary flowrate as measured by the primary loop flow meter equals the chillers' minimum flow rate.
4. Note the pump VFD speed.

4) Report

a) See Pump test data above for pump data

b) For each chiller evaporator

1. Design flow rate and pressure drop.

2. Measured inlet and outlet pressure and pressure drop and flow rate deduced from pressure drop from manufacturer's data.

5) Report and the minimum pump speed corresponding to the conditions listed below to the BAS installer

1. Each chiller's minimum flow rate
2. The minimum flow rate when both chillers are operating in series
3. The minimum flow rate when both chillers are operating in parallel

7. Hot Water Plant

a. Boiler Balancing

1) Test and balance each boiler primary pump

a) Run primary pump.

2) Report

a) See Pump test data above for pump data

b) Design and final flow rate at each boiler

c) Design and final inlet and outlet pressure at each boiler

C. Air Systems

1. Air Outlets

a. Adjust diffusers' throw pattern prior to balance as indicated below unless otherwise indicated on Drawings. Review manufacturer's instructions for proper diffuser blade or weir gate positions to provide this throw pattern as it is not always intuitive. It is TAB contractor's responsibility to adjust throw patterns for all adjustable throw diffusers. If diffuser has a fixed throw pattern and is incorrectly installed, HVAC contractor shall correct pattern prior to balance.

1) Ceiling diffusers: As indicated on the Drawings.

a) Star pattern diffuser deflectors shall be adjusted for corner blow pattern unless otherwise indicated on Drawings.

2) Slot diffusers supplying cooling-only, or heating and cooling with ceilings 15 feet and lower: Adjust to throw away from adjacent walls along the ceiling toward the center of the room served.

3) Slot diffusers supplying heating-only, or heating and cooling with ceiling above 15 feet: Adjust to throw downward and slightly toward adjacent wall.

4) Double-deflection grilles: Adjust rear blades horizontal 22 degree upward and splay front blades in 45 degree pattern at each end gradually rotating to be almost straight at blades in center of grille.

b. Test and adjust each diffuser, grille and register to within plus or minus 10 percent of design requirements

1) Start with all dampers wide open.

2) Adjust dampers, starting with nearest to terminal unit or fan. Make adjustments using duct mounted volume dampers rather than dampers at diffuser face (if any) unless absolutely required.

3) At least one damper shall remain wide open at end of balance.

c. Each grille, diffuser and register shall be identified as to locations and area. Size, type and manufacturer of diffusers, grilles, and registers shall be identified and listed. Readings and tests of diffusers, grilles, and registers shall include design, initial test, and final adjusted FPM velocity and CFM.

2. Fan Coils

a. Minimum outdoor air

1) Total air quantities for all fan-coil units shall be by duct traverse where possible as well as totaling the readings of individual air outlets.

2) Minimum outside air quantities shall be established by pitot tube traverse of outside air duct or louver, or by deduction from pitot traverse of return air and supply air ducts.

3) Balance by measurement of return air, outside air, and mixed air temperatures shall NOT be used due to inherent inaccuracy.

b. Total air quantities shall be obtained within 10 percent of design by adjustment of fan speed via speed potentiometer controlling ECM.

c. Test and adjust minimum outside air flow

1) Supply air fan and return air fan (if any) shall first be operating at design airflow.

2) Fully open the return air damper.

3) Determine minimum outdoor air damper signals required to deliver design minimum outdoor airflow rate by adjusting the minimum damper signal through the BAS at the following conditions:

a) Design supply fan airflow and speed

b) 30 percent of design supply fan speed

4) Convey the two minimum signals and associated fan speeds to the BAS installer and note on air balance report.

d. Test with system operating at minimum outside air flow condition described above and record the following on a schematic of the system

1) Tag

2) Manufacturer and model of fan and motor

3) Sheave data at motor and fan; belt data

4) Motor horsepower, rpm, volts, phase, FLA

5) Fan airflow rate at all locations measured, as listed above

6) Final measured amps

7) Static pressures measured at

a) Mixed air plenum

b) Downstream of filter

c) Downstream of coil

d) Discharge of fan

8) Concurrent airflow rate readings from BAS airflow sensors, where applicable

9) Minimum OA damper position at design airflow

10) Minimum OA damper position at 30% design airflow

D. Provide upon completion of running tests, two (2) complete sets of data listed below for all items of equipment for incorporation in Owner's Operation and Maintenance Manual for the job

1. Name and address of testing agency and name of individual responsible for the work
2. Make, model and latest calibration date of testing equipment
3. Sketch or written description sufficient to identify individual devices tested
4. Final air quantities at each air outlet and inlet and maximum and minimum air flows for each fan coil unit
5. BAS setpoints
   a. Variable flow hydronic system differential pressure
6. Entering and leaving water pressures, flow rates, and test temperatures at each piece of hydronic equipment
7. Manufacturer, size, model, serial number, motor hp, rpm, voltage, full load amps, vee belt sheave sizes, grooves, belts, sizes, length, starter heater size, rating and fuse size of each fan and pump.

3.15 COMMISSIONING

A. Commissioning (Cx) activities shall be coordinated by a representative of the General Contractor who shall serve as the Commissioning Coordinator (CxC) as directed by a 3rd party Commissioning Provider (CxP) retained by the Owner.

B. The commissioning responsibilities of the HVAC Contractor are as follows:

1. Include requirements for submittal data, commissioning documentation, O&M data and training.
2. Attend a commissioning scoping meeting, assist in commissioning schedule development and other meetings necessary to facilitate the Cx process.
3. Attend regular commissioning meetings during the start-up, pre-functional test and functional test periods as scheduled by the General Contractor's commissioning coordinator.
4. Assist and cooperate with the TAB contractor by putting all HVAC equipment and systems into operation and continuing the operation during each working day of TAB and commissioning, as required.
5. Develop and complete pre-functional checklists and submit for review.
6. Develop a full start-up and initial checkout plan and schedule using manufacturer's and specified start-up procedures for all commissioned equipment. Submit for review and approval prior to startup.
7. Provide skilled technicians to execute starting and pre-functional testing of equipment, and to assist in executing functional performance tests and interpret the data, as necessary. Ensure that they are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustments and problem-solving.

8. Provide all Title 24 Acceptance testing, including all documentation.
9. Prepare an outline and schedule for training programs for approval.
10. Include start up, pre-functional test documentation, and Operations and Maintenance Manual to CxP in electronic format.

C. Title 24 Acceptance Testing
   1. Responsible Parties
      a. Field Technician. Acceptance tests shall be conducted by a technician certified by an Acceptance Test Technician Certification Provider approved by the California Energy Commission. The Field Technician shall complete and sign all forms including the Certificate of Acceptance.
      b. Responsible Person. The Certificate of Acceptance form shall be signed by a representative of the Contractor who is a licensed professional who is eligible under Division 3 of the Business and Professions code in the applicable classification. The Responsible Person shall assume responsibility for the acceptance testing work performed by the Field Technician, and if necessary shall interview the person who performed the acceptance test work in order to ascertain whether the testing work reported on the Certificate of Acceptance was completed as reported and is consistent with the Responsible Person's expectation.
   2. Provide acceptance testing and complete documentation forms for all applicable tests and systems. For test procedures, see Appendix NA7 of the Title 24 Reference Appendices. For test forms, see 2013 Nonresidential Compliance Manual.
   3. Prepare and issue a Certificate of Acceptance for each test for each system. Each Certificate of Acceptance shall include the Contractor’s signature and California License number.

D. Training
   1. General Training: Upon completion of work, provide Owner's operating personnel 10 hours of training in operation and maintenance of material and equipment. Training shall include instruction from factory technicians for chillers, boilers, and cooling towers.
   2. Minimum 2 training sessions. First training period immediately upon completion, subsequent training to be performed within 30 days of completion.
   3. Schedule equipment training to be consecutive (e.g. one 5 hour block for training from the factory technicians for the chillers, cooling towers and boilers).
   4. Training shall be video recorded and all copies of training material shall be provided electronically.
   5. Control System Training: See Division 25 BAS.

END OF SECTION

SECTION 260000

ELECTRICAL DESIGN CRITERIA

1.0 ELECTRICAL OVERVIEW

1.1 Basis of Design includes:

a. Electrical overview

b. Electrical Distribution

c. Grounding and bonding

d. Mechanical HVAC, plumbing and fire protection

e. Wiring devices, branch circuiting and miscellaneous equipment

f. Lighting system and controls

g. Fire alarm system

h. Field quality control

1.2 Project summary:

a. General:

1. Project will be built using the design-build approach.
2. Design of project shall conform to this document, Electrical Drawings, Owner's Requirements, and bid instructions prepared by General Contractor.
3. Materials and installation shall conform to the Basis of Design, Division 26 – Electrical.
4. Additionally, the design shall utilize preliminary Architectural, Structural, Civil, Drawings, as well as HVAC and Plumbing drawings, Basis of Design and/or Specifications for coordination purposes with other trades.

b. Project description:

1. The project consists of renovating the Laney College central utility plant **and adding a new Utility Building** located in Oakland, California. The project is limited to the following scope:
   a) Providing and/or modify electrical connections for ~~f~~retrofitting the existing central utility plant at the Laney College Campus in Oakland, CA.
      1) The scope of work for this bid includes~~ the~~ **providing power to all replacement** chilled and hot water plant equipment located in Building E**'s Central Utility Plant** ~~that~~ **which** provides heating and cooling to all buildings on campus. In addition, the existing cooling towers will be demolished and relocated to a new **Utility Building** ~~-~~enclosure south of Building F.
      ~~1)~~**2)**
   b) **A new Utility Building** ~~Electrical Central Utility Plant space~~**with** ~~and~~ **space and** connection pathways for the Laney College Library and Learning Resource Center building replacement**:**
      1) Space and conduit pathway for new high fire point liquid filled pad mounted transformer 12.47KV PRI, 277/480VOLT, 3 PHASE, 4 WIRE SECONDARY,

1500 KVA transformer specified and provided **under**~~in~~ the Library and Resource center project.

2) Space and conduit for a new ~~200~~ **500** kW Generator **and supporting equipment to be** specified and provided ~~in the~~**under a separate** Library and Resource center project.

c) Panels and battery inverter to support designated equipment in the Utility Building.

~~c)~~**d)** Power, lighting**,** and fire alarm connections for new ~~Central Utility Plant~~ **Utility B**~~b~~uilding for mechanical equipment, electrical equipment and storage. Refer to architectural plans.

~~d)~~**e)** Reroute existing electrical feeders as shown on the Civil drawings.

~~e)~~**f)** Reroute existing site lighting circuits **and high voltage lines running** ~~routed~~ through **existing** site work **which will**~~to~~ be demolished for the new Library and **L**~~l~~earning **and new Utility Building** ~~back to the Central Utility Plant~~**.**

2. Electrical features shall consist of the following:
   a) Normal power distribution system
   b) Service grounding, power system and distribution grounding, equipment bonding
   c) Power connections to all motors to include equipment for HVAC, plumbing, etc.
   d) Power connections to all owner furnished equipment
   e) Wiring devices and associated branch circuiting
   f) Interior and exterior lighting systems
   g) Emergency and egress lighting system
   h) Lighting control system per requirements of Title 24
   i) Lighting branch circuiting
   j) Fire alarm system

c. Bid documents:

1. General:
   a) The components of the electrical design-build bid package include the following:
      1) Electrical Drawings
      2) Electrical Basis of Design
   b) A copy of the preliminary architectural, structural, civil, etc. drawings have been provided the electrical contractors to assist in developing bid pricing.
   c) A copy of the design-building bid packages for HVAC, plumbing, and fire protection have also been provided the electrical contractors to assist in developing bid pricing.
   d) Instructions to Bidder's, developed by the General Contractor, have also be provided.
2. Electrical Drawings: The purposes of the Electrical Drawings are to provide an overview of the power distribution system with equipment and feeders, general layout information for the electrical system equipment, entrance locations for utility services, riser diagrams, etc. Drawings are generally at a 100% Schematic design development level of completeness, so not everything has been shown and assumptions will need to be made.
3. Electrical Basis of Design: The purpose of the Basis of Design is to cover in written format what is not shown on the electrical drawings and to establish performance criteria for the electrical systems, which should be the basis of the electrical design. As part of the Basis of Design we have included an Interface/ Responsibility Matrix at the end of this Section.

1.3 Design-Build approach:

a. Design-Build overview:

1. The work for this project will be built using a "Design-Build" approach. The Design-Build contractor ("EOR/Contractor") and The Engineering Enterprise ("Electrical Designer") shall have responsibilities as indicated herein.
2. The Design-Build process requires the EOR/Contractor to participate as a team member with other Design Consultants within other disciplines. This is not a conventional 'Plan & Spec' project.
3. Bid documents are at a 100% Schematic Design development level of completeness and are primarily, intended to establish scope. These documents are not complete and should not be viewed as construction documents. Prior to bid, the EOR/Contractor shall perform an engineering review of the bid documents and include in their pricing all work, whether shown or not, required for a complete and operational electrical system.
4. The engineer or project manager representing the EOR/Contractor shall participate in regular design and construction meetings, from the award of contract through the end of construction.
5. The EOR/Contractor shall provide engineering services during the development of the construction documents and this engineering service capability shall be a significant factor in the bid selection process.
6. The EOR/Contractor shall be the Engineer-of-Record for the project, stamping and signing the drawings prior to permit submission.
7. Once the EOR/Contractor has been selected, Revit and/or CAD files of the 100% Schematic Design development drawings will be provided to them for preparation of the construction documents.
8. The table below indicates responsibility assignments for the EOR/Contractor and the Electrical Designer.

Item	EOR/Contractor	Electrical Designer
Electrical Engineer-of-Record	P	N
Design and construction meetings	P	S
Load calculations	P	R
Final equipment sizing	P	R
Equipment selection	P	R
Construction details	P	R
Seismic restraints	P	R
Coordination with other trades	P	S
Preparation of 100% construction drawings	P	R
Title 24 lighting calculations & forms	P	R
Preparation of electrical specifications	R	P
Review of construction document drawings	S	P
Shop drawings and submittals	P	R
Project construction management	P	N
Construction and all field work	P	R
Construction quality control	P	R
Start-up & testing	P	R
Training	P	N

9. Explanatory notes:
    a) Primary (P) responsibility shall mean making all decisions and taking responsibility for the item.
    b) Secondary (S) responsibility shall mean taking an active role assisting the party with primary responsibility for the item.
    c) Review (R) shall mean that the party shall review and comment on the work done by the party with primary responsibility for the item.
    d) No (N) responsibility shall mean the party will have no role regarding the item.
10. The following parties will participate in the coordination and preparation of the electrical construction drawings:
    a) Major equipment suppliers for power distribution equipment, emergency generators, etc.
    b) Special system suppliers for lighting controls, sub-metering, etc.
    c) Fire alarm system suppliers.

b. Engineering and design:

1. Coordination:
    a) Contractor's engineers and designers shall coordinate all aspects of the electrical systems with the Architect and all others trade disciplines that require electrical interface.
    b) Review all proposed lighting fixtures with the Architect prior to proceeding with detailed calculations, layouts and circuiting.
    c) Review finishes of all electrical devices, coverplates, etc., with the Architect.
    d) Coordinate all conduit routing, equipment room layouts, risers, penetrations, etc., with the Architect and other trade disciplines.
    e) Attend design coordination meetings with Owner Representative, Architect, General Contractor and other trade disciplines to coordinate the design of the electrical system and obtain information related to Division 26 work.
    f) Cooperate with other Designers and Contractors to verify the proper locations and circuit configurations for equipment provided by other Divisions of work requiring electrical service connections.
2. Construction documents:
    a) Upon award of bid, the successful EOR/Contractor shall immediately precede with the preparation of the construction documents for review and approval by the Owner.
    b) The final design shall fully coordinate all architectural, structural, HVAC, plumbing, fire protection, landscape, civil, etc., elements of the project.
    c) The drawings shall be prepared and stamped by a California registered Professional Electrical Engineer, employed or retained by the Electrical Contractor.
    d) The construction document package shall contain drawings prepared in Revit or AutoCad format, which include the following to clearly describe and detail the proposed work:
        1) Symbols list
        2) General and/or numbered notes
        3) Schedules:
            (a) Fixture schedule
            (b) Feeder schedule
            (c) Panelboard schedules
            (d) Lighting control schedules

(e) Miscellaneous control schedules, as required
4) Title 24 lighting compliance forms as required
5) Floor plans locating all lighting fixtures and control devices, to include branch circuiting
6) Floor plans locating all power devices, mechanical equipment, Owner furnished equipment, etc., to include branch circuiting and power connections.
7) Enlarged scale plans of heavily congested areas (minimum ¼" to ½" scale).
8) Equipment layouts of all electrical rooms, etc. (minimum ¼" to ½" scale).
9) Proposed routing of all conduits 2" and larger
10) Normal power riser diagram
11) Power system grounding riser diagrams
12) Electrical details as required.

e) The package shall also contain all calculations required by the Building Inspection Department, but as a minimum shall include the following:
1) Panelboard connected load summary schedule
2) Voltage-drop calculations
3) Short circuit calculations
4) Feeder and service load calculations
5) Lighting calculations
6) All Title 24 compliance forms

f) Construction documents are required to be prepared in Revit and shall meet the following requirements:
1) All Construction Document (CD) drawings shall be created using the latest version of Revit.
2) Design shall be coordinated with architecture and structure at the start of the CD phase. Detailed clash detection shall occur at the 50% CD issuance.
3) Final CD drawings shall be Level of Development (LOD) 350.
4) Shop drawings and as-built model shall be LOD 350.

3. Design review:
a) The EOR/Contractor shall submit their construction document package for progress review by the Owner at specified intervals within the design process. Assume the submissions will be at the 100% Design Development Phase, plus 75% and 95% Construction Document Phase.
b) Upon receipt of the construction documents at each of the review stages, the Owner and Architect will review the package and notify the EOR/Contractor regarding any proposed changes.
c) When the construction documents are complete and review comments implemented, the final design package shall be submitted to the Building Department for plan check and permit. The package shall include drawings, all calculations, back-up information, and documentation or additional drawings as required to obtain the Building Permit. The EOR/Contractor shall make any changes requested by the Building Department and resubmit the package for back-check.
d) The EOR/Contractor shall, within thirty (30) days of completion of construction documents, provide detailed shop drawings and submittals for all electrical equipment.

1.4 Value engineering:

a. Value engineering 'VE' is an integral part of the design-build process taking advantage of the Contractors breath of experience and expertise.

b. The bid documents establish the base bid for contractors pricing on this project, so that apples-to-apples comparisons can be made between bidding contractors. Where a contractor sees opportunities for VE, they shall prepare and submit their ideas with their bid proposal, listing each item for the Owners consideration. Each item shall be described in enough detail to accurately convey the Contractors proposal and shall be accompanied by a lump sum value amount that if accepted would be deducted from the base bid amount.

c. No VE items shall be applied directly to the Contractors base bid amount.

1.5 Permits and fees:

a. Provide all necessary notices, obtain all permits and pay all government taxes, and other costs in connection with this work.

b. Obtain all required certificates of inspection for this work and deliver same to the Owner before request for acceptance and final payment for the work.

2.0 ELECTRICAL DISTRIBUTION

2.1 The bid documents have included a scheme in the form of Power Riser Diagram(s) for the electrical distribution system, which represents the Designer's best assumptions at this stage of the project. The EOR/Contractor is not limited to this scheme, if they have a more cost-effective approach. The preference is for the EOR/Contractor to price the bid document scheme as part of their base bid cost and present their alternate scheme as a value engineering approach. In this alternate approach, all design parameters outlined herein, as well as that addressed by Code, shall be met. The EOR/Contractor shall submit their scheme in the form of a Power Riser Diagram with load calculations and value engineering savings, along with their bid proposal.

2.2 The electrical drawings include load calculations for the buildings, which is the basis for sizing of the electrical service and distribution system throughout the building/facility. The EOR/Contractor shall revisit the calculations as the design progress through construction documents and update the calculations as system change.

2.3 Refer to the floor plan drawings for locations of electrical rooms that house the power distribution equipment. Determine if there is sufficient space for equipment and equipment clearances to house the required system as outlined in the Power Riser Diagram.

2.4 Distribution equipment:

a. The electrical equipment forming the distribution system has all been sized on the Power Riser Diagram(s), indicating ampacity, voltage, phase and wire quantity ratings. EOR/Contractor shall verify these ratings and shall provide equipment with enough space for overcurrent devices required to accommodate connections, as well as space to accommodate the possibility of future connections, i.e. 25% spare space as a minimum.

2.5 Central battery inverter system:

~~a. Central battery inverter system for powering the emergency egress lighting system and exit signs, upon loss of utility power, for 90-minutes of backup power.~~

~~b.~~**a.** Central battery inverter system for powering the utility building pumps, upon loss of utility power, for 90-minutes of backup power.

~~c.~~**b.** The inverter shall be rated at 20 kva with an input voltage of 480volt, 3-phase, 3-wire with an output voltage of 277/480volt, 3-phase, 4-wire.

3.0 GROUNDING AND BONDING

3.1 System description:

a. Provide for the grounding and bonding of all electrical apparatus, machinery, appliances, building components, fittings and accessories where required to provide a permanent, continuous, low impedance, grounded electrical system.

b. Provide grounding for all separately derived system neutrals.

c. Include supplemental grounding electrodes as required for separately derived system grounding.

d. The complete electrical installation including the neutral conductor, metallic conduits and raceways, boxes, cabinets and equipment shall be completely and effectively grounded in accordance with all code requirements.

3.2 Requirements:

~~b.~~**a.** An insulated ground conductor shall be installed in the following:

1. All feeders
2. All branch circuit wiring runs

~~c.~~**b.** Provide separately derived system grounding for all transformers and generator.

~~d.~~**c.** For concrete building structures, provide a separate power system grounding riser with wall mounted ground bus bars in all electrical rooms and interconnecting ground riser conductor between each. At level where main electrical room occurs, provide a grounding conductor connection between the riser bus bars and the main electrical ground bus bar.

4.0 MECHANICAL HVAC AND PLUMBING

4.1 The HVAC and plumbing systems bid documents are an integral part of this Division 26 package and as such shall be viewed inclusive in all respects as it relates to the electrical connection of Divisions 21, 22, 23 and 25 equipment. The Contractor shall review these documents for equipment electrical characteristics~~:~~; i.e. sizes in load, voltage, phase, etc., as well as equipment locations.

4.2 The electrical documents indicate connection requirements for the major Divisions 21, 22 and 23 equipment, but are not all-inclusive. The Contractor shall determine all other mechanical equipment not shown in the electrical documents, but still requiring electrical connections and make provisions to include in pricing.

4.3 HVAC and controls systems:

a. The following is a schedule of the major HVAC system equipment at the time of bid document preparation. This does not alleviate the Contractor from doing a thorough review of the mechanical system schematic design package for additional information. Also, as the

design progress through to final construction documents, loads and equipment may change somewhat:

Equipment	Load	Voltage	Starter/ VFD by M/E	Emerg Power Y/N	Location
Chiller CH-1	381 FLA	480v, 3ph, 3w	M (VFD)	N	CUP
Chiller CH-2	381 FLA	480v, 3ph, 3w	M (VFD)	N	CUP
Cooling Tower CT-1	15hp	480v, 3ph, 3w	M (VFD)	N	Utility Building
Cooling Tower CT-2	15hp	480v, 3ph, 3w	M (VFD)	N	Utility Building
Fan Coil FC-1	1/7hp	208v, 3ph, 3w	E	N	CUP
Fan Coil FC-2 **(Alternate)**	1/6hp	208v, 3ph, 3w	E	N	CUP
Transfer Fan TF-1	1hp	208v, 3ph, 3w	E	N	CUP
Boiler B-1	18 FLA	208v, 3ph, 3w	E	N	CUP
Boiler B-2	18 FLA	208v, 3ph, 3w	E	N	CUP
Boiler B-3	18 FLA	208v, 3ph, 3w	E	N	CUP
Boiler B-4	18 FLA	208v, 3ph, 3w	E	N	CUP
Primary Chilled Water PCHP-1	10hp	480v, 3ph, 3w	M (VFD)	N	CUP
Primary Chilled Water PCHP-2	10hp	480v, 3ph, 3w	M (VFD)	N	CUP
Secondary Chilled Water SCHP-1	50hp	480v, 3ph, 3w	M (VFD)	N	CUP
Secondary Chilled Water SCHP-2	50hp	480v, 3ph, 3w	M (VFD)	N	CUP
Primary Hot Water PHWP-1	7.5hp	480v, 3ph, 3w	M (VFD)	N	CUP
Primary Hot Water PHWP-2	7.5hp	480v, 3ph, 3w	M (VFD)	N	CUP
Primary Hot Water PHWP-3	7.5hp	480v, 3ph, 3w	M (VFD)	N	CUP
Primary Hot Water PHWP-4	7.5hp	480v, 3ph, 3w	M (VFD)	N	CUP
Secondary Hot Water SHWP-1	20hp	480v, 3ph, 3w	M (VFD)	N	CUP
Secondary Hot Water SHWP-2	20hp	480v, 3ph, 3w	M (VFD)	N	CUP
Building E Territory Hot Water THWP-1	5hp	480v, 3ph, 3w	M (VFD)	N	CUP
Building E Territory Hot Water THWP-2	5hp	480v, 3ph, 3w	M (VFD)	N	CUP
Condenser Water CW-1	20hp	480v, 3ph, 3w	M (VFD)	N	CUP

Equipment	Load	Voltage	Starter/ VFD by M/E	Emerg Power Y/N	Location
Condenser Water CW-2	20hp	480v, 3ph, 3w	M (VFD)	N	CUP
Water Treatment System WTS-1	15amp	120v, 1ph, 2w	E	N	CUP
Air Compressor AC-1	25hp	480v, 3ph, 3w	M ~~(VFD)~~	N	CUP
Compressed Air Dryer D-1	15amp	120v, 1ph, 2w	E	N	CUP
TCP-3	15amp	120v, 1ph, 2w	E	N	CUP

b. The fourth column above indicates which of the subcontractors will be furnishing the starters and/or VFDs. "M" means mechanical subcontractor and "E" means electrical subcontractor. Installation of this equipment will be by the electrical subcontractor, unless equipment is furnished as a package and pre-mounted by equipment vendors.

c. The fifth column above indicates whether the equipment is served by emergency power source or not. "Y" is for yes and "N" is for no.

d. The electrical contractor shall furnish and install local service disconnect switches at every piece of equipment listed above. Although, where VFDs are provided by the mechanical subcontractor, the VFDs shall contain an integral disconnecting means and if located within sight of equipment, a local disconnect would not be required.

e. Additional HVAC equipment requirements:

~~e.~~1. Provide the Central Utility Plant with a web-based power monitoring communication system, including monitoring equipment and a BACnet data acquisition server gateway

~~1.~~2. HVAC system temperature control panels: Provide a 20amp, 120volt dedicated circuit connection to **one new** ~~each~~ temperature control panel **in the new cooling tower enclosure**. **Existing temperature control panels in Building E are planned to be reused.** ~~Assume there will be a temperature control panel in each electrical room on every level of the building. Also, assume three TCP's in the mechanical penthouse level.~~

4.4 Plumbing systems:

a. The following is a schedule of the major plumbing system equipment at the time of bid document preparation. This does not alleviate the Contractor from doing a thorough review of the plumbing system bid package for additional information:

Equipment	Load	Voltage	Starter/ VFD by P/E	Emerg Power Y/N	Location
SE-1A	3HP	480v, 3ph, 3w	~~M~~ **P** ~~(VFD)~~	Y	UTILITY
SE-1B	3HP	480v, 3ph, 3w	~~M~~**P** ~~(VFD)~~	Y	UTILITY
SDP-1A	2HP	480v, 3ph, 3w	~~M~~**P** ~~(VFD)~~	Y	UTILITY

Equipment	Load	Voltage	Starter/ VFD by P/E	Emerg Power Y/N	Location
SDP-1B	2HP	480v, 3ph, 3w	~~**MP** (VFD)~~	Y	UTILITY

b. The fourth column above indicates which subcontractor will be furnishing the starters and/or VFDs. "P" is for plumbing and "E" is for electrical. Installation of this equipment will be by the plumbing subcontractor, unless otherwise noted.

c. The fifth column above indicates whether the equipment is served by emergency power source or not. "Y" is for yes and "N" is for no.

d. The electrical contractor shall furnish and install local service disconnect switches at every piece of equipment listed above.

e. Additionally, for the fire protection system, there will be a need to make fire alarm system connections at the fire pump for monitoring purposes, each sprinkler flow switches, and each sprinkler tamper switch. These connections are covered under the fire alarm/life safety system section.

5.0 WIRING DEVICES, BRANCH CIRCUITING AND MISCELLANEOUS EQUIPMENT

5.1 Lighting branch circuiting:

a. The interior lighting system shall be circuited utilizing conduit and wire in open ceiling spaces.

b. No lighting circuit shall be loaded over 75% of circuit breaker capacity.

c. Hardwire homeruns shall utilize #10awg conductors as a minimum.

d. Emergency/egress lighting circuits shall be wired completely independent of all other circuiting.

5.2 Wiring device branch circuiting:

a. Wiring devices shall be circuited utilizing conduit and wire in all open ceiling spaces and MC cable in concealed ceiling spaces or walls. Where MC cable is used, all homeruns shall be conduit and wire.

b. Connect a maximum of six (6) receptacles per 20amp, 120volt circuit.

c. Hardwire homeruns shall utilize #10awg conductors as a minimum.

d. Provided dedicated circuits to receptacles where noted.

e. Provided hardwired homeruns from each specialty outlet.

f. Where homeruns share neutral conductors, handle ties shall be used at the breakers.

5.3 Wiring devices:

a. Specification grade, 20 amp rated devices shall be used exclusively, unless indicated otherwise.

b. Device colors shall be as follows, unless otherwise noted by the architect:

1. Standard normal power wiring devices shall be white in color.
2. Emergency power wiring devices shall be red in color.

c. All GFCI type receptacles shall be standalone, not feed through type.

d. All receptacles installed outside shall be GFCI type with weatherproof while in use style covers.

5.4 Mechanical, electrical and plumbing rooms:

a. Provide a duplex receptacle on ever wall of each mechanical/plumbing/fire protection room and within sight of every piece of equipment. If more devices are required to maintain the "within sight" condition, then add more devices as necessary.

b. Provide a duplex receptacle on each wall of the main electrical rooms, or a minimum of 20' on center along the walls, whichever is greater.

c. Provide one wall mounted duplex receptacle in each satellite electrical room.

d. Connect a maximum of six (6) devices per 20amp, 120volt circuit.

5.5 Storage rooms: Provide a minimum of one (1) duplex receptacle for every storage room. If the room is larger than 200 square feet, provide two (2) duplex receptacles.

6.0 LIGHTING SYSTEM AND CONTROLS

6.1 Lighting system:

a. Provide a complete interior and exterior, normal and emergency/egress lighting system consisting of fixtures, lamps, LEDs, ballasts, drivers, transformers and controls. Fixtures shall be securely attached to support system to meet all seismic code requirements.

b. Lighting components, energy consumption and controls shall conform to the California Energy Efficiency Standards, Title 24.

c. Refer to the drawings for typical lighting fixture layout and quantities, and the Luminaire Schedule for lighting fixture types, which should form the basis of Contractor's bid price.

d. The lighting fixture selection and quantity identified in the bid documents meet the requirements of the illumination levels in the schedule below. The Contractor shall be responsible for providing lighting level calculations of the core & shell spaces at the completion of the design development stage, to identify any space that is either under or over illuminated, so that adjustments can be made prior to proceeding with construction documents.

e. Illumination levels:

Area Served	Average Maintained Foot-Candle Levels
Storage	15 to 20
Elec., Mech. & Elev. Equipment Rooms	30 to 40

6.2 Emergency/egress lighting requirements:

a. Contractor shall select the appropriate quantity of fixtures to be on emergency power to provide 1fc average in egress pathways

b. Contractor shall provide all exit signs as required for Code compliance and in accordance with the Architect's egress plan for the complete project.

6.3 Lighting controls:

a. Interior common area control system:

1. A digital lighting control system that provides controls for interior and exterior lighting fixtures. The system shall interconnect stand-alone components such as drivers, electronic dimming and non-dimming ballasts, photocell, occupancy sensors, switches, etc., as well as analog lighting controls to provide a complete stand-alone room/area control system. Control devices shall interconnect either by communication type cables or shall employ a wireless technology.
2. The system shall be a centralized addressable system to include the following control options:
   a) On/off/dim control via local low-voltage switches
   b) Automatic/manual on and automatic/manual off via occupancy sensor and low voltage switch
   c) Astronomical time schedule control through the central headend.
3. Controls by areas:
   a) Corridors/circulation:
      1) Shall be controlled by occupancy sensors to reduce normal and emergency lighting levels down to 50% when no occupancy is present. Occupancy sensors shall be set to be automatic on to 100%.
   b) Electrical and mechanical rooms: Shall be controlled by local line voltage toggle switches to allow for bi-level control. These rooms shall not be tied into the lighting control system.
   c) Other interior spaces:
      1) Shall be controlled by occupancy sensors for on/off control.
      2) Provide daylight harvesting photocells as required by 2019 Title 24.
      3) Provide manual dimming controls to give the user adjustability of the light fixtures.

b. Exterior lighting control system:

1. All exterior lighting shall be controlled with a lighting relay control panel for on/off control via photocells and an astronomical time clock schedule to turn off lighting during daylight hours.
2. Wall mounted fixtures mounted under 24' and rated over 30 watts and pole mounted fixtures under 24' and rated over 75 watts shall be controlled with a standalone integral occupancy sensor that shall automatically reduce lighting between 40 and 80% when no occupancy is present. Sensors shall be automatic on to 100%.

7.0 FIRE ALARM SYSTEM

7.1 System shall include:

a. Initiating devices

b. Notification appliances

c. Auxiliary equipment controls and supervision

7.2 System description:

a. Provide a Code compliant fire alarm system to conform with the existing ~~Simplex~~ Fire Alarm system, ~~Electrical Specification~~ and as outlined herein in this Electrical Basis of Design document, as a minimum requirement. In general:

~~1.~~ The Drawings provide floor plans of building space**s.** ~~where some, not all, of the initiating and notification appliances have be shown.~~

~~2.~~**1.** ~~The Specifications cover the material and performance requirements of the system~~

~~3.~~**2.** The Electrical Basis of Design covers the application.

7.3 Fire alarm system equipment:

a. Initiating devices (minimums):

1. Manual pull stations: One at the main control panel location
2. Smoke detectors:
   a) Minimum of one in every electrical and telecommunication equipment room. Additional devices will be required if room exceeds 900 square feet in area or where beam pockets necessitate additional coverage.
   b) One at each return air fire/smoke damper 36" wide or less or two if over 36" and under 72" wide or three if over 72" and under 108" wide. None are required if area served by FSD has full coverage smoke detection~~. such as elevator lobbies, electrical or telecommunication rooms, etc.~~
   c) One at the FACP location and where FATCs are located, if not already being provided by conditions outlined above, i.e. electrical rooms and telecommunication rooms

b. Fire alarm notification system:

1. Individual horn and strobe appliances or combination appliances, including both, will be installed throughout the building to allow them to be easily heard and seen per the requirements of Code. The operation of these appliances will occur upon activation of any sprinkler flow switch, manual pull station, or smoke detection. The system will be set up in such a manner to allow for voice messages to override the "whoop" sound via the microphones at the FCC.
2. Locations:
   a) Full coverage throughout the entire core/shell portion of the facility per NFPA 72, to include:
      1) Service corridors, receiving and loading dock area
      2) Equipment rooms

c. Remote Central Station: The following summary alarm conditions will be transmitted to a UL approved remote central station facility via leased telephone lines:

1. Smoke detection system alarms
2. Sprinkler flow alarm
3. Activation of any manual pull station
4. Trouble

8.0 FIELD QUALITY CONTROL

8.1 General:

a. Perform tests to prove installation is in accordance with contract requirements. Perform tests in presence of the Owner's representative and furnish test equipment, facilities and technical personnel required to perform tests. Tests shall be conducted during the construction period and at completion to determine conformity with applicable codes and with these Specifications.

b. Any products which fail during the tests or are ruled unsatisfactory by the Owner's representative shall be replaced, repaired or corrected as prescribed by the Owner's representative at the expense of the Contractor. Tests shall be performed after repairs, replacements or corrections until satisfactory performance is demonstrated.

c. Include all test results in the maintenance manual. Cost, if any, for all tests shall be paid by the Contractor.

d. After other work such as sanding, painting, etc. has been completed, clean lighting fixtures, panelboards, switchboards and other electrical equipment to remove dust, dirt, grease or other marks. Leave work in clean condition.

e. Voltage check:

1. At completion of job, check voltage at several points of utilization on the system that has been installed under this Contract. During test, energize all installed loads.
2. Adjust taps on transformers to give proper voltage, which is 118 to 122 volts for 120 volt nominal systems and proportionately equivalent for higher voltage systems. If proper voltage cannot be obtained, inform the Owner and the serving Utility Company.

8.2 Project close-out:

a. Training: At the time of completion, a period of not less than 24 hours shall be allotted by the Contractor for instruction of building operating and maintenance personnel in the use of all systems. This 24 is in addition to any instruction time called out in the Specifications for specific systems. All personnel shall be instructed at one time, the Contractor making all necessary arrangements with manufacturer's representative. The equipment manufacturer shall be requested to provide product literature and application guides for the users' reference. Costs, if any, for the above services shall be paid by the Contractor.

b. Special tools: Provide one of each type of tool required for proper operation and maintenance of the equipment provided under this Section. All tools shall be delivered to the Owner at the Project completion.

c. Keying: Provide two keys for each lock furnished under this Section and turn over to Owner.

END OF ELECTRICAL BASIS OF DESIGN