STATE of ALABAMA
REGISTERED ARCHITECTS

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A PROJECT MANUAL FOR

HUXFORD ELEMENTARY SCHOOL GYMNASIUM AND CLASSROOM ADDITION FOR ESCAMBIA COUNTY BOARD OF EDUCATION

HUXFORD, ALABAMA

JUNE 18, 2025 RTA

VOLUME 2

PH&J #2312SC

DCM # 2023650

PSCA # 9551

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LIST OF ABBREVIATIONS

REFERENCED STANDARDS AND AGENCIES

AA	ALUMINUM ASSOCIATION
AASHTO	AMERICAN ASSOCOCIATION STATE HIGHWAY & TRANSPORTATION OFFICIALS
AABC	ASSOCIATED AIR BALANCE COUNCIL
ABC	ALABAMA BUILDING COMMISSION
ACI	AMERICAN CONCRETE INSTITUTE
ACIL	AMERICAN COUNCIL OF INDEPENDENT LABORATORIES
ACPA	AMERICAN CONCRETE PIPE ASSOCIATION
ACRMA	AIR CONDITIONING AND REFRIG.MACHINERY ASSOC.
ADC	AIR DIFFUSION COUNCIL
ADEM	ALABAMA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT
AGA	AMERICAN GAS ASSSOCIATION
AGC	ASSOC. GEN. CONTRACTORS OF AMER.; ALABAMA GAS CORP.
AHA	AMERICAN HARDBOARD ASSOCIATION
AHD	ALABAMA HIGHWAY DEPARTMENT
AIA	ALABAMA INSTITUTE OF ARCHITECTS
AIA	AMERICAN INSURANCE ASSOCIATION
AIA	ASBESTOS INFORMATION ASSOCIATION
AISC	AMERICAN INSTITUTE OF STEEL CONSTRUCTION
AISI	AMERICAN IRON AND STEEL INSTITUTE
AITC	AMERICAN INSTITUTE OF TIMBER CONSTRUCTION
ALDOT	ALABAMA DEPARTMENT OF TRANSPORTATION
AMMA	AMERICAN METAL MANUFACTURERS ASSOCIATION
ANSI	AMERICAN NATIONAL STANDARDS INSTITUTE
APA	AMERICAN PLYWOOD ASSOCIATION
APC	ALABAMA POWER COMPANY
ARI	AIR CONDITIONERS AND REFRIGERATION INSTITUTE
ASA	AMERICAN STANDARDS ASSOCIATION
ASHRAE	AMER. SOC. HEATING, REFRIG. & AC ENGINEERS
ASLA	AMERICAN SOCIETY OF LANDSCAPE ARCHITECTS
ASME	AMERICAN SOCIETY OF MECHANICAL ENGINEERS
ASTM	AMERICAN SOCIETY FOR TESTING & MATERIALS
AT&T	AMERICAN TELEPHONE & TELEGRAPH COMPANY
AWCI	ASSOCIATION OF WALL AND CEILING INDUSTRIES
AWI	ARCHITECTURAL WOODWORK INSTITUTE
AWMA	ALUMINUM WINDOW MANUFACTURERS ASSOCIATION
AWPA	AMERICAN WOOD PROTECTION ASSOCIATION
AWWA	AMERICAN WATER WORKS ASSOCIATION
AWS	AMERICAN WELDING SOCIETY
BIA	BRICK INSTITUTE OF AMERICA
BHMA	BUILDERS HARDWARE MANUFACTURERS ASSOCIATION
CABRA	COPPER AND BRASS RESEARCH ASSOCIATION
CLFMI	CHAIN LINK FENCE MANUFACTURING INSTITUTE
CPA	CONSUMER PROTECTION AGENCY
CPSC	CONSUMER PROTECTION SAFETY COMMISSION
CRA	CALIFORNIA REDWOOD ASSOCIATION
CRSI	CONCRETE REINFORCING STEEL INSTITUTE
CS	COMMERCIAL STANDARD
CSI	CONSTRUCTION SPECIFICATIONS INSTITUTE
DFPA	DOUGLAS FIR PLYWOOD ASSOCIATION
DHI	DOOR & HARDWARE INSTITUTE
EPA	ENVIRONMENTAL PROTECTION AGENCY
EIA	ELECTRONICS INDUSTRIES ASSOCIATION
FHA	FEDERAL HOUSING ADMINISTRATION
FM	FACTORY MUTUAL LABORATORIES
FS	FEDERAL SPECIFICATION
FGJA	FLAT GLASS JOBBERS ASSOCIATION
FTI	FACING TILE INSTITUTE
GRDF	GYPSUM ROOF DECK FOUNDATION
GSA	GENERAL SERVICES ASSOCIATION
IBC	INTERNATIONAL BUILDING CODE
ICC	INTERNATIONAL CODE COUNCIL
IECC	INTERNATIONAL ELECTRICAL CODE COUNCIL
IFC	INTERNATIONAL FIRE CODE
IFGC	INTERNATIONAL FUEL GAS CODE
IES	ILLUMINATING ENGINEERING SOCIETY
ILA	INDIANA LIMESTONE INSTITUTE
MBMA	METAL BUILDING MANUFACTURERS ASSOC.
MBSA	MODULAR BUILDING STANDARDS ASSOCIATION
MFMA	MARBLE FLOORING MANUFACTURERS ACCOCIATION
MIA	MARBLE INSTITUTE OF AMERICA
MLMA	MARBLE LATHE MANUFACTURERS ASSOCIATION
MWI	METAL WINDOW INSTITUTE
NAAMM	NATIONAL ASSOC. ARCHITECTURAL METAL MANUF.
NBLP	NATIONAL BUREAU OF LATHING AND PLASTERING
NACA	NATIONAL ACOUSTICAL CONTRACTORS ASSOCIATION
NAEC	NATIONAL ASSOCIATION OF ELEVATOR CONTRACTORS
NASFCA	NATIONAL AUTOMATIC SPRINKLER AND FIRE CONTROL
NBS	NATIONAL BUREAU OF STANDARDS
NCHA	NATIONAL CONTRACT HARDWARE ASSOCIATION
NCMA	NATIONAL CONCRETE MASONRY ASSOCIATION
NEC	NATIONAL ELECTRICAL CODE
NEMA	NATIONAL ELECTRICAL MANUFACTURERS ASSOC.
NFPA	NATIONAL FIRE PROTECTION ASSOCIATION
NIOHS	NATIONAL INST.OF OCCUPATIONALHEALTH & SAFETY
NLI	NATIONAL LIMESTONE INSTITUTE
NLMA	NATIONAL LUMBER MANUFACTURERS ASSOCIATION
NOFMA	NATIONAL OAK FLOOR MANUFACTURING ASSOCIATION
NPCA	NATIONAL PRECAST CONCRETE ASSOCIATION
NSF	NATIONAL SANITATION FOUNDATION
NTMA	NATIONAL TERRAZZO AND MOSAIC ASSOCIATION
OSHA	OCCUPATIONAL SAFETY AND HEALTH ADMIN.
PATMI	POWER ACTUATED TOOL MANUFACTURERS INSTITUTE
PCA	PORTLAND CEMENT ASSOCIATION
PCI	PRESTRESSED CONCRETE INSTITUTE
PDI	PLUMBING AND DRAINAGE INSTITUTE
PEI	PORCELAIN ENAMEL INSTITUTE
PI	PERLITE INSTITUTE
PSC	PUBLIC SERVICE COMMISSION
SAA	SURETY ASSOCIATION OF AMERICA
SBI	STEEL BOILER INSTITUTE
SBTMA	SOUTHERN BRICK AND TILE MANUFACTURERS ASSOC.
SCB	SOUTH CENTRAL BELL
SCPI	STRUCTURAL CLAY PRODUCTS INSTITUTE
SDI	STEEL DOOR INSTITUTE; STEEL DECK INSTITUTE
SIGMA	SEALED INSULATING GLASS MANUFACTURERS ASSOC.
SJI	STEEL JOIST INSTITUTE
SMACCA	SHEET METAL & AIR COND.CONTRACTORS ASSOC.
SPA	SOUTHERN PINE ASSOCIATION
SPIB	SOUTHERN PINE INSPECTION BUREAU
SPR	SIMPLIFIED PRACTICE RECOMMENDATIONS
SPC	STRUCTURES PAINTING COUNCIL
SRI	STEEL RECYCLING INSTITUTE
SSPC	SOCIETY FOR PROCTIVE COATING
SWI	STEEL WINDOW INSTITUTE
TAIA	THE AMERICAN INSURANCE ASSOCIATION
TCNA	TILE COUNCIL OF NORTH AMERICA
TMA	TILE MANUFACTURERS ASSOCIATION
UL	UNDERWRITERS LABORATORIES
USDA	U.S. DEPARTMENT OF AGRICULTURE
VI	VERMICULITE INSTITUTION
VWPI	VACCUM WOOD PRESERVATIVE INSTITUTE
WCLIB	WEST COAST LUMBER INSPECTION BUREAU
WRI	WIRE REINFORCEMENT INSTITUTE

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MISCELLANEOUS REFERENCES

A	AMPERES; AREA; ARCHITECTURAL
AB	ANCHOR BOLT
ABD	ACOUSTICAL BOARD
AC	ALTERNATING CURRENT; AIR CONDITIONING
ACOU	ACOUSTICAL
ACT	ACTIVE
AD	AREA DRAIN
ADJ	ADJUSTABLE
AFF	ABOVE FINISH FLOOR
AHU	AIR HANDLING UNIT
AL	ALUMINUM
ALT	ALTERNATE
ALUM	ALUMINUM
ASPH	ASPHALT
AT	ACOUSTICAL TILE
AUTO	AUTOMATIC
AVE	AVENUE
AVG	AVERAGE
AWG	AMERICAN WIRE GAUGE
B	BATH
BC	BACK CHECK
BD	BOARD
BEJ	BUILDING EXPANSION JOINT
BET	BETWEEN
B4E	BEVELED 4 EDGES
BKBD	BACKBOARD
BL	BUILDING LINE
BLDG	BUILDING
BM	BENCH MARK; BEAM
BRDG	BRIDGING
BS	BOTH SIDES
B&S	BROWN & SHARP
BT	BULB TEE
BTB	BACK-TO-BACK
BTU	BRITISH THERMAL UNIT
BU	BUILT UP
C	CARPET; CONDUIT; COURSE; CENTIGRADE; CIVIL; CORRIDOR
CAB	CABINET
CAT	CATALOG
CB	CHALKBOARD; CONCRETE BLOCK
CC	CUBIC CENTIMETER
CDC	CLOSE DON'T COUNT
CEM	CEMENT
CFM	CUBIC FEET PER MINUTE
CG	CORNER GUARD
CI	CAST IRON
CJ	CONSTRUCTION JOINT
CL	CENTER LINE
C&G	CURB & GUTTER
CLG	CEILING
CM	CONSTRUCTION MGR; CORRUGATED METAL
CMU	CONCRETE MASONRY UNIT
CO	CLEAN OUT; CHANGE ORDER
COND	CONDENSATE
COL	COLUMN
CONC	CONCRETE
CONN	CONNECT
CONT	CONTINUOUS
COR	CORRIDOR
CR	COLD ROLLED; CORROSION RESISTANT
CRS	CORROSION RESIS STEEL
CRT	CATHODE RAY TUBE
CSK	COUNTERSUNK
CST	CENTRAL STAN TIME
CSV	CRAWL SPACE VENT
CT	CERAMIC TILE; EAST THRESHOLD
CTC	CENTER TO CENTER
CTR	COUNTER
CW	COLD WATER
CWR	COLD WATER RETURN
CWS	COLD WATER SUPPLY
CYL	CYLINDER
D	PENNY (NAILS, ETC)
DA	DOUBLE ACTING
DBL	DOUBLE
DET	DETAIL
DF	DRINKING FOUNTAIN
DIA	DIAMETER
DIAG	DIAGONAL DIAGRAM
DIM	DIMENSION
DO	DITTO
DOZ	DOZEN
DN	DOWN
DP	DAMPPROOF
DR	DRAWER; DRAIN; DOOR; DINING ROOM
DS	DOWNSPOUT
DW	DISHWASHER
DWG	DRAWING
E	EAST; ELECTRICAL; ENTRY
EA	EACH
EB	EXPANSION BOLT
EDF	ELEC DRINKING FOUNTAIN
EJF	EXPANSION JOINT FILLER
EL	ELEVATION
ELEC	ELECTRIC
ELEV	ELEVATOR; ELEVATION
ELD	ELECTRIC LOCKING DEVICE
ENT	ENTRANCE
EOS	END OF SECTION
EQ	EQUAL; EQUIPMENT
EQUIP	EQUIPMENT
EW	EACH WAY
EWC	ELECTRIC WATER COOLER
EXB	EXPANSION BOLT
EXH	EXHAUST
EXIST	EXISTING
EXP	EXPANSION
EXP.JT	EXPANSION JOINT
EXT	EXTERIOR
EXTN	EXTENSION
F	FAHRENHEIT; FACE
FBP	FIRE BARRIER PARTITION
FC	FOOT CANDLE
FD	FLOOR DRAIN; FIRE DAMPER
FE	FIRE EXTINGUISHER
FEC	FIRE EXTINGUSHER CABINET
FED	FEDERAL
FF	FINISH FLOOR
FH	FIRE HYDRANT; FLAT HEAD
FHC	FIRE HOSE; CABINET
FL	FLOW LINE; FLOOR LINE; FLOOR; FUSIBLE LINK
FOW	FACE OF WALL
FPM	FEET PER MINUTE
FR	FIRE RATED
FS	FULL SIZE; FEDERAL SPEC
FT	FOOT
FTF	FACE TO FACE
FVC	FOOTING
FVC	FIRE VALVE CABINET
FYC	FOR YOUR CONSIDERATION
FYI	FOR YOUR INFORMATION
G	GAS
GA	GAUGE
GAL	GALLON
GALV	GALVANIZED
GB	GRAB BAR; GYPSUM BOARD
GBR	GUINESS BOOK OF RECORDS
GC	GENERAL CONTRACTOR; GENERAL CONDTIONS
GG	GRAVEL GUARD
GI	GALVANIZED IRON
GL	GLASS
GLM	GOOD LUCK MEN
GND	GROUND
GOVT	GOVERNMENT
GPF	GALLONS PER SQAURE FOOT
GPM	GALLONS PER MINUTE
GPY	GALLONS PER SQUARE YARD
GR	GRADE
GT	GLAZED CERAMIC TILE
GV	GATE VALVE
GYP	GYPSUM
H	HEATING (HVAC); HALL
HAC	HEATING/AIR CONDITIONING
HB	HOUSE BIBB
HC	HOLLOW CORE; HANDICAPPED
H/C	HANDICAPPED
HD	HEAVY DUTY
HDF	HANDICAP DRINKING FOUNTAIN
HFS	HALF FULL SIZE
HG	HEAVY GAUGE
HL	HIGH LIMIT
HM	HOLLOW METAL
HMR	HORIZONTAL MASONRY REINFORCE
HO	HOLD OPEN
HORIZ	HORIZONTAL
HP	HORSEPOWER; HIGH PRESSURE
HPL	HIGH PRESSURE LIMIT
HR	HANDRAIL; HOUR

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HT	HEIGHT
HW	HOT WATER; HARDWARE (SET)
HWD	HARDWARE
HVAC	HEATING; VENTILATING, & AC
HZ	HERTZ
ID	INSIDE DIAMETER
INCL	INCLUDE
INSUL	INSULATING MATERIAL
INT	INTERIOR
INV	INVERT
IPS	IRON PIPE SIZE
ISF	INSIDE FACE
ITC	IN THIS CONTRACT
J	JANITOR
JAN	JANITOR
JB	JUNCTION BOX
JR	JUNIOR
JS	JANITOR SINK
JSV	JOINT SPACE VENT
JT	JOINT
K	KIP (1000 LB); KITCHEN
KA	KEY ALIKE
KD	KNOCK DOWN; KEY DIFFERENT
KG	KILOGRAM
KM	KILOMETER
KV	KILOVOLT
KVA	KILOVOLT AMPS
KW	KILOWATT
L	ANGLE (METAL SHAPE)
LAM	LAMINATE
LAV	LAVATORY
LBS	POUNDS
LDW	LESS DOOR WIDTH
LED	LIGHT EMITTING DIODE
LG	LIGHT GAUGE
LH	LEFT HAND
LIN	LINEAR
LL	LOW LIMIT
LLH	LONG LEG HORIZONTAL
LLV	LONG LEG VERTICAL
LOC	LOCATION
LP	LOW PRESSURE; LIQUID; PETROLEUM; LIGHT PROOF
LPL	LAMINATED PLASTIC
LPT	LOCAL PREVAILING TIME
LSG	LAMINATED SAFETY GLASS
LT	LIGHT
LVR	LOUVER
M	MEN
MAX	MAXIMUM
MBT	MARBLE THRESHOLD
MC	MEDICINE CABINET
MDO	MEDIUM DENSITY OVERLAY
MDS	METAL DIVIDER STRIP
MECH	MECHANICAL
MED	MEDIUM; MEDICAL
MEMB	MEMBER
MET	METAL
MFG	MANUFACTURER
MH	MANHOLE
MI	MALLEABLE IRON
MM	MINIMUM; MINUTE
MISC	MISCELLANEOUS
MK	MASTER KEY; MARK
MO	MASONRY OPENING
MP	MEDIUM PRESSURE
MPH	MILES PER HOUR
MT	METAL THRESHOLD
MTD	MOUNTED
MTP	METAL TOILET PARTITION
N	NORTH
NA	NOT APPLICABLE
NIC	NOT IN CONTRACT
NL	NIGHT LATCH
NO	NUMBER; NITROUS OXIDE
NRP	NON-REMOVABLE PIN
NTR	NO TEMPERATURE RATING
NTS	NOT TO SCALE
OA	OUTSIDE AIR
OC	ON CENTER
OCEW	ON CENTER EACH WAY
OLF	OUNCE PER LINEAR FOOT
OD	OUTSIDE DIAMETER
OH	OVERHEAD; OVAL HEAD
OPG	OPENING
OPH	OPPOSITE HAND
OPN	OPENING
OPP	OPPOSITE
OSF	OUTSIDE FACE
OTO	OUT TO OUT
OXY	OXYGEN
OZ	OUNCE
P	PLUMBING
PA	PARALLEL ARM; PUBLIC ADDRESS
PAR	PARAGRAPH
PAS	POWDER ACTUATED STUD
PB	PROJECT BOOK
P/C	PRESTRESSED CONCRETE; PRECAST CONCRETE
PCF	POUNDS PER CUBIC FOOT
PCY	POUNDS PER CUBIC YARD
PDF	POWER DRIVEN FASTENER
PGL	PLATE GLASS
PH	PHILLIPS HEAD
PL	PROPERTY LINE; PLATE
PLB	PLUMBING
PLF	POUNDS PER LINEAR FOOT
PLYW	PLYWOOD
POL	POLISH
PP	POWER POLE
PPS	POUNDS PER SQUARE
PRV	PRESSURE REDUCING VALVE
PSF	POUNDS PER SQUARE FOOT
PSI	POUNDS PER SQUARE INCH
PSIG	POUNDS PER SQUARE INCH GAGE
PSY	POUNDS PER SQUARE YARD
PT	PRESSURE TREATED
PTD	PAPER TOWEL DISPENSER
PTP	PLASTIC(FACED)TP
PVC	POLYVINYL CHLORIDE
QT	QUARRY TILE
R	RADIUS; RUBBER
RA	RETURN AIR
RCP	REFLECTED CEILING PLAN
RD	ROOF DRAIN; ROAD; ROUND
RE	REFERENCE
REF	REFRIGERATOR
REG	REGISTER
REV	REVISED
REQD	REQUIRED
RH	RELATIVE HUMIDITY; RIGHTHAND; ROUND HEAD; ROBE HOOK
RM	ROOM
RO	ROUGH OPENING
ROW	RIGHT OF WAY
R/W	RIGHT OF WAY
RPM	REVOLUTIONS PER MINUTE
RS&S	ROD STOCK & SEALANT
RT	RESILIENT TILE
S	SOUTH; STAIR; STRUCTURAL
SA	SUPPLY AIR SINGLE ACTING
SAN	SANITARY
SBP	SMOKE BARRIER PARTITION
SC	SOLID CORE; SCALE
SCH	SCHEDULE
SCHED	SCHEDULED
SD	SOAP DISPENSER OR DISH; SMOKE DAMPER
SEC	SECTION
SF	SQUARE FEET
SG	SOAP GRAB
SGT	STRUCTURAL GLAZED TILE
SH	SHEET
SHF	SHELF
SHVS	SHELVES
SI	SQUARE INCH
SIM	SIMILAR
SLA	SINGLE LEVER ARM
SNB	SEX NUTS & BOLTS
SND	SANITARY NAPKIN DISPENSER
SOT	SEE OTHER TRADES
SP	SINGLE PHASE; SINGLE POLE
SPEC	SPECIFICATION
SP	SPLASH PAN
SQ	SQUARE
SR	SHOWER ROD
SS	STAINLESS STEEL; SANITARY SEWER
SSD	SUB-SURFACE DRAIN
SSMH	SANITARY SEWER MANHOLE
STL	STEEL
STR	STRUCTURAL
SW	SWITCH
SY	SQUARE YARD
SYP	SOUTHERN YELLOW PINE
S4S	SURFACE 4 SIDES

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T	TOILET
TAB	TEST & AIR BALANCE
TB	TACKBOARD
T&B	TOP &BOTTOM
TC	TERRA COTTA
TEL	TELEPHONE
TGL	TEMPERED GLASS
TLC	TENDER LOVING CARE
TOC	TOP OF CURB
TOW	TOP OF WALL
TP	TOILET PARTITION
TPH	TOILET PAPER HOLDER
TR	TOWEL ROD
TRANS	TRANSFORMER
TS	TERRAZZO STRIP
TS	TUBE (STRUCTURAL SHAPE) TERRAZZO (EXPANSION) STRIP
TSTAT	THERMOSTAT
TV	TELEVISON
TYP	TYPICAL
U	URINAL
UC	UNERCUT; UNDERCOUNTER
UOS	UNLESS OTHERWISE SHOWN
USG	UNITED STATE GAGE
V	VOLTAGE; VESTIBULE
VAC	VACUUM
VB	VAPOR BARRIER
VC	VITROUS CLAY
VCT	VINYL COMPOSITION TILE
VIB	VIBRATOR
VDT	VIDEO DISPLAY TERMINAL
VP	VAPORPROOF
VAT	VINYL ASBESTOS TILE
W	WOMEN; WATT; WEST
W/	WITH
WC	WATER CLOSET
WD	WINDOW DIMENSION; WOOD
WDW	WINDOW
WF	WIDE FLANGE(BEAM)
WG	WIRE GLASS
WH	WEEP HOLE; WATER HEATER, WALL HYDRANT
WM	WASHING MACHINE
WOT	WORK OF OTHER TRADES
WP	WATER/WEATEHER PROOF
WR	WATER RESISTANT
WS	WOOD SCREWS
W&V	WASTE AND VENT
WWF	WOVEN WIRE FABRIC
WWM	WOVEN WIRE MESH
YH	YARD HYDRANT

*WHERE AN ABBREVIATION HAS MORE THAN ONE MEANING, ASSUME THE USE APPROPRIATE TO THE TRADE OR ITEM REFERRED TO.

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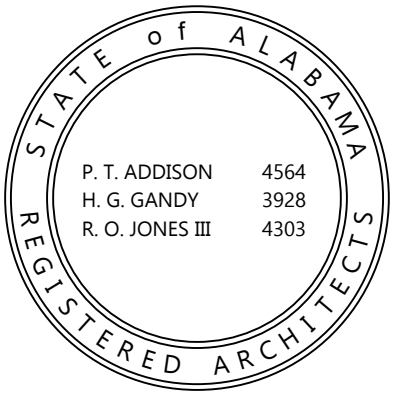
These Specifications were prepared by and under the direct supervision of P.H. & J. Architects, Inc., Montgomery, Alabama



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16231 Package Engine Genrator Power Generation
16415 Automatic Transfer
16715 Structural Cabling

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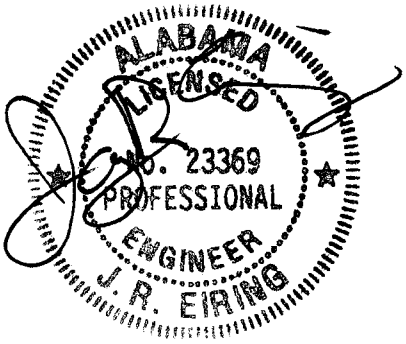
Huxford Elementary
School Gymnasium
And Classroom Addition
PHJA/2312SC

These specifications sections were prepared by and under the direct supervision of the Engineer of Record for this project.

Division 15 – MECHANICAL
15010 Mechanical General Provisions
15400 Plumbing
15500 Fire Protection
15700 Heating, Ventilating & Air Conditioning



June 18, 2025

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SECTION 15010

GENERAL MECHANICAL PROVISIONS

PART 1. GENERAL

1.1. **General Requirements:** Carefully and completely read all the specifications, review all plans and all related construction documents. Pay particular attention to strict submittal requirements and note the ramifications of providing incomplete or incorrectly formatted and incorrectly submitted submittals.

The respective Contractor is responsible for paying all fees, utility connections, permits, etc., required. No consideration will be given after bid opening for alleged misunderstanding regarding the specifications, plans, utility connections, permits, fees, etc..

Division One is applicable in full hereto. Where the words, "provide", "furnish", "include" or "install" are used in the specifications, Codes or on the Drawings, it must mean to furnish, install, and test, complete and ready for operation as specified and required.

No materials or products that contain asbestos, formaldehyde, polychlorinated biphenyl (PCB), lead or mercury, in excess of limits mandated and defined by OSHA, LEED and the EPA, must be utilized.

Manufacturers not mentioned in the specifications require prior approval, seven (7) days prior to bid date. Follow procedures set forth in Division 1 of the specifications. All prior approvals must be submitted through the Architect. Where substitutions are proposed, unless the Contractor states in writing, on a separate recap/summary sheet in front of the respective submittal, the differences of the substituted equipment or material, he must be responsible to replace such items any time discrepancies are found.

Where conflicts occur between a Code, Standard or Listing and the contract drawings or contract specifications, the most stringent requirements must govern and be applied.

The Architect and Engineer must interpret the meaning of the drawings and specifications and will reject all work and materials, which in their judgment, is not in full accordance therewith.

1.2. **Provision For Future Expansion And/or Installations:** Where piping, ductwork and equipment is indicated for use in future expansion of the building and/or for future installations within the building, the Contractor must leave sufficient clear space and install the piping, ductwork and equipment in such manner that connections to the future building expansion and/or future installations within the building can be made without removing existing walls and ceilings. The Contractor must consult with the Architect whenever

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necessary for this purpose. Any piping stub-outs provided for future connections must be arranged so that “dead legs” (i.e., pipe sections where there is no water circulation) are prevented. The termination points of any piping stub-out must be as close to the main piping flow as physically possible. Where future branch lines must extend a distance greater than six (6) branch line pipe diameters or more than 18” from the main piping flow, a valved drain port or blind flange with a valved drain must be provided at the end of the branch piping to allow periodic flushing.

1.3. **Spare Parts:** Manufacturer of any equipment specified must have a wholesale outlet for readily available replacement parts in the nearest major USA city.

1.4. **Codes and Standards and Listings:** Unless specified otherwise, comply with all current editions of all referenced publications within these specifications and all current editions of applicable NFPA, ASME, OSHA, IBC, ASHRAE, ASTM, ASME, ANSI, SMACNA, Americans with Disabilities Act (ADA), ADA Standards for Accessible Design, with Local Building Codes, Mechanical Codes, Gas Codes, Plumbing Codes, ANSI/ASHRAE/IESNA Standard 90.1, ANSI/ASHRAE Standard 135, International Energy Conservation Code (IECC), International Fuel Gas Code (IFGC), International Fire Code (IFC), Americans with Disability Act Accessibility Guidelines (ADA), ICC A117.1 Standard for Accessible and Usable Buildings and Facilities, U.S. Department of Energy Regulatory requirements and with all applicable local ordinances and codes. Equipment must bear Underwriters Laboratories Inc. (UL) listing label, Canadian Standards Association (CSA) listing label or ETL approved rating. All electrical components and products must also comply with the respective Code of Federal Regulations (CFR).

Where conflicts occur between a Code, Standard or Listing and the contract drawings or contract specifications, the most stringent requirements must govern and be applied. Advisory provisions listed in all Codes referenced in the Contract Documents are mandatory and the word “should” must be interpreted as “must”.

1.5. **Permits and Inspections:** Provide all permits, pay all fees and arrange for inspections as required by all applicable Governing Authorities. Furnish certificates of all inspections and approvals from all Governing Authorities to the Architect. Include certificates of all inspections and approvals from all Governing Authorities in the Plumbing, Fire Protection and HVAC closeout documents. Provide additional materials, parts, methods, etc. and modify the work as required by Governing Authorities’ Inspections and Regulations. Correct all deficiencies required by Code officials at no additional cost to the Owner or the Owner’s Project Design Professionals.

The Plumbing Contractor must arrange and pay for the State of Alabama Boiler and Pressure Vessel Safety Division/Inspection Divisions, Elevators/Boilers Inspector to visit job site to inspect water heater and/or boiler installation and obtain written approval, certification and Certificate for Potable Water Heater (PWH) as required. This inspection must be accomplished prior to the final site

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visit; to include the tagging of the equipment with the inspection tag, else DCM will cancel the site visit and impose a reinspection fee.

Correct all deficiencies required by any Governmental Inspector without additional cost to the Owner or the Owner's Project Design Professionals, using materials and methods, as directed by, State of Alabama Boiler and Pressure Vessel Safety Division/Inspection Divisions and Elevators/Boilers inspector as required.

1.6. **Site Visits:** It is the contractor's responsibility to have the job ready for site visits when they are scheduled. If the project is not ready for the requested site visit and the Architect, any governmental agency or any other entity requires a re-inspection with the Engineer present, the contractor must pay Zgouvas, Eiring & Associates a re-inspection fee of $2,000. The payment must be made directly to Zgouvas, Eiring & Associates 5 days prior to the scheduled re-inspection.

The Contractor is urged to carefully review the extensive requirements of Paragraph "Identification" in this Section 15010 of the specifications and note that certain identification is required to be completed before certain site visits. There are specific identification requirements prior to the above ceiling and final site visits, respectively, that are mandatory. The Engineer will cancel on-site, the site visit if not completed as specified. Failure to comply with this provision will be cause for cancellation of the site visit, and a fee imposed for the additional site visit, with all costs of the additional site visit to be borne by the Contractor.

1.7. **Drawings and Specifications:** The Architect and Engineer must interpret the meaning of the drawings and specifications and will reject all work and materials, which in their judgment, is not in full accordance therewith. Where doubt arises as to the meaning of the plans and specifications, obtain the Architect's decision, in writing, before proceeding with parts affected; otherwise assume liability for damage to other work and for making necessary corrections to work in question.

All drawings are diagrammatic and are intended to quantify the materials specified and indicate their intended relationship with each other. The drawings and specifications are complementary, and work shown, but not specified, or specified, but not shown, must be the same as though required by both.

Bidders must carefully examine the contract documents during the bidding phase. Any missing information, clarifications, conflicts, etc. in the contract documents that is required to provide accurate pricing must be brought to the attention of the Architect, **prior to bid date**, so all may be clarified and/or corrected. Failure to identify and resolve any issue prior to bid must require the Contractor to provide said items, complete, without additional cost to the Owner or the Owner's Project Design Professionals, using materials and methods specified by, and as directed by, the Owner's Design Professionals.

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Bidders must visit the site and become acquainted with all job conditions that may affect the work shown on the plans. Report to the Architect, prior to bid, any new or existing conditions that require modifications to accomplish the installation of all items. Provide for required adjustments to complete the intent of the work. No consideration will be given after bid opening for alleged misunderstanding regarding new or existing job conditions, utility connections, permits, fees, construction documents, etc.

DO NOT SCALE the Plumbing, Fire Protection and HVAC drawings. In the interest of clearness, the work is not always shown to scale or exact location. Refer to Architectural drawings for dimensions and verify scale shown on the drawings. The various scales used on the drawings do not allow for all fittings, offsets and accessories that may be required to complete the work. Check all measurements, location of pipe, all required and specified appurtenances for duct and piping, ducts, and equipment with the architectural and electrical drawings, and lay out work to fit in with ceiling grids, lighting, and other parts. All wiring, piping, ductwork, etc., must be concealed unless specified or noted otherwise. Adjust in the field as required to provide the optimum result to facilitate ease of service, efficient operation, and best appearance.

1.8. **Conflicts, Coordination and Changes:** If interferences or conflicts occur, the Architect must decide which equipment must be relocated regardless of which was first installed. In the interest of avoiding such conflicts, each Sub-Contractor who is using common space, etc., must coordinate his work with all other trades and other parts of his own work. If during this coordination, it is discovered that necessary or desirable changes are required to be made, advise the Architect and secure his decision in writing prior to proceeding. Do not fabricate or install any items, equipment, etc. until all coordination has been accomplished.

Coordinate the location of all Division 15 work with Division 16. Do not run piping,
ductwork and similar Division 15 work in NEC dedicated service areas for electrical
equipment, including above panel boards, starters, communication panels, control panels, telephone backboards, data panels and similar electrical elements.

1.9. **Coordination Drawings:** Follow procedures set forth in Division 1. Before starting work, submit for review, coordination shop drawings showing proposed arrangement of all equipment, all piping, ducts, floor drains, power requirements, all equipment maintenance requirements and controls. As a minimum, submit detailed layouts of potential conflicts at plumbing risers, equipment rooms, limited ceiling space, etc. Refer to subsequent Sections for additional specific requirements.

Coordinate the submission of shop drawings and refer questionable locations to
Architect/Engineer for resolution prior to installation. Failure to coordinate all

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items, and correct non-conforming installed work, must be provided at no additional cost to the Owner or the Owner's Project Design Professionals.

Failure to submit shop drawings must make the Contractor responsible for changes required to facilitate installation of, and the proper operation of, all systems at no additional cost to the Owner or the Owner's Project Design Professionals.

1.10. **Maintenance, Replacement and Service Access:** Locate equipment as shown on the plans. The Contractor must install valves, controllers, actuators, manual dampers, motorized dampers, air vents, cleanouts, smoke detectors, fire dampers, smoke dampers, fans and any other items requiring maintenance access with the maintenance, service and replacement access required by the Manufacturer of the respective installed item. All items must be installed to provide maximum safety, service, replacement, and maintenance access.

To ensure proper maintenance access, all piping with valves, any equipment, and any other items that may require maintenance, service or replacement, must be located no more than 12" above the finished ceiling and no more than 14'-0" above finish floor in areas without ceilings.

Coordinate all questionable access or location of items that may present a problem, if installed as specified above, with the Engineer or the Architect's field representative prior to installing any item; else, relocation will be at the Contractor's expense once discovered.

1.11. **Warranty:** Refer to Division 1. Additionally, guarantee in writing to make good without cost any defects in materials and workmanship for one year following the date of substantial completion of the project as determined by the Architect. Provide free maintenance and service during the guarantee period.

Refer to other Division 15 Sections for additional detailed warranty requirements.

1.12. **Submittal Data:** Within 25 days of contract award, all contractors must submit a complete submittal for review, including a detailed schedule of materials, means and methods, equipment, etc. of **all** specified items proposed. Failure to submit any specified items will result in rejection of non-compliant materials, equipment, or means and methods when discovered, with replacement costs borne solely by the contractor. The Architect and/or Engineer's review of submittals does not absolve the contractor of full responsibility for strict compliance with all contract documents.

The General Contractor must review and stamp all submittals prior to submitting them to the Architect. Submittals provided without the General Contractor's review will be automatically rejected and a possible re-review fee of $700 imposed.

Variations from the specifications, plans and all value engineered (VE)

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items for the items submitted for review must be explicitly indicated in front of the submittal, immediately after the submittal cover page, otherwise, it will be assumed the product will conform to the plans and specifications in all respects.

Where substitutions are proposed, unless the Contractor states in writing, on a separate recap/summary sheet in front of the respective submittal, the differences of the substituted equipment or material, he must be responsible to replace such items any time discrepancies are found.

Submittals must include catalog data, scheduled capacities, fan curves, sound data, materials and methods of installation, various components of various assemblies, etc.

Only ONE complete submittal will be accepted for each specification section. Do not submit plumbing fixtures separately without the remaining Section 15400 items submittal. If a partial or incomplete submittal is provided, it will be automatically rejected and a possible re-review fee of $700 imposed. If the Contractor provides a submittal for review and then provides additional items for review after the initial submittal was submitted, a $700 review fee will be imposed. The objective is to provide one complete submittal as specified hereinbefore. **Providing submittals piecemeal is not allowed.**

All submittals must be separately bound by specification Section (Plumbing, Fire Protection and HVAC) in pdf format. Submittals must be electronically indexed and tabbed. Refer to the Architectural General Conditions and Division 1 for the format required by the Architect. A cover sheet must be provided in front of the submittal package which states, as a minimum, the Project name and location, the name of the Owner, the Architectural firm, the Engineering firm, **the Engineer's Project number, NOT THE ARCHITECT'S PROJECT NUMBER,** located within the Engineer's logo in the bottom right corner of the HVAC, Fire Protection and Plumbing plans, the General Contractor, the Mechanical Contractor, Fire Protection Contractor and Plumbing Contractor and each Contractors' point of contact, with phone number, as applicable for the respective trade's submittal. The respective Contractor's contact phone number is requested in an effort to obtain submittal clarifications which otherwise may be cause for rejection by the Engineer.

A recap/summary sheet must be inserted at the beginning of each tabbed section to summarize the contents of each respective tabbed section. The recap/summary sheet must include all items that have been changed or removed due to Project cost constraints, addendums, or Value Engineering (VE).

Failure to include items changed or removed due to Project cost constraints, addendums or VE items that require an additional review by the Engineer will require the Contractor to reimburse the Engineer a minimum of $700 for the effort involved to review the corrected submittal.

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Submittals must include specifications section numbers and related sub-paragraph numbers, materials used, methods of installation, product manufacturer, equipment capacities, etc. HVAC equipment items must follow the identical tabular format, category by category, nomenclature, etc., as shown on the HVAC equipment schedules. As a minimum, the recap/summary sheet must indicate the submitted values compared to each of the specified values. **Failure to provide the submittals in the format specified will be cause for immediate rejection without review.** If there is any doubt as to the format required for the HVAC equipment summary sheet, contact ZEA and an example will be provided. Plumbing and Fire Protection submittals must follow the identical procedure specified for the Mechanical Contractor.

1.13. **Submittal Rejection and Resubmittal:** The Contractor must carefully review the submittal data requirements specified above. Pay particular attention to specific items within the specifications that are cause for immediate rejection when submittals are not provided to the Engineer as requested or specified. Any submittal that requires a review before the Engineer receives a complete submittal or portions thereof that are rejected TWICE and resubmitted a third, fourth, etc. time for review will require the Contractor to reimburse the Engineer each time for his effort. The minimum fee for each re- review is $700. When resubmitting, provide a clean submittal for review.

When submittals are rejected, **DO NOT** return a copy of the rejected submittal with the Engineer's review stamp or notations. Provide a clean submittal addressing all requested and outstanding items.

1.14. **Site and Existing Conditions:** Bidders must visit the site and become acquainted with all job conditions that may affect the work shown on the plans. Report to the Architect, prior to bid, any new or existing conditions that require modifications to accomplish the installation of all items. Provide for required adjustments to complete the intent of the work. No consideration will be given after bid opening for the alleged misunderstanding regarding new or existing job conditions, utility connections, permits, fees, etc.

1.15. **Line Locators:** Before proceeding with excavating or trenching, arrange with the Owner, all utility companies, and line locating firm(s) to describe, mark and locate utilities, piping, conduits, etc. which might be damaged by construction operations. Failure to provide the above must make the offending Contractor responsible for all costs involved to correct the damage incurred.

1.16. **Phasing:** Interrupt existing services only at times approved by the Architect and the Owner. The General Contractor must make a written request to the Architect and the Owner for permission to interrupt services at the facility. The request must be provided with a minimum of seven (7) days prior to the desired date of the interruption. Hold interruptions to a minimum in duration and frequency.

1.17. **Contractor Requested Electronic Drawing Files:** Not available.

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1.18. **Record Documents:** Provide in such detail, as is set forth under General and Supplemental Conditions.

Keep an accurate record of changes made during construction. The respective Contractor must take as-built measurements, including all depths, prior to commencement of backfilling operations. It will not be sufficient to check off line locations. Definite measurements must be taken for each service line. The location of buried piping must be shown on the drawings and dimensioned from fixed points.

The Plumbing Contractor and the Fire Protection Contractor must take as-built measurements, including all depths, inverts, etc., prior to commencement of backfilling operations. It must not be sufficient to check offline locations. Definite measurements must be taken for each line entering and leaving the facility. The location of buried piping must be shown on the record drawings and dimensioned from fixed points. Additionally, the Plumbing Contractor must indicate the location of all cleanouts, dielectric unions and valve numbers from the specified valve chart on record/as-built drawings.

The respective Contractor must complete the Record Documents, using the As-Built Drawings from the General Contractor's construction site office. Transfer these changes to a set of reproducible copies of original drawings that the Architect will sell to Contractor at printing cost. The drawings will be provided to the Contractor "As Is".

The final drawing set within the Record Documents must be labeled "***Record Documents***" in the Title Block and must not include "clouds" or other indications of the changes during the project process. The Contractor must provide hard copies and an electronic set of all documented modifications to the contract documents.

The Contractor is responsible for providing and showing all changes to the drawings that are different from the original contract drawings, including but not limited to addendums, change-orders, VE items, RFI's, test reports, field observations/site visit reports, etc. Hard copy plans may be a set of reproducible copies of the final corrected contract drawings. When work is completed, submit corrected reproducible drawings to the Architect for record and include copies in the Owner's Operating and Maintenance Manual.

Record documents must also be provided in PDF digital format on CD-R type CD(s). Include a CD of the documents in the Owner's Operating and Maintenance Manual.

PART 2. MISCELLANEOUS REQUIREMENTS TO BE COORDINATED WITH OTHER TRADES

2.1. **Foundations and Supports:** The Plumbing, Fire Protection and Mechanical

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Contractor, as applicable, must provide foundations, support, etc. not specified under other Divisions, and as required to mount all items in a safe, professional and structurally sound manner. The respective Contractor must provide all supplemental steel between various types of structural members, including between bar joists, purloins, wood trusses, miscellaneous structural items, etc. as required for the item(s) proper support. All supports and related components and assemblies must be sized for a minimum of 300% (3 times) the anticipated load carried by the respective item.

Where the Contractor has doubt as to proper supporting requirements, he must consult with, and seek the guidance of, the Architect and the project Structural Engineer for resolution. Consult all contract documents pertaining to other trades to determine extent of their work.

Concrete pads for outside equipment are specified under other Sections. Concrete work must meet the requirements of Division 3. Respective Contractor must provide all concrete pads not indicated or specified on the Architectural, Civil or Structural plans. Refer to the various equipment specifications for requirements in the absence of requirements by the various disciplines and provide as specified.

2.2. **Pipe Sleeves:** Sleeves are required for all interior partitions, floors, perimeter exterior walls, etc. regardless of whether the above ceiling penetration occurs at locations where partitions go to the structure above or stop short of the structure above. All pipe sleeves must be installed as work progresses. Split sleeves are not allowed. See plan details for additional requirements.

All penetrations of new construction that were not built-in must be core drilled or sawcut large enough to allow all conduits, piping, wiring, sleeves, etc., to continue uninterrupted, and as required to install new items as shown and specified. See plan details for additional requirements. **Note that ALL penetrations of partitions that go to the deck/structure above require a firestopping/sleeve assembly, regardless of whether partition is rated or not.**

All wiring penetrating any exterior wall, interior partition, floor, and similar construction must be in conduit, not sleeves, with protective grommets on the conduit ends. HVAC outdoor control wiring must be routed within a conduit that terminates above the ceiling in an accessible location.

Where non-rated walls or partitions do not extend to the structure above, a firestopping assembly or device is not required at the penetration. Instead, provide a 10 ga. galvanized sleeve of size required and specified. Pack the opening on both sides of the partition/sleeve with mineral wool insulation and seal on both sides with materials the same as the material penetrated. i.e., If it is a penetration of gypsum board, seal with gypsum board joint compound. If it is a penetration of concrete block, seal with cementitious type product. Provide escutcheon on both sides of the partition in spaces exposed to view. See plan

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details for additional requirements.

Do not route any wiring through sleeves/firestop assembly in partitions containing piping. Do not route multiple items through a single sleeve/firestop assembly. Do not route HVAC equipment control wiring through any sleeve containing refrigerant or other piping. Outdoor control wiring for HVAC equipment must be in conduit to a point above the ceiling in an accessible location. Provide a grommet at the conduit termination point to avoid control wiring abrasion at the conduit termination point.

Each pipe and conduit must have its dedicated sleeve/firestopping assembly.

All floor sleeves, except slab on grade, must be cast-in-place Schedule 40 steel pipe. Floor sleeves in foundations above the finish floor must terminate 2" above finish floor or housekeeping pad as applicable, and flush on the bottom side of the concrete foundation.

Sleeves for piping passing through exterior walls or exterior partitions must be Schedule 40 PVC pipe, 1" larger in diameter than piping and piping covering, neatly sawed off flush with the exterior wall, sealed water tight and vermin proof, and exposed edge painted to match building, unless specified otherwise. **Spray foam is not an approved sealant.** Refrigerant piping suction and liquid lines routed through a singular pipe sleeve in an exterior wall is acceptable only in this circumstance.

Any pipe that passes through a below grade foundation wall must be provided with a relieving arch, or a pipe sleeve pipe cast in place into the foundation wall. The sleeve must be two pipe sizes greater than the pipe passing through the wall. Example: A 6" uninsulated pipe must require an 8" sleeve.

Piping installed through a foundation wall must be structurally protected from any transferred loading from the foundation wall. The annular space between pipe and sleeve must be filled with backing material and sealants in the joint between the pipe and concrete or masonry wall. Sealant selected for the earth side of the wall must be compatible with damp proofing/waterproofing materials that are specified in Architectural section of the specifications to be applied over the joint sealant.

2.3. **Firestopping:** Provide assemblies to form a specific U.L. or ASTM tested and listed system with minimum 10 ga. sleeve and appropriate UL/ASTM listing that maintains the required or specified integrity of the fire barrier and non-fire barrier to stop the passage of fire, gases, smoke and water. The through-penetration firestop systems and firestop devices must be tested and listed in accordance with ASTM E814 or UL 1479 using the "F" or "T" rating to maintain the same rating and integrity as the fire barrier being sealed or a minimum of 1-hour protection for non-rated assemblies. The assembly or device must prevent passage of fire, smoke, gases and water through openings, and prevent transmission of sound and vibration from the penetrating element to the structure. Penetrations involving insulated piping must be a tested and

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listed firestop system not requiring removal of insulation and in accordance with ASTM E 814 or UL 1479.

Wherever pipes, conduit, ducts, etc. penetrate any type of interior construction that extends to the underside of the structure/deck above it, **regardless of whether the wall, partition or floor is a rated assembly or not,** the space between the penetrating member and the building construction must be sealed with an ASTM E814 or UL 1479 listed, approved and labeled factory fabricated firestop assembly or device as specified above.

Where partitions are not indicated as fire rated, the firestopping assembly used must provide a minimum of one-hour resistance.

Where walls or partitions do not extend to the structure above, a factory fabricated firestopping assembly is not required. Instead, provide a 16 ga. galvanized sleeve or conduit (for wiring) and pack the respective sleeve or conduit as specified above in Para. Sleeves.

At each through penetration, attach identification labels on both sides, in location where label will be visible to anyone seeking to remove penetrating items or firestopping. Attach labels permanently to surfaces adjacent to and within 6 inches of edge of the firestop systems so that labels will be visible to anyone seeking to remove penetrating items or firestop systems. Provide metal labels in areas used as return air plenums. Use mechanical fasteners for metal labels. For plastic labels, use self-adhering type with adhesives capable of permanently bonding labels to surfaces on which labels are placed and, in combination with label material, will result in partial destruction of label if removal is attempted. Additionally, secure to the wall with metal thumbtack at each corner of the label. Labels must be Hilti Firestop Identification Labels 00339611, 3M Sticker 98040056289 or approved equivalent. Firestop identification labels must include the following information on labels:

1. The words: "*Warning--Through-Penetration Firestop System--Do Not Disturb. Notify Building Management of Any Damage*."
2. Contractor's name, address, and phone number.
3. Through-penetration firestop system designation of applicable testing and inspecting agency.
4. Date of installation.
5. Through-penetration firestop system manufacturer's name.
6. Installer's name.

All fire stop material employed on the project must be the same brand throughout. The firestopping assemblies must be manufactured by Hilti, 3M, USG or other pre-approved Manufacturer.

2.4. **Access Panels and Doors:** Do not locate serviceable items above inaccessible, hard ceilings without written approval from the Architect. Coordinate all items' locations with the Architectural ceiling plans before installing any items. Furnish access panels and doors required to the General

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Contractor for installation for access to valves, controllers, actuators, manual dampers, motorized dampers, air vents, cleanouts, smoke detectors, fire dampers, smoke dampers, fans and any other items requiring maintenance access. Refer to Section 15700, Paragraph Access Doors and Panels for access in ductwork.

Doors/panels must be suitable for location and finish involved, 16" x 16" unless otherwise indicated, required or specified to permit removal of equipment and provide acceptable maintenance access.

Access panels and doors must be fire rated where rated assemblies are penetrated. Access panels and doors for items located outdoors or in damp environments must be weatherproof.

Access panels and doors must be manufactured by Milcor, Philip Carey, Zurn, Mifab or approved equivalent. The Architect must approve the use of, and type of, panels and doors to be installed in areas that are exposed to view or in finished areas. Exposed access panels and doors must be factory cleaned and primed for painting in the field. Colors, materials and methods must be selected by the Architect. Refer to Architectural Section, Painting, for additional information.

Where device occurs above a lift-out acoustical ceiling panel, provide engraved plastic labels of type specified in “Miscellaneous Requirements, Identification” below.

In addition to identification of items above the ceiling, provide engraved plastic labels below the item, on the ceiling grid. Engraved plastic labels must match ceiling grid color and be neatly glued to the ceiling grid adjacent to the ceiling tile that should be removed for access to the item. The label must have engraved on it the item being identified and its designation as shown on the plans, valve chart, etc. Refer to Section “Identification” below for additional requirements.

2.5. **Cutting and Patching:** All openings must be laid out. Furnish detailed layout shop drawings to other trades in advance of their work. Failure to furnish layout shop drawings to the General Contractor must make the applicable Mechanical/Plumbing/Fire Protection Contractor responsible to rebuild openings as directed by the Architect. Where openings have not been laid out or built in, or they occur in existing partitions, floors, etc., they must be core drilled or saw cut large enough to allow all penetrating items with or without insulation to continue uninterrupted, with clearances specified.

Piping and duct within walls or behind walls must be installed before wall is erected otherwise, walls, floors, ceilings, etc., affected must be reworked by the trade which erected it at expense of the respective Contractor. Chasing and cutting new work is not allowed without written permission from the Architect.

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2.6. **Duct and Miscellaneous Items Painting and Finishes:** Painting of ducts, piping, piping insulation, grilles, diffusers, and other surfaces in finished areas is specified in Architectural Section "Painting" or similar section. Refer to those sections for requirements. If not specified in other sections, paint items with two coats of paint as directed by the Architect. Where the Architectural specifications require items to be painted, the Contractor must furnish it with a Manufacturer provided, factory applied prime coat.

Where factory finished items are marred, scratched, or damaged, replace the item, or upon approval from the Architect or Owner, refinish or touch-up as required or specified to bring to a like new condition.

All paint and coatings must have a fire hazard rating not to exceed 25 for flame spread and 50 for fuel contributed and smoke developed as determined by ASTM E84. Also, see the Specification Section, "Identification", for additional requirements.

PART 3. EXCAVATION, TRENCHING & BACKFILLING

3.1. **Excavation:** Keep excavation free from water by pumping if necessary. Ensure that walls and footings and adjacent loadbearing soils are not disturbed in any way, except where lines must cross under a footing. Where a line must pass under a footing, make crossing with the smallest possible trench to accommodate the pipe. Where a line must pass adjacent to and below the bottom of a column footing, or the corner of a continuous footing, backfill the trench with concrete up to the level of the footing bottom, for a distance away from the footing equal to the depth of the fill.

3.2. **Over-Excavation:** Where trenches are excavated below the installation level of the pipe such that the bottom of the trench does not form the bed for the pipe, the trench must be backfilled to the installation level of the bottom of the pipe with sand or fine gravel placed in layers not greater than 6 inches in depth. The backfill must be compacted after each placement.

3.3. **Trenching and Bedding of Piping:** Buried piping must be supported throughout its entire length. Where trenches are excavated, such that the bottom of the trench forms the bed for the pipe, solid and continuous load-bearing support must be provided between joints. Bell holes, hub holes and coupling holes must be provided at points where the pipe is joined. Such pipe must not be supported on blocks to grade. In instances where the material manufacturer’s installation instructions are more restrictive than those prescribed by the IPC, the material must be installed in accordance with the more restrictive requirement.

3.4. **Backfilling:** Backfill within the building and under paved areas must meet compaction requirements established under Division 2.

Backfill must be free from discarded construction material and debris. Loose

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earth free from rocks, broken concrete and frozen chunks must be placed in the trench in 6-inch layers and tamped in place until the crown of the pipe is covered by 12 inches of tamped earth. The backfill under and beside the pipe must be compacted for pipe support. Backfill must be brought up evenly on both sides of the pipe so that the pipe remains aligned. In instances where the manufacturer's instructions for materials are more restrictive than those prescribed by the IPC, the material must be installed in accordance with the more restrictive requirement.

3.5. **Protection of Footings:** Trenching installed parallel to footings and walls must not extend into the bearing plane of a footing or wall. The upper boundary of the bearing plane is a line that extends downward, at an angle of 45 degrees from the horizontal, from the outside bottom edge of the footing or wall.

3.6. **Rock Removal:** Where rock is encountered in trenching, the rock must be removed to not less than 3 inches below the installation level of the bottom of the pipe, and the trench must be backfilled to the installation level of the bottom of the pipe with sand tamped in place so as to provide uniform load-bearing support for the pipe between joints. The pipe, including the joints, must not rest on rock at any point.

3.7. **Soft Load-Bearing materials**: If soft materials of poor load-bearing quality are found at the bottom of the trench, stabilization must be achieved by over excavating not less than two pipe diameters and backfilling to the installation level of the bottom of the pipe with fine gravel, crushed stone or a concrete foundation. The concrete foundation must be bedded with sand tamped into place so as to provide uniform load-bearing support for the pipe between joints.

3.8. **Shoring, Sub-Soil Assumptions and Data, Work Around Trees and Surplus Earth:** Refer to Section "Earthwork".

3.9. **Broken Pavement:** In public streets, sidewalks, right of ways, etc., backfill and repair to satisfaction of authorities having jurisdiction.

PART 4. PIPE SUPPORTS, PIPE HANGERS AND MISCELLANEOUS SUPPORTS

4.1. **General:** **Below requirements do not apply to refrigerant piping.** Refer to Section 15700, Refrigerant Piping and Accessories for refrigerant piping support requirements. Refer to the plan details and these specifications for various piping support requirements.

Provide factory fabricated galvanized pipe hangers and supports for all piping, complete with properly sized bolts, washers, clamps, etc. and with coatings and finishes specified below, and all as required for a complete and safely functioning installation. Material items, methods and general requirements not covered in this specification must be provided in strict accordance with current edition of Manufacturer's Standardization Society Specification MSS SP-58 and Manufacturer's Published Product Information.

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All hangers, supports, related components and assemblies must be sized for a minimum of 300% (3 times) the anticipated load carried by the respective item. Where the Contractor has doubt as to proper supporting requirements, he must consult with, and seek the guidance of, the Architect and the project Structural Engineer for resolution.

Where in contact with bare copper pipe provide same assembly except it must be copper, continuous-thread rod, nuts, and washers made of copper-coated steel.

Hangers must be manufactured by Elcen Metal Products Co., Fee & Mason Mfg. Co., ITT Grinnell Corp, B-Line Systems or preapproved equivalent.

4.2. **Coatings and Finishes:** Pipe hangers, Unistrut pipe supports and duct Unistrut support assemblies of galvanized, zinc and similarly coated items are considered to **NOT** be coated. All must be painted, powder coated, epoxy coated or plastic coated. Hanger rods and associated bolts, and clamps on Unistrut assemblies are not required to be painted or coated.

All damaged or rusted steel pipe, all uncoated cast iron pipe, and all hangers, Unistrut and other support assemblies, must be cleaned, primed and painted with two coats of compatible black enamel paint as specified below. Any rusted items must have the rust removed, then etched and primed for painting as recommended by the respective manufacturer. After prepping the surfaces, then paint with two coats of compatible black, rustproof enamel paint. Do not use spray paint.

All paint and coatings must have a fire hazard rating not to exceed 25 for flame spread and 50 for fuel contributed and smoke developed as determined by ASTM E84. See specification section, "Identification" for additional requirements.

In lieu of painted surfaces as specified hereinbefore, the Contractor may provide factory fabricated hangers and Unistrut assemblies with rust resistant powder coating, epoxy coating or plastic coating. All paints/coatings/finishes must meet or exceed a fire hazard rating not to exceed 25 for flame spread and 50 for fuel contributed and smoke developed as determined by ASTM E84.

4.3. **Hangers at Typical Single Suspended Horizontal Pipe:** Galvanized adjustable clevis or split-ring type equal to Elcen Fig. 12 or 10c. Refer to Coatings and Finishes above for additional requirements. See other specifications and plan details for additional requirements. See part “Hanger Rods” below for limitations on use of clevis hangers.

Do not use clevis hangers for refrigerant piping. See refrigerant piping support requirements in Section 15700, Refrigerant Piping and Accessories.

Where in contact with bare copper pipe provide same assembly except it must

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be copper, continuous-thread rod, nuts, and washers made of copper-coated steel.

4.4. **Manifolds and Parallel Runs:** At his option, Contractor may provide a Unistrut system complete with fittings, clamps and accessories required and specified. Horizontal and vertical mounted piping must all be secured to each Unistrut hanger assembly. Refer to the plan details and specifications for requirements. Refer to Coatings and Finishes above for additional requirements. Refer to "Hanger Rods" below for locations that require a Unistrut assembly. Furnish for review proposed system components.

Where in contact with bare copper pipe provide same assembly except it must be copper, continuous-thread rod, nuts, and washers made of copper-coated steel.

Unistrut assemblies must also be provided for refrigerant piping. Refer to Section 15700, Refrigerant Piping and Accessories for requirements.

4.5. **Spacing:** Install supports as required or specified to prevent sags, bends or vibration. Provide additional building supports and attachments where support is required or specified for additional concentrated loads, including valves, in-line pumps, flange guides, strainers, expansion joints and at all changes in direction of piping.

At no-hub pipe, support as specified below for cast iron piping.

In all cases, provide on all sides of, and within 12 inches of, all elbows, take-off fittings, joints, valves, any change in direction of item supported, at ends of branches over 5 feet long and on centers not exceeding the following:

Piping Material	Pipe Size	Maximum Spacing
Copper Piping/Tubing (Water)	1 1/4" or less	6 ft. Horizontal 8 ft. Vertical
	1 1/2" or larger	8 ft. Horizontal 8 ft. Vertical
Refrigerant Piping	All	8 ft. Horizontal 6 ft. Vertical
Cast Iron	All	4 ft. Horizontal 12 ft. Vertical
Steel Natural Gas Piping (Including Roof Mounted Piping)	1/2" to 1"	6 ft. Horizontal 6 ft. Vertical
	1-1/4" or larger	8 ft. Horizontal 8 ft. Vertical

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Where horizontal cast iron pipe is installed in 10ft. lengths, spacing must be increased to 9 ft. In addition to specified cast iron support requirements, provide additional support for cast iron pipe within 6" of each fitting on all sides of the fitting.

PVC	All	4 ft. Horizontal 8 ft. Vertical

Where vertically installed piping is provided, a guide must be installed midway between the specified/required vertical supports, at the base of each riser and at each floor. Such guides must prevent pipe movement in a direction perpendicular to the axis of the pipe.

4.6. **Protection of Physical Damage for Piping:** In concealed locations where piping is installed through holes or notches in studs, joists, rafters or similar type members, the pipe must be protected by shield plates. Protective steel shield plates having a minimum thickness of 0.0575 inch (16 gage) must cover the area of the pipe where the member is notched, drilled or bored, and must extend not less than 2 inches above sole plates and below top plates.

4.7. **Hanger Rods:** Must be mild steel, hot dipped galvanized, threaded as required. Rods must be selected as specified hereinbefore. Use not smaller than 3/8" rods for pipe 2" and under, 1/2" rods for pipes 2 1/2" through 4", 3/4" rods for 5" through 12" and 1" rods for piping over 12". Support rods with threaded Underwriters listed inserts, expansion shields or beam clamps must be all galvanized. Beam clamps must be equal to Elcen Fig. 34 or 36 with rod and eye end.

Where in contact with bare copper pipe provide same assembly except it must be copper, continuous-thread rod, nuts, and washers made of copper-coated steel.

At bar joists, support from bottom chord at panel points. For piping over 6" provide supplemental steel angle supports and welding to span 3 joists when running parallel to joists and welded angle between two panel points for piping running perpendicular to joists. Concrete inserts must be equal to Grinnell Figure 282.

Wherever piping hanger support rods heights exceed 36" length from top of the supported item to the structure above, Contractor must provide a Unistrut support assembly and bracing of the assembly with minimum 1"x1"x1/4" angle iron or as required for the weight of the supported item, whichever is greater, and anchor to structure above to prevent swaying. Assembly must be welded at the connection to Unistrut and building structural assembly. Follow welding procedures set forth in the structural division of the specifications.

4.8. **Bracing:** Where hanger rods heights exceed 36", provide sway bracing as specified above in "Hanger Rods". Bracing must be provided at each Unistrut assembly and attached to the building structural system.

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4.9. **Approved Equivalents:** Grinnell, Elcen, Stockham or Crane will be accepted.

PART 5. IDENTIFICATION REQUIREMENTS

5.1. **Identification: All of the above ceiling identification specified must be completed prior to the above ceiling site visit. All remaining identification must be completed prior to the final site visit.**

The Engineer will cancel on-site, the site visit if not completed as specified. Failure to comply with this provision will be cause for cancellation of the site visit, and a fee imposed for the additional site visit, with all costs of the additional site visit to be borne by the Contractor.

All identification must follow the nomenclature used on the plans.

All equipment, smoke detectors, fire dampers, equipment filter access locations, access panels, access doors, motor starters, disconnects, thermostats, humidistats, sensors, valves, trap primers, control systems components, switches, all built-up air handling unit access doors and any other items or devices which cannot be readily identified by the Architect, Engineer or Owner and his personnel, must be equipped with engraved laminated plastic nameplates, as described below.

All filter access locations' identification must include the size and number of filters required for each specific piece of equipment.

Identify all access openings/panels/doors to indicate item for which access is provided. Ex. Motorized damper, fire damper, smoke detector, filters, valves, coils, etc. Additionally, add the following to each access identifier: "***ACCESS - DO NOT BLOCK***."

All above ceiling identification must have a corresponding engraved plastic label identifier neatly attached to the ceiling grid below the aforementioned equipment, item, valve, access door, etc. Attach to the ceiling grid with permanent adhesive. The engraved plastic labels background must match ceiling grid color with contrasting black or red letters as desired by the Architect. The label must have engraved on it the item being identified and its designation as shown on the plans, valve chart, etc. Refer to Section "Identification" below for additional requirements.

Engraved equipment designation and numbers must be as shown on the Mechanical and Plumbing drawings on the upper half of tag, leaving lower half of tag for future engraving by Owner. Where equipment is typed (HP-A, HP-B, EF-A, etc.) rather than numbered (HP-1, HP-2, EF-1, etc.) the tag must include the room number(s) of the area served. Room numbers must be designated by the Owner. In absence of Owner's room numbers, numbers must be as indicated on the architectural plans.

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Identify all piping, including refrigerant suction lines, refrigerant liquid lines, refrigerant hot gas reheat coil lines, condensate drainage piping located in concealed areas above ceilings and exposed to view in finished spaces, all water piping, fire sprinkler piping, gas piping, jacket of all insulated pipe and all pipe exposed to view and/or accessible through removable ceilings, attics, access panels, etc... Sanitary vent piping above the ceiling, in chases and similar areas, and condensate drainage piping on the floor in mechanical rooms or located outside, are not required to be identified **except that all sanitary vent piping associated with an acid resistant waste and vent piping system must be identified**.

Identification must be visible from all sides of the piping, bear name of pipe contents and show direction of flow. Install identification within 12" of all flanges, valves, fittings, elbows, change in piping direction, at each branch take-off, both sides of floor and wall penetrations, and along all straight runs of pipe not further apart than 15 feet. In the case of natural gas systems, the identification must also indicate pressure of the pipe contents.

Gas piping identification must be provided as specified above except intervals must be a maximum of 12 feet for straight runs of piping. Identification must indicate direction of flow and pressure of piping contents and placed at intervals and locations specified. See plan notes for special identification requirements for gas piping at electric generator.

Piping identification must be provided over every space, including small areas (closets, storage rooms, etc.) above accessible ceilings. All piping identification must be installed such that the Owner or maintenance personnel can remove any ceiling tile and visually identify any overhead piping with the specified identification markers.

Pipe labels must be flat wrap-around markers that completely surround the pipe. The markers' colors, designations, etc., must comply with IBC/IPC/IMC requirements, ANSI/ASME Standard A13.1 and ANSI Z535.1, current editions. Markers must be Seton "Snap-Around" or Seton "Strap-Around" pipe line markers, Marking Services Inc (MSI) Series MS-970, Kolbi Pipe Marker Co., Brimar or approved equivalent. **Stick-on, painted, stenciled or hand written type identification is not allowed.**

Fit all Plumbing dielectric unions, all gas valves and plumbing valves (except equipment service valves and sprinkler valves) with a custom laser engraved brass valve tag at each valve and dielectric union and include on the specified valve chart. Tag must be 1-1/2 inches in diameter, 18-gauge polished brass tags with 3/16-inch chain hole and 1/4-inch-high stamped, black-filled service designation. All gas valve identification must indicate gas pressure, including the entering and leaving side of all gas pressure regulators, as applicable. Number tags in sequence, starting with number 1; prefix the number with "P" for plumbing items. After numbering plumbing valves, also indicate valve numbers on the record/as-built drawings.

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Fit all Fire Protection valves with engraved laminated plastic valve tags firmly secured with brass jack-chain and S-hooks to valve yoke or stem (not handles) or adjacent pipe. Fabricate tags as 4" x 3" x 1/16" white plastic with beveled corners, engraved both sides with 1/2" high x 1/4" stroke red letters and numerals. After numbering all fire protection valves, also indicate valve numbers on the record/as-built drawings.

Provide a valve chart laminated and framed which shows the valve number and location of each valve and dielectric union, and type of service of each valve (Cold water, hot water, hot water circulating, natural gas, air, etc.). Locate a valve chart in each water heater room and each janitor closet. Permanently attach each chart to the wall as directed by the Architect. All valves' numbers must also be shown on the Record drawings. Include a copy of the valve chart and the record drawings with the valves and dielectric union identification in the Owner's Operation and Maintenance Manuals.

In addition to valves identification specified above, provide an engraved laminated label, of the type specified above, and glue to the ceiling tile grid below the valve for each valve concealed from view. Where there is more than one valve located within a span of eight (8) feet, above the ceiling, it is not necessary to provide multiple identifiers on the ceiling grid. It will be acceptable to place a single identifier on the ceiling grid reading as, "Water Valves". Each valve above the ceiling is still required to have its own individual valve tag and identified on the specified valve chart. Example: Over the toilets ceiling, there may be multiple shut-off valves to each individual fixture instead of to a bank of fixtures. Where there are multiple valves for each fixture, the Contractor may attach a single identifier on the ceiling grid that states, "Water Valves", or similar description. Thereafter, each individual valve above the ceiling still requires its own engraved valve brass tag as originally specified. The intent is to NOT have multiple individual identifiers for each valve exposed to view on the ceiling grid and thereby creating an undesirable appearance.

Access openings/panels/doors to all items requiring access must be permanently identified on the exterior of the access panel and on the ceiling grid below by a label having letters not less than 3/4" in height and reading: ***"XXX – DO NOT OBSTRUCT ACCESS"*** where "XXX" is the item requiring access.

Permanently affixed warning labels must be attached to all equipment, inside the facility and outside of the facility, on a highly visible location on the equipment, which can be automatically started. The warning label must read as follows: ***"CAUTION!! This equipment is operating under automatic control and may start or stop at any time without warning. Place disconnect switch in the "OFF" position before servicing or attempting to work on equipment."***

Permanently affixed warning labels must be attached to all motor starters and all control panels which are connected to multiple power sources utilizing

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separate disconnect switches. The warning labels must read as follows: ***"THIS EQUIPMENT IS FED FROM MORE THAN ONE POWER SOURCE WITH SEPARATE DISCONNECTS. DISCONNECT ALL POWER SOURCES BEFORE SERVICING OR WORKING ON THIS ITEM"***

Provide signage on each access point to the UV-C lights and on each side of the unit. Signage materials and methods must be as specified below, white letters with red background. Do not use the UV-C Manufacturer provided signage.

Warning signage must read as follows: ***"DANGER!! UV-C LIGHT SOURCE! UV-C RADIATION CAN CAUSE SEVERE BURNS OF THE SKIN AND EYE INJURIES. DISCONNECT POWER BEFORE SERVICING UNIT OR UV-C LIGHTING!"***

Identify the UV-C lighting redundant shut-off switch specified in Section 15700. Signage materials and methods must be as specified below, white letters with red background.

UV-C lighting redundant shut-off switch signage must read as follows: "***UNIT XX-YY UV-C LIGHTING REDUNDANT SHUT-OFF SWITCH."*** XX denotes the unit, and YY is the unit number or type, all as scheduled on the plans.

Labels must be Norplex-Micarta stock meeting ASTM D709, a minimum of 3" x 3" x 1/8" thick, laminated plastic labels (larger if needed) with engraved, all caps, 3/8" high, 1/8" stroke letters for thermostats, CO2 sensors and similar control devices in the finished space and 6" x 4" x 1/8" thick, laminated plastic labels (larger if needed) 3/4" high x 1/4" stroke numerals and all capital letters to identify all items furnished under Division 15 specifications, to include all warning signage, access panels, equipment and all other items above the finished ceiling requiring identification.

Labels attached to the ceiling grid must be the same width as the ceiling grid to which it is attached. Properly adjust lettering height to fit within the smaller width label. Labels color on the ceiling grid must match the ceiling grid and be provided with contrasting black or red letters as desired by the Architect.

All items above the ceiling or in mechanical rooms, attics, mezzanines and similar type spaces must be red with white lettering.

Where the tag, label or marker occurs in a plenum (return air) space, the material employed must carry a Class A Flame Spread Rating per ASTM E84. If the material does not meet the Class A Flame Spread Rating per ASTM E84, provide custom laser engraved, 0.029" thickness, red, 316 Stainless Steel with white letters. Sizes, letter heights, etc., and colors must be as specified for the laminated plastic labels specified hereinbefore.

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Gas piping identification must be provided as specified in this Section 15010, Identification, except intervals must be a maximum of 12 feet for straight runs of piping.

All exterior and interior fire protection and natural gas piping, fittings, etc., must be clean and rust free when installed. All exterior and interior gas piping exposed to view piping in finished and unfinished areas must be painted. Gas piping concealed above the ceiling or in partitions is not required to be painted unless it is rusted. Where piping, fittings, etc., are rusted, all rust must be removed and then pre-treated with acidic etching primer specifically manufactured for the piping installed. Apply two coats of a compatible base and rustproof enamel paint. Rusted portions of piping, fittings, etc., in attic and other concealed areas must be painted black after prepping for paint. Do not use spray paint. Gas piping that is exposed to view must be painted with colors in accordance with IBC/IPC/IMC requirements and ANSI Standard A13.1, current edition. After piping is painted, identify with pipe markers and tags as specified hereinbefore.

All piping exposed to view in unoccupied finished spaces, mechanical rooms, plumbing chases, housekeeping and similar spaces, and jacket of insulated piping exposed to view in mechanical rooms, janitor/housekeeping and similar type spaces must be painted with two coats of compatible enamel paint in accordance with IBC/IPC/IMC color requirements and ANSI Standard A13.1, current edition. Do not use spray paint. After piping is painted, identify with pipe markers, valves tags, etc. as specified hereinbefore.

Exposed piping and the jacket of insulated piping in occupied finished spaces must be painted with two coats of compatible enamel paint, with color selected by the Architect.

Painting of the jacket of the insulated piping is not required where a protective aluminum jacket is specified and provided. Provide identification markers as specified hereinbefore on piping with aluminum jacket. Refer to Sections 15400 and Section 15700 for piping requiring aluminum jacket.

5.2. **Refrigerant Piping Identification: All refrigerant piping must be identified**. The pipe identification must be located at intervals not exceeding 15 feet on the refrigerant piping or pipe insulation. Provide piping identification over every space, including small areas (closets, storage rooms, etc.) above accessible ceilings. All piping identification must be provided such that the Owner or maintenance personnel can remove any ceiling tile and visually identify any overhead refrigerant piping with the specified identification markers. Minimum height of the lettering of the identification label must be 3/4".

IMC 1109.2.7 requires that the identification must indicate the refrigerant designation and safety group classification of refrigerant used in the piping system. For Group A2, A3, B2 and B3 refrigerants, the identification must also include the following statement: "***DANGER - Risk of Fire or Explosion. Flammable Refrigerant***." For any Group B refrigerant, the identification must

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also include the following statement: "***DANGER - Toxic Refrigerant***."

Basic identification for all refrigerant lines to and from all of the various split systems must be identified as specified above. Refrigerant piping identification must use the nomenclature on the plans for the specific unit it identifies. Where equipment is typed (HP-A, HP-B, F-A, F-B, etc.) the piping identification must include the room number of the space the respective unit serves. Ex. An HP-A that serves Classroom 102A must be identified as "Refrigerant Suction Line HP-A Rm. 102A", "Refrigerant Liquid Line HP-A Room 102A" and "Refrigerant HGRHC Hot Gas Line HP-A Room 102A" as required.

Due to the complexity of the required identification, the piping may require multiple, side by side identification wrap arounds.

Custom factory fabricated refrigerant piping labels are required. Stick-on, painted, stenciled or hand written type identification is not allowed.

5.3. **Natural Gas Pipe Painting and Identification:** Gas piping identification must be provided as specified in this Section 15010, Identification, except intervals must be a maximum of 12 feet for straight runs of piping.

All exterior and interior gas piping, fittings, etc., must be clean and rust free when installed. All exterior and interior exposed to view piping in finished and unfinished areas must be painted. Gas piping, related fittings, etc., which are concealed above the ceiling or in partitions are not required to be painted unless it is rusted. Where any part of the gas piping is rusted, regardless of location, the rust must be removed and then pre-treated with acidic etching primer specifically manufactured for the piping installed. Apply two coats of a compatible base and two coats of compatible rustproof enamel paint. Rusted portions of gas piping, fittings, etc., in attic and other concealed areas must be painted black after prepping for paint. Do not use spray paint.

Color for the exterior piping and all piping in all mechanical rooms and similar locations where the piping is exposed must comply with IBC/IPC/IMC requirements and ANSI Standard A13.1, current edition. After gas piping is painted, identify with pipe markers and tags as specified.

PART 6. MISCELLANEOUS REQUIREMENTS

6.1. **Materials and Equipment:** New and of best quality in every respect. Pipe and fittings must conform to the ASTM Standard designated for pipe of each material. Equipment must bear Underwriters Laboratories Inc. (UL) listing label, Canadian Standards Association (CSA) listing label or ETL approved rating.

All electrical components and products must also comply with the respective Code of Federal Regulations (CFR). All pressure vessels must be constructed and tested in accordance with applicable ASME Codes and must bear ASME

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stamps unless specified otherwise. Minimum pressure rating must satisfy job conditions.

All equipment must be provided by the same manufacturer throughout the project. No mix matching of equipment Manufacturers is allowed. Where units of the same class of equipment are required or specified, these units must be products of a single manufacturer, however, the component parts of each unit need not be.

No materials or products that contain asbestos, formaldehyde, lead or mercury, in excess of limits mandated and defined by OSHA, LEED and the EPA, must be utilized.

Where conflicts occur between a Code, Standard, Listing and the contract drawings or contract specifications, the most stringent requirements must govern and be applied.

6.2. **Workmanship:** Workmanship must be first class, premium and in accordance with superior practice. Work must be executed by experienced mechanics and must present a neat and professional appearance. Exact location of pipe, duct, equipment, etc., must be determined in field, considering work of other trades. Do not attach any items to other trades' assemblies. Items must be separately attached to the building structural system.

Lines required to be sloped have the right of way over those not required to be sloped. Lines whose elevations cannot be changed have the right of way over lines whose elevations can be changed. Lines and equipment whose locations are dimensioned have precedence over lines and equipment not dimensioned.

Except in unfinished areas and where specifically indicated on the drawings or approved in writing, ductwork, piping, conduit, wiring, and similar items must be concealed in the construction.

Pipe must be clean, cut clean, properly reamed, threaded or soldered, erected plumb and secure. Make changes in pipe size by reducing fittings without the use of bushings. Install all items in accordance with manufacturer's recommendations. Absolute coordination is required with the other Contractors on the project before proceeding with installation of any system or item.

At all stages of installation, protect pipe openings, floor drains, hub drains, fixtures, ductwork, condenser coils and equipment against the entrance of foreign materials and from damage by the elements, mortar, concrete, paint, etc. Plugs of rags, wool, cotton, waste or similar materials are not acceptable.

If air moving equipment must be used during construction, temporary filtration media with a Minimum Efficiency Reporting Value (MERV) of 11 must be installed at each return air grille, return air register, exhaust grille, exhaust register, and unit return air inlet. ALL open portions of ductwork and equipment must be covered with self-adhesive film (not Visqueen) or airtight sheet metal

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caps to prevent the intrusion of contaminates.

All equipment openings, duct openings, duct take-offs, etc., must be protected immediately after the tap, take-off, opening, etc. has been fabricated in the field. In effect, there must be no ductwork opening or equipment opening that is exposed to the ambient air. The material must be a minimum of 3 mils thick and have a minimum tensile strength of 10 psi. It must be waterproof and recyclable. Material must be DuroDyne Dyn-O-Wrap or approved equivalent.

Where bare sheet metal is delivered unassembled to the job site, all ductwork must be covered and protected with Visqueen. After fabricating the duct in the field, the interior bare metal must be wiped clean with a clean damp cloth before installing in the field. After installation, the duct must be protected as specified above. Any ductwork discovered to be unprotected as specified is subject to immediate rejection for use on this project.

6.3. **Testing Documentation:** Throughout the Division 15 specifications, there are various tests required and specified. Provide the Architect written certification and results of all tests specified, including those indicating failure. The absence of written testing certification and results will be considered the same as if testing was never done. Include all testing documentation in the Operating and Maintenance Manuals.

6.4. **Factory Finishes:** Furnish to the Architect, color cards for standard and premium colors available. The Architect must select color where choices exist. Provide Manufacturer's standard color where color choices are not available. Coordinate all color selections with appropriate Architectural specification sections.

6.5. **Expansion:** Provide for expansion and contraction of all piping, ductwork, etc. and make proper provisions so that excessive strain will not occur on piping, ductwork or other parts. Provide flexible connections for all piping and ductwork at all building expansion joints.

6.6. **Safety Provisions:** Provide covers or guards on all hot, moving, projecting items and at any other location that could be construed by the Engineer, Owner or Architect as a hazard.

6.7. **Cleaning and Adjusting:** Upon completion of work, clear all drains, traps, fixtures, ducts and pipe. Adjust all valves, remove rubbish and leave work in clean and excellent operating condition. Clean and polish all floor drains, floor and wall cleanouts, wall hydrants and any other exposed metal objects.

Install final permanent type filters only after cleaning of building is completed.

6.8. **Escutcheons:** Where pipes pass through cabinets, walls and ceilings of finished rooms provide one-piece, cast-brass type with polished, chrome-plated finish and setscrew fastener or stainless steel type securely fastened in place. Do not use split ring type escutcheons.

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Pack penetrations with mineral wool insulation, seal with firestopping compound and install escutcheons to prevent passage of fire, smoke and vermin.

6.9. **Delivery and Storage:** All equipment and materials delivered and placed in storage must be protected from the weather, humidity and temperature variations, dirt and dust, and other contaminants. See Section 15700 and this Section 15010 for additional requirements for ductwork and equipment.

6.10. **Dielectric Isolation:** Provide dielectric isolation where dissimilar metals are joined, at supports, etc. For pipe sizes 2" through 6", copper piping flanges must be drilled to ANSI B 16.5 150/125 Standard and powder coated, with an EPDM insulator adhered to the plate steel flange protruding inside of the steel flange to prevent contact with the copper flange adapter. The copper component of the flange adapter must be Third Party Classified by Underwriters Laboratories, Inc. Minimum working pressure must be 300 psi at 272°F.

6.11. **Miscellaneous Bonding/Grounding of Metallic Items:** Wherever any bare metallic piping, conduit, structural elements or any other metallic assembly is in contact with externally insulated duct or bare sheet metal duct, bonding/grounding must be provided. The Contractor must provide 1/2" thickness, unslit AP Armaflex insulation of sufficient inside tubular diameter to snuggly and completely cover the respective metallic item. The insulation must extend the full length of the affected area. Where channel shapes are used, orient the open side of the Unistrut assembly down. Materials that are not supported by Unistrut, sheet Armaflex may be used provided it is properly attached to the duct or affected items. Refer to Section 15700, Part "Pipe and Miscellaneous Insulation Work" for AP Armaflex material specification.

END OF SECTION

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SECTION 15400

PLUMBING

PART 1. GENERAL & MISCELLANEOUS

1.1. **General Provisions:** Section 15010 is applicable in full hereto. No building materials or products that contain asbestos, formaldehyde, polychlorinated biphenyl (PCB), lead or mercury, in excess of limits mandated and defined by OSHA, LEED and the EPA, must be utilized.

Do not fabricate, or install, any pipe or equipment until all coordination has been accomplished. Refer to Section 15010 for coordination requirements.

1.2. **Qualifications:** The Plumbing Contractor and the required third party Insulation Contractor must be properly licensed and established at the location of the work and must maintain locally adequate service facilities. They must have had previous experience in the satisfactory installation of at least six (6) systems of this type, size, complexity and scope.

1.3. **General Scope:** Include all equipment, material and labor required for a complete operating plumbing system even though every item involved is not indicated. Refer to architectural drawings and verify all plumbing fixture's locations and mounting heights. Notify the architect prior to bidding of any discrepancies. Do not attach any items to other trades' assemblies. Items must be separately attached to the building structural system.

The Plumbing Contractor must not install the piping insulation. All piping insulation work must be provided by a third party licensed and experienced insulation subcontractor whose primary business is the sale and installation of insulation materials in accordance with the insulation manufacturers' recommendations and these specifications. **The insulation sub-contractor must provide a complete insulation submittal on his company letterhead detailing materials and methods as specified. The plumbing submittal will be automatically rejected and not be reviewed without a submittal from the specified insulation sub-contractor.**

Advisory provisions listed in all Codes referenced in the Contract Documents are mandatory. Codes are minimum requirements. Where conflicts occur between a Code, Standard, the contract drawings or these specifications, the more stringent requirements must govern and be applicable.

Manufacturers not mentioned in the specifications require prior approval, seven (7) days prior to bid date. Follow procedures set forth in Division 1 and Section 15010 of the specifications. All prior approvals must be submitted through the Architect.

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Arrange and install piping systems sizes as shown, as close as practical, straight, properly supported and run as directly as possible forming right angles or
running parallel with building lines, true to line and grade, free of sags and bends. Locate piping as high as practical and in parallel groups as close together as practical.

All penetrations of floors and partitions are required to be built-in as work progresses. All penetrations of new construction that were not built-in as required by these specifications, and all existing floors, walls and existing partitions must be core drilled or sawcut large enough to allow all conduits, piping, firestopping assemblies, etc., to continue uninterrupted, and to provide proper firestopping of the penetration as required to install new items as shown and/or specified.

All piping must be clean and rust free when it is installed. Before installation, it must be checked, upended and swabbed. All rust or dirt from materials in storage or from lying on the ground must be removed. Any dirty piping installed must be cleaned. Any rusted piping must have the rust removed, etched and primed for painting as recommended by the respective piping manufacturer, and then painted with two coats of black, compatible, rustproof enamel paint. Do not use spray paint. Refer to gas piping specification for requirements of gas piping painting. The paint must comply with the requirements of ASTM E84 for flame spread and smoke development.

The Plumbing Contractor must take as-built measurements, including all depths, inverts, etc., prior to commencement of backfilling operations. It must not be sufficient to check offline locations. Definite measurements must be taken for each line entering and leaving the facility. **The location of buried piping must be shown on the record drawings and dimensioned from fixed points**.

1.4. **Provision For Future Expansion And/or Installations:** Where piping and equipment are indicated for use in future expansion of the building and/or for future installations within the building, the Contractor must leave sufficient clear space and install the piping and equipment in such manner that connections to the future building expansion and/or future installations within the building can be made without removing existing floors, walls, ceilings. The Contractor must consult with the Architect whenever necessary for this purpose. Any piping stub-outs provided for future connections must be arranged so that “dead legs” (i.e., pipe sections where there is no water circulation) are prevented. The termination points of any piping stub-out must be as close to the main piping flow as physically possible. Where future branch lines must extend a distance greater than six (6) branch line pipe diameters or more than 18” from the main piping flow, a valved drain port or blind flange with a valved drain must be provided at the end of the branch piping to allow periodic flushing.

1.5. **Record Documents:** Provide in such detail, as is set forth under General and Supplemental Conditions and in Section 15010. **Note that the Plumbing Contractor must take as-built measurements, including all depths, inverts, etc., prior to commencement of backfilling operations. It must not be sufficient to check offline locations. Definite measurements must be taken for each line entering and leaving the facility. The location of buried**

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piping must be shown on the record drawings and dimensioned from fixed points. Also, show locations of all dielectric unions, cleanouts and all valve numbers on the record documents.

1.6. **Access Panels and Doors in Finished Areas:** Do not locate serviceable items above inaccessible, hard ceilings or in partitions without written approval from the Architect. Coordinate all items locations with the Architectural plans before installing any items. Furnish access panels and doors to the General Contractor for installation wherever required for access or maintenance to any items including but not limited to valves, controllers, actuators, trap primer assemblies, water hammer arrestors, air vents, cleanouts, etc.

Access panels/doors in finished areas or areas exposed to view must be suitable for wall or ceiling finish involved, 24" x 24" unless otherwise indicated or as required to permit removal of equipment and provide acceptable maintenance access. Access panels and doors must be fire rated where rated assemblies are penetrated.

Access panels and doors must be manufactured by Milcor, Elmdor, Zurn, Mifab or approved equivalent. The Architect must approve the use of, and type of, all panels and doors to be installed in areas that are exposed to view or in finished areas.

Access panels/doors exposed to view and in finished spaces must be factory cleaned and primed for painting in the field. Colors must be selected by the Architect. Refer to Architectural Section, Painting, for additional information.

For detention and similar institutional type facilities, refer to Section 1122 for type of access panels/doors required.

Refer to Section 15010, Part Access Panels and Doors for additional requirements.

1.7. **Warranty:** Guarantee work as set forth in Section 15010 and Division 1. Guarantee in writing to make good without cost any defects in materials and workmanship for one year following the date of substantial completion of the project as determined by the Architect, unless specified otherwise. Flush valves and faucets must be provided with a complete replacement, including labor, and a five year guarantee in the event of failure. Provide free maintenance and service during the guarantee period. Refer to other parts for additional requirements and extended warranty requirements.

1.8. **Site Visits:** It is the contractor's responsibility to have the job ready for site visits when they are scheduled. If the project is not ready for the requested site visit and the Architect, any governmental agency or any other entity requires an additional site visit with the Engineer present, the contractor must pay Zgouvas, Eiring & Associates a re-visit fee of $2,000. The payment must be made directly to Zgouvas, Eiring & Associates 5 days prior to the scheduled site visit.

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The Contractor is urged to carefully review the extensive requirements of Part "Identification" in Section 15010 of the specifications and note that certain identification **is required to be completed before certain site visits. There are specific identification requirements prior to the above ceiling and final site visits, respectively, that are mandatory. The Engineer will cancel on-site, the site visit if not completed as specified. Failure to comply with this provision will be cause for cancellation of the site visit, and a fee imposed for the additional site visit, with all costs of the additional site visit to be borne by the Contractor.**

1.9. **Governmental Inspections:** The Plumbing Contractor must arrange and pay for the State of Alabama Boiler and Pressure Vessel Safety Division/Inspection Divisions, Elevators/Boilers Inspector to visit job site to inspect water heater and/or boiler installation and obtain written approval, certification and Certificate for Potable Water Heater (PWH) as required. The written approval, certification and Certificate for Potable Water Heater (PWH) must be provided and be attached to the respective item prior to the date of the final site visit. Failure to provide the aforementioned requirement prior to the final site visit will be cause for cancellation of the site visit by DCM and a reinspection fee imposed.

Correct all deficiencies required by the Inspector without additional cost to the Owner or the Owner's Project Design Professionals, using materials and methods, as directed by, State of Alabama Boiler and Pressure Vessel Safety Division/Inspection Divisions and Elevators/Boilers inspector as required.

1.10. **Miscellaneous:** Bidders must visit the site and become acquainted with all job conditions that may affect the work shown on the plans. Report to the Architect, prior to bid, any new or existing conditions that require modifications to accomplish the installation of all items. Provide for required adjustments to complete the intent of the work. No consideration will be given after bid opening for alleged misunderstanding regarding new or existing job conditions, utility connections, permits, fees, construction documents, etc.

The Contractor must carefully examine the contract documents during the bidding phase. Any missing information, clarifications, etc. in the contract documents that is required to provide accurate pricing must be brought to the attention of the Architect, **prior to bid date**, so all may be clarified and/or corrected. Failure to identify and resolve any issue prior to bid must require the Contractor to provide said items, complete, without additional cost to the Owner or the Owner's Project Design Professionals, using materials and methods specified by, and as directed by, the Owner's Design Professionals.

Refer to Section 15010 for additional requirements.

1.11. **Spare Parts:** Manufacturer of any equipment specified must have a wholesale outlet for readily available replacement parts in the nearest major USA city.

1.12. **Electrical Work:** All electric power wiring required for installation of equipment under this Section is specified under the Electrical Division. The Plumbing Contractor must furnish and install all controls and control wiring as specified or

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required to properly complete the installation. Control conduit is specified under the Electrical Division or shown on electrical drawings; all other control conduit must be provided under this Section of the work.

All control conduit, power wiring, relays, transformers, contactors, etc. which are required and are not shown on the electrical drawings or specified in the Electrical Division of the specifications, must be provided under this Plumbing Section.

Coordinate all requirements with the Electrical Sub-Contractor prior to bid. Electrical work performed under this Section must meet the requirements set forth in the Electrical Division and the National Electric Code (NEC), current edition.

1.13. **Submittals:** Refer to Section 15010 for **strict requirements** and, especially as it applies to format, project cost constraints, addendums and Value Engineering (VE) items.

Only ONE complete submittal will be accepted for review. Providing submittals piecemeal is not allowed. If a partial or incomplete submittal is provided, it must be cause for immediate rejection.

1.14. **Identification:** The Contractor is urged to carefully review the extensive requirements of Part "Identification" in Section 15010 of the specifications and note that certain identification is required to be completed before certain site visits. **There are specific identification requirements prior to the above ceiling and final site visits, respectively, that are mandatory. The State of Alabama Department of Construction Management (DCM) will cancel, on-site, the site visit if not completed as specified. Failure to comply with this provision will be cause for cancellation of the site visit, and a fee imposed for the additional site visit, with all costs of the additional site visit to be borne by the Contractor.**

1.15. **Firestopping:** Refer to Section 15010, Part "Partial Work to be Coordinated With Other Trades", Paragraph "Firestopping". **Note that Division 15 firestopping specifications require firestopping of all penetrations regardless of wall/ceiling/floor construction. Refer to Division 1 regarding additional requirements.** Where there is a conflict between Division 1 specifications and Division 15 specifications, the most stringent requirements must govern, be applicable and must be provided.

1.16. **Motors:** All furnished motors must be designed, manufactured, and tested in accordance with the current applicable standards of NEMA, ANSI, IEEE, and ASTM. As a minimum requirement, all motors must conform to the current applicable sections of NEMA Standard No. MG-1. Motors must meet or exceed The Consortium for Energy Efficiency (CEE) Premium Efficiency full load efficiencies. All motors must be listed under the UL recognized component file as applicable. All motors must be suitable for installation according to the requirements of NEC. Motors must be wound for the specified voltage and a 1.5 service factor, 1750 RPM open drip proof construction unless otherwise

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shown or specified.

All motors must be provided with overload protection and phase protection on all legs. Do not run motors until correct overload elements are installed in starters, as applicable.

All motors serving outdoor equipment exposed to weather must have TEFC motors meeting the requirements set forth previously.

Premium efficient motors must be **warranted for 36 months** from the date of substantial completion of the project, as determined by the Architect. Motors must be by Allis Chalmers, General Electric Goulds, Louis Allis, and Westinghouse or an approved equivalent.

1.17. <u>Operating and Maintenance Manuals</u>: Two weeks before the final site visit, furnish three complete sets of operating and maintenance instructions, bound in hard cover, indexed and tabbed.

The Contractor must also provide this information in digital Adobe Acrobat PDF format, on a CD-R CD. The PDF file must be provided with an embedded index for each specified item. The index must appear in the left hand window of the opened document so that the Owner or his maintenance personnel can “click” on the indexed item and move immediately to that specific item.

Minimum requirements for the Operating and Maintenance Manuals must be as follows:

a. The first page of the bound instructions must be a listing of:

    1. The Owner/Project Title.
    2. The Architect and Architect’s Job Number.
    3. The Engineer and Engineer’s Job Number (Found in the Engineer’s Logo in the Bottom Right Corner of the Plumbing Plans).
    4. The General Contractor and Contact Information.
    5. The Plumbing Subcontractor and Contact Information.

b. Second page must be a Table of Contents listing all products in the order which appear in the specifications and label the tab accordingly. Include all “P” numbers for fixtures, water heater numbers, valves, floor drains, etc.
c. The third page must be a summary page that lists each item with its respective warranty listed, including all extended warranties.
d. All warranty card information must be filled in by the Plumbing Contractor; Serial numbers, Model Numbers, etc. all as required for proper warranty registration. The warranty registration date must be the date of substantial completion as determined by the Architect.
e. Provide copies of all filled in warranty cards.
f. Provide a local source of supply for parts and replacement, including names and telephone numbers of parts suppliers.
g. Provide a general maintenance summary section. Section must be a list of each piece of equipment or device using the designations as shown on the

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plans, and the routine maintenance procedures based on the respective manufacturer's recommended intervals. As a minimum, maintenance must be grouped and individually tabbed to indicate maintenance operations required:

1. Once a month
2. Quarterly
3. Once every six months
4. Once a year

h. Provide drawings of system controls and wiring diagrams and condensed operating instructions. Include hard copy in binder and digital copy on CD in PDF format. All components must be numbered and identified on the diagram. Laminate, frame under plastic and mount in each mechanical/water heater room(s) in an optimally viewed location for the respective equipment.
i. Provide written results of all specified tests.
j. Copies of all Site Visit Reports including Contractor's written response that items listed were corrected.
k. Copies of all certificates of all site visits, comments and approvals from all Governing Authorities, to include all water heater and pressure vessel inspections by the Authority having jurisdiction.
l. Provide domestic water samples testing and results specified.
m. Provide a copy of the valve chart required in Section 15010, Part Identification. Include all dielectric unions on chart.
n. Provide copy of Section 15010 and 15400 Specifications.
o. Provide a copy of all shop drawings/submittals.
p. Provide record drawings of the Plumbing drawings, in hard copy and PDF format on CD. Refer to Section 15010, Part 1, General, Paragraph, Record Drawings for detailed requirements. Record drawings must indicate the valve numbers from the required valve chart, all clean outs and all dielectric unions.

PART 2. TESTS

2.1. **General: Do not test when freezing conditions exist or are anticipated. Test when freezing conditions have subsided.** Perform all tests in the presence of the Architect. Refer to Division One for Fuel, water and power required, therefore. In absence of specific testing procedure comply with code requirements and/or nationally acceptable industry standards. Furnish written reports of all tests results specified to Architect.

Once the tests are conducted as specified below, seal any leaks discovered, and then repeat the testing process until all tests are successfully completed and the systems are fully verified.

2.2. **Drainage and Vent System Pretest: Do not test PVC or any non-metallic piping with compressed air.** A water test must be applied to the drainage system in its entirety. All openings in the pipe must be tightly closed and sealed air tight with cast iron or PVC caps as applicable for the pipe installed, except

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the highest opening. Then, the system must be filled with water to the point of overflow.

If the system is tested in sections, each opening must be tightly closed and sealed air tight with PVC or cast iron caps as applicable for the pipe installed, except the highest openings of the section under test. Each section must then be filled with water. Sections must not be tested with less than a 10-foot head of water. In testing successive sections, not less than the upper 10 feet of the next preceding section must be tested so that no joint or pipe in the building, except the uppermost 10 feet of the system, must have been submitted to a test of less than a 10-foot head of water.

Test pressure must be held for not less than 8 hours. Check all portions for leaks. Correct all leaks and retest. The system must then be tight at all points.

Do not test when freezing conditions exist or are anticipated. Test when freezing conditions have subsided.

2.3. **Drainage and Vent System Final Test: Do not test PVC or any non-metallic piping with compressed air.** A smoke test must be utilized as a final test. It must be made by filling all traps with water and then introducing into the entire system a pungent, thick smoke produced by one or more smoke machines as required to achieve the specified pressure. **Do not test when freezing conditions exist or are anticipated. Test when freezing conditions have subsided.**

When the smoke appears at stack openings on the roof, the stack openings must be sealed air tight with PVC or cast iron caps and a pressure equivalent to a 1-inch water column must be held for a test period of not less than 8-hours. Check all piping visually for smoke leakage and odors and correct all leaks.

The final test of the completed drainage and vent systems must be visual and in sufficient detail to determine compliance with the provisions of the International Plumbing Code.

After fully inspecting the installed piping for mechanical damage and visually suspect joints, use expandable plugs to cap off each section to be tested.

2.4. **Acid Resistant Waste and Vent Piping Test:** Slowly fill piping with water one section at a time, removing all trapped air in the section using air release valves at high points in the system. Once the section is filled with water and all air has been purged, let it sit for at least three hours to allow an equilibrium temperature to be reached, which will minimize thermal expansion effects. Visually inspect the section for leaks. If clear, check for and remove any remaining air in the system. Pressurize the system to a maximum of 10 ft head by means of a standard 10-ft standing water test using a 10-ft vertical riser, or a low pressure hand pump. Leave the system at 10 ft of head pressure for a minimum of 24 hours, during which time the water level must not change for a standing water test, nor should the pressure gauge be reading change for a hand pump test. If there is a drop in pressure or extended times are required to achieve the correct pressure, joint leakage has occurred or there is still air trapped in the piping

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section. In this event, inspect for joint leaks. If none are found, check for trapped air. This air must be removed prior to continuing the test. If joints are found to be leaking, the system must be fully drained, and the joints repaired. Once all leaking joints have been repaired, repeat the test procedure as outlined above until the specified results have been obtained.

2.5. **Water Supply System Test:** Test and secure acceptance of entire system before the piping is insulated or otherwise concealed. **Do not test when freezing conditions exist or are anticipated. Test when freezing conditions have subsided.**

Disconnect and cap all outlets to all plumbing fixtures and all other equipment not designed for the full test pressure. Fill the system with water and prove tight under a water pressure not less than the working pressure of the system; or, for piping systems other than plastic, by an air test of not less than 50 psi. **Do not test plastic piping with air.** This pressure must be held for not less than 10 hours without a loss of pressure.

The water utilized for the test must be obtained from a clean potable source of supply. All piping throughout must be air tight under test. Water piping must remain under normal water pressure during construction except when freezing weather is expected.

2.6. **Natural Gas Piping System:** Test before equipment, appliances, etc. are connected. The test pressure to be used must be not less than 1-1/2 times (1.5x) the proposed maximum working pressure, but not less than 3 psig, irrespective of design pressure.

Where the test pressure exceeds 125 psig, the test pressure must not exceed a value that produces a hoop stress in the piping greater than 50 percent of the specified minimum yield strength of the pipe. The test duration must be not less than 1/2 hour for each 500 cubic feet of pipe volume or fraction thereof.

When testing a system having a volume of less than 10 cubic feet, the test duration must be not less than 8 hours and no more than 24 hours. The piping system must withstand the test pressure specified without showing any evidence of leakage or other defects.

The leakage must be located by means of an approved gas detector or a noncorrosive leak detection fluid. Where leakage or other defects are located, the affected portion of the piping system must be repaired or replaced and retested. The purging of piping systems must be in accordance with the provisions of IFGC 2021, Sections 406.7.1.1 through 406.7.1.4.

2.7. **Fixtures:** Test for soundness, stability of support and satisfactory operation.

PART 3. SANITARY PIPING

3.1. **General Scope:** Provide a system of soil, waste and vent piping connecting all plumbing fixtures, equipment, etc. to the house sewer, with consolidated vent

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connections extending through the building roof, all as shown on the drawings and as required for complete installation. All piping must be concealed below grade, within walls, chases, above ceilings, etc., unless specifically noted otherwise. Waste and vent piping must be sloped in accordance with the applicable codes.

The Plumbing Contractor is responsible for and must consider pipe-grading requirements when coordinating pipe routing for the project. The contractor must determine inverts/connection points in the field based on the shop drawings of the sanitary system submitted. Coordination is required with the Civil Contractor before proceeding.

Do not begin work until the elevation of the final connection point is verified and grading of entire system can be determined (even if final connection is specified under another Section.)

Do not route the sewer line in the same trench as the domestic water line. Maintain a minimum of six (6) feet of separation between the two utilities.

Each pipe length and each pipe fitting, trap, fixture, material and device utilized in the plumbing system must bear the identification of the manufacturer and any markings required by the applicable referenced standards.

Rework existing waste roughing as required to facilitate renovation work as applicable.

3.2. **Utility Connection:** Utility connection is specified under Division 2. Connect to temporarily capped main as indicated on the plumbing plans.

3.3. **Soil, Waste and Vent Piping Underground, Inside the Building Walls, Any Equipment or Item Whose Discharge Into the Sanitary System is Greater than 125°F and to Points Outside the Building as Indicated:** Provide service weight hub-and spigot cast iron soil pipe and fittings for underground service and hubless for above ground service, meeting ASTM A-74 for hub and spigot and ASTM A-888 for hubless, coated inside and out. Pipe exposed within the building must be uncoated outside, primed and left clean for painting. Fittings to receive screwed pipe arms must be recessed drainage type. Soil and waste pipe must have long sweeping connections. All cast iron soil pipe and fittings must be marked with the collective trademark of the Cast Iron Soil Pipe Institute (CISPI) and be listed by NSF International.

Joints for hubless pipe and fittings must be equivalent to MG couplings meeting ASTM A-48 and ASTM C-564, or Anaco Husky SD 4000, super-duty, shielded couplings of Type 304 AISI stainless steel, meeting ASTM C1540 and Factory Mutual 1680, Class 1 and vulcanized virgin compound in which the primary elastomer is neoprene conforming to ASTM C-564. Equivalent by Ideal Tridon Heavy Duty HD (Green) or Charlotte Pipe Heavy Duty HD (Green) are acceptable.

Option: Contractor may use solid wall PVC Schedule 40 DWV pipe and fittings meeting ASTM Standard D2665 and ASTM Standard D1785 for above ground

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service and underground service with the following exceptions. Use cast iron as specified hereinbefore or PVDF (Polyvinylidene Fluoride) piping and fittings in areas used as return air plenums, return air platforms, commercial dishwasher, commercial washer/extractors, steam kettles, any equipment or item whose discharge into the sanitary system is greater than 125°F and when passing through or within a fire rated assembly.

Piping and fittings above the floor must be solid wall PVC Schedule 40 DWV pipe and fittings, cast iron pipe and fittings as specified above or PVDF pipe and fittings as specified below, and with exceptions as noted.

THE USE OF "CELLCORE" OR "FOAMCORE" TYPE PIPING IS EXPRESSLY FORBIDDEN.

PVDF piping and fittings, where specified and required, must be Orion Super Blue PVDF (Polyvinylidene Fluoride) or equivalent products manufactured by Enfield, Zurn, GEO or Fisher. The PVDF material must conform to ASTM D3222 ASTM F1673, ASTM E-84 and UL 723. Pipe must be marked with its UL Classification to indicate compliance with UL723 (ASTM E84). All fittings must meet or exceed Schedule 40 dimensions.

All vents thru roof, regardless of type provided, must be cast iron pipe (minimum 10" both sides of the roof). Secure the cast iron VTR to structure with heavy gauge 1-hole strap. **THE CAST IRON PIPING THROUGH THE ROOF DOES NOT APPLY TO GAS FIRED APPLIANCES. Vents through the roof for gas appliances must be as specified for the appliance in its respective specification section.**

All floor drains must have cast iron deep seal p-traps with trap primer and required connections.

3.4. **Laying Out Work:** Vents from any fixture, when connected to a vent line serving other fixtures, must be extended at least 6 inches above flood level rim of highest of such fixtures to prevent use of vent lines as a waste. Make changes in direction by appropriate use of 45-degree Y's, 1/2 Y's, or long sweeping 1/4, 1/6, 1/8 or 1/16 bends. Sanitary T's or short 1/4 bends may be used on vertical stacks or drainage lines where change in direction of flow is from horizontal to vertical; except that long-radiused, double TY's must be used when two fixtures are installed back-to-back with common drain. Do not use double sanitary T's. Straight T's, Ells and Crosses may be used on vent lines. Make no change in direction of flow greater than 90 degrees. Where different sizes of drainage pipe or fittings are connected, use standard increasers and reducers of proper size. Do not reduce the size of drainage piping in direction of flow. Drilling and tapping of house drains, soil, waste or vent pipes, and use of saddle hubs and bands are prohibited. Route all vent lines high as possible while maintaining proper slope. All plumbing vents **through the roof, regardless of type provided, and EXCEPT FOR NATURAL GAS FIRED EQUIPMENT VENTS, must be cast iron and located a minimum of 10'-0" away from all outside air intakes**. Coordinate all plumbing vent locations with the HVAC plans prior to routing vent piping through the roof.

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3.5. **Grading:** Uniform and not less than 1/8" PLF for pipe 3" and over, and not less than 1/4" PLF for piping less than 3".

3.6. **Hangers and Sway Bracing:** Refer to Section 15010 and plans for requirements.

3.7. **Roof Flashing:** Roof penetrations are to be flashed by the roofing contractor, using materials as recommended by the roofing manufacturer and approved by the Architect. Coordinate work with Roofing Contractor. Offset vents as required to clear gravel guards and flashing courses. Extend vents to 10" above roof level.

3.8. **Waste Arms:** Type K copper or IPS brass pipe typical. Alloy steel or IPS brass pipe at urinals.

3.9. **Escutcheons:** Where pipes pass through cabinets, walls and ceilings of finished rooms provide one-piece, cast-brass type with polished, chrome-plated finish and setscrew fastener or stainless steel type securely fastened in place. Pack penetrations with mineral wool insulation, seal with firestopping compound and install escutcheons to prevent passage of fire, smoke and vermin. Do not use split ring type escutcheons.

3.10. **Test Fittings:** Not shown on the drawings. Provide where required for partial tests.

PART 4. DRAINAGE SPECIALTIES

4.1. **Manufacturers:** Except as noted, catalog numbers are from J.R. Smith and/or Zurn. Equivalents by Josam, Sioux Chief or MIFAB will be considered.

4.2. **Cleanouts:** Provide in sanitary piping at all changes in direction, at ends of branches, at intervals not exceeding 40 feet on straight runs, and elsewhere as shown. Cleanouts must be fully opening type and completely accessible without obstruction. Size same as lines in which they occur, but not larger than 4 inch. Tees and extensions must be of same weight as soil pipe. Plugs must be countersunk or raised head type with lead-free seals. Coordinate with plan details and specifications and provide as required. Provide flashing clamps and flashing flanges in all areas where cleanouts are accessible from floor below or above, as applicable.

Extreme care must be taken when roughing in cleanouts in each wall mounted lavatory and hand sink. Cleanouts must be located within the specified Lav Shield piping cover when possible. All cleanouts must be roughed in high enough to clear the Architectural base molding without cutting the base molding.

All cleanouts must be indicated on the record/as-built drawings.

In Tile Floors: J.R. Smith 4052L, Zurn Model ZN1400-T-BP, adjustable, cast iron body with bronze plug and satin finished square scoriated nickel bronze top. Where soft tile occurs, provide 4172L, Zurn ZN1400-TX-BP, recessed

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square nickel bronze cover.

In Concrete Floors: J.R. Smith 4238L, Zurn Model Z1400-BP, adjustable head, cast iron head and ferrule with bronze plug, round loose-set scoriated tractor cover.

In Outside Lines: J.R. Smith 4262L-NB, Zurn Model Z1474-N-BP, cast iron head and ferrule with bronze plug. Terminate cleanout within 8" of finish grade at grade in 18"x18"x18" deep concrete pad with tooled edges or flush in pavement as applicable. Provide with loose set scoriated bronze tractor cover as shown on the plan details.

In Accessible Unfinished Spaces: J.R. Smith 4400 or 4511-S, Zurn Model ZS1468, cast iron with bronze plug, as appropriate.

In Finished Walls: J.R. Smith 4530S, Zurn Model Z1446-BP cast iron cleanout tee with bronze plug and 16 ga., 304 stainless steel, flat, wall plate cover. Where distance from plug to finish wall exceeds 4 inches provide extension from sanitary tee to bring plug within 2 inches of the stainless steel cleanout cover. rough in all wall cleanouts such that stainless steel cover occurs above the Architectural base. Do not cut Architectural base.

In Terrazzo Floors: J.R. Smith 4192L, Zurn Model ZN1400-Z-BP, adjustable cast iron head and ferrule, bronze plug and round nickel bronze cover and rim.

In Carpeted Floors: J.R. Smith 4032L-X, Zurn Model ZN1400-CM-BP, adjustable head, cast iron, round polished bronze top with carpet clamping device.

4.3. **Typical Drains:** Size outlets same as pipe to which they connect. Install temporary closures during construction. **Each drain connected to sanitary sewer must have cast iron deep seal p-trap with trap primer and required connections.** Provide trap primer connections on floor drains and trap primers as specified below.

Where drains occur above finished spaces, furnish with clamping collar to secure waterproof membrane.

Floor Drain (FD): J.R. Smith Series 2005B-05, Zurn Models ZN415-5S-P, J.R. Smith 2005B-06, ZN415-6S-P, J.R. Smith 2005B-08, ZN415-8S-P (as required) two-piece cast iron drains with gasketed outlet and adjustable nickel bronze strainer and rim. Strainer tops for 2" drains 5" x 5" (ZN415-5S-P), for 3" drains 6" x 6" (ZN415-6S-P), for 4" drains 8" x 8" (ZN415-8S-P). Provide PO5 trap primer connection as indicated on the plans.

Shower Drain (SD): Where not specified with the shower, provide J.R. Smith Series 2005B-05, -06 NBSS, Zurn ZS415SS-P, two-piece cast iron drains with gasketed type outlet and adjustable stainless-steel strainer and rim. Provide clamping collar to secure waterproofing membrane. Strainer tops for 2" drains must be 5" square (Zurn ZS415-5SS-P) for 3" drains, 6" square (Zurn ZS415-6SS-P); and for 4" drains, 8" square (Zurn ZS415-8SS-P).

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Mechanical Room Drain (MFD): J.R. Smith Series 2005G, Zurn Model Z541-P, galvanized cast iron body drain with adjustable strainer head, gasketed outlet, P05 trap primer connection, sediment bucket and cast-iron grate.

PART 5. WATER PIPING

5.1. General Scope: Connect to water main as indicated and extend to all plumbing fixtures, wall hydrants, trap primers, water heaters, etc.; and to all plumbing items as required.

Piping systems must be sloped to drain points. Drain points are not shown on the plans. They must be determined in the field based on the actual system installed. The Contractor must grade pipe upward from source to facilitate drainage and air relief. Where low points are required because of long runs or where sections may be valved off, provide with 3/4" globe valve and hose nipple for drainage at low point.

All piping must be concealed below grade, within walls, chases, above ceilings, etc., unless specifically noted otherwise.

Refer to Section 15010 for hanger rods, hangers, spacing, firestopping, sleeves, uni-strut support assembly, etc., requirements.

5.2. General Workmanship: Cut water piping accurately to measurements established at site and work into place without springing or forcing, clearing all openings, finished ceilings, etc.

All piping not in an accessible attic or similar spaces that contain valves and other items which may require maintenance or service access must be located no more than 12” above the finished ceiling. Piping located in attics must be supported such that maintenance access can be accomplished without the use of a ladder.

In finished spaces where water piping is exposed to view, route piping high as possible. Where valves or other items requiring service or maintenance are shown in piping of finished areas and exposed to view, the piping must be installed high as possible, except where a valve or other item requiring maintenance and service is shown in the line, the item must be no more than 14’-0” above the finish floor. Provide a drop, offset, etc., as required to maintain maximum service height of 14’-0” above the finished floor.

Route all piping through previously built-in sleeves/firestopping assembly as specified in Section 15010. Avoid excessive cutting or other weakening of the building structure. Make changes in direction and size with fittings. Cap or plug open pipe ends during installation to keep out foreign material. Make connections carefully to ensure unrestricted flow, eliminate air pockets, and to permit complete drainage of the systems.

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Supply piping to fixtures, faucets, hydrants, showerheads and flush valves must be anchored to prevent movement.

Install all buried piping with at least 36" of earth cover. Do not route the water line in the same trench with the sewer/sanitary piping. Maintain a minimum of six (6) feet of separation between the two utilities.

Uninsulated pipes passing through concrete or cinder block walls and floors, or other corrosive material must be protected against external corrosion by a protective sheathing or wrapping that will withstand any reaction from the lime and acid of concrete, cinder block or other corrosive material. Sheathing or wrapping must allow for movement including expansion and contraction of piping. The wall thickness of the sheathing material must be not less than 0.125 inch thickness. The protective wrapping/sheathing is not an alternative where sleeves are specified and required. Coordinate requirement with Section 15010 sleeves/firestopping specifications and provide as specified.

All piping below slab-on-grade construction must be installed in plastic jacket equivalent to Plasti-Sleeve, as manufactured by Plastic Products Co. of Stanton, California.

5.3. **Freeze Protection: Do not install piping or any device in spaces subject to freezing.** All water piping must be routed within the building insulation envelope unless specifically noted otherwise. Route all overhead water piping and water piping within masonry and non-masonry walls within the building insulation envelope.

All overhead piping must be located between the architectural air barrier at the bottom of the structure and the finished ceiling. Do not route overhead piping in the attic when it can be located between the architectural air barrier and the finished ceiling.

All water piping shown to be located in exterior perimeter masonry walls must be insulated before being routed within the cells of the masonry block. If block is to be cut to allow for the installation of the insulated piping it must be in strict accordance with the procedures required by the Structural Engineer and the Architect. **Do not allow masonry block cells that contain water piping to be filled with concrete.**

Piping located in exterior stud walls must be located on the warm side of the insulation.

5.4. **Water Piping Insulation:** Refer to Part Pipe Insulation for requirements.

5.5. **Grading:** The Contractor must consider pipe-grading requirements when coordinating pipe routing for the project. All piping must be carefully installed to eliminate traps and pockets in pressurized lines. Where air pockets and traps cannot be avoided, provide valved hose connections for water traps and valved automatic air vents for air traps. The pipe slope must be maintained throughout the project.

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Pressurized plumbing piping systems must be sloped to drain points. Drain points are not shown on the plans. They must be determined in the field based on the actual system installed. The Contractor must grade pipe upward from source to facilitate drainage and air relief. Where low points are required because of long runs or where sections may be valved off, provide with 3/4" globe valve and hose nipple for drainage at low point. **Make all connections to risers and fixtures from top or sides of mains. Do not make take-offs from bottom of mains.**

5.6. **Nipples:** Of same material as pipe in which they are installed. Provide extra strength when unthreaded portion is less than 1 inch long. Steel nipples are not allowed.

5.7. **Escutcheons:** Where pipes pass through cabinets, walls and ceilings of finished rooms provide one-piece, cast-brass type with polished, chrome-plated finish and setscrew fastener or stainless steel type securely fastened in place. Pack penetrations with mineral wool insulation, seal with firestopping compound and install escutcheons to prevent passage of fire, smoke and vermin. Do not use split ring type escutcheons.

5.8. **Piping and Fittings: ProPress or similar type joints and fittings are not allowed.** Typical lines to be of copper tubing meeting ASTM B-88, Type "L" hard above ground and Type "K" soft below ground. Cut copper pipe square and ream to remove burrs. Clean fitting socket and pipe ends with sand cloth, No. 00 cleaning pads or wire brush. No acids must be used to clean either pipe or fittings or as a flux in sweating joints. Make up joints with sweat fittings of wrought copper, and 0.25% of the total wetted surface area, lead free compliant solder complying with ASTM B-32 and the Safe Drinking Water Act. Surfaces must be prepared for soldering as required by ASTM B828. Do not make joints or branch connections below a slab on grade.

5.9. **Hangers:** Refer to Section 15010 and plan details for requirements.

5.10. **House Supply Connection:** Utility connection at street, meter installation, etc. is specified under Division 2. Connect to temporarily capped main as indicated. Where shut-off valve is indicated outdoors on the plumbing plans, provide a concrete or steel valve box with hinged medium duty, traffic rated cover, minimum 16x16, larger as required for proper access to valve. Provide valve extension as required so that top of valve handle is within 8” of top of hinged cover.

5.11. **Water Pressure:** Supply system is designed for static pressure of 50 to 75 psi. Gauge the city water supply adjacent to building to verify that pressure is within those limits. Submit report in writing. Provide water pressure reducing valve, if required, to meet designed water pressure. See Water Piping Specialties for pressure reducing valve specification.

5.12. **Disinfection:** New potable water systems must be purged of deleterious matter and disinfected prior to utilization. The method to be followed must be as prescribed by the health authority or water purveyor having jurisdiction or,

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in the absence of a prescribed method, the procedure described in AWWA C651 or as described in this section below.

The potable water piping system must be flushed with clean, potable water until dirty water does not appear at the points of the outlet. The system or part thereof must be filled with a water/chlorine solution containing not less than 50 parts per million of chlorine, and the system or part thereof must be valved off and allowed to stand for 24 hours; or the system or part thereof must be filled with a water/chlorine solution containing not less than 200 parts per million of chlorine and allowed to stand for 3 hours. Following the required standing time, the system must be flushed with clean potable water until the chlorine is purged from the system.

Upon completion of the disinfection procedure, the Plumbing Contractor must engage the services of the Alabama Department of Public Health Clinical Laboratories or a certified, licensed, testing laboratory to provide a lead and bacteriological water analysis to include a standard heterotrophic plate count (HPC), microbial, bacterial, pathogens and coliform count.

Test a minimum of two (2) samples of domestic water from two (2) separate locations within the facility. If portions of the building are finalized and turned over for the Owner's use and tested portion of the system is interrupted to plumb in remaining portions, all water must be re-tested after each area released and with the same requirement for two testing locations selected by the Architect.

Test locations must be selected by the Architect and must be noted on the Testing Laboratory's report. Test each sample for Coliform Present, Fecal Present, E. Coli and lead present.

If the test results for any building or portion thereof indicates positive results for Total, Fecal, or E. Coli coliform per 100 ml respectively, or an HPC greater than 500 CFU/mL, or lead maximum contaminant level goal (MCLG) greater than zero, the Contractor must disinfect the system in its entirety, as specified above, and obtain new test results as outlined hereinbefore until levels are reached as required by AWWA C651. If maximum contaminant level goal (MCLG) of lead is greater than zero, immediately notify the Architect in writing and furnish copy of test results.

Prior to the final site visit, the Contractor must provide to the Architect, certified test results on the testing facility letterhead. The report must indicate the name of the project, the locations from where the samples were taken, the testing laboratory findings and written indication whether the water is safe for consumption. **No Certificate of Occupancy will be provided to the Owner without the required lab results indicating the potable water system is safe for consumption.**

5.13. **System Drainage:** Provide valves and hose nipple to allow for drainage of all risers and other system low points.

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PART 6. WATER PIPING SPECIALTIES

6.1. **General:** All specialties in potable water distribution must be certified as lead free compliant design as required by Code, Regulations and Standards.

6.2. All specialties in potable water distribution must be certified lead free compliant design as required by Code, Regulations and Standards.

All specialties/valves must be bronze or heat-treated DZR, CW511L brass, lead free compliant, AB 1953 compliant, NSF/ANSI 61 compliant and must be the product of one American Manufacturer and must meet the Buy American Act 41, USC 10a-10d as specified hereinbefore. Valves must have MSS SP-25, MSS SP-80 listings as applicable. Provide extended operators for all valves installed in insulated piping. Seal the opening where the stem, nipple, etc., penetrates the insulation as required to maintain the continuity of the insulation and vapor barrier.

All valves must be identified. Provide a custom laser engraved brass valve tag at each valve. Tag must be 1-1/2 inches diameter, 18-gauge polished brass tags with 3/16-inch chain hole and 1/4 inch high stamped, black-filled service designation. Refer to Section 15010, Part Identification for detailed requirements and provide all as specified.

Valves must be Nibco, Jomar, Watts, Apollo, Kitz, Hammond/Milwaukee, Matco-Norca or Mueller. Nibco and Jomar units are the basis of design unless specified otherwise.

6.3. **Unions:** 150 psi rated; WOG pattern, cast brass ground-joint type in copper pipe. Unions in steel pipe must be malleable iron, WOG female pattern brass seat, ground joint, 150 psi type. Provide in all sizes of threaded pipe, and in sweat-jointed pipe over 1 inch, to facilitate easy repairs. In such lines, install at all inlets and outlets of all devices and equipment, adjacent to water heaters, pumps, tanks, etc. into which piping is terminated; and on each side of valves, cocks, strainers, etc. and other devices that occur in piping runs.

6.4. **Dielectric Unions:** Provide dielectric unions between ferrous and non-ferrous piping as required, including piping and water heater stubs where different, and stainless-steel water hammer arrestors. Dielectric unions must be constructed using lead free compliant materials as required by all Governmental Agencies, Codes and Standards and must comply with ASTM 1545. Dielectric unions must be Watts Series LF or equivalent by Mueller or Matco Norca. Where dielectric unions are installed, they must be provided with factory fabricated brass tag. 1-1/2 inches diameter, 18-gauge polished brass tags with 3/16-inch chain hole and 1/4 inch high stamped, black-filled service designation. Indicate valve tags on the record drawings. **Contractor must provide a ball valve on the respective piping containing the union as required to allow for proper maintenance of the union.**

6.5. **Valves and Valve Extensions:** Provide as specified, including all fixtures or equipment not furnished with stops. Arrange and install valves to be readily accessible for servicing. All valves must be bronze or heat-treated CW511L

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brass, lead free compliant, AB 1953 compliant and must be the product of one American Manufacturer and must meet the Buy American Act 41, USC 10a-10d as specified hereinbefore. Nibco and Jomar units are basis of design.

Coordinate valve handle height requirement with specified insulation thickness. Provide height extension as required to clear insulation and properly operate without causing damage to piping insulation. All handles must comply with UL 2043 and must be UL listed for installation in return air plenums. Valve extensions must be provided by the valve manufacturer and must have blowout-proof stems. Valve extensions must be Matco-Norca (for Matco-Norca valves) P759EXT, Nibco Series RG (for Nibco valves) or similar type extensions for the other specified valve manufacturers and constructed of all brass or stainless steel.

6.6. **Globe Valves 3" and Smaller:** Nibco T-235-LF, threaded, bronze type with replaceable disc, 150 WSP.

6.7. **Check Valves 2" and Smaller:** Jomar T-511G, Nibco T-413-Y-LF or equivalent, MSS SP-80, ANSI B1.20.1, NSF/ANSI 61 and NSF/ANSI-372 compliant, all lead free bronze, threaded, Y-Pattern swing check, 300 WOG, Class 150 WSP.

6.8. **Ball Valves for Water Piping Up to 3":** Valves must be Jomar T-200CSSG EH, Nibco T-585-66-LF, or equivalent, 600 CWP, 150 WSP, two-piece body, full port, blowout proof ASTM A276, Type 316 stainless steel stem and ball, reinforced PTFE seats and 2" minimum valve extension to bring valve handle beyond insulation. Valves must comply with NSF/ANSI 61/372-8, ANSI Z1157 and MSS SP-110/145 standards. Note that ball valves are also required on one side of each dielectric union.

6.9. **Ball Valve for Non-Shelter Storm Area:** Same as specified above for ball valves except valve must be quarter turn, easy operation.

6.10. **Strainers:** Watts Series LF77SI, lead free, Wye-Pattern, 125 WSP, 400 psi WOG, sediment separators with a 20-mesh, 304 stainless-steel screen.

6.11. **Thermometers:** Trerice Series BX, Model AX9, universally adjustable type with 7-inch scale and suitable temperature range, mercury free, 0°F to 160°F range as manufactured by Trerice. Thermometers must be "blue liquid" actuated with Phenol Condensate and lead-free cast aluminum case and brass stem and thermowell, with extension neck and other accessories required for a complete installation. Locate for convenient reading. Equivalent product by Blue Ribbon, Weksler, March or Maxwell Moore will be accepted.

6.12. **Exterior Wall Hydrants (WH):** Encased, Ecolotrol, lead-free compliant, non-freeze automatic draining wall hydrant for flush installation. Hydrant must have integral backflow preventer with anti-siphon type, copper casing, all-bronze interior components with 1/2 turn long-life ceramic disc cartridge, combination 3/4" female solder and 3/4" male pipe thread inlet connection, 3/4" male hose connection', with type 304 stainless steel housing with locking hinged cover stamped "WATER" and operating key. Hydrant housing must fit within one

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standard modular masonry course. Provide one extra stock spare hydrant repair kit and one extra stock spare cartridge removal tool for EACH wall hydrant.

Seal all interior joints, seams, gasket seams/closures including around the hydrant box flange with an appropriate sealant recommended by a sealant manufacturer. Wall hydrant must be JR Smith 5519 QT, Zurn Z1320XL-EZ or approved equivalent by Woodford. Install approximately 24 inches above finished grade.

6.13. Water Hammer Arrestors (Shock Absorbers): Certified by the American Society of Sanitary Engineers and in compliance with current edition of ASSE 1010, ANSI A112.26.1M, Plumbing and Drainage Institute Standard PDI-WH201, heavy-duty construction and designed for a minimum 150-PSI working pressure. Arrestors must consist of a Type 304 stainless steel casing and piston. The device must be pre-charged and sealed at the factory. Install on both hot and cold water branch lines in an upright position as close as possible to the valve or valves being served.

Arrestors must be installed at all solenoids, remote operated or quick closing valves and at each electric water cooler, each plumbing fixture or battery of plumbing fixtures. Type, location and size must be as recommended by the arrestor Manufacturer. Plumbing Contractor must provide a dielectric union at connection of this device to the copper water piping.

Arrestors must be Zurn Z1700, J.R. Smith Hydrotrol Series 5005-5050, Watts Series SS, Sioux Chief Series 660-G2B or MIFAB Series WHB.

6.14. Automatic Trap Primer Units Where Water Closets Occur: Trap primers must comply with the International Plumbing Code and local codes and must be served from the water closet flush valve tube assembly as shown on the plans. Provide trap primer line from flush tube to each floor drain, hub drain, etc. as shown, specified or required by Code. Water saver type trap primers that attach to lavatory p-traps or any other type of assemblies that use grey water are not allowed.

Trap primers must be Sloan VBF-72-A1, Zurn P6000-TPO or equivalent.

6.15. Automatic Trap Primer Units Where Not Shown Connecting to Water Closets Flush Tube: Refer to the plans for locations required. Units must be lead-free, UPC/IAPMO listed, and ASSE certified to the ASSE 1018. It must be provided with copper or brass body distribution unit (as required), copper waterway, vacuum breaker, brass ball type stop valve, union to allow for removal of the trap primer for cleaning, brass FIP/MIP fittings, integral strainer, air gap, and all required accessories. Units must comply with the International Plumbing Code and Local Codes. Allow for required modifications to meet local codes.

Units must be accessible for service and must be located between the architectural air barrier at the bottom of the structure and the finished ceiling. Do not locate in the attic where it will be subject to freezing. Provide required

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piping and drainage. Provide trap primer line to each floor drain, hub drain, etc. as shown, specified or required by Code. Provide isolation valve for each trap primer line.

Unit must be Sioux Chief Prime Perfect Series 695, Precision Plumbing Products, Inc. Series PR-500 or equivalent by Watts or MIFAB.

6.16. **Automatic Electronic Trap Primer Units:** Units for multiple trap primers must be provided where shown and must be lead-free and self-contained within a NEMA 1, UL 50 galvanized steel enclosure and galvanized steel hinged cover with screwdriver latch, surface mounted panel on a partition wall above the ceiling or with vertical, contractor provided Unistrut assembly. It must contain a distribution unit with header as required for the number of items shown to require trap primers, copper waterway, brass ball type stop valve, slow closing solenoid valve with integral strainer, anti-scaling copper header, brass atmospheric vacuum breaker, transformer for 24V operation as required, timer, and complete with all required accessories. All units must be hardwired unless allowed otherwise by NEC. Where units are mounted on fire rated wall, it must be within a fire rated housing. Units must comply with the International Plumbing Code and Local codes. Allow for required modifications to meet local codes. Units must be accessible for service and must be located between the architectural air barrier at the bottom of the structure and the finished ceiling. Do not locate in the attic where it will be subject to freezing. Provide required piping and drainage.

Trap primer's water release must be factory-set for daily operation of 2 ounces of water and allow adjustment of the frequency and duration of the priming operation. Provide trap primer line to each floor drain, hub drain, etc. as shown, specified or required. Provide isolation valve for each trap primer line.

Singular units must be provided where shown and must be lead-free, surface mounted on a partition wall above the ceiling or with vertical contractor provided Unistrut assembly. It must contain a distribution unit for a single trap primer, copper waterway. Unit for single trap primer must be listed and certified to ASSE 1044, ASSE 1010 stainless steel arrester with EPDM O-ring, piston and lubricant to protect the solenoid device, brass solenoid actuating device, vacuum breaker, timer and all required electrical hardware and timer. All units must be hardwired unless allowed otherwise by NEC. Units must comply with the International Plumbing Code and Local codes. Allow for required modifications to meet local codes. Units must be accessible for service. Provide required piping and drainage. Trap primer's water release must be factory-set for daily operation of 2 ounces of water and allow adjustment of the frequency and duration of the priming operation.

Singular trap primer units must be Precision Plumbing Products, Inc. Series MP-500, Sioux Chief Series 695-ES01, MIFAB MI-300-DU, J.R. Smith 273-SW or equivalent to Zurn.

The multiple trap primer units must be Zurn Series Z1020XL, Precision Plumbing Products, Inc. Series MPB-500-24V, Sioux Chief Series 695-ES, MIFAB MI-100 or J.R. Smith 270FM.

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Plumbing Contractor must coordinate all power requirements with electrician and provide as required. Provide all required transformers, fittings, control wiring, transformers, etc. as required for complete and functional installation.

6.17. **Pressure-Reducing Valve and Strainer:** Verify water pressure at site prior to ordering. Device may not be required. If required, provide Zurn/Wilkins 500XL-YSBR or equivalent to Apollo or Watts. Provide full size valved bypass around PRV, two pressure gauges, a hose bibb, valve and union on each side of PRV. Provide if required to meet designed water pressure (not to exceed 70 psi).

PART 7. PIPE HANGERS AND SUPPORTS

7.1. **General:** Refer to Section 15010, plan details and Pipe Insulation below.

1.1. **Coatings and Finishes:** Pipe hangers, Unistrut pipe supports and duct Unistrut support assemblies of galvanized, zinc and similarly coated items are considered to **NOT** be coated. All must be painted, powder coated, epoxy coated or plastic coated. Hanger rods and associated bolts, and clamps on Unistrut assemblies are not required to be painted or coated.

All damaged or rusted steel pipe, all uncoated cast iron pipe, and all hangers, Unistrut and other support assemblies, must be cleaned, primed and painted with two coats of compatible black enamel paint as specified below. Any rusted items must have the rust removed, then etched and primed for painting as recommended by the respective manufacturer. After prepping the surfaces, then paint with two coats of compatible black, rustproof enamel paint. Do not use spray paint.

All paint and coatings must have a fire hazard rating not to exceed 25 for flame spread and 50 for fuel contributed and smoke developed as determined by ASTM E84. See specification section, Part "Identification" for detailed requirements.

In lieu of painted surfaces as specified hereinbefore, the Contractor may provide factory fabricated hangers and Unistrut assemblies with rust resistant powder coating, epoxy coating or plastic coating. All paints/coatings/finishes must meet or exceed a fire hazard rating not to exceed 25 for flame spread and 50 for fuel contributed and smoke developed as determined by ASTM E84.

PART 8. NATURAL GAS DISTRIBUTION SYSTEM

8.1. **General Scope:** Make house supply connection as indicated and extend to all gas fired equipment as well as other locations shown. Refer to Section 15010, Part Identification and this Part for identification of gas piping and painting. Refer to Section 15010 for support requirements.

8.2. **Utility Connection:** Arrange with the local Gas Company for service, with meter and regulator to be located as shown on the plans. Meter and all piping

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upstream of meter/regulator by Gas Company. Verify gas company pressure available at the site and provide meter/regulator assembly as required. Pay for all costs in connection with the installation. Provide main cut-off valve and a dielectric insulating union in service lines to building.

8.3. **General Installation:** Any damaged gas piping, fittings, etc., must be replaced. Installation must be in accordance with the local gas code, requirements of the local utility company, AGA, International Fuel Gas Code and NFPA Standard 54. Brazed or welded joints and fittings must be provided as specified. **Flare joint/fittings and press type joint/fittings systems are forbidden and must not be used.**

Cut the pipe accurately to measurements established at site and work into place without springing or forcing. Avoid running through solid walls or floors. Route through previously built in sleeves/firestopping assembly and avoid excessive cutting or other weakening of the structure. Ream all pipes to remove burrs. Make changes in direction and size with fittings. **Make take-offs from top or sides of mains, not from bottoms**. Cap or plug open pipe ends during installation to keep out foreign material. Lay out and grade work (1/4" in 15 feet min.) to avoid trapped lines, where unavoidable provide 4-inch drip leg with removable cap at low point. Provide complete system testing per NFPA 54. Provide combination stop valve and insulating union at each point piping drops to underground or rises above grade from underground.

Gas piping must enter and exit the installation at a point above grade. The annular space between the pipe and concrete pad must be sealed air and water tight. When passing through an outside wall or concrete pad, the piping must also be protected against corrosion by coating or wrapping with an inert material. Seal penetrations using steel or cast-iron pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals. Select type and number of sealing elements required for the pipe material and size. Position pipe in the center of the sleeve. Assemble mechanical sleeve seals and install them in an annular space between pipe and sleeve. Tighten bolts against the pressure plates that cause sealing elements to expand and make watertight seal.

Piping installed outdoors must be elevated not less than 8 inches above the concrete pad to allow for a proper dirt leg.

Piping installed above ground or outdoors must be securely supported and located where it will be protected from physical damage.

All gas pipe, tubing and fittings must be clear and free from cutting burrs, defects in structure or threading. Piping must be thoroughly brushed, and chip and scale blown. Defects in pipe, tubing, and fittings must not be repaired. Defective pipe, tubing, and fittings must be replaced.

Metallic pipe and fitting threads must be taper pipe threads and must comply with ANSI/ASME B1.20.1, Pipe Threads, General Purpose, Inch. Pipe with threads that are stripped, chipped, corroded, or otherwise damaged must not

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be used. Where a weld opens during the operation of cutting or threading, that portion of the pipe must not be used.

Provide unions and supports that are AGA rated for natural gas. Refer to Section 15010 and plan details for pipe hangers, supports, assemblies, rods and uni-strut requirements.

8.4. **Above Grade Piping:** ASTM A53/A53M, Type as required by welding method, Grade B, seamless or ERW, Schedule 40 black steel pipe with ASME B16.3, Class 150 black malleable iron screwed fittings for 2" and smaller.

8.5. **Electrical Bonding and Grounding for Pipe and Tubing:** Each above ground portion of the gas piping system must be electrically continuous and bonded to an effective ground fault current path. Provide bonding in strict accordance with NFPA 70, Section 250. Bonding of gas piping systems is electrical work and must be provided by a qualified licensed Electrical Contractor who is recognized by the Authority Having Jurisdiction as capable of doing such work. Points of connection must comply with the current edition of NFPA 70, the National Electric Code. **It is the responsibility of the Plumbing Contractor to engage a qualified, licensed Electrical Contractor to provide the bonding and grounding as specified.** Allow as required and provide as specified.

8.6. **Gas Valve and Connections:** For gas piping 2" and below, provide a 2-piece, full port, threaded connection ball valve, 600 WOG, FM Approval, UL Listed, CSA certified for use in natural gas systems, ANSI Z21.15 (.5 psig), CGA 3.16 (125 psig), ASME B16.33 (125 PSIG) rated, ANSI B1.20.1 and MSS SP-110 compliant. It must have triple sealing stem with two FKM O-Rings and PTFE G300 seat and packing, C38500 brass packing gland and steel, Geomet® plated handle and handle nut.

The Valve must be Jomar Series T-100NE or equivalent by Flowserve/Nordstrom or Homestead will be accepted. Jomar is the basis of design.

Provide a custom laser engraved brass valve tag at each valve identifying gas pressure and pipe contents. Tag must be 1-1/2 inches diameter, 18-gauge polished brass tags with 3/16-inch chain hole and 1/4 inch high stamped, black-filled service designation.

8.7. **Gas Pressure Regulators:** Provide a regulator at each gas fired appliance/device. Standard service type gas regulators for indoor or outdoor use as applicable, meeting project and Local Gas Company requirements with automatic safety shut-off valves, overpressure protection device (OPD) as required, leak/vent limiting device, cast iron body, with automatic safety shut-off valves, aluminum orifice and chromate covered casting, e-coated or primed with enamel topcoat and tamper proof seals.

Line gas pressure regulators must be listed as complying with ANSI Z21.80/CSA 6.22. All regulators provided on systems with inlet pressure greater than 2 psi must be provided with over pressure device (OPD).

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Regulators installed on the exterior of the building must be approved for outdoor installation. Verify supply (inlet) pressure prior to selecting regulators.

Provide a custom laser engraved brass valve tag at each regulator identifying gas pressure and pipe contents. Tag must be 1-1/2 inches diameter, 18-gauge polished brass tags with 3/16-inch chain hole and 1/4 inch high stamped, black-filled service designation.

The Contractor must provide to the Engineer a letter from the local gas company attesting to the maximum pressure drift to the facility downstream of the local gas company's meter/regulator assembly. If the local gas company states that pressure will exceed 2 psi on **any** occasion, for **any** period of time, the regulator furnished at each appliance within the facility must be Maxitrol Series 325-5L with OPD or equivalent by Sensus, Emerson/Fisher, Security or American as required by job conditions.

Failure to provide the required letter from the local gas company will be cause for immediate rejection of the submittal.

8.8. **Shutoff Valve:** Main gas shutoff valve controlling the gas piping system must be easily accessible for operation and shall be installed in the service line as indicated and protected from physical damage. Main shut-off valve at the building shall be seismic type shut-off valve equal to Pacific Seismic Products Series 300 or equivalent, for gas line size as indicated on the plans. Valve shall be UL/ASCE/ANSI/SEI 25-06 and CGA CR90-02 compliant. .

Provide a custom laser engraved brass valve tag identifying gas pressure main on house side of the meter. Tag must be 1-1/2 inches diameter, 18-gauge polished brass tags with 3/16-inch chain hole and 1/4 inch high stamped, black-filled service designation.

8.9. **Gas Pipe Painting and Identification:** Gas piping identification must be provided as specified in Section 15010, Part Identification, except intervals must be a maximum of 12 feet for straight runs of piping.

All exterior and interior gas piping, fittings, etc., must be clean and rust free when installed. All exterior and interior gas piping exposed to view in finished and unfinished areas must be painted. Gas piping and fittings concealed above the ceiling or in partitions are not required to be painted unless rusted. Where any piping or fittings are rusted, all rust must be removed from the piping and then pre-treated with acidic etching primer specifically manufactured for the piping installed. **Apply two coats of the base and finish** rustproof enamel paint. Rusted portions of gas piping, fittings, etc., in attic and other concealed areas must be painted black after prepping for paint.

Color for piping where the piping is exposed must comply with IBC/IPC/IMC requirements and ANSI Standard A13.1, current edition. After gas piping is painted, identify with pipe markers as specified hereinbefore. See plan notes for special identification requirements for gas piping at electric generator.

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PART 9. PIPE INSULATION

9.1. **General: The Plumbing Contractor must not install the piping insulation.** All piping insulation work must be provided by a licensed, experienced insulation subcontractor whose primary business is the sale and installation of insulation materials in accordance with insulation manufacturers' recommendations and these specifications. **The Insulation Contractor must provide a complete insulation submittal on his company letterhead detailing materials and methods as specified. The plumbing submittal will be automatically rejected and not be reviewed without a submittal from the specified Insulation Contractor.**

Where a conflict exists between these specifications and the Manufacturer's recommendations, the strictest installation must be provided.

Piping must be clean, dry and pressure tested before covering is applied. Size pipe hangers to fit insulated pipe size. **No installation of pipe hangers for insulated piping will be allowed to be in contact with piping or penetrate the piping insulation. Piping insulation must be continuous through partitions sleeve/firestop assembly and must not be cut away for installation of clamps, valves, fittings, etc.** Refer to details on plans, Section 15010, "Pipe Hangers and Supports", plan details and below for additional requirements.

Insulate all hot and cold water piping except that below grade and excluding plated brass fixture connections. All piping must be routed within the building insulation envelope to prevent freezing. Insulate all p-traps and related piping located in return air plenums, return air platforms, all horizontal overhead drain lines, including p-traps and drain sumps from mechanical room floor drains, ice machine drains, cooler drains, condensate drainage piping, hub drains and other condensate receiving drains, as specified below.

Fiberglass piping insulation Manufacturers must be Owens-Corning SSL II or equivalent by Johns Manville or Knauf. Owens-Corning is the basis of design.

9.2. **Installation of Fiberglass Insulation:** No installation of pipe hangers for insulated piping will be allowed to be in contact with piping or penetrate the piping insulation. Refer to details on plans for additional requirements. Size hanger loops to fit **over** insulation. Insulate with Owens-Corning SSL II with ASJ Max Fiberglass pipe insulation, thickness as shown below, thermal conductivity of k= 0.23 Btu-in/hr-ft2-ºF at 75ºF mean temperature. Insulation must comply with ASTM C547, ASTM C585, ASTM C1136, ASTM C795, NFPA 90A and 90B and be UL Labeled for Flame Spread Index of 25 or less and Smoke Developed Index of 50.

Adhere SSL by removing release paper after the insulation is installed on pipe and sealing the lap starting in the center of each section, working towards ends. Lap must be pressurized by rubbing with a plastic sealing tool. Install 5" butt strips in the same manner at the joint between sections and at 5'-0" on center. Staple jacket flaps and premolded PVC fittings with nominal 3/4" wide stainless steel or Monel outward-clinching insulation staples on 12" centers. PVC covers

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must be stapled on both sides of the fitting. Insulation staples must have a retarder coating or covered with 4" width 3M Venture Tape Film Faced ASJ Facing Tape, Series 106FXP adhesive tape or vapor barrier mastic that conceals the entire staple. Thereafter, neatly seal the entire jacket flap with vapor retarding sealant. Neatly bevel and seal all insulation at all unions to allow for the proper operation of the union without damaging the insulation.

Sealant must be water based, LEED, UL 723 (ASTM E84), ASTM C731/C732 Standard Test Method for Extrudability, ASTM E96 Water Vapor Permeance and ASTM D5590 Antifungal. The sealant must be Foster 32-19, Childers CP-35 or Vimasco 714.

Insulate all fittings and elbows with premolded fiberglass fittings containing 3lb. density **rigid** polyisocyanurate pipe insulation of equal thickness as the adjacent piping with PVC covering and UL Labeled for Flame Spread Index of 25 or less and Smoke Developed Index of 50.

In lieu of premolded PVC covers at elbows and fittings, which contain rigid polyisocyanurate pipe insulation as specified hereinbefore, Contractor may, at his option, miter the fiberglass insulation.

Cold Water/Domestic Water Insulation Thickness

All pipe sizes 1" thickness

Hot Water/Domestic Hot Water Insulation Thickness

For pipe sizes up to 1-1/4" – 1.0" thickness
For pipe sizes 1-1/2" to 6" – 1.5" thickness

9.3. **Insulation for Piping Within Concrete Block Walls:** Insulate with 1" or 1.5" thickness insulation for the respective piping as specified above. Insulation must be black, flexible foamed, elastomeric, closed cell pipe insulation with a fire hazard rating not to exceed 25 for flame spread and 50 for fuel contributed and smoke developed as determined by ASTM E84. It must be GreenGuard certified tubular insulation with Microban antimicrobial protection. Insulation must have a 'k' factor of not more than 0.26 at 90°F mean temperature and a water vapor transmission rate of 0.05 perm-inches or less. Slip insulation onto pipe prior to installation. **Slit insulation and longitudinal cutting of the insulation is prohibited. Slip insulation onto pipe prior to erecting. Do not stretch or bend insulation at any turn, tee, etc.** Insulate sweat/brazed fittings with miter-cut pieces of insulation as recommended in AP Armaflex installation instructions or, provide factory fabricated, made to order prefabricated fittings for tees, elbows, unions, etc. the same size as on adjacent piping as manufactured by AP Armaflex, Aeroflex Aerofit, K-Flex K-Fit or Aerocell.

9.4. **Fiberglass Insulation Fittings:** Insulate with Fiberglas insulation mitered to fit snugly or with PVC covers with integral, 3lb. density **rigid** polyisocyanurate pipe insulation of the same thickness as the adjacent pipe insulation. After

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installing the insulation and PVC covers, staple, seal, etc. as specified above. Do install sealant over PVC covers. Install cover, staple, seal fitting to the pipe insulation with 3M Venture Tape Film Faced ASJ Facing Tape Series 106FXP and then neatly cover the tape joints with the specified sealant.

Sealant must be water based, LEED, UL 723 (ASTM E84), ASTM C731/C732 Standard Test Method for Extrudability, ASTM E96 Water Vapor Permeance and ASTM D5590 Antifungal. The sealant must be Foster 32-19, Childers CP-35 or Vimasco 714.

Loose insulation within premolded covers is not allowed. Insulation must be as specified above or mitered.

Premolded PVC covers must have a flame spread index of 0-25 and a smoke developed index of 0-50 when tested in accordance with ASTM E84.

9.5. **Exposed Ends:** Finish open ends of sectional covering by rounding off with cement, and sizing with fiberglass cloth jacket around the pipe and finish with Foster 30-36 mastic cement.

9.6. **Partitions and Floors:** Refer to Section 15010 Pipe Sleeves and Firestopping. In any case, insulation must extend through floors, partitions and walls and firestopped. Note that Section 15010, Firestopping, requires firestopping of all penetrations, regardless of rating. Refer to Section 15010, Firestopping, for specifics and additional requirements.

9.7. **Electric Water Coolers:** Insulate drain connections and traps with 1/8" thick insulating tape by AP Armaflex, K-Flex or Aerocel AC EPDM or 1/2" thick fiberglass insulation as specified for piping insulation.

9.8. **Unistrut Support Saddle Requirements:** For all piping suspended with Unistrut assembly, provide a factory fabricated pre-formed, pre-insulated saddle assembly consisting of an **integral** hot dipped G-90, ASTM A653 compliant galvanized saddle per table below. **Do not use loose saddles.** The assembly must be a 360-degree section of 3.0 PCF density, 4.0 PCF density or 6.0 PCF density, non-compressive as appropriate for the manufacturer's standard. For IPS 6" and above provide an additional load distribution plate of all point loaded Unistrut or trapeze hangers. The assembly must be ASTM D1621, ASTM C209, ASTM E96, ASTM D2856 compliant. The assembly must have a 6-mil thickness, industrial grade vapor retarder film in compliance with ASTM D-374 and 0.01 perm rating in compliance with ASTM E-96. The assembly must also be provided with an insulation lock joint longitudinal seam. The insulation jacket must have a hazard rating not to exceed 25 flame spread and 50 for fuel contributed and smoke developed as determined by ASTM E-84, NFPA 255 and UL 723. Insulation thickness required must be same as specified above.

Installation must be in strict accordance with the Manufacturer's requirements. After installation, install **3" zero perm** butt strips at the joint between insulation sections where fiberglass insulation and the polyisocyanurate insulation butt

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together. Staple insulation jacket flaps and seal staples as specified above for fiberglass insulation.

Each assembly must have a genuine “Quick-Inspect” sticker applied at the bottom of each saddle for easy jobsite verification by the Engineer or Inspector. **Failure to provide the sticker on each assembly will be cause for immediate rejection of the installation.**

Refer to the plan details for additional requirements.

The assembly must be Buckaroos Model 3300E-LT or equivalent to Thermal Pipe Shields, Inc, Pipe Shields, Inc. Carpenter & Paterson, Inc., Clement Support Services or VEP/ASC Engineered Solutions. Buckaroos Model 3300E-LT is the basis of design.

Unistrut Saddle Requirements

Nominal Pipe Size	Insulation Length	Saddle Length	Saddle Gauge
1/2” - 3”	6”	4”	22 Ga.

9.9. **Clevis Hanger Saddle Requirements:** For a single pipe suspended with a single clevis hanger assembly, provide same insulated saddle assembly as specified above for the Unistrut assembly. Refer to the plan details for additional requirements.

9.10. **Painting:** Paint exposed insulation after insulation is completed as specified in Section 15010.

9.11. **Identification:** Refer to Section 15010, Part Identification for identification of piping systems.

PART 10. ELECTRIC WATER HEATING EQUIPMENT

10.1. **Water Heater:** Rheem Series ELD, A.O. Smith Series DEN, Lochinvar ESX Rheem Series EGSP, A.O. Smith Series DEL, Lochinvar Series ETX or equivalent by Lochinvar, Rheem or Bradford-White. Water heater(s) must be light duty, commercial, glass-lined tank with heating elements designed for current shown on the Electrical Drawings, copper dip tube, drain pan, storage capacity not less than indicated on the drawings and must meet new UEF ratings established by the U.S. Department of Energy. Coordinate Series water heaters required with the plan details and provide as specified.

The water heater must bear the UL or ETL label and be covered by a minimum 3-year manufacturer's tank warranty and 1-year parts and labor warranty from the date of substantial completion as determined by the Architect.

10.2. **Power Wiring:** Specified under Electrical Division. **Verify voltage and power requirements with Electrical Contractor and Electrical plans prior to ordering equipment.**

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10.3. **Circulating Pumps:** Furnish and install, as shown on the plans, an all lead-free bronze (0.25% or less lead content of all wetted surfaces) or stainless steel construction, stainless steel flanges, pipe-mounted centrifugal pump with high efficiency ECM motor with algorithm to automatically adjust speed, flow and operation based on the actual requirements of the system, to include maintaining flow rates below recommended practice for the piping installed. The pump must be ETL or UL listed and be NSF 372 compliant.

Provide a strap-on aquastat equal to Honeywell L606A for insertion into the immersion well and wire to control the pump through a 7-day program clock, which must be programmed to the Owner's requested operating schedule. Clock must be equivalent to Tork EWZ-201C, Intermatic ET8215CR or Eaton ATC 2000 with NEMA 3 enclosure, automatic daylight savings time adjustment, automatic leap year compensation and minimum 4-day battery or super capacitor back-up power. Provide all required control wiring, power wiring and connections as required for proper operation as specified.

The circulating pump for WH-1, WH-2 and WH-3 must be Taco 0026e-SF2, Armstrong Series Compass H or Grundfos Alpha HWR 15-29 SF/T. Taco 0026e-SF2 is the basis of design. Pump power must be as shown on the electrical plans.

The circulating pump for WH-4 must be Taco 0034ePlus, Armstrong Series Compass R, B&G Ecocirc XL or Grundfos Alpha HWR 15-55 SF/T. Taco 0034ePlus is the basis of design. Pump power must be as shown on the electrical plans.

10.4. **Relief Valve:** The relief valve must comply with ANSI Z21.22 and CSA/ASME rated temperature and pressure relief valve on the water heater with copper relief line piped as indicated on the plans. Temperature and pressure relief valves, or combinations thereof devices must bear the label of an approved agency and must have a temperature setting of not more than 210°F and a pressure setting not exceeding the tank or water heater manufacturer's rated working pressure or 150 psi, whichever is less. The relieving capacity of each pressure relief valve and each temperature relief valve must equal or exceed the heat input to the water heater or storage tank. Do not pipe/connect relief discharge line and auxiliary drain pan lines together. The manufacturers must be Watts, Apollo or McDonnell and Miller.

10.5. **Thermometers:** Trerice Series BX, Model AX9, universally adjustable type with 7-inch scale and suitable temperature range, mercury free, 0°F to 160°F range as manufactured by Trerice. Thermometers must be "blue liquid" actuated with Phenol Condensate and lead-free cast aluminum case and brass stem and thermowell, with extension neck and other accessories required for a complete installation. Locate for convenient reading. Equivalent product by Blue Ribbon, Weksler, March or Maxwell Moore will be accepted.

10.6. **Expansion Tank:** Provide diaphragm type with NSF liner, designed for 150 psig working pressure and must bear an ASME stamp. Tank must have minimum acceptance as recommended by the water heater manufacturer.

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Expansion tank must be supported at the wall by a HoldRite QS-U Quick Strap with 1/2" wide, 0.025" thick, 200/410 stainless steel bands and 16 Ga. galvanized steel bracket of required capacity and load rating for the expansion tank shown on the plans or approved equivalent.

10.7. **Auxiliary Drain Pan:** Provide 2" deep, 18 ga. (0.05" thickness) galvanized steel or 18 ga. (0.05") thickness stainless steel auxiliary drain pans with seamless, welded or brazed watertight joints. Width of pan must provide minimum of 3" clearance between water heater and inside face of the pan. Provide 3/4" copper drain line in **bottom** of pan to floor drain with dielectric separation where water heater is elevated or placed on a stand. Do not pipe relief discharge line and auxiliary drain pan lines together. Auxiliary pan must be manufactured by Killarney Metals, an approved equivalent or a shop fabricated pan with construction specified above with welded or soldered joints. **Factory manufactured pans that do not meet the specified requirements above are not allowed.**

10.8. **Wall Mounted Water Heater Stand:** In lieu of the wall mounted assembly indicated on the plan detail for WH-2 and WH-3, the Contractor may provide for water heaters up to 35 gallons of capacity, a factory fabricated unit with watertight pan constructed of 18 ga. galvanized metal and integral metal 1-1/4" auxiliary drain, 16 ga. galvanized C-brackets, 12 ga. galvanized 45 degree brackets with low carbon steel, zinc plated, threaded rods as required for a 750 lb. load with 2x safety factor. Provide minimum of 1" Rubatex insulation over all edges of the stand to protect individuals from injury should they hit the stand. Cap auxiliary drain connection provided with the specified stand and provide drain in the bottom of the pan. Provide dielectric fitting between galvanized drain outlet and copper auxiliary drain line specified.

The assembly must be QuickStand 60W-SWHP-WM steel, wall mounted equipment platform manufactured by HoldRite or approved equivalent. Note that where this assembly is provided, the auxiliary drain pan specified above is not required. In all circumstances, the 1" thick, heat resistant neoprene pad under the respective heater is required. The stand and installation of stand must be as recommended by the Manufacturer for a 750 lb. load regardless of water heater volume.

10.9. **Inspections:** The Plumbing Contractor must arrange and pay for the State of Alabama Boiler and Pressure Vessel Safety Division/Inspection Divisions, Elevators/Boilers Inspector to visit job site to inspect water heater and/or boiler installation and obtain written approval, certification and Certificate for Potable Water Heater (PWH) as required. Correct all deficiencies required by the Inspector without additional cost to the Owner or the Owner's Project Design Professionals, using materials and methods, as directed by, State of Alabama Boiler and Pressure Vessel Safety Division/Inspection Divisions and Elevators/Boilers inspector as required.

PART 11. ACID RESISTING SOIL, WASTE, AND VENT PIPING

11.1. **Acid-Resisting Soil, Waste, and Vent Piping:** All piping and fittings must be

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flame retardant, corrosive waste drainage system, polypropylene Schedule 40 pipe and fittings**.** Installation must be in strict accordance with the manufacturer's requirements. Pipe must be marked with its UL Classification to indicate compliance with its required UL listing. The manufacturer must be IPEX Corporation Enfield. Equivalent systems by Fuseal/George Fischer, Town and Country, or Orion/Watts will be considered.

Acid resisting soil, waste and vent piping located in the return air platforms, and when passing through or within a fire rated assembly, must conform to ASTM D3311, ASTM F1673, ASTM 1673, ASTM D3222, UL 723, ASTM E84 25/50 requirements for flame spread and smoke and made of **PVDF (Polyvinylidene Fluoride)** equivalent to IPEX Corporation PlenumLine. Equivalent systems by Fuseal/George Fischer, Town and Country, or Orion/Watts will be considered.

Provide electro fusion joints below the slab and mechanical joints above the slab. Joints and piping installation must be in strict accordance with manufacturer's recommendations. **All PVDF pipe and fittings located below the slab must be joined using fusion method. All PVDF pipe and fittings located above the slab must be joined by a no-hub mechanical joint method with plain end fittings and no-hub couplings.** Each No-Hub coupling must have an outer band of 300 series stainless steel with 5/16" bolts and quantity required by the Manufacturer, nuts and washers plated to meet a 100-hour salt spray test per ASTM B117. The No-Hub joint must conform to the requirements of ASTM F1673. PVDF piping must be marked with its UL Classification to indicate compliance with UL723 (ASTM E84). All fittings must meet or exceed Schedule 40 dimensions.

After fully inspecting the installed piping for mechanical damage and visually suspect joints, use expandable plugs to cap off each section to be tested and test piping as specified hereinbefore.

All PVDF piping and fittings installation must be in strict accordance with the Manufacturer's recommendations.

PART 12. LABORATORY ACID NEUTRALIZING TANK

12.1. **General:** Contractor must furnish and install high-density polyethylene neutralization tank and sampling port. Tank and sampling port must be rotationally molded seamless construction, with flanged top and bolt-down cover, as supplied by IPEX Corporation. Tank must be equivalent to IPEX Neutratank #SP055 with sampling port, having 55-gallon capacity, complete with 4" inlet and outlet, and 2" vent connection. Coordinate inlet, outlet and vent connections required with plans and provide as shown. Tank must be installed in accordance with manufacturer's recommendations. The sampling probe must be located as required to be accessible from within 12" below finished grade. Provide heavy-duty, manhole (full size) extension to finished grade with bolted or locking steel cover and set in 14" square x 6" thick concrete pad.

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Tank must be furnished with the piping manufacturer's Neutrasystem2 TPH 501, UL 508 listed monitoring and alarm system. System must be provided complete with recessed NEMA 4X rated panel, transformer, wiring, conduit, chemically resistant PH probe for the continuous sampling of the downstream flow with visual alarm, audible alarm and dry contacts for interface to alarm at the BAS operator's console should effluent concentrations drift outside of the manufacturer's preset parameters. The panel must be located where shown on the plans. All wiring from the tank to the panel must be concealed below grade within 1" waterproof conduit. Conduit must be as specified in the Division 16 specifications for underground conduits.

The contractor must furnish and fill the tank prior to operation with approved neutralization agent such as limestone or marble chips, one to three inches in size, to a level just below the tank outlet as recommended by the Manufacturer. Water must be added to the tank after placement of the neutralization agent.

Provide required anchors to prevent flotation.

Manufacturer must be IPEX Corporation or equivalent unit systems by Fuseal/George Fischer, Town and Country, Striem or Orion/Watts will be considered.

PART 13. FIXTURES SUPPORTS AND CONNECTIONS

13.1. **General:** Verify exact size and location of water, vents, waste and supply connections from approved rough-in drawings and/or catalog data sheets. Allow for modifications required by the shop drawings without additional cost to the Owner or the Owner's Project Design Professionals.

All fixtures including lavatories, urinals, water closets, electric water coolers, etc., must be securely fastened to the walls or floor. **Coordinate all mounting heights and fixture types required with Architectural plans prior to rough-in and ordering fixtures.**

All penetrations of floors and partitions are required to be built-in as work progresses. All penetrations of new construction that were not built-in as required by these specifications, and all existing floors, walls and partitions must be core drilled or sawcut large enough to allow all conduits, piping, firestopping assemblies, etc., to continue uninterrupted, and to provide proper firestopping of the penetration as required to install new items as shown and/or specified.

13.2. **Wall Mounted Fixtures:** Support all wall mounted fixtures that are specified without carriers using 1/4" thick 6" high plates full length and width of fixture, mounted behind wall. Where fixtures are back to back on a solid wall, mount with bolts from fixture hanger to fixture hanger. Do not use toggle bolts or expansion bolts unless noted on the plans or specified.

Where fixtures are mounted on solid (single wythe) walls finished both sides, install fixtures with plated toggle bolts.

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Where fixtures are mounted on wood or light gauge steel studs, employ pressure treated blocking of 2” x 12” nominal size well secured into stud line with non-corrosive, dielectric separation fasteners. Fit behind stud flanges, using especially placed studs as required.

Demolish and modify all existing walls, partitions, ceilings and saw cut all floors as required to install new items as shown and/or specified. Reconstruction and repair of the demolished/modified items above must be as directed by the Architect. Coordinate demolition and repairing/rebuilding of items with General Contractor prior to bid to allow for installation of carriers, piping, etc., as applicable.

13.3. **Floor Connections:** Provide cast iron or galvanized malleable iron floor flanges at least 3/16" thick, screwed or caulked to drainage pipe. Bolt the connection and make tight to fixture with plumbing fixture setting compound, wax setting ring or polyethylene gasket flange. Offset flanges for water closets are not allowed.

13.4. **Water Supply Connections:** Provide rigid, lead-free brass nipple from water riser to fixture stop valve threaded connections. Steel pipe is unacceptable. Exposed portion of nipple must be chromium plated. Stops’ risers must be lead-free, threaded with chrome over copper pipe. Quick connect fittings and braided supplies are not allowed.

13.5. **Waste Arms to Fixtures:** As specified hereinbefore. Where copper or brass pipe is specified, all joints downstream from the trap must be brazed joints.

PART 14. SCHEDULED FIXTURES AND MISCELLANEOUS ITEMS

14.1. **Acceptable Manufacturers:** American Standard, Zurn, Elkay, Kohler and Toto catalogs.

Where three (3) Manufacturers are listed for fixtures below, use only those Manufacturers. Manufacturers not mentioned in the specifications require prior approval, seven (7) days prior to bid date. Follow procedures set forth in Division 1 of the specifications. Where substitutions are proposed, unless the Contractor states in writing, on a separate recap/summary sheet in front of the respective submittal, the differences of the substituted equipment or material, he must be responsible to replace such items any time discrepancies are found. All prior approvals must be submitted through the Architect.

Architect must select all colors where choices exists.

14.2. **Fixture Trim:** Exposed metal parts to be of heavy weight polished brass, heavily chromium plated, of best quality as regularly furnished by the plumbing fixture manufacturer. Provide stop valve in supply to all fixtures and equipment.

14.3. **Compliance with Americans Disabilities Act:** All fixtures, faucets, flush valves, etc., specified or shown to be ADA type must be manufactured and

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installed in complete compliance with the current requirements of the Americans Disabilities Act and ICC A117.1 Standard for Accessible and Usable Buildings and Facilities

14.4. **Guarantee:** Guarantee in writing to make good without cost any defects in materials and workmanship for one (1) year. **ALL** flush valves and faucets must be provided with a five (5) year, full replacement warranty, including labor.

The warranty/guarantee must start on the date of substantial completion of the project as determined by the Architect. Provide free maintenance and service during the first 12 months of the guarantee period.

14.5. Scheduled Items:

P – 1 Water Closet: American Standard Madera 3451.001 EverClean, Kohler Welcomme Ultra K-96053, Zurn Model Z5655-BWL1-AM or Toto CT725CUFG-#01, floor mounted, 15" high vitreous china, siphon jet, elongated bowl with 1-1/2" top spud, fully glazed trapway, china bolt caps, 1.6 GPF Zurn Z6000AV-WS1, Sloan Royal 111-1.6 or equivalent flush valve by Kohler or Toto with trap primer connection on flush tube where shown on the plans, Bemis 1655SSCT white open-front seat with self-sustaining stainless steel check hinge and hardware with Sta-Tite locking system or equivalent by Zurn, Church or Beneke, Zurn Z5972-COMB closet bolt and wax ring kit, china bolt caps and all other items required for a complete and functional installation. Provide YJ chrome plated split-ring wall bracket for supply pipe.

P – 2 ADA Water Closet: American Standard Madera 3461.160, EverClean, Zurn Model Z5665-BWL1-AM, Kohler Highcliff Ultra K-96057 or Toto CT725CUFG-#01 17" high vitreous china, siphon jet, fully glazed trapway, elongated bowl with 1-1/2" top spud, 1.6 GPF Zurn Z6000AV-WS1, Sloan Royal 111-1.6 or equivalent flush valve by Kohler or Toto with trap primer connection on flush tube where shown on the plans, Bemis 1655SSCT white open-front seat with self-sustaining stainless steel check hinge and hardware with Sta-Tite locking system or equivalent by Zurn, Church or Beneke, Zurn Z5972-COMB closet bolt and wax ring kit, china bolt caps and all other items required for a complete and functional installation. Provide chrome plated YJ split-ring wall bracket for supply pipe. Coordinate flush valve installation with grab bar. Flush valve control/handle must be mounted for use from the wide side of the toilet stall.

P – 3 Urinal: American Standard Allbrook 6550.001, Zurn Model Z5755, Kohler Bardon K-4991 or Toto CT725CUF#01 vitreous china siphon jet, 3/4" top spud, flushing rim urinal, vandal resistant, stainless steel outlet strainer, china bolt caps, 1.0 GPF Zurn Z6003-AV-WS1, Sloan Royal 186-1 or equivalent flush valve by Kohler or Toto with vacuum breaker and Zurn series Z-1222 or equivalent carrier by J.R. Smith. Strainers for Zurn urinals must be Z5755-STR. Provide chrome plated YJ split-ring wall bracket for supply pipe. Refer to Architectural plans for mounting heights.

P – 4 ADA Lavatory: American Standard Lucerne 0355.012, Zurn Model Z5364, Kohler Kingston K-2005, 20" x 18" wall hung vitreous china

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lavatory complete with Zurn Z81000-XL-17M, single control, solid cast brass, polished chrome plated faucet, 1.5 GPM vandal resistant, pressure compensating aerator, McGuire #LF2167, Zurn Z8803-XL-LRLK-PC or equivalent by Brasscraft or Dearborn Brass offset drain, Nibco 1/2" supplies with full turn wheel handles and stops, McGuire #155WC, Zurn Z8746-PC, Brasscraft or Dearborn Brass offset drain, McGuire 8872, Brasscraft, Zurn or Dearborn Brass p-trap and heavy-duty floor supported JR Smith Series 0710, Z1231EZ chair carrier with concealed arms. Where lavatory manufacturer drain outlet complies with ADA requirements, offset drains are not required. Supplies must be lead-free, AB 1953 certified by recognized authority and bear manufacturer and testing mark. Refer to Architectural plans for mounting heights.

Provide lead-free mixing valve (ASSE 1070) with tempered water line to faucet. Mixing valve must be provided with wall bracket, dual check valves and 40-mesh stainless steel screen. Mixing valve must be Watts LFUSG-B-SC-M2, Leonard 170D-LF or Zurn-Wilkins ZW3870XLT. The entire assembly must comply with ADA and ANSI standards.

Provide for each fixture an ADA compliant, heavy-duty, impact-resistant, stain-resistant and chemical-resistant rigid vinyl vandal-resistant enclosure with vandal resistant fasteners that shields all piping, electronic faucet components (as applicable), mixing valves and instantaneous water heaters. If plans indicate an instantaneous water heater to be installed at the lavatory, the Contractor must contact the Lav Shield Manufacturer for guidance on the required installation. **Do not install Lav Shield until Engineer has inspected the piping installation.**

The Lav Shield must contain an antimicrobial additive that resists fungal and bacterial growth. The Lav Shield must comply with ASME A112.18.9-2001, ADA article 4.19.4 (606.5), ANSI A117.1, BOCA P 1203.4, and other required State and Local regulations. The Lav Shield must be provided in standard white finish for the exact fixture specified or custom color, fit to field Lav Shield in the color selected by the Architect. Furnish standard **and** custom color chart to Architect for selection. Lav Shield must be manufactured by Zurn Model Z6900-VG, Truebro/IPS corporation or approved equivalent.

P – 5 Mop Basin: American Standard 7741.000 Florwell, Zurn Model Z5850-D3-RG-HH-MH-WG or Kohler K-6710-0 acid resisting enameled cast iron corner model floor type service sink, complete with American Standard 8354.112, Zurn Z843M1-XL or T&S Brass B-0665-CR-BSTRK wall mounted faucet with offset shanks and integral stops, levered vandal resistant handles, vacuum breaker, integral check valves, adjustable wall brace, pail hook, 3/4" hose thread on spout, four foot rubber hose, Bradley 9933 combination utility shelf/broom holder and utility shelf constructed of 18 ga. 304 stainless steel with 16 ga. stainless steel gussets and hooks, 7745.811 rim guard, strainer for 3" screw connection, 304 stainless steel wall guards and silicone sealant at all points where wall guard meets the basin, wall and floor.

P – 6 Bi-Level ADA Indoor Electric Water Cooler with Bottle Filler: Elkay # LZSTL8WSSP, bi-level, ADA cooler, refrigerated stainless steel high

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capacity lead reduction filtered, wall mounted, front and side bubbler push bar, electronic bottle filler sensor, ADA and ICC A117.1 compliant with cane apron, stainless steel cabinet and receptor, safety bubbler and 5-year warranty on refrigeration system. It must provide 8 gal/hr. of filtered water at 50°F based on 80ºF inlet water and 90ºF ambient temperature, per ASHRAE 18 testing. Unit must be certified to UL 399 and CAN/CSA C22.2 No. 120 and NSF/ANSI 42, 53, 61 & 372 for lead free compliant design. Unit must be provided with quick filter change wrapper providing easy access to filter from the front and side of cooler for efficient filter changes. Furnish with 1-1/4" McGuire, Dearborn Brass, Brasscraft or Zurn rough brass p-trap, 17-gauge brass tailpiece and waste with wheel stop valve, concealed Elkay MLP200 or equivalent by Zurn or J.R. Smith bi-level floor mounted support, related floor support plates and base as required for applicable wall construction. Refer to Architectural plans for wall type. Equivalent units by Halsey Taylor, Oasis or Murdock will be considered.

Provide three (3) extra stock 51600C Water Sentry Plus Replacement Filters for each set of coolers shown on the plans, 6,000-gallon filter tested and certified to NSF 42 and 53 under manufacturer's name to reduce lead, Class 1 particulates and chlorine taste and odor certified to NSF 42, NSF 53, NSF-401 and NSF 372 at greater than stated product flow rate for each bi-level water cooler provided. Upon completion of the project, turn over replacement filters to Architect for transfer to Owner.

P- 7 ADA Shower: Provide Willoughby # WBIS-FA-ADA-L-TPLR-DVLR-2.5-CSH-2HD single handle ligature resistant combination thermostatic / pressure balanced shower valve (T/P ASSE 1016) with stops, (2) CSH conical shower heads and ligature resistant diverter valve. Valve and trim must be front accessible.

P – 8 Refrigerator Icemaker Water Connection Box: Guy Gray/IPS Corporation 82392 or 82396 as applicable. Unit must be NSF-372 compliant; IAMPO listed and accommodate supply line from above. Supply box must include a 1/4-turn, chrome plated, forged brass, lead-free, ASME A112.18.1 ball valve with stainless steel water hammer arrester and a top inlet water sweat fitting. Valve must accommodate all common industry inlet connections. Box must be 20 ga. stainless steel, fire rated frame if required, and outlet connection must be 1/2". Each unit must include a frame, and a debris cover for protection during rough-in. Equivalents by Sioux Chief, Oatey, SharkBite or LSP will be acceptable.

P – 9 ADA Sink: Elkay LRAD 221955, 22" x 19" x 6" deep, single compartment 18 gauge stainless steel sink with self-rimming construction complete with one LKGT4083 ADA faucet with forward only lever handle, pull-down spray, deck plate and escutcheon, LKAD35 strainer and offset tail piece, Oatey 8912, McGuire, Dearborn Brass, Brasscraft or Zurn 1-1/2" p-trap 17 gauge continuous waste, Brasscraft XR1720A with full turn wheel handles and angle stops and all other items required for a complete installation. Sink must have drain at rear of the compartment as required to meet ADA regulations. Verify cabinet depth and slope with Architectural plans prior to ordering sink.

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Provide lead-free mixing valve (ASSE 1070) with tempered water line to faucet. Mixing valve must be provided with wall bracket, dual check valves and 40-mesh stainless steel screen. Mixing valve must be Watts LFUSG-B-SC-M2, Leonard 170D-LF or Zurn-Wilkins ZW3870XLT.

P – 10 Tankless Water Heater: Chronomite Invizible CompliantMix thermostatic tankless water heater within a fully recessed enclosure with rounded safety corners, concealed pivoting rod hinge and Allen key latch. The heater must be provided with 304 stainless steel satin finish and a 40A, NEMA 4x lockable rotary disconnect. The entire assembly must be suitable for recessed mounting in a CMU or stud wall. Refer to the Architectural plans for required wall type.

The heater must be Model CMI-30L/120, 3.6 KW, 49°F temperature rise at 0.50 GPM, complete with operating and safety controls, factory set for 110°F water supply temperature in compliance with current ADA requirements. The water temperature must be controlled by an integral microprocessor and integrated thermostatic mixing valve meeting ASSE 1070, NSF-61 and CSA B125.3-12 requirements. Provide all required accessories required for a Manufacturer recommended installation.

P-11 Emergency Shower/Eyewash: Must be ADA compliant, recessed barrier-free eye/face wash and shower safety station with ceiling mounted recessed shower head, drain pan and 16 gauge, Type 304 stainless steel cabinet/cover, an electric strobe light, alarm horn with silencing, and fire rated construction if mounted in a fire rated partition. Coordinate rated requirement with the Architect's Fire Safety Plan.

Unit must have a recessed 11-3/4" diameter stainless steel shower head with 20 GPM flow control and flange for flush mounting in the ceiling. The shower valve must be 1" IPS brass stay-open valve with stainless steel panic bar actuator.

The eye/face wash assembly must have two FS-Plus spray heads mounted on supply arms. Each spray head must have individually adjustable flow controls and water filters. Each eye/face wash valve must have 1/2" IPS brass plug type valve with PTE seals and in-line strainer.

Each unit must be provided with TM 6040 integral ANSI/ASSE 1071 thermostatic mixing valve for tepid water output that complies with ANSI Z358 and enclosed within the recessed assembly. Valve must be furnished with lockable shutoff valves on the hot and cold water supplies, internal check valves to prevent cross-mixing of hot and cold water, stainless steel basket filters, and temperature and pressure gauges.

If the supply of hot water is restricted or interrupted, an internal bypass must allow the valve to deliver cold water only. In bypass mode, the valve must deliver 25 GPM at 15 PSI.

If the supply of cold water is interrupted, the valve must close completely and not deliver any water at all, to eliminate any possibility of scalding.

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Plumbing Contractor is responsible for the furnishing and installation of all related wiring required.

Unit must be WaterSaver Series SSBF 2150 as required for the ceiling height shown on the Architect's plans. Provide overhead/ceiling drop down shower head assembly where ceiling height exceeds 8'-0".

The unit must have 2-year parts and a labor warranty from the date of substantial completion as determined by the Architect.

Equivalent units by Acorn, Bradley, Guardian, Haws and Leonard will be considered.

14.6. **Lab Classroom Fixtures, Sinks and Fume Hoods:** All lab fixtures, sinks, fume hoods, etc. must be furnished completely with faucets, drains, acid resisting traps, vacuum breakers, overflow drains and in general all control and operating trim by equipment and fixture supplier (See Architectural Lab Equipment Section).

The Plumbing Contractor must rough-in; provide acid-resisting waste fitting from trap to sewer; provide service stop valves in all water supplies, other accessories, materials, labor and make all connections as required for a complete first class installation ready for operation. The Plumbing Contractor must also install sinks in casework and assemble required piping, faucets, outlets and trim as outlined in Architectural Lab Equipment Section.

Refer to acid resistant piping requirements specified hereinbefore.

END OF SECTION

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SECTION 15500

FIRE PROTECTION

1.01 SCOPE:

A. Section 15010 and Division 16 are applicable in full as required.

1.02 GENERAL WORKMANSHIP

A. Cut all piping accurately to measurements established at site and work into place without springing or forcing properly clearing all windows, doors and other openings. Cutting structural members for passage of pipe will not be permitted. Route all pipe around existing structure etc. Ream all pipe to remove burrs. Make changes in direction and size with reducing fittings. Cap or plug open ends of pipe during installation to keep out foreign materials.

B. Refer to and carefully check the installation against all drawings and existing conditions, and note where walls, ceilings, beams and pipe shafts are furred or enclosed. Refer to and check with the contract drawings and conditions for the HVAC, plumbing and electrical work and work of other trades.

C. Install all piping so as not to cause delay to other work, and to allow ample time for the necessary tests and approvals.

D. Install swing joints or expansion loops wherever necessary to allow for pipe expansion. Securely anchor pipes so that expansion can occur at these points.

E. All equipment must be installed in strict accordance with the manufacturer's recommendations and with NFPA requirements.

1.03 COORDINATION

A. For purposes of clearness and legibility, the drawings are essentially diagrammatic, and not intended to indicate all necessary piping, offsets, sprinklers, valves, or other required items. It must be the responsibility of this contractor to install the system in such a manner as to conform to the structure, avoid obstructions, and observe proper clearances without extra cost to the Owner. Prefabricated piping does not preclude coordination with other trades. It must be this contractor's responsibility to request and obtain all drawings of other trades work in areas where the contractor is involved, and to field check all work prior to any shop fabrication.

B. Piping must be offset, relocated or resized or other piping and/or sprinklers must be furnished as necessary to provide space for and coordination with other trades. The Architect does not assume responsibility for coordination by approval of shop drawings. Refer to Section 15010 for additional requirements.

1.04 FIELD SUPERVISION

A. The contractor must have a responsible representative of his organization at the site of the work for coordination of the system installation with other trades as early as is required

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by the progress of the work. Details of proposed departures from approved shop drawings due to field conditions must be submitted to and receive written approval of the Architect prior to installation.

1.05 SHOP DRAWINGS:

A. Prepare hydraulic calculations and a working pipe shop drawing layout showing precise locations, elevations and sizes of sprinkler piping. When submitted to Architect, drawings and calculations must bear the stamps of approval from Owner's Underwriter and local Fire Marshal's Office and any authorities having jurisdiction.

B. Hydraulic Calculation are to be prepared utilizing a current water flow test (maximum 90 days old). If a current Water Flow Test is not available, obtain a current test and pay for all fees required.

1.06 RECORD DRAWINGS

A. Contractor must maintain a set of drawings showing location and size of all piping, valves, and related items, both interior and exterior. On completion of work, the contractor must provide a set of mylar reproducible transparencies corrected to show all changes and noted "As-Built Drawings" together with two sets of blueline drawings to the Architect. Note that the Fire Protection Contractor must take as-built measurements, including all depths, inverts, etc., prior to commencement of backfilling operations. It must not be sufficient to check offline locations. Definite measurements must be taken for each line entering and leaving the facility. The location of buried piping must be shown on the record drawings and dimensioned from fixed points**.** Refer to Section 15010 for additional requirements.

1.07 CODES:

A. Provide all equipment, piping, valves, switches and complete operating system to standard of NFPA, Pamphlets 13, 14, 20 and 24 and in compliance with local, county and state authorities, Owner's Underwriter, and these Specifications.

1.08 SERVICE:

A. Connect to site fire service provided under the Civil Section. Verify exact location in the field, at the site, prior to beginning work.

1.09 WATER SUPPLY

A. Hydraulic design must be based on the available water supply at the point of connection to the existing yard main

The contractor must provide flow test at site prior to final design and must make any required adjustments without additional cost to owner.

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2.00 PRODUCTS

2.01 GENERAL:

A. The scope of this project is to provide a complete fire sprinkler and standpipe system per NFPA, latest editions.

B. Refer to Electrical Drawings and Specifications for wiring alarms of supervisory switches and related equipment.

C. All wiring other than power wiring, supervisory switches, flow switches and alarm wiring must be the responsibility of this Section. Wiring must conform to the requirements of the Electrical Section.

D. Provide one (1) wall mounted sprinkler head cabinet with 6 heads of each type utilized together with required wrenches.

2.02 SPRINKLER HEADS:

A. Sprinkler Heads: Sprinkler heads must be UL Listed with a temperature rating as required by NFPA.

B. Match existing sprinkler heads in color, provide updated sprinkler heads compatible with existing sprinkler heads where heads are being replaced.

1. Upright: Reliable Model F1FR, bronze finish.

2. Pendant: Reliable Model F1FR with one (1) piece chrome plated with shallow escutcheon, Reliable Model F1FR with one (1) piece chrome plated cup assembly for recessed applications, Reliable Model F4FR with factory painted cover plate in color selected by Architect for concealed applications. Install in center of lift-out ceiling tiles. Recessed and semi-recessed sprinkler heads only to be used in normally unoccupied areas.

3. Sidewall: Reliable Model F1FR horizontal extended coverage with one (1) piece chrome plated escutcheon, Reliable Model G horizontal extended coverage with one (1) piece chrome plated cup for recessed applications, Reliable Model F1FR upright for upright applications.

4. Dry: Pendant Reliable Model F3QR with one (1) piece plated escutcheon, Reliable Model F3QR with one (1) piece chrome plates recessed cup for recessed applications, Reliable Model F3QR with factory painted cover plate in color selected by Architect for concealed applications.

5. Dry Sidewall: Reliable Model DH56 horizontal extended coverage with one (1) piece chrome plated escutcheon for recessed applications, Reliable Model DH56 horizontal extended coverage with factory painted cover plate in color selected by Architect for concealed applications.

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2.03 FIRE PROTECTION PIPING:

A. The system must comply with NFPA Pamphlets 13, 14, and 20.
B. All Fire Protection Piping within the building must be clean and RUST FREE
C. All Fire Protection piping within the building must be black steel. All Fire Protection Piping outside of building must be ductile iron.
D. Ductile iron pipe: Cement lined, ANSI A-21.50.
E. Schedule 40 black steel for all piping 2" and smaller of for cut grooving. Schedule 10 black steel for roll grooving.
F. Joints on black steel screwed piping: Make up with Teflon tape applied to male threads only.
G. Joints on ductile iron piping: Standard mechanical joint ANSI A-21.11. Provide retainer glands, on all fittings. Provide concrete thrust black, minimum 1 cubic yard, at all fittings.
H. Joints on black steel grooved piping: Victaulic or Gustin Bacon couplings, ASTM A-47.
I. Connect to fire service, provided and installed under Civil Section. Verify exact size and location with Civil Section prior to beginning work.
J. Support all pipe in accordance with Section 15010 “GENERAL PROVISIONS”.

2.04 HANGERS

A. Hanger rings must be zinc plated, adjustable swivel ring band-type.

B. Beam clamps must be malleable iron with cup-pointed set screw and jam nut.

C. Provide anchors or clamps compatible with structure.

2.05 DRAINS AND TEST CONNECTIONS

A. Provide valved drain lines throughout the system to permit complete system drainage. All of the above to be as shown on the drawings and/or as required by codes and authorities. Discharge location of all drain and test lines required but not indicated on the contract drawings must be subject to specific approval of the Architect.

2.06 VALVE:

1. Fire Protection Valves:

    a. Gate Valves 2" and Smaller: All bronze, 175 psig WP, UL listed, OS&Y, solid disc, Stockham B-133, Crance 459, Nibco T-104-O, Milwaukee valve BB-SC100.

    b. Gate Valves 2-1/2" and Larger: Iron body, bronze trim, flanged, 175 psig WP, UL listed, OS&Y, Stockham G6343, Crane 467, Nibco F-607-0.

    c. Check valves: Iron body, bronze trim, 175 psig WP, UL listed, Stockham G-939, Crane 375, Nibco F-908-B.

2. Test Header: Croker 6806 Series flush mount three 2-1/2" outlets with valves, polished chrome plated finish. Inlet threads must match that of local fire department. Factory labeling: "FIRE PUMP TEST".

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3. Fire Department Connection (FDC): Croker 6000 Series flush mount clapper inlet with cap and chain, polished chrome plated finish. Inlet threads must match that of local fire department.
   Factory labeling: " SPRINKLER SYSTEMS"

2.07 SWITCHES:

1. Flow Switch: Notifier Sprinkler Equipment group WFD Series.

2. Supervisory Switches: Notifier Sprinkler equipment group OS&Y two (2) for OS&Y gate valves or Pibor for post indicator/butterfly valves.

2.09 FIRE PROTECTION PIPING TEST:

1. Test in accordance with NFPA Pamphlets 13, 14, 20 and 24. Architect's, Owner's Underwriters and local fire marshal must witness tests. Provide certificate of inspection to the Architect/Engineer including the name of those witnessing the test.

2. On completion of roughing-in and before connection to piping, cap all outlets, make connections with house supply line, and put under full water pressure. Test by applying additional pressure, by temporary pump or compressed air connection (as applicable), to total hydrostatic pressure 1-1/2 times street pressure, but not less than 200 psig for a period of not less than four (4) hours. Immediately and completely stop all leaks. Retest when system is watertight.

3. After testing, leave general pressure on until ready to install sprinkler heads and fire department valves, etc. except when necessary to drain to avoid freezing during construction.

2.11 SUBSTITUTE MANUFACTURERS:

A. Where Croker is listed above Potter/Roemer, Elkhart, Guardian or Sierra may be substituted.

3.00 EXECUTION

3.01 SPRINKLER HEADS:

A. Installation of sprinkler heads must be made using factory recommended and approved wrenches only.

B. Install sprinkler heads in the center of lift-out ceiling titles.

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3.02 PIPING:

A. Provide drain piping to approved locations for all low points. Provide inspectors test piping to the building exterior at approved locations.

B. Install using tradesmen regularly engaged in fire protection piping.

C. Fire protection piping may be factory cut to lengths, but field modifications will be required to coordinate with other trades.

D. Clean and paint all piping in mechanical rooms, at main riser, and other areas where exposed to view. See General Mechanical specifications for additional requirements.

3.03 EQUIPMENT:

A. Valves, test headers, Fire Department Connections and any point that the fire department may connect to and must be compatible with the local fire department.

3.04 PERIODIC INSPECTION:

A. Make two (2) periodic inspections within the first year after completion and acceptance of the work. Furnish a complete written report of each inspection to the Architect and the Underwriter.

3.05 TESTS

A. All completed work must remain uncovered if at all possible until required tests have been completed. However, in the event the project construction schedule requires it, the contractor must make arrangements for prior tests on the portions of the work involved. The Architect and all inspection authorities must be notified of tests five days in advance and must be represented at such tests if they so desire.

B. All portions of the system must be hydrostatically tested at 200 psi for 2 hours. Tests must be repeated until work is proved tight at these pressures. Repair all defects disclosed by tests and replace defective materials. Caulking of screw joints will not be permitted. Test pressure is to be maintained by a small capacity pump to minimize water damage in the event of a break. Tests are to conform to the requirements of NFPA 13.

C. Operational tests of all signal initiating devices must be conducted. Tests must be performed by actual operation of the equipment to which the device is attached, and devices must be adjusted and tests repeated until performance is satisfactory and acceptable.

D. Records of all tests are to be made available for Architect's inspection as required. Contractor is to provide all labor and materials required for the tests, and assume all costs, including those for repair of damage caused to other work or equipment. Tests are to be performed only at such times that the ambient temperature throughout the test period will be high enough to prevent freezing in any portion of the system and to assure complete drainage afterward.

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END OF SECTION

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SECTION 15700

HEATING, VENTILATING AND AIR CONDITIONING

PART 1. GENERAL

1.1. **General Provisions:** Section 15010 is applicable in full hereto. No materials or products that contain asbestos, formaldehyde, polychlorinated biphenyl (PCB), lead or mercury, in excess of limits mandated and defined by OSHA, LEED and the EPA, must be utilized.

Do not fabricate any duct or install any pipe or equipment until all coordination has been accomplished. Refer to Section 15010 for coordination requirements.

Manufacturers not mentioned in the specifications require prior approval, seven (7) days prior to bid date. Follow procedures set forth in Division 1 of the specifications. All prior approvals must be submitted through the Architect.

1.2. **Qualifications:** The Mechanical Contractor and the required third party external duct Insulation Contractor must be properly licensed and established at the location of the work and must maintain locally adequate service facilities. They must have had previous experience in the satisfactory installation of at least six (6) systems of this type, size, complexity and scope. Each Contractor must have an adequate service facility to provide complete service and maintenance of the facility within 100 miles of the installation.

The Mechanical Contractor must not install the external duct insulation. All external duct insulation work must be provided by a third party licensed and experienced Insulation Contractor whose primary business is the sale and installation of insulation materials in accordance with the insulation manufacturers' recommendations and these specifications. Refer to Part Duct Insulation Work (External) for detailed requirements.

1.3. **General Scope:** Include all equipment, material, and labor required for complete and proper installation and operation of mechanical systems, even though not every item involved is indicated. Do not attach any items to other trades' assemblies. Items must be separately attached to the building structural system.

Advisory provisions listed in all Codes referenced in the Contract Documents are mandatory. Where conflicts occur between a Code, Standard, the contract drawings or specifications, the most stringent requirements must govern and be applied.

Manufacturers not mentioned in the specifications require prior approval, seven (7) days prior to bid date. Follow procedures set forth in Division 1 of the specifications. All prior approvals must be submitted through the Architect. Where substitutions are proposed, unless the Contractor states in writing, on a separate recap/summary sheet in front of the respective submittal, the

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differences of the substituted equipment or material, he must be responsible to replace such items any time discrepancies are found.

Where units of the same class of equipment are required or specified, these units must be products of a single manufacturer, however, the component parts of each unit need not be. All major equipment (split systems, packaged equipment, etc.) must be provided by the same manufacturer throughout the project. No mix matching of equipment Manufacturers is allowed unless specified otherwise.

Architect must select all colors where a choice exists.

1.4. **Record Documents:** Provide in such detail, as is set forth under General and Supplemental Conditions and in Section 15010.

1.5. **Access Panels and Doors in Finished Areas:** Do not locate serviceable items above inaccessible, hard ceilings or in partitions without written approval from the Architect. Coordinate all items locations with the Architectural plans before installing any items. Furnish access panels and doors to the General Contractor for installation wherever required for access to any items requiring maintenance.

Access panels/doors in finished areas or areas exposed to view must be suitable for wall or ceiling finish involved, 24" x 24" unless otherwise indicated or as required to permit removal of equipment and provide acceptable maintenance access. Access panels and doors must be fire rated where rated assemblies are penetrated.

Access panels and doors must be manufactured by Milcor, Elmdor, Zurn, Mifab or approved equivalent. The Architect must approve the use of, and type of, all panels and doors to be installed in areas that are exposed to view or in finished areas.

Exposed access panels and doors must be factory cleaned and primed for painting in the field. Colors, materials and methods must be as directed by the Architect. Refer to Architectural Section, Painting, for additional information.

Refer to other parts of this specification for access doors/panels required for ductwork and other related items.

For detention and similar institutional type facilities, refer to Section 1122 for type of access panels/doors required.

Refer to Section 15010, Part Access Panels and Doors for additional requirements.

1.6. **Site Visits:** It is the contractor’s responsibility to have the job ready for site visits when they are scheduled. If the project is not ready for the requested site visit and the Architect, any governmental agency or any other entity requires an additional site visit with the Engineer present, the contractor must pay Zgouvas, Eiring & Associates a re-visit fee of $2,000. The payment must be

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made directly to Zgouvas, Eiring & Associates 5 days prior to the scheduled site visit.

The Contractor is urged to carefully review the extensive requirements of Paragraph Identification and Refrigerant Piping Identification in Section 15010 of the specifications. Note that certain identification is required to be completed before certain site visits. **There are specific identification requirements prior to the above ceiling and final site visits, respectively, that are mandatory. The Engineer will cancel, on-site, the site visit if not completed as specified. Failure to comply with this provision will be cause for cancellation of the site visit, and a fee imposed for the additional site visit, with all costs of the additional site visit to be borne by the Contractor.**

1.7. **Miscellaneous:** Bidders must visit the site and become acquainted with all job conditions that may affect the work shown on the plans. Report to the Architect, prior to bid, any new or existing conditions that require modifications to accomplish the installation of all items. Provide for required adjustments to complete the intent of the work. No consideration will be given after bid opening for alleged misunderstanding regarding new or existing job conditions, utility connections, permits, fees, construction documents, etc.

The Contractor must carefully examine the contract documents during the bidding phase. Any missing information, clarifications, etc. in the contract documents that is required to obtain accurate pricing must be brought to the attention of the Architect, **prior to bid date**, so all may be clarified and/or corrected. Failure to identify and resolve any issue prior to bid must require the Contractor to provide said items, complete, without additional cost to the Owner or the Owner's Project Design Professionals, using materials and methods specified by, and as directed by, the Owner's Design Professionals.

Refer to Section 15010 for additional requirements.

1.8. **Identification: Custom factory fabricated refrigerant piping labels are required. Stick-on, painted, stenciled or hand written type identification is not allowed.** The Contractor is urged to carefully review the extensive requirements of Part Identification in Section 15010 of the specifications and note that certain identification is required to be completed before certain site visits**.** There are specific identification requirements prior to the above ceiling and final site visits, respectively, that are mandatory. **The Engineer will cancel on-site, the site visit if not completed as specified. Failure to comply with this provision must be the cause for cancellation of the site visit, and a fee imposed for the additional site visit, with all costs of the additional site visit to be borne by the Contractor**.

1.9. **Painting and Colors:** Furnish to the Architect, color cards for standard and premium colors available. **The Architect must select color where choices exist**. Refer to the Architectural Painting Section of the specifications for additional requirements.

1.10. **Coatings and Finishes:** Pipe hangers, Unistrut pipe supports and duct Unistrut support assemblies of galvanized, zinc and similarly coated items are

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considered to **NOT** be coated. All must be painted, powder coated, epoxy coated or plastic coated. Hanger rods and associated bolts, and clamps on Unistrut assemblies are not required to be painted or coated.

All damaged or rusted steel pipe and all hangers, Unistrut and other support assemblies must be cleaned, primed and painted with two coats of compatible black enamel paint as specified below. Any rusted items must have the rust removed, then etched and primed for painting as recommended by the respective manufacturer. After prepping the surfaces, then paint with two coats of compatible black, rustproof enamel paint. Do not use spray paint.

All paint and coatings must have a fire hazard rating not to exceed 25 for flame spread and 50 for fuel contributed and smoke developed as determined by ASTM E84. See specification Section 15010, Part Identification for detailed requirements.

In lieu of painted surfaces as specified hereinbefore, the Contractor may provide factory fabricated hangers and Unistrut assemblies with rust resistant powder coating, epoxy coating or plastic coating. All paints/coatings/finishes must meet or exceed a fire hazard rating not to exceed 25 for flame spread and 50 for fuel contributed and smoke developed as determined by ASTM E84. Refer to Section 15010 for additional requirements.

1.11. **Safety Provisions:** Provide covers or guards on all hot, moving and projecting items that may be deemed by the Engineer, Architect or Owner to be a hazard to occupants of the building or to service personnel.

1.12. **Spare Parts:** Manufacturer of any equipment specified must have a wholesale outlet for readily available replacement parts in the nearest major USA city.

1.13. **Submittals:** Refer to Section 15010 for **strict requirements** and, especially as it applies to format, project cost constraints, addendums and Value Engineering (VE) items.

Only ONE complete submittal will be accepted. Providing submittals piecemeal is not allowed. If a partial or incomplete submittal is provided, it must be cause for immediate rejection.

1.14. **Firestopping:** Refer to Section 15010, Part “Partial Work to be Coordinated With Other Trades”, Paragraph “Firestopping”. **Note that Division 15 firestopping specifications require firestopping of all penetrations regardless of wall/ceiling/floor construction. Refer to Division 1 regarding additional requirements.** Where there is a conflict between Division 1 specifications and Division 15 specifications, the most stringent requirements must govern, be applicable and must be provided.

1.15. **Service, Charges, Lubrication, Filters, etc.**: Furnish complete first charges of refrigerant, lubrication, oils, etc., and be responsible for such full charges for the guarantee period. Provide service and maintenance for all equipment and systems during the guarantee period. As a minimum, quarterly service calls and reports are required. Make the last service call two weeks prior to year-

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end site visit. All quarterly service must include lubrication of all motors, bearings, calibration and adjustment of all controls and equipment, full refrigerant charge, new filters, belts, etc.

The Contractor is responsible for quarterly filter changes of all disposable filters, and cleaning of all washable filters, during the guarantee period. The Contractor must inscribe onto the disposable filters' casing the date filters were installed/replaced.

The Contractor must furnish to the Architect and the Owner individual written service reports for all work done under this warranty. Failure to provide the Architect with the Owner's written acknowledgement of service calls must be construed to mean that the service calls have not been accomplished and are still required.

1.16. **Field Instructions:** The Contractor must operate all systems for a period of six (6) days after completion of the work. During this time, provide competent personnel to thoroughly instruct representatives of the Owner in the proper operation and care of all equipment and control systems, to include the installation of the air conditioning equipment maintenance tool on the personnel's mobile devices. Example: For Trane equipment, install the Symbio Maintenance App.

Secure written acknowledgement of such training and the installation of the Maintenance App from the Owner. Failure to provide the Architect with the Owner's written acknowledgement of this training must be construed to mean that the instructions have not been accomplished and are still required.

1.17. **Operating and Maintenance Manuals: Two weeks before the final site visit**, furnish three complete sets of operating and maintenance instructions, bound in hard cover, indexed and tabbed.

The Contractor must also provide this information in digital Adobe Acrobat PDF format, on a CD-R CD. The PDF file must be provided with an embedded index for each specified item. The index must appear in the left hand window of the opened document so that the Owner or his maintenance personnel can "click" on the indexed item and move immediately to that specific item.

Minimum requirements for the Operating and Maintenance Manuals must be as follows:

a. The first page of the bound instructions must be a listing of:

1. The Owner/Project Title.
2. The Architect and Architect's Job Number.
3. The Engineer and Engineer's Job Number (Found in the Engineer's Logo in the Bottom Right Corner of the Mechanical Plans).
4. The General Contractor and Contact Information.
5. The Mechanical Subcontractor and Contact Information.
6. HVAC Controls Subcontractor and Contact Information.

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b. Second page must be a Table of Contents listing all products in the order which appear in the specifications and label the tab accordingly. Include all equipment using nomenclature shown on the Mechanical plans, UV-C lights, and similar devices, control valves, motorized dampers, fire dampers, etc.
c. The third page must be a summary page that lists each item with its respective warranty, including all extended warranties.
d. All warranty card information must be filled in by the Mechanical Contractor; Serial numbers, Model Numbers, etc. all as required for proper warranty registration. The warranty registration date must be the date of substantial completion as determined by the Architect.
e. Provide copies of all filled in warranty cards.
f. Provide a local source of supply for parts and replacement, including names and telephone numbers of parts suppliers.
g. Provide a general maintenance summary section. Section must be a list of each piece of equipment or device using the designations as shown on the plans, and the routine maintenance procedures based on the respective manufacturer's recommended intervals. As a minimum, maintenance must be grouped and individually tabbed to indicate maintenance operations required:

    1. Once a month
    2. Quarterly
    3. Once every six months
    4. Once a year

h. Provide copy of the results of all specified tests.
i. Copy of Test and Balance Report.
j. Copies of all the Mechanical Engineer's Site Visit Reports including Contractor's written response that items listed were corrected.
k. Copies of all certificates of all site visits, comments and approvals from all Governing Authorities.
l. Provide copy of all the specified start-up reports.
m. Provide copy of all Division 15 Specifications except Section 15400.
n. Provide a copy of all shop drawings/submittals.
o. Provide drawings of system control and wiring diagrams, condensed operating instructions, specified sequences of operation. Include hard copy in binder and digital copy on CD in PDF format. All components must be numbered and identified on the diagram. Laminate, frame under plastic and mount in each mechanical room in an optimally viewed location.
p. Provide record drawings of the Mechanical drawings, in hard copy and PDF format on CD. Refer to Section 15010, Part 1, General, Paragraph, Record Drawings for detailed requirements.

1.18. **Warranty:** Guarantee work as set forth in Section 15010 and Division 1. Guarantee in writing to make good without cost any defects in materials and workmanship for one year following the date of substantial completion of the project, as determined by the Architect, and unless specified otherwise a 5-year warranty on all air conditioning compressors. Provide free maintenance and service during the guarantee period to **include furnishing and replacing of**

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filters, and the cleaning of all washable filters. Refer to other parts for additional requirements and extended warranty requirements.

PART 2. ELECTRICAL WORK AND EQUIPMENT

2.1. **Power:** All power wiring required for installation of equipment is specified under the Electrical Division. Electrical equipment must be compatible with the electrical power shown on electrical drawings. **Contractor must verify all voltage and power requirements with Electrical Contractor, Electrical plans, and at the project site, prior to ordering equipment.**

2.2. **Motors:** All furnished motors must be designed, manufactured, and tested in accordance with the current applicable standards of NEMA, ANSI, IEEE, and ASTM. As a minimum requirement, all motors must conform to the current applicable sections of NEMA Standard No. MG-1, Part 3. Motors must meet or exceed The Consortium for Energy Efficiency (CEE) Premium Efficiency™ full load efficiencies. All motors 1 HP and over must be premium efficiency. All motors with scheduled capacity of less than 1 HP must be ECM type as required by ASHRAE 90.1 and with minimum motor efficiency of 70% when rated in accordance with DOE 10 CFR 431.

All motors must be listed under the UL recognized component file as applicable. All motors must be suitable for installation according to the requirements of NEC. Motors must be wound for the specified voltage and a 1.5 service factor, 1750 RPM open drip proof construction and minimum of Class “F” insulation unless otherwise shown or specified.

The bearings must have a rated fatigue life of B-10 of 150,000 hours for direct-coupled applications and 50,000 hours for belted applications minimum. Belted rating must be based on radial loads and pulley sizes called out in NEMA MG 1. Load on motors must not exceed 100% nominal horsepower. Routine factory testing must be conducted in accordance with Method B of IEEE 112 (current edition), Standard Test Procedure for Polyphase Induction Motors and Generators and must be as described in Article 12.55 of NEMA MG1, Motors and Generators. **Premium efficient motors must be warranted for 36 months from date of substantial completion of the project as determined by the Architect.**

Where shown, specified or required, furnish increment wound motors for two-step starting. All motors must be provided with overload protection and phase protection on all legs. Do not run motors until correct overload elements are installed in starters. Trading overload elements for elements of correct size for motors actually furnished must be included in this Section.

All motors serving outdoor equipment exposed to weather must have TEFC motors meeting the requirements set forth previously.

Motors must be by Allis Chalmers, General Electric Goulds, Louis Allis, Westinghouse or approved equivalent.

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2.3. **Fusing:** Provide factory installed fuses in all equipment requiring fusing for branch circuit protection.

2.4. **Motor Starters as Required:** To be furnished under this Section; installation thereof is specified under the Electrical Division, except for those which are specified to be factory assembled. Starters must be Cutler-Hammer, Allen-Bradley, Square D or General Electric. Starters must be U.L. and NEMA approved. Where required for interlocks provide built-in step down transformer. Motors for VFD drives must be designed for NEMA MG-1, Part 30.

Motor starters must be mounted on wall at accessible height standing from floor. Equipment mounted or Uni-strut type frame mounting is not acceptable.

Provide for each motor or group of motors requiring a single control (and not controlled from a motor-control center), a suitable controller and devices that must function as specified for the respective motors.

Provide overload protection for each ungrounded conductor to each motor 1/8 HP or larger (manual reset type unless indicated otherwise). The overload-protection device must be integral with the motor or controller. Unless indicated otherwise, furnish pilot lights with all remote starters. Where auxiliary control devices are connected into control circuit, these devices must not bypass safety controls (motor-overload protective devices, high-pressure cutouts, low pressure cutouts, etc.). Provide "Hand - Off - Auto" switches, auxiliary contacts, etc. for all starters.

2.5. **Unit Protection:** All fan motors, indoor units, outdoor units, condensing units, packaged units, etc., must be provided with equipment manufacturer, factory installed surge protection and phase protection to ensure against voltage unbalance, over/under voltage, phase loss, reversal, incorrect sequencing and rapid short cycling. When not available from the equipment manufacturer, protection must be provided for all 3-phase equipment utilizing ICM Controls Model 450 A Plus+ or equivalent. All single phase equipment with horsepower greater than or equal to 1/8 HP must be provided with protection utilizing ICM Controls Model ICM 492 or equivalent. The Contractor must consult with the Owner's maintenance personnel and set up all programmable options based on the Owner's requirements, within the device's capabilities. Phase protection is not required on equipment being controlled via a variable speed frequency drive; if the specified protection is inherent with the variable speed drive furnished.

2.6. **Controls:** All HVAC controls cabling and wiring must be in EMT conduit (no “whips”) or on J-hooks. Above accessible lay-in ceilings, control wiring must be installed on J-Hook assemblies. Above all hard, inaccessible ceilings, in all mechanical rooms and in areas with exposed structure (no ceilings), controls wiring must be in conduit. Do not attach any wiring, cabling or conduits to refrigerant piping.

Do not route control wiring through sleeves containing piping. Do not route any control wiring through or within any ductwork. **All wiring penetrating any exterior wall, interior partition, floor, and similar construction must be in**

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conduit with protective grommets on the conduit ends. HVAC outdoor control wiring must terminate above the ceiling in an accessible location. Through the base control wiring/conduit is not allowed.

EMT control conduit must be as specified in the Electrical Division of the specifications and/or as shown on electrical drawings. Minimum HVAC Controls conduit size must be 3/4" in size. All control conduit, power, relays, contactors, transformers, wiring, etc., required for a complete functional system as specified, shown on the plans, or as required to accomplish the specified sequences of operation, which is not shown or specified by the Electrical Division, must be furnished and installed by the HVAC Controls Contractor. This must include all power, interlock control wiring between the various components of the heating, ventilating and air conditioning system, lighting interlocks and all smoke detection system electrical wiring.

Electrical work performed under this Section must conform to requirements set forth in the Electrical Division of the specifications. All wiring must be in accordance with the National Electrical Code, and all State and local codes. Coordinate all requirements with the Electrical Sub-Contractor prior to bid and provide all as required.

All thermostat and humidistat boxes must be mounted 46" A.F.F. to the center of the box (ADA height). Where wall mounted CO_2 Sensors are indicated, they must be mounted 58" A.F.F to the center of the box. Electrical work performed under this Section must conform to requirements set forth in the Electrical Division of the specifications. All wall-mounted devices must be provided with hinged, locking metal covers with rounded edges.

Provide drawings of system control and wiring diagrams, condensed operating instructions and specified sequences of operation. Include hard copy in Operating and Maintenance Manuals binder and digital copy on CD in PDF format. All components must be numbered and identified on the diagram. Laminate, frame under plastic and mount in each mechanical room in an optimally viewed location.

All work must be done by an approved, independent HVAC Controls Contractor whose primary business is the installation and servicing of HVAC controls systems.

2.7. **Controls and Instrumentation Cable:** Instrumentation cable must be minimum AWG as recommended by the equipment Manufacturer or the HVAC controls system Manufacturer. The most stringent must be provided. All wiring, cabling, conduit, connections, etc., must be plenum rated and rated for use at temperatures and conditions expected in the location of mounting. Do not attach any wiring, cabling or conduits to refrigerant piping.

2.8. **Wiring Diagrams:** Furnish to the Electrical Contractor for the specific makes and models of electric-motor operated equipment to be installed. **The contractor must verify all voltage and power requirements with the Electrical Contractor, Electrical plans, and at the project site, prior to ordering equipment.**

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2.9. **Modifications:** The cost of any modifications of the electrical power wiring, breakers, and/or control wiring conduit, etc. that is required for any items specified in Section 15700, or controls having electrical power requirements differing from that shown on the electrical drawings and/or as specified, must be the responsibility of the Mechanical Contractor.

PART 3. VIBRATION AND NOISE CONTROL

3.1. **General:** Elimination of objectionable vibration and noise is the responsibility of the Contractor, who must provide all foundations, spring isolators, flexible connections, air chambers, curbs, etc. required thereby. Pay special attention to vibration problems at year end site visit and correct all deficiencies noted.

All items of mechanical equipment must be properly isolated from the structure by means of the Engineer's approved vibration absorbing accessories, foundations or supports.

3.2. **Vibration Isolation Pads - Indoor Units:** One layer of 3/4" thick, fire/heat resistant, continuous neoprene pad. Coordinate with details on plans.

3.3. **Sound Levels:** Sound levels caused by operation of pumps, fans, air handling systems, etc., whether generated within rooms or transmitted to rooms through ducts, walls or floors, pipes, etc., must not exceed specified NC rating at any point within room not more than 6 feet from an air outlet in accordance with ASHRAE octave band method. Offices, classrooms, conference rooms, libraries and similar spaces must have a maximum NC-25; corridors, gymnasiums and lobbies, NC-35; toilets, NC-40; auditoriums, NC15.

PART 4. TESTING, START-UP, BALANCING, ETC.

4.1. **General:** Conduct tests upon completion of the heating, ventilation and air conditioning installations, and at times as designated by the Architect. Furnish written reports to the Architect of all tests results. Provide copies of all test results in the Bound and Framed Instructions specified hereinbefore. Furnish all necessary personnel, test instruments, power, fuel, etc., as required to complete the specified requirements.

4.2. **Refrigerant Piping Testing:** The Mechanical Contractor must provide two tests for the refrigerant piping installation. The medium used for pressure testing the refrigerant system must be oxygen-free nitrogen, helium or argon. Oxygen, air, combustible gases and mixtures containing such gases must not be used as a test medium. Systems erected on the premises with tubing not exceeding 5/8 inch outside diameter must be allowed to use the refrigerant identified on the nameplate label or marking as the test medium.

The refrigerant piping system must be tested as a whole, or separate tests must be conducted for the low-pressure side and high-pressure side of the

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piping system. The refrigerant piping system must be tested in accordance with both of the following methods:

Test 1: The system must be pressurized for a period of not less than 60 minutes to not less than the lower of the design pressures or the setting of the pressure relief device(s). The design pressures for testing must be the pressure listed on the label nameplate of the condensing unit, compressor, compressor unit, pressure vessel or other system component with a nameplate. Additional test gas must not be added to
the system after the start of the pressure test. The system must not show loss of pressure on the test pressure measuring device during the pressure test for a minimum 24 hours.

Test 2: A vacuum of 500 microns must be achieved. After achieving a vacuum, the system must be isolated from the vacuum pump. The system pressure must not rise above 1,500 microns for a period of not less than 60 minutes.

Where using refrigerant as a test medium as specified above, the test pressure must be not less than the saturation dew point pressure at 77°F.

4.3. **Ductwork for Systems Less Than 2,000 CFM:** The Mechanical Contractor must test all supply, return, relief and outside air, exhaust ducts, plenums and casings and make substantially airtight before covering with external insulation or concealing masonry. Substantially airtight must be construed to mean that no air leakage is noticeable to the senses of touch or sound at joints.

4.4. **Ductwork for Systems 2,000 CFM or Greater:** The Mechanical Contractor must test all supply, return, relief and outside air, exhaust ducts, plenums and casings and make airtight before covering with external insulation or concealing in masonry. Test supply ductwork under the positive pressure for the respective system. Test return and exhaust ducts, plenum and casing under a positive pressure of 0.75“WG. The maximum allowable leakage must be 10%. Vacuum clean ducts, plenums, casings and coils. Demonstrate operation of fire dampers before testing and starting. Check that flexible connections are installed in folds (not pulled tight) and not transmitting vibration.

4.5. **Testing of all Fire Dampers:** The Mechanical Contractor, with assistance from the Testing and Balancing Contractor, must test all fire dampers and verify installation of access panels to each damper. Test all fire dampers by cutting/releasing holding mechanism and verify that dampers close properly. Install new fusible links after testing each fire damper. Certify in writing that all dampers have been checked and perform correctly.

4.6. **Testing of Smoke Detectors:** The Mechanical Contractor must attend the testing of all smoke detectors which are a part of the mechanical system. A smoke machine is required to be used for testing the smoke detectors. Anything other than a smoke machine is not allowed. Coordinate the provision of the smoke machine three days prior to the day of testing with the Electrical/Fire Alarm Contractors and provide as required. **If a smoke machine is not present at the time of testing, DCM and/or the Engineer, as**

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applicable, will cancel on-site, the site visit and a reinspection fee imposed, with all costs of the re-inspection to be borne by the Contractor.

4.7. **Domestic Water Circulating System:** The Testing and Balancing Contractor must test and adjust domestic water recirculation system to ensure hot water circulation in all mains. Provide flow rate of pump and determined head.

4.8. **Performance Tests:** After cleaning, balancing, and testing are completed as specified, test each system as a whole to see that all items perform as integral parts of the system, and that temperatures and conditions are evenly controlled throughout the building. Verify all sequences of operation and submit report. Make corrections and adjustments as necessary to produce the indicated conditions.

All work must be performed by an independent test and balancing agency whose primary business is the testing and balancing of heating and air conditioning systems and its related components. The Test and Balancing Contractor must hold a current NEBB or AABC certification. Proof of certification must be provided at the submittal stage.

The test must cover a period of not less than three days and must demonstrate that the entire system is functioning properly. Provide the following:

Date of testing, space temperature and humidity, outdoor air temperature (DB & WB), air temperature entering condenser coil; and load amperes for all motors. Also, provide CFM readings at all grilles, registers and diffusers and entering and leaving air temperatures at each evaporator coil.

Provide a typed list indicating job setting of all automatic controls. Include settings of thermostats, humidity controls, CO_2 sensors, safety controls, minimum damper settings, fire-safety thermostats, pressure controls, temperature controls, and other similar items. Tabulate to show type of control, location, setting and function. Verify that all safety settings and limits are appropriate and comply with current safety Codes and Regulations for the respective system.

After building is occupied, adjust as requested by Owner.

4.9. **Balancing:** The Testing and Balancing Contractor must check airflow at all supply air, return air and exhaust air devices, all diffusers and outside air intakes with a recently calibrated direct-reading velocity instrument. Adjust systems to deliver, supply air, return air, outside air and exhaust air quantities to within 10 percent of the indicated amounts. Provide instruments and otherwise assist the Architect in checking balancing at final site visit.

4.10. **Settings:** Contractor must permanently mark the settings of all valves, dampers, and other adjustment devices in a manner that will allow the settings to be restored. If a balancing device is provided with a memory stop, it must permit the closing and reopening of the device to its balanced position.

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4.11. **Unit Protection Verification:** The Test and Balance Contractor, with cooperation from the Mechanical Contractor, must verify that all phase protection specified has been installed where specified, and installed per the Manufacturer's requirements. The verification of this requirement must be furnished in tabular form with findings included in the test and balance report. The summary must list all equipment specified to have the protection, verification that the device is installed per the Manufacturer's recommendation and has been programmed to the Owner's requirements.

4.12. **Test Data:** The Testing and Balancing Contractor must submit typewritten report as specified above. Include schedules of readings taken during the testing and balancing operations and a line diagram or plan of the system indicating specified quantities and final balanced quantities **seven (7) days prior to final site visit**. **The Alabama Department of Construction Management (DCM) will cancel on-site, the site visit if the test and balance report has not been submitted as specified. Failure to comply with this provision will be cause for cancellation of the site visit, and a reinspection fee imposed, with all costs of the re-inspection to be borne by the Contractor. No final site visit must be made without this data.** Report the required or specified reading, the first reading taken, and final balanced reading for the following items:

Fans: Size, type, fan motor speed in rpm, outlet velocity in fpm, static pressure inches water, air quantity in cfm, and motor load in amperes.

Air Handling Equipment: Size, type, fan speed in rpm, outlet velocity in fpm, external static pressure inches water, total static pressure inches water, air quantity cfm, and motor load in amperes.

All Air Outlets and Inlets: Size, velocity in fpm, and air quantity in cfm.

Coils: CFM, size, face velocity in fpm; air temperature entering coil and air temperature leaving coil, wet-bulb and dry-bulb degrees F.

Refrigerant Hot Gas Reheat Coils: The Mechanical Contractor, with assistance from the Testing and Balancing Contractor, must adjust the humidistat so that the hot gas reheat coil valve opens. Verify modulation of the coil valve. Provide coil size, face velocity in fpm; air temperature entering coil and air temperature leaving coil, wet-bulb and dry-bulb degrees F.

Ducts: Size, velocity in fpm, and air quantity in cfm.

Heat Pumps Auxiliary Heaters Electric Heaters: Provide heater capacity (KW), number of stages of heat and load amperes.

Electric Duct Heaters: Size, face velocity in fpm, air temperature entering and leaving air temperatures and load amperes. Provide verification that SCR control is properly set up and is operating correctly.

Air Cooled Condenser Sections of All Outdoor Units: Air temperature entering condenser coil; refrigerant suction temperature and pressure at

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compressor and evaporator coil; condensing temperature and pressure and load amperes for all motors.

Kitchen Hood and Related Fans: CFM, size, face velocity at exhaust entry into filters with filters installed and with filters removed, CFM to A/C and make-up air plenum for each run out and exhaust CFM at each hood collar. Include duct and collar pressure drops.

4.13. Control Settings: In cooperation with the HVAC Controls Contractor and/or the Mechanical Contractor as required, must calibrate, adjust, and verify sequences of operation and the control systems, including the refrigerant hot gas reheat coils, to show that the requirements of these specifications have been met.

Verify all specified sequences of operation and provide report.

Provide a tabulation of setting on all controls indicating set point and throttling range, etc. after controls and systems have been finally adjusted. Include settings on safety controls and cutouts. Verify that all safety settings and limits are appropriate and comply with current safety Codes and Regulations for the respective system. Provide a typed list indicating job setting of all automatic controls. Include settings of thermostats, humidity controls, CO_2 sensors, safety controls, minimum damper settings, fire-safety thermostats, pressure controls, temperature controls, and other similar items. Tabulate to show type of control, location, setting and function. Verify that all safety settings and limits are appropriate and comply with current safety Codes and Regulations for the respective system.

4.14. Seasonal Adjustments: At the beginning of the first heating season adjust and balance operating phases and repeat at the beginning of the first cooling season or vice versa as requested by the Architect or Owner.

4.15. Notification: Notify the Architect one week prior to all testing. The Contractor must provide all testing equipment and must furnish written reports to Architect of all tests results. Additionally, provide copies in the Bound and Framed Instructions specified hereinbefore.

PART 5. SHEET METAL DUCT WORK (LOW VELOCITY 2" S.P.)

5.1. General Scope: All ductwork must be shop fabricated unless noted or specified otherwise. Provide as shown and as required for the air conditioning, heating and ventilation systems. Make changes in dimensions, offsets or crossovers as necessary to clear piping, lights and structural members, and to maintain scheduled headroom. Provide all accessories required. Refer to architectural drawings and specifications.

All exposed internally lined or double wall ductwork must have paint grip finish or must be primed in the field to receive paint. Refer to Architectural section “Painting” for painting of exposed ductwork. In case of the absence of painting requirements in the aforementioned Specification Section(s), the interior and

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exterior of ductwork visible from any finished space must be cleaned, primed and painted with two coats of paint as directed by the Architect. Ductwork visible through all grilles, registers, diffusers, ceilings, etc. must be painted flat black with paint having a fire hazard rating not to exceed 25 for flame spread and 50 for fuel contributed and smoke developed as determined by ASTM E84.

5.2. **Protection of Interior of Duct from Debris:** ALL open portions of ductwork must be covered with a self-adhesive film or airtight sheet metal caps to prevent the intrusion of contaminates. All duct taps, duct take-offs, etc., must be protected immediately after the tap, take-off, etc. has been fabricated in the field. When sections of sheet metal are delivered to the facility for fabrication in the field, which cannot be protected with the specified material, the sheet metal must be covered with Visqueen. Prior to erecting same, ductwork must be manually cleaned to remove all dust, dirt and construction debris. All ductwork must be erected clean. After each section of ductwork is erected, immediately protect all openings as specified herein before. In effect, there must be no ductwork opening that is exposed to the ambient air. The material must be a minimum 3-mil thickness and have a minimum tensile strength of 10 psi. It must be UV resistant, waterproof and recyclable. Material must be DuroDyne Dyn-O-Wrap or approved equivalent. **Any ductwork discovered to be unprotected as specified is subject to immediate rejection for use on this project.**

5.3. **Protection of Interior Ductwork and Equipment When Any Air Moving Equipment is Operating During Construction and Prior to Owner's Occupancy:** It is the Mechanical Contractor's responsibility to ensure the inside of each air handling unit and associated air distribution system is kept clean and not allow construction dust to infiltrate the system. Should the system become contaminated as determined by Architect, Engineer or Owner, the Mechanical Contractor must be responsible for cleaning.

If air moving equipment must be used during construction, temporary filtration media with a Minimum Efficiency Reporting Value (MERV) of 8, as determined by ASHRAE 52.2 and must be installed at each return air grille, return air register, exhaust grille, exhaust register, and unit return air inlet.

The General Contractor must make a written request to the Architect for permission to temporarily operate any equipment during construction. The request must be made a minimum of seven (7) days prior to the desired date of the interruption. Do not operate any equipment without the Architect's written approval.

5.4. **Sizes:** Take measurements at job and fit work into available space. Report to the Architect any unworkable conditions encountered and alter layout or duct sizes as directed without additional cost to the Owner or the Owner's Project Design Professionals. Unless otherwise approved, conform to dimensions indicated. Duct dimensions shown indicate NET FREE AREA after installation of duct liner; increase sizes indicated to allow, therefore.

5.5. **Sheet Metal:** ARMCO, or equal, prime quality, G-90 galvanized sheet steel. Unless indicated otherwise on the plans, gauges must be as recommended in the current edition of the current SMACNA "Duct Construction Standards" **but**

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in no case must be less than listed in the table below for the respective duct largest dimension or diameter. **No 26 gauge ductwork is allowed unless specified otherwise.**

Up to 30 inches	24 ga.
31 to 54 inches	22 ga.
55 to 84 inches	20 ga.
85 to 96 inches	18 ga.

5.6. **Acceptable Manufacturers:** McGill Airflow, Southeastern Metals (SEMCO), Hamlin Sheet Metal, ECCO Manufacturing, Conklin, Spiral Systems Inc or Eastern Sheet Metal, Inc. All other manufacturers require 7-day prior approval.

5.7. **General Fabrication:** Construct and erect in a skillful manner, meeting requirement of the current SMACNA "Duct Construction Standards" for 2" static pressure unless noted or specified otherwise. **Where conflicts occur between current SMACNA requirements and the contract drawings or specifications, the most stringent requirements must apply. In general, the heaviest gauge metal and the strictest installation/fabrication methods must be provided.** Form straight and smooth on the inside, with joints neatly finished. Make up in sections of such length that mechanic can reach thru open end to seal insulation at previous joint. Assemble and anchor to be completely free from vibration and drumming under all conditions of operation. Make takeoffs at round ducts with prefabricated round-to-rectangular and rectangular-to-round transitions.

All rectangular ductwork traverse joints must be made with all metal DuctMate joints system manufactured by DuctMate Industries, Inc., Quikduc Transverse Duct Connection Systems, Duro Dyne Dyn-O-Mate or approved equivalent. DuctMate system must be installed in strict accordance with current SMACNA and Manufacturer's recommendations and instructions.

Where ductwork penetrates non-rated partitions above the ceiling or insulation support/attic air barriers, draft stops and similar partitions, the openings must be sized as required for duct and insulation, plus 2" and sealed as specified below. Provide duct supports as specified within 12" of each side of the partition penetrated. **DO NOT ALLOW DUCT TO REST ON PARTITION WALLS**.

All openings in new construction must be laid/blocked out as walls and floors are constructed. Furnish detailed layout shop drawings to other trades in advance of their work. Openings in new construction which were not laid/blocked out, and all openings in existing construction, must be saw cut and present a neat appearance.

Where penetration occurs at rated assemblies, provide appropriate fire damper and install as specified and detailed.

Where penetration occurs at non-rated assemblies, the maximum allowable gap/void around the duct penetration must be 2". Any penetration larger than 2" must be filled to the 2" mark using the same materials used to construct the assembly. Thereafter, the penetration between the assembly and the duct

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must be filled with fire resistant mineral wool insulation and sealed on both sides of the assembly with a fire stopping compound to prevent the passage of smoke and fire. After sealing, provide a 6" wide, 16 gauge galvanized steel closure plate around the penetration on each side of the assembly. Closure plates must fit snugly to the duct and must be secured to the wall. All ductwork and closure plates that are exposed to view in finished areas must be primed and painted as directed by the Architect. **Do not install closure plates until Engineer or Architect has verified the proper sealing of the penetration. If closure plates are installed prior to the Architect's or Engineer's inspection, they will be removed to verify proper sealing as specified above.**

Where ducts pass through floors that do not require fire dampers, fill void with fire retardant mineral wool insulation and seal with fire stopping material to prevent the passage of smoke and fire. Thereafter, support duct and close opening with minimum 2"x2"x1/4" steel angles on all sides and, secured to both floor and duct. At plenums and risers just above the floor, provide suitable chair assemblies of welded structural shapes. **Do not install angle iron around opening until Engineer or Architect has verified the proper sealing of the penetration.**

Provide additional supports to raise ductwork off any metallic item above the ceiling. Wherever any bare metallic piping, conduits and metallic structural members are in contact with externally insulated duct or bare sheet metal duct, there must be dielectric separation provided. The Contractor must provide 3/4" thickness, **unslit** AP Armaflex insulation of sufficient inside tubular diameter to snuggly and completely cover the respective metallic item. The insulation must extend the full length of the affected area plus 6" on both sides. Refer to Part "Pipe and Miscellaneous Insulation Work" in this division for AP Armaflex material specification. The use of Rubatex insulation between piping and the ductwork must only be allowed when providing the proper supports is not an option.

Refer to Paragraph "Hangers and Supports" for additional requirements.

5.8. **Exposed Ductwork:** Install tight against the wall, overhead structure or ceiling with drive slip joints and other supports as required. Refer to Architectural plans for duct locations. If duct locations are not shown on the Architectural plans, coordinate locations with the Architect prior to fabricating or installing any ductwork.

Required openings in exterior perimeter walls, and interior walls and partitions must be saw cut or properly blocked out and present a neat appearance. Where penetration occurs at rated assemblies, provide appropriate fire damper and install as specified and detailed. Where penetration occurs at non-rated assemblies, it must be installed as specified hereinbefore in Paragraph, General Fabrication.

All floor/shelter lid penetrations must be as specified in Paragraph Hangers and Supports, below.

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All ductwork and closure plates that are exposed to view in finished areas must be primed and painted as directed by the Architect. Penetrations and closure of the penetrations must be as specified above. **Do not install closure plates until Engineer or Architect has verified the proper sealing of the penetration. If closure plates are installed prior to the Architect's or Engineer's inspection, they will be removed to verify proper sealing as specified above.**

All exposed rectangular ductwork traverse joints must be made with all metal DuctMate joints system manufactured by DuctMate Industries, Inc., Quikduc Transverse Duct Connection Systems, Duro Dyne Dyn-O-Mate or approved equivalent. DuctMate system must be installed in strict accordance with current SMACNA and Manufacturer's recommendations and instructions.

All exposed internally lined or double wall ductwork must have paint grip finish or must be primed in the field to receive two coats of paint. Refer to Architectural section "Painting" for painting of exposed ductwork. In the absence of painting requirements in the aforementioned Specification Section(s), the exterior of ductwork visible from any finished space must be cleaned, primed and painted with two coats of paint as directed by the Architect.

Ductwork visible through all grilles, registers, diffusers, ceilings, etc. must be painted flat black with paint having a fire hazard rating not to exceed 25 for flame spread and 50 for fuel contributed and smoke developed as determined by ASTM E84.

5.9. **Cross-Joints, Seams and Stiffening:** Join and stiffen with combination of joint types and structural angles as recommended in current SMACNA "Duct Construction Standards". **Cross break all flat areas over 35 inches wide.** Install internal ends of slip joints in the direction of flow.

All transverse joints with long dimension over 23" must be made with all metal DuctMate joints system manufactured by DuctMate Industries, Inc., Quikduc Transverse Duct Connection Systems or Dyn-O-Mate with roll-formed flanges, corner pieces, gasket, and cleat. The system used must be installed in strict accordance with current SMACNA and Manufacturer's recommendations and instructions.

Make all cross joints and all branch, grille and diffuser take-offs, except DuctMate joints, air tight by applying fibrated, low VOC, LEED IEQ 4.1 compliant duct sealer. Sealer must meet and pass ASTM D-2202, ASTM C-731 and EPA regulations. Sealer must meet the requirements for the pressure classification of the ductwork installed. Sealer must be Hardcast Iron Grip 601, Duro Dyne Duro Seal, Design Polymerics DP1020 or United McGill Uni-Seal Duct Sealant.

5.10. **Branch Ducts to Diffusers:** Round runouts to diffusers, up to and including 14" round, must be 24 ga., G-60 galvanized, DuctMate Series GreenSeam +Snap Lock pipe with factory sealed longitudinal and transverse gaskets. Gasket for GreenSeam +Snap Lock pipe must contain antioxidants, fungicides,

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adhesion promoters, zero VOCs and must meet or exceed ASTM E-84 test requirements. 16” round to 20” round runouts must be 24 ga. and equal to DuctMate Series Reeves Lock Pipe, G-60 galvanized pipe.

5.11. **Branch Duct Take-Off:** Provide at all points where branch ducts take off from trunks, and where ducts divide. Refer to details on the drawings. Damper must be minimum 22 Ga., G-90 Galvanized steel with 2” build out. Body must be a minimum of 24 Ga., G-90, galvanized steel with 4” W.G. construction. Fitting must have 1” flange with corner clips, pre-punched mounting holes and adhesive coated gasket. Take-off must be Flexmaster LDS, BO3, GSI HETO, HTS2, Elgen HETO, Crown 3300-DS2 or approved equivalent.

5.12. **Turns and Transitions:** Fabricate turns with an inside radius equal to width of duct. At 90-degree turns, Contractor may substitute square elbows, with standard factory-made, multiple, double-blade constructed vanes. Vanes must be a double wall, true airfoil contour with smoothly rounded entry nose with extended trailing edge. Vanes must be formed from a single piece of 26 ga., hot dipped galvanized steel and must be 3” radiused vanes on 2.4” centers. Vanes must be provided with two (2) tie rods and continuous internal tubes for stiffening and rigidity. Maximum pressure drop must be .06” W.G. at 1500 FPM. Generated sound power level must not exceed 54 decibels in band 4 at 2000 FPM (24”x24” duct size). **Single wall turning vanes are not allowed.** Vanes must be manufactured by Aero/Dyne Series HEP, Duro Dyne HTV/DHV, DuctMate, Hamlin Sheetmetal or Spiral Systems Inc. Avoid abrupt changes in shape, with a slope of 4:1, the minimum allowed.

5.13. **Fire Dampers:** Provide as shown on drawings and in each duct passing through firewalls, floors, and other fire barriers in accordance with NFPA Code 90A. Install in such manner that fusible links can be replaced. Employ UL listed links rated at 165 degrees F (212 degrees within 10 feet of a heating coil).

Typical dampers must be UL labeled, minimum 1-1/2 hour rated, (higher where required), equal to Prefco #5500, with Type B, 21 gauge galvanized steel wrap around low resistance frame, 21 gauge galvanized steel blades and 16 ga. factory sleeves. Where damper is installed behind wall grilles or registers use No. 5500-E6-LPB.

Install in accordance with all applicable conditions of the UL listing, for which data sheets must be submitted for review. At internally insulated ducts, size dampers for gross duct size, so that liner butts into damper frame surround.

At typical ducts, provide 16 ga. sleeves secured in opening with 1-1/2” x 1-1/2” x 14 ga. (min.) angles, minimum 12 ga. angles at storm shelter penetrations, bolt angles and damper sleeve with galvanized bolts. Size structural openings so that space between sleeve and masonry is not less than 1/8” per linear foot of duct or more than 1/2”. Secure ducts to sleeve per detail and current SMACNA requirements. After installation release holding mechanism and verify proper closure of each damper.

Fire dampers indicated for use in storm/tornado/safe areas and

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storm/tornado/safe areas lid penetrations must have 10 ga. sleeves and angles.

Ductwork in fire-rated floor-ceiling or roof-ceiling assembly system with air ducts that pierce the ceiling of the assembly must be constructed in conformance with designs in UL Fire Resistance Directory. In general, ducts must be encased in fire rated material.

Equivalent products by Air Balance, Ruskin, Pottorff, Greenheck or Nailor will be accepted. Prefco is the basis of design.

5.14. **Return Air Platforms:** Return air platforms must be constructed with 1-1/2”x1-1/2”x1/4” steel angle iron frame and 18 ga. G-90 galvanized steel all sides, top and bottom, then sealed airtight by welding or soldering. Insulate all sheet metal sides, top and bottoms with 2” thickness, 1.5 lb. density, unfaced duct liner, same as internally lined ductwork. Provide angle iron supplemental supports and pedestal type pipe columns to support the units and allow individuals to stand on the platform without platform deformation or failure. Platforms must be a minimum of 24” tall, or as space permits. The bottom of all wall mounted return air registers that are connected to the return air platform must be approximately 6” above the finish floor, i.e., above the Architectural base.

No combustibles are allowed in the return air platform.

5.15. **Motorized Dampers Used with Automatic Controls:** See Controls at end of Section 15700.

5.16. **Volume Dampers:** For round ducts less than 12” diameter and rectangular ducts less than 12” in height in either dimension: Class 1A leakage, single leaf, blade constructed with 20-gauge galvanized metal frame and locking type control quadrant, single center U-bolt and pivot rod extending through opposite side of duct with brass bushing at both ends. Dampers must be manufactured by Ruskin MD-35, United Enertech MD-105, Greenheck MBD-10, Nailor 0800 or Pottorff CBD-01.

5.17. **Volume Dampers:** For round ducts greater than or equal to 12” diameter or rectangular ducts greater than or equal to 12” height in either direction, provide opposed blade, airfoil blades of 16 ga.-galvanized steel mounted in steel frames by 3/8” steel trunnions riding in brass bushing with dual U-bolts. Blade width must not exceed 10 inches and individual blade length must not exceed 48 inches. Extend one trunnion to permit operation from outside the duct. Provide manually operated dampers with cadmium plated steel locking quadrant. Dampers opening to the outside must have felted edges. Dampers must be manufactured by Ruskin MD-35, United Enertech MD-105, Greenheck MBD-15, Nailor 0810 or Pottorff CBD-01.

5.18. **Stand-Off Mounting Brackets:** Locking-type quadrant operators for dampers, when installed on ducts to be externally insulated, must be provided with standoff mounting brackets, bases or adapters to provide clearance between the duct surface and the operator not less than the thickness of the insulation.

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Standoff mounting items must be integral with the operator or standard accessory of the damper Manufacturer.

5.19. **Access Panels/Doors:** Refer to Section 15010 for access doors required for equipment, valves, etc. in exposed/finished locations.

Provide double wall access door in the side of the duct for each fire damper, motorized damper, on each side of duct mounted coils and duct heaters, smoke detectors and elsewhere indicated, specified or required for proper maintenance. Size and position to provide maximum access to all items with minimum 12”x12”.

Typical doors must be double metal faced, 22 ga. steel door panels and 22 ga. frame, internally insulated same as duct (1” minimum) fiberglass insulation, neoprene gasket seal and full length plated steel piano hinges with cam lock. Provide access panels/doors with cam locks only, where hinged access panels/doors cannot be completely opened without obstruction. When access panels/doors are provided with cam locks only, they must be provided with a safety chain. Access panels/doors must be rated for the anticipated duct pressure, plus 1”. All access doors located outside must be airtight and weatherproof.

Hinged access doors must be Ruskin Series ADH22. Removable access doors/panels with cam locks must be Ruskin Series ADC22 with minimum of two cam locks and safety chain. Nailor Industries Model 08SCL/Model 08SH, Kees ADH/ADC, Greenheck HAD or Pottorff Series HAD/CAD will be acceptable.

For ducts 10” round and smaller, access doors must be flush mounted, flat oval, 1” insulated, low leakage, 20 ga. steel door panels and frame, except with two large hand knobs or cam locks with safety chain, and equivalent to Ruskin Model ADR1 for round ducts or equivalent by Nailor, Greenheck, Kees or Pottorff.

Hinged access doors for round ductwork over 10” must be flush mounted, flat oval, 1” insulated, low leakage, 20 ga. steel door panels and frame, except with two large hand knobs or cam locks with safety chain, and equivalent to Ruskin Model ADR2 for round ducts 12” round, up to and including, 16” round duct. Nailor Series 0800, Pottorff Series DMR or equivalent by Nailor or Kees will be acceptable.

Refer to other sections for access doors required in kitchen hood exhaust ducts, moisture-laden ductwork, etc.

Refer to Section 15010 for additional access door/panel requirements including Part Identification.

5.20. **Duct Instrument Test Holes:** Provide for each system four test holes (two in supply duct and two in return air plenum) at opposite ends near air handling units with screwed caps. In addition, at duct mounted coils and electric duct

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heaters provide one on either side of the coil or duct heater.

5.21. **Flexible Connections and Bonding Jumpers:** Install so that the cloth is in folds (not drawn tight). Connect all ducts to air handling equipment and fans with preassembled flexible connection. Fabric width must be 6" for all air handling equipment. Ceiling mounted exhaust fans must be 4" width.

Connectors for all air handling equipment must be a factory fabricated and assembled unit with 6" dual fabric, heavy duty, 20 oz/sq. yd polyester/polyester fabric with flame resistant coating and mildew resistant per ASTM G-21. The assembly must comply with NFPA 701, NFPA 90A, NFPA 90B and ASTM E-84. The unit must be constructed of a minimum of 24 ga. galvanized steel meeting ASTM A-653-94-G60. Metal to fabric connectors must be double locked, airtight and waterproof to 10" W.C. positive pressure and 10" W.C. negative pressure. The assembly must be DuctMate PROflex with power lock connection or approved equivalent by DuroDyne.

Flexible connections for ceiling exhaust fans must be preassembled flexible connection of 29 ounce fire-resistant, neoprene coated glass fiber cloth equal to Ventfabrics "Ventglas" (4" fabric width) and manufactured by Ventfabrics, Wiremold or Thermaflex.

Provide preassembled flexible connections for all ducts that cross building expansion joints. Flexible connections must be 6" in width as specified hereinbefore. Coordinate requirement with Architectural plans and provide as required.

Externally insulate all flexible connectors to prevent condensation with 2" thickness external duct insulation as specified later in this section. **Do not insulate flexible connectors until the installation of the below specified bonding jumper has been verified.**

Prior to insulating, provide copper jumpers across all flexible connectors taking care that jumpers do not bind flexible connections. Provide compression lug and grounding connector screwed into the duct with two (2) screws, on both side of the flexible connector. Bonding wire must be shielded 12 AWG.

5.22. **Miscellaneous Bonding/Grounding of Metallic Items:** Wherever any bare metallic piping, conduit, structural elements or any other metallic assembly is in contact with externally insulated duct or bare sheet metal duct, bonding/grounding must be provided. The Contractor must provide 1/2" thickness, unslit AP Armaflex insulation of sufficient inside tubular diameter to snuggly and completely cover the respective metallic item. The insulation must extend the full length of the affected area. Where channel shapes are used, orient the open side of the Unistrut assembly down. Materials that are not supported by Unistrut, sheet Armaflex may be used provided it is properly attached to the duct or affected items. Refer to Section 15700, Part "Pipe and Miscellaneous Insulation Work" for AP Armaflex material specification.

5.23. **Register and Grille Connections:** Where take-offs are in side of a duct, clinch lock short tee sections onto trunk. Install collars with slip joints and 3/4" flange

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at outlet end. At sheetrock and other hard surfaces, set the collars exactly flush with surface.

Install boots above lay-in ceilings simultaneously with ceiling work.

At return air, relief air and exhaust air grilles 36” or more in either dimension, collars must be 1” x 2” x 1/8 inch steel angle frames with corners mitered, welded and ground smooth. Frames in the ceiling must be independently suspended from the ceiling structure, or the duct must have special reinforcing to prevent sagging of the boot.

The interior of all ductwork visible through grilles and diffusers must be painted flat black with paint having a fire hazard rating not to exceed 25 for flame spread and 50 for fuel contributed and smoke developed as determined by ASTM E84.

5.24. **Hangers and Supports: Duct hangers must NOT penetrate the external insulation vapor barrier. All duct hanger materials must be external of the insulation materials, insulation jacket and vapor barriers. All vapor barriers must be continuous and without penetrations.** All supports, assemblies, related components, attachments and required appurtenances must be sized for a minimum of 300% (3 times) the anticipated load carried by the respective assembly. Where the Contractor has doubt as to proper supporting requirements, he must consult with, and seek the guidance of, the Architect and the Project Structural Engineer.

Where duct supports are specified to be a Unistrut assembly, the Unistrut must be painted, powder coated or plastic, same as specified above and in Section 15010, Part 4, Para. Coatings and Finishes. Duct Unistrut support assemblies of galvanized, zinc and similarly coated items are considered to **NOT** be coated. All must be painted, powder coated, epoxy or plastic coated. Hanger rods and associated bolts, and clamps on Unistrut assemblies are not required to be painted.

All paint and coatings must have a fire hazard rating not to exceed 25 for flame spread and 50 for fuel contributed and smoke developed as determined by ASTM E84.

“Sammy” bolts are prohibited. Contractor must provide supplemental steel between structural purloins, bar joists, etc., for duct support as required to meet support spacing specified. Supplemental steel must be welded in place as directed and specified by the Structural Engineer. Support small (less than 40 united (w+h) inches) horizontal ducts without external insulation with 1-1/4” x 20 ga. band hangers. Provide in pairs close to each transverse joint and in no case more than six feet apart. Bands must be turned 3” under the lower corner of ductwork and fastened with one (1) self-tapping screws into the bottom of the duct surface. Bands must be attached up the sides of the ductwork at a maximum of 6” intervals and in the bottom of the duct. Seal all screws with duct sealer as specified for ductwork.

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Support vertical runs larger than 40 united (w + h) inches with structural brackets with welded joints.

Support all non-externally insulated horizontal ducts larger than or equal to 40 united (w+h) inches on trapeze type hanger assembly same as specified below for externally insulated duct except without AP Armaflex surround on the Unistrut. Install inserts or clamps as required to accommodate overhead construction. Spacing must not exceed 6 feet.

All 14” or less concealed round ducts with external insulation must be provided with band hangers and saddles. Suspend ducts, at six (6) foot intervals with 8” long, 3” wide, 22 gauge galvanized metal saddles hung from structure with 22 gauge, 1” wide straps. Bands must pass completely under and around round ducts. Loop strap under duct and attach to strap with two (2) galvanized bolts. Thereafter, loop top end of hanger over steel structural members above and fasten with two (2) galvanized bolts. Where concrete joists occur overhead, secure straps to side of joist with galvanized expansion or ramset bolts. Where flat concrete surface occurs overhead, secure with ramset or expansion bolt fasteners. See other Specification Sections in the Contract Documents for limitations on use of power driven fasteners.

All concealed and externally insulated rigid round metal ducts greater than or equal to 16”, all externally insulated rectangular ductwork, all externally insulated square ductwork, and all externally insulated flat oval ductwork that is specified to have external insulation with a vapor sealed facing **must be supported with trapeze hangers consisting of Unistrut, threaded rods and inserts or clamps as required to accommodate overhead construction.** Threaded rods must be of size required to provide support of three (3) times the anticipated load of the assembly. Trapeze hanger assembly spacing must not exceed 8 feet. Hanger rods must not be in contact with external duct insulation nor metal duct work.

Where ducts are specified to have external insulation with a vapor sealed facing, support duct on trapeze hangers consisting of a Unistrut assembly with threaded rods.

On externally insulated ducts, install 3/4” thickness, **unslit** AP Armaflex insulation of sufficient inside tubular diameter to slide over the Unistrut support, completely cover and snuggly fit to the bottom horizontal Unistrut duct support. The AP Armaflex insulation must extend the full width of the insulated/uninsulated duct plus a minimum of 6”, each side. Space hanger rods a minimum of 6” (maximum of 12”) from the sides of the ductwork to permit the duct to be placed within the trapeze hanger assembly without being in contact with the externally insulated ductwork or bare metal ductwork. Where channel type Unistrut shapes are used, orient the open side, down. Refer to Section 15700, Part Pipe and Miscellaneous Insulation Work for AP Armaflex material and installation methods specification.

All concealed internally insulated round ducts must be supported as specified above for externally insulated ductwork except without insulation saddle. Coordinate exposed duct support requirements with plan details.

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Wherever any duct hanger support exceeds 36” length from the top of the supported duct to the structure above, do not use band hangers. The Contractor must provide a Unistrut support assembly and provide bracing of the assembly with minimum 1”x1”x1/4” angle iron, or as required for the weight of the particular duct, to prevent swaying of the duct work. Weld angle iron to the Unistrut and attach to the overhead structure, as specified and directed by the Structural Engineer, to prevent swaying.

Where the ducts rise at the outside walls, the contractor must provide a welded chair assembly, required supports, attachments and, related and required appurtenances. The duct riser at the outside wall must maintain a distance between the wall and the finished insulated assembly as required to insulate the back side of the ductwork.

Where horizontal ducts with standing joints exceed 72 inches in width they must be provided with additional hangers at the mid-point of their width, consisting of a support bolted to an interior 1/8 x 1-1/2 inch strap that must, in turn, be bolted to the duct. Internal straps and hangers must be spaced one for each duct section.

Where trapeze type hangers or DuctMate is used to support exposed ductwork in finished areas, the width of the support must not exceed the duct width by more than six (6) inches on either side of the duct.

5.25. **Roof Exhaust Caps:** For exhaust ducts up to and including 12x12, must be low profile, sloped, galvanized steel construction with built-in bird screen, integral flashing flange and all accessories required for a complete installation. Cap must be Greenheck Series RJ, Gemini RJ, Fantech RC or equivalent as required for sloped shingle roofs. Provide similar device for standing seam metal roofs or flat roofs as required by the roofing Manufacturer. All items furnished must adhere to roofing Manufacturer’s requirements so as not to void the roofing warranty. Hoods must be factory primed for painting in the field or factory baked enamel finish as selected by the Architect.

5.26. **Roof Intake and Relief Hoods:** Greenheck Series FGI/FGR, Loren-Cook GI/GR, CaptiveAire EV-CA & IV-CA or Carnes Series GI/GE, low silhouette, for flat or sloped roof as required, 18 ga. aluminum or 20 ga. galvanized steel construction unit with welded joints, Hi-Pro Polyester or Lorenized polyester coating with standard or optional premium color selection must be by the Architect. Hoods must be complete with 1/2” aluminum bird screen, rain gutter, weather baffle, 10” high (exhaust/relief) or 14” high (intake) height NRCA approved roof curb for flat or sloped roof as required, with built-in cant strip, integral fiberglass insulation and wood nailer. All hoods smaller than 24”x24” must be hinged type. All intakes, relief or exhaust vents greater than 12x12 must be 125 MPH rated. Maximum intake face velocity of 250 FPM, maximum throat velocity of 500 FPM and .05” WC maximum pressure drop. Maximum relief throat velocity of 600 FPM, maximum 300 FPM face velocity and .05” WC maximum pressure drop. Hood, throat and curb cap must be minimum 18ga.

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Roof curbs must be painted with two coats of non-reflective paint. The paint type and color must be selected by Architect. All roof curbs furnished must adhere to the roofing Manufacturer's requirements so as not to void the roofing warranty. The top of all roof curbs must be level with pitch built into curb when deck slopes 3/8 of an inch per foot or more. Coordinate with architectural and structural plans for required slope.

Coordinate roof curb and interface in the building roofing system, flat or sloped roof, and verify minimum net height to be as required by Code or as required by Architect. Refer to architectural specification and plans for additional requirements. All roof curbs interfacing must comply with the Architectural requirements. Coordinate and provide as required.

5.27. **Flexible Air Ducts:** Flexible air duct must be factory made and composed of an inner duct of woven and coated fiberglass providing an air seal and permanently bonded to coated steel wire helix, a fiberglass insulating blanket and low permeability outer vapor barrier of fiberglass reinforced metallized film laminate. R-value must be a minimum R=8 per ASTM C-518.

Duct must be rated for a maximum pressure of 16" (4-10 in. ID) or 10" (12-16 in. ID) water column positive and 2" water column maximum negative pressure and 5000 FPM maximum velocity and Listed by Underwriters Laboratories, Inc., under UL Standard 181 as a Class 1 air duct and complying with NFPA Standards 90A and 90B. Duct must have a maximum flame spread of 25 and a maximum smoke developed rating of 50.

Flexible duct length must not exceed six (6) feet. Supply each duct with 1/2" wide, 200 Series **stainless steel worm gear driver and stainless steel band** at take-off fitting and supply fixture connections equal to Thermaflex Snaplock clamp. Zip tying is not allowed.

Suspend ducts, at three (3) foot intervals with 8" long, 3" wide, 22 gauge galvanized metal saddles hung from structure with 22 gauge 1" wide straps. Loop strap under duct and attach to strap with two (2) galvanized bolts. Thereafter, loop top end of hanger over steel structural members above and fasten with two (2) galvanized bolts. Branch duct connectors for connecting round low velocity branches to rectangular low velocity trunks must be rectangular to round take-off fittings as detailed on the drawings with damper and standoff mounting bracket.

Provide a full size radiused, galvanized sheet metal elbow transition piece from flexible duct connection to each diffuser boot. Elbow gauge must be as specified hereinbefore in Part, "Sheet Metal Ductwork" for respective duct size.

The flexible duct must be GreenGuard Level 4 certified, Thermaflex M-KE, ATCO UPC #031 or Flexmaster Type 1M.

5.28. **Factory Fabricated Duct and Fittings:** All exposed round or rectangular supply air, return air, relief and exhaust ducts and fittings must be factory fabricated and insulated duct and fittings must be equal to McGill Airflow K27

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with metal perforated inner shell. Duct to duct joints in diameters up to 48", and 42" major axis and 24" minor axis must be by the use of sleeve couplings, reinforced by rolled beads. All duct-to-duct connections or duct to fitting connections for exposed double wall ductwork, regardless of size, must be provided with factory-fabricated couplings to provide a neat, smooth appearance tack welds and rated for 2” static pressure. All divided flow fittings must be manufactured as separate fittings, not as tap collars welded into spiral duct sections. Do not cut the duct in the field for take-offs, etc. without approval from the Architect or the Engineer.

Insulation must be Acousti-Line with EPA registered anti-microbial, erosion-resistant acrylic coating. The coating must resist the growth of fungus and bacteria as determined by ASTM C 1071, ASTM G21 and ASTM G22. The insulation thickness must be 1” thickness where exposed within the conditioned space and 2” thickness where concealed. Ductwork must comply with NFPA 90A.

Provide as shown and as required for the air conditioning, heating and ventilation systems. Make changes in dimensions, offsets or crossovers as necessary to clear piping, lights and structural members, and to maintain scheduled headroom. Provide all accessories required.

Construction and installation must comply with current SMACNA Standards. Required duct gages must be same as specified in Part Sheet Metal Duct Work (Low Velocity 2" S.P.). Where conflicts occur between current SMACNA requirements and the contract drawings or specifications, the most stringent requirements must apply. In general, the heaviest gauge metal and the strictest installation/fabrication methods must be provided.

All duct-to-duct connections or duct to fitting connections for exposed double wall ductwork, regardless of size, must be provided with factory-fabricated couplings to provide a neat, smooth appearance. All factory-fabricated ducts must be shipped from the factory with factory installed heavy duty protective plastic to cover duct and all openings.

Where ductwork is indicated or specified to be exposed to view in occupied spaces, provide materials which are free from visual imperfections, including pitting, dents and other imperfections including those which would impair post painting. Exposed to view ductwork must be as outlined above. Any ductwork installed, which is damaged, must be replaced at no cost to the Owner, at the discretion of the Architect.

Provide additional supports to raise ductwork off any metallic item or as a minimum, provide Rubatex insulation between ductwork and the respective metallic item. The use of Rubatex insulation between piping and the ductwork must only be allowed when providing supports is not an option.

Refer to architectural drawings and specifications. Refer to Architectural section “Painting” for painting of exposed ductwork. In case of the absence of painting requirements in the aforementioned Specification Section(s), the interior and exterior of ductwork visible from any finished space must be

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cleaned, primed and painted with two coats of paint, as directed by the Architect. Ductwork visible through all grilles, registers, diffusers, ceilings, etc. must be painted flat black with paint having a fire hazard rating not to exceed 25 for flame spread and 50 for fuel contributed and smoke developed as determined by ASTM E84.

Acceptable Manufacturers are McGill Airflow, Southeastern Metals (SEMCO), Hamlin Sheet Metal, ECCO Manufacturing or Eastern Sheet Metal, Inc. All other manufacturers require 7-day prior approval.

PART 6. FABRIC AIR DISPERSION (DUCTSOX)

6.1. **General:** Non-metal ductwork, as shown on the plans, consisting of a non-condensing, fabric air dispersion product assembly. Product must be classified by Underwriter's Laboratories and must have a fire hazard rating not to exceed 25 for flame spread and 50 for fuel contributed and smoke developed as determined by ASTM E84, NFPA 90-A and are also classified in accordance with ICC Evaluation Service AC167 and UL 2518. **All product sections must be labeled with the logo and classification marking of Underwriter's Laboratories.** Manufacturer must have and submit documented design support information including duct sizing, vent and orifice location, vent and orifice sizing, length, and suspension. Parameters for design, including maximum air temperature, velocity, pressure and fabric permeability, must be considered and documented. Tensioning system must be an IHS internal hoop system consisting of internal 360-degree hoop system spaced on 5'-0" centers for 95% full round tension in any airflow mode. System must be installed with a one row suspension system located 1.5" above top-dead-center of the textile system. System attachment to cable or U-Track must be made using Gliders spaced 12 inches. Provide 316 Stainless Steel components including coupler assembly, vertical cable support and Gripple quick cable connector. System must be designed by the fabric air dispersion system Manufacturer to provide a **maximum NC 35** sound rating at 6 feet above the floor. Provide all items necessary and required for a complete, finished and properly functioning installation. Duct Sox must be provided with **custom print color, custom print logo and custom print wording**. Do not use stock print. The Architect must select color, wording and logo. Basis of design is DuctSox Verona. Equivalents by Durkee Sox Nano Model NSL with IRR support system, Prihoda or Fabric Air will be considered.

6.2. **Textile Air Dispersion System:** Air diffusers must be constructed with a metallic internal tensioning and skeletal system and of a woven fire retardant fabric that must be 100% flame retardant and treated with a machine wash-able anti-microbial agent from the Manufacturer. Fabric must be a minimum of 6.8 oz. /sq. yd. per ASTM D3776 with custom color as selected by the Architect. The fabric must operate within a temperature range of 0 degrees F to 180 degrees F. Fabric must be coated with an antimicrobial agent must be proven 99% effective after 10 laundry cycles per AATCC Test Method 100. Air dispersion must be accomplished by vent nozzles as shown on the plans. Linear vent is to consist of an array of open orifices rather than a mesh style vent. Inlet connection to metal duct must be via zip screw fastener. Inlet

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connection must include zipper for easy removal and maintenance. The system must include adjustable flow devices to balance turbulence, airflow and distribution as needed. Flow restriction device must include ability to adjust the airflow resistance from 0.06 – 0.60 in W.G. static pressure. End cap must include zipper. Fabric system must include connectors to accommodate suspension system listed. Each section of the textile must include identification labels documenting order number, section diameter, section length, piece number, code certifications and other pertinent information. Any deviation from a straight run must be made using a gored elbow or a high efficiency tee. Normal 90-degree elbows are five gores, and the radius of the elbow is 1.5 times the diameter of the DuctSox. Fabric diffusers must be designed from 0.25" water gauge minimum to 3.0" maximum, with 0.5" as the standard. System overall design: diameter, length, airflow, operating static pressure and dispersion must be designed and approved by the Manufacturer. The textile must be warranted for 10 years.

6.3. **Shop Drawings:** Manufacturer must submit for review, shop drawings indicating all sizing, fittings, attachments, dispersion pattern, etc. to achieve proper airflow at the design cfm and mounting height required for comfort and NC criteria specified. Provide sound analysis with submittal verifying NC ratings specified. Provide drawings indicating system design and certified performance rating. Additionally, supplier of the fabric sox material must submit factory drawings, for review, showing the vent hole configuration with number and size of air outlet holes and spacing angles to adequately supply air to the floor based on the mounting height and locations of the fabric sox within each space.

6.4. **Warranty:** Manufacturer must provide a 15-Year Product Warranty for products supplied for the fabric portion of this system as well as a Design and Performance Warranty

PART 7. FUME HOOD EXHAUST DUCTS

7.1. **General:** The mechanical contractor must provide exhaust air duct for each lab fume hood constructed of 16-gauge type 316 stainless steel and terminate with stack head as shown on the drawings. All duct work must be installed as required by SMACNA and must have welded connections. See plan details for additional requirements.

PART 8. FUME HOOD AIR FLOW ALARM

8.1. **General:** Provide for each hood an alarm system complete with a velocity monitor, velocity sensor, visual and audible alarms, LED signals and other auxiliaries required to provide safe hood operation. Note the hood fan is constant volume. The system must be equal to TSI Fume Hood Monitor, Model FHM-10. Coordinate requirement with Lab Furnishings Contractor and provide if not included with hoods.

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The fume hood face velocity monitor system must be furnished and installed to monitor the measured face velocity of a fume hood independent of sash position and duct static pressure. The system must continuously monitor and display face velocity to comply with the recommendation set forth in Appendix A of OSHA regulation 29 CFR 1910.1450. The system must also indicate the presence of airflow to comply with the NFPA 45 Standard. Coordinate all power requirements with the Electrical Contractor prior to bid and provide all as required for installation.

PART 9. DUCT INSULATION WORK (EXTERNAL)

9.1. **General: The Mechanical Contractor must not install the external duct insulation.** All external duct insulation work must be provided by a third party licensed and experienced Insulation Contractor whose primary business is the sale and installation of insulating materials in accordance with insulation manufacturers' recommendations and these specifications.

The Insulation Contractor must provide a complete insulation submittal on his company letterhead detailing materials and methods as specified. The Mechanical/HVAC submittal will be automatically rejected and not be reviewed without a submittal from the specified Insulation Contractor.

Where a conflict exists between these specifications and the Manufacturer's recommendations, the strictest installation must be provided.

The finished insulation system must provide complete thermal barrier throughout the equipment and air distribution system, including effective and durable vapor barriers and vapor stops for any system or condition potentially subject to condensation. An insulation system must be provided to prevent condensation or potential thereof, to prevent the transmission of water vapor into the insulation system (vapor barriers), and to prevent transmission of water vapor within the insulation system should vapor barrier compromises occur during operation and/or maintenance of the building (vapor stops).

The duct must be clean, dry and pressure tested before covering is applied. Cover flexible connections with insulation material as hereinafter specified to same thickness as adjacent duct. Install insulation with longitudinal seams at top and bottom of horizontal runs. Install multiple layers of insulation with longitudinal and end seams staggered. All insulation materials (coatings and mastics) must be fire resistive per NFPA Pamphlet No. 90, ASTM C 411, must be UL listed and must have a fire hazard rating not to exceed 25 for flame spread and 50 for fuel contributed and smoke developed as determined by ASTM E84, NFPA No. 255 or UL 723.

Refer to Section Sheet Metal Ductwork, Paragraph Hangers and Supports, for miscellaneous insulating requirements for externally insulated ductwork.

9.2. **Material:** Provide GreenGuard certified glass fiber duct insulation with reinforced foil kraft laminate jacket, formaldehyde-free.

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All **supply air and return air ducts** located in the attic, mechanical mezzanine or outside the building insulation envelope must be provided with a total of 3.5" thickness external insulation, in addition to the specified acoustical liner. The first layer must be **1.5" thickness, 0.75 lb. density, without reinforced foil kraft laminate jacket** and with characteristics specified above. The second layer must be **2" thickness, 1.5 lb. density, with reinforced foil kraft laminate jacket** and with characteristics specified below. When using this requirement, the insulation sub-contractor may use bare stainless steel wire or a single strip of FSK tape to hold the butt joints of the first layer together until the second layer of insulation is installed.

OPTION: In lieu of providing two layers of insulation for supply and return air ducts as specified above, the Contractor may substitute one layer of 4.25" thickness, 0.75 lb. density **with reinforced foil kraft laminate jacket** with characteristics specified below.

All **supply air** and **return air** ductwork located above the ceiling within the building insulation envelope and below the ASHRAE required air barrier, in chases and other similar areas, but not in the attic, or outside the building insulation envelope or in the mechanical mezzanine, must be provided with **2" thickness, 1.5lb. density, duct wrap with reinforced foil kraft laminate jacket** as specified below. Note that this requirement does not apply to ductwork that is exposed to view in finished areas. Refer to internal duct insulation requirements for duct exposed to view in finished areas.

All **outside air** and **exhaust air** ductwork must be provided with **1.5" thickness, .75lb. density, with reinforced foil kraft laminate jacket** as specified below. Note that this requirement does not apply to ductwork that is exposed to view in finished areas. Refer to internal duct insulation requirements for duct exposed to view in finished areas.

Thermal conductivity for **1.5" thickness** per ASTM C-518, **0.75 lb. density** must be not less than k=0.27 BTU·in/(hr·ft²·°F) and minimum installed R=4.2 at 75°F mean temperature with test based on material thickness compressed 25%.

Thermal conductivity for **2" thickness** per ASTM C-518, at its rated thickness, and **1.5 lb. density** must be not less than k=0.24 BTU·in/(hr·ft²·°F) and minimum installed R=6.3 at 75°F mean temperature with test based on material thickness compressed 25%.

Thermal conductivity for **4.25" thickness** per ASTM C-518, **0.75 lb. density** must be not less than k=0.27 BTU·in/(hr·ft²·°F) and minimum installed R=12.0 at 75°F mean temperature with test based on material thickness compressed 25%.

See "Duct Insulation (Internal)" for internal acoustical insulation required in addition to the external insulation specified hereinbefore.

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Supply air, return air, relief air and outside air ducts within enclosed mechanical rooms or on the mechanical mezzanine do not require flexible, external, duct insulation. Instead, supply air, return air, relief air and outside air ducts in all mechanical rooms must be insulated with 1" thickness, 4.25 lb. density, R=4.5, rigid glass fiber duct insulation to a point 8" vertically above the mechanical room ceiling into the attic or 8" horizontally above the ceiling of the adjacent conditioned space, as applicable. Seal all ends of bare, exposed insulation board with vapor barrier sealant as specified hereinbefore.

Facing must be aluminum foil reinforced with fiberglass yarn and laminated with fire resistant adhesive to Kraft paper. Thermal conductivity value must be per ASTM C-612, Type 1B, at its specified thickness and must be not less than k=0.22 BTU·in/ (hr·ft²·°F) at 75°F mean temperature. Insulation must meet or exceed the requirements of ASTM E 84, UL 723, ASTM C1136, Type II:FSK, NFPA 90A, NFPA 90B, NFPA 255, FHC 25/50 and ASTM795. Moisture sorption must be less than 5% by weight and maximum moisture vapor transmission of 0.02 perms.

Insulation must be Owens-Corning Series 815 Spin-Glas or equivalent material by Knauf, Schuller or CertainTeed. Rigid board insulation is not required when equipment is located in the attic or on a mechanical mezzanine.

9.3. **Thickness:** Toilet/shower and janitor closet/housekeeping exhaust ducts, louver and brick vent plenums, back panels of ceiling diffusers, ceiling return air, ceiling relief air and ceiling exhaust air registers and grilles, and outside air ducts: 1.5" thickness, 3/4 lb. density with reinforced foil kraft laminate jacket. All other locations: Minimum 2.0" thickness and density specified above with reinforced foil kraft laminate jacket. Coordinate with variations specified above for additional layers or 4.25" thickness and provide as required.

See limits of acoustic insulation in Part Duct Insulation Work (Internal) below. Where duct board is specified within the mechanical rooms or mechanical mezzanines, external duct wrap insulation is not required.

9.4. **Manufacturer:** Johns-Manville Micro-Lite EQ, Type 150 or Type 75 with thickness and density as specified above. Equivalent material from Knauf, Schuller, Owens Corning or CertainTeed will be accepted.

9.5. **Ducts to be Insulated Externally:** Supply air and return air ducts including ducts with acoustical liner, outside air ducts, make-up air ducts, toilet/shower/housekeeping/janitor closet areas exhaust ducts, louver and brick vent plenums, short branch duct collar connections to grilles, registers and diffusers, supply air fan intake and discharge air ducts related to the storm shelter, all flexible canvas connectors and exterior rim/cone/panel of all ceiling diffusers, ceiling exhaust grilles and registers and ceiling return registers and grilles. Factory fabricated and insulated exposed ductwork within the building does not require external insulation unless located within mechanical rooms/spaces at which it must be insulated with duct board as specified hereinbefore.

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See Part “Duct Insulation Work (Internal)” for sound attenuating insulation requirements of externally insulated ductwork.

Do not externally insulate flexible canvas connectors until installation of the specified bonding jumper has been verified by the Engineer or the Authority having jurisdiction. If insulated at the time of the site visit, the insulation will have to be removed to verify the proper installation.

9.6. **Application:** Sheet metal duct must be clean, dry and tightly sealed at all joints and seams before applying duct wrap. Installation must be in strict accordance with the Manufacturers recommendations and these specifications. Adhere insulation to sheet metal with a brush or roller in manufacturer recommended workable sections with a water based, LEED compliant, low VOC liquid, not spray, insulation bonding adhesive. Wrap insulation tightly on the ductwork with all circumferential joints butted and longitudinal joints overlapped a minimum of 2”. The 2” flange of the facing must be secured using 9/16” flare-door staples applied 6” on center and taped as specified hereinafter. On longitudinal joints, the overlap must be secured using 9/16” flare-door staples applied 6” on center and taped as specified hereinafter. For rectangular ducts wider than 23”, additionally support insulation with weld pins and speed clips 18” on center with a minimum of two pins and washers for each section.

The liquid adhesive must be UL-723, ASTM E-84, NFPA 90A and 90B, LEED and ASTM C916 compliant, low VOC, moisture and mildew-resistant with suitability for high-humidity environments. The liquid adhesive must be Hardcast IG-601, Design Polymerics DP 2505, Foster 85-15, Vimasco 714 or Childers Chil-Lag CP-52.

Stop and point insulation around access doors and damper operators to allow operation without disturbing duct wrapping. Insulate standing seams and stiffeners that protrude through the insulation with 2” thick, faced, flexible blanket insulation.

Vapor seal all seams, joints, pin penetrations, other breaks, circumferential and longitudinal joints with reinforcing mesh and coat with vapor barrier facing. Mesh must be **4” wide pre-sized glass cloth** adhered and finished with two (2) coats of UL 181A-M compliant for sheet metal and duct board applications and UL 181B-M compliant for flexible ducts and flexible connectors. The sealant must be McGill Uni-Mastic 181, Hardcast Versa-Grip 181, Vimasco Vima-Seal 714 or Childers Chil-Tuff CP-181, vapor barrier coating as required to completely cover the mesh. **No FSK tape will be allowed.** Fiberglass cloth must be Great Lakes Textiles Style GL1658, 20x10 thread count per square inch, 0.004-inch thickness and 1.60 oz. /sq. yd., Childers Chil Glas #10 glass mesh, Foster Mast-A-Fab polyester mesh or equivalent product by 3M.

Any externally insulated duct with metallic vapor barrier that is in contact with metallic piping, conduits or metallic structural members must be provided with a section of Rubatex insulation between ductwork and the metallic member. Rubatex must be 3/4” thickness, AP Armaflex insulation of sufficient inside tubular diameter to slide over, completely cover and snuggly fit the contacted item. The insulation must extend the full width of the duct plus a minimum of

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6", each side of the duct. Refer to Part Pipe and Miscellaneous Insulation Work for AP Armaflex material and installation methods specification. The use of AP Armaflex insulation between piping and the ductwork must only be allowed when raising the effected duct is not an option.

9.7. **Insulation Pins and Washers: The use of adhesives for attaching pins and washers to the ductwork is prohibited.** Pins must be cupped-head, capacitor-discharge-weld pins, zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135 inch diameter shank, length to suit depth of insulation specified with integral 1-1/2 inch galvanized carbon-steel washer. Insulation retaining washers must be self-locking type formed from 0.016-inch thick galvanized steel with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

9.8. **Hot Gas Reheat Coil and Cabinet:** Where hot gas reheat coils are specified and the coil is not within the insulated Heat Pump or Air Handling Unit equipment cabinet, externally insulate the hot gas reheat coil cabinet with 1.5" thickness, 4.25 lb. density, R=6.8, duct board equal to Owens-Corning Series 815 Spin-Glas. Protect external insulation with open weave glass or polyester cloth by Johns-Manville Duramesh, Childers Chil Glas #10 or Foster Mast-A-Fab, embedded between two 1/8" coats of Foster 60-91 (gray) Monolar Mastic or Childers Encacel X-1 (gray). Coordinate coil requirements with the Mechanical Contractor prior to the bid and provide as required.

9.9. **Ducts From Outdoor Packaged Equipment to Point Inside Building (PHAC-A):** Must be insulated externally (in addition to duct liner) with 2" thickness, 4.25 lb. density, R=9.1 duct board equal to Owens-Corning Series 815 Spin-Glas. Protect external insulation with open weave glass or polyester cloth by Johns-Manville Duramesh, Childers Chil Glas #10 or Foster Mast-A-Fab, embedded between two 1/8" coats of Foster 60-91 (gray) Monolar Mastic or Childers Encacel X-1 (gray). After insulating, cover all ductwork with 24 ga. cross-broken or beaded prefinished Kynar 500 sheet metal and slope to drain away from the building and to sides of ductwork with so as not to discharge rain water to the supply and return air connections of the unit. Provide a trough as required. Sheet metal cover must be cross broken or beaded. **The Architect must select color**.

9.10. **Ducts From Outdoor Packaged Equipment to Point Inside Building (PHAC-A) (OPTION):**

At his option, the Contractor may substitute non-fibrous, closed cell ductwork with minimum insulation value of R-12 and manufactured by Thermaduct or approved equivalent. The panels must be manufactured of CFC-free Kingspan Kooltherm closed cell rigid thermoset resin thermally bonded on both sides to a factory applied .001" aluminum foil facing reinforced with a fiberglass scrim. It must have an added UV stable, IR reflective 1000-micron high impact resistant titanium infused vinyl that is factory bonded using a full lamination process. The lamination process must permanently bond the vinyl clad to the outer surfaces of the phenolic foam panel to provide a zero-permeability watertight barrier and to form a structurally insulated panel (SIP) in which to form duct segments. Processes that do not employ a full lamination process are not acceptable. Self-applied adhesives such as tapes, caulks or cladding

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that incorporate pressure sensitive or spray adhesives are not acceptable**. Ductwork color must be selected by the Architect.**

Duct Leakage Class must be SMACNA Leakage Class 3 or less. Thermaduct must incorporate a Kingspan KoolDuct fortified inner liner compliant to UL (C-UL) 181 Standard for Safety Listed, Class 1 system, with included testing and passing the Test for Surface Burning Characteristics, Flame Penetration Test, Burning Test, Mold Growth and Humidity Test, Low Temperature Test and High Temperature Test, Puncture Test, Static Load Test, Impact Test, Pressure Test and Collapse (negative pressure) Test, High Temperature and Humidity for 90 days, Cone Calorimeter, ASTM E2257 Standard Test Method for Room Fire Test of Wall and Ceiling Materials and Assemblies, ASTM E 84 tested, Tunnel Test, Does not exceed 25 flame spread, 50 smoke developed, DW144, Class B, NRTL product approval, (Subpart S of 29 CFR Part 1910, OSHA), ASTM C 423 noise reduction, ASTM E 96/E 96M Procedure A for permeability, ASTM C 1071 for erosion, ASTM C 518: 2004, Standard Test Method for Steady–State Thermal, Transmission Properties by Means of the Heat Flow Meter Apparatus, UL 723, Test for Surface Burning Characteristics of Building Materials, NFPA 90A, "Installation of Air Conditioning and Ventilating Systems", NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems", NFPA 255, “Standard Method of Test of Surface Burning Characteristics of Building Materials. Thermaduct outer shell must be a UV stable 1000 micron high impact resistant titanium infused vinyl with included testing UL-94 Flammability V-0, ASTM D-638 Tensile Strength of 6250 psi, ASTM D-790 Flexible Strength of 11,000 psi, ASTM D-4226 Drop Impact Resistance, ASTM D-4216 Cell Classification.

Material must have continuous rating of 185 degrees F inside ducts or ambient temperature surrounding ducts. Maximum Thermal Conductivity must be 0.146 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature and permeability: 0.00 perms maximum when tested according to ASTM E 96/E 96M, Procedure A. Product must pass UL bacteria growth testing procedures. Noise-Reduction Coefficient must be 0.05 minimum when tested according to ASTM C 423, Mounting A. All interior duct liner must bear UL label and other markings required by UL 181 on each full sheet of duct panel; UL ratings for internal closure materials. All insulation materials must be closed cell with a closed cell content of >90%. Duct must be double wall thick panel with R=12.0.

Closure materials must be V-Groove adhesive, silicone (interior only). It must be UV stable 1000 micron high impact resistant titanium infused vinyl (exterior), factory manufactured seamless corners for zero perms, cohesive bonded over-lap at corner seam covers for zero perms. It must have water resistant titanium infused welded vinyl seams and must be mold and mildew resistant.

It must have a polymeric sealing system. Its structural membrane must be aluminum scrim with woven glass fiber with UV stable vinyl clad applied. Minimum Seam Cover Width must be 2-7/8” inches. Sealant must be low VOC. **Color must be selected by the Architect.** The entire assembly must be water, mold and mildew resistant. Duct connectors must be factory furnished galvanized 4-bolt flanges

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The outdoor ductwork must incorporate UV stable 1000-micron high impact resistant titanium infused vinyl. Flange coverings must be field sealed airtight before flange covers are installed. Flange covering must consist of foam tape insulation with molded 39 mil covers and air gap with molded 39 mil covers.

Reinforcement must be factory designed and built with adequate reinforcement to both; withstand air pressure forces from within the duct from blower pressure where the Thermaduct is being installed. Thermaduct must employ Airtruss reinforcement system when both specified static pressure and duct sizes dictate the need. This is a factory installed system, and no field installation of the reinforcement system must be required. Hangers, supports and tie-downs must be detailed on the Manufacturer’s installing contractors detail drawings prior to installation and designed to carry the weight and wind load of the ductwork as prescribed in IBC Section 1609 and IMC 301.12.

Ducts must be detailed and fully factory manufactured by an authorized Thermaduct, LLC facility system. All fabrication labor must be certified “yellow label” building trade professionals, compliant to SMWIA and SMACNA labor guidelines.

Fabricated joints, seams, transitions, reinforcement, elbows, branch connections, access doors and panels, and damage repairs must be according to the Manufacturer’s written and detailed instructions. Fabricated 90-degree mitered elbows must include turning vanes. Fabricated duct segments must be in accordance with Manufacturer’s written details. Duct Fittings must include 6 inches of connecting material, as measured, from the last bend line to the end of the duct. Connections on machine manufactured duct may be 4 inches. Fabricated duct segments utilizing v-groove method of fabrication. Factory welded or cohesively bonded seams must apply to fully manufactured ductwork and fittings. Internal seams must be supplied with an unbroken layer of low VOC silicone or bonding. Each duct segment must be factory supplied with either aluminum grip pro-file or pre-insulated duct connectors in accordance with Manufacturer’s detailed submittal guide. Applied duct reinforcement to protect against side deformation from both positive and negative pressure per Manufacturer’s design guide based on specified ductwork size, and system pressure. The ductwork must be designed and fabricated duct segments and fittings in accordance with “SMACNA Duct Construction Standards” latest edition. Both positive and negative pressure ductwork and fittings must be constructed to incorporate a UL Listed as a Class 1 air duct to Standard for Safety UL 181 liner with an exterior clad for permanent protection against water intrusion. Duct must be constructed to meet requirements to withstand the minimum wind loads prescribed in IBC Section 1609 and IMC 301.12.

Install ducts and fittings to comply with Manufacturer’s installation instructions. Comply with SMACNA's "Duct Cleanliness for New Construction Guidelines." Use prescribed duct support spacing as described in this specification and Manufacturer’s recommendations. Manufacturer’s recommendations must take precedence over specifications. Duct air leakage rates must be in compliance with “SMACNA HVAC Duct Construction Standards” latest version per applicable leakage class based on pressure.

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The Contractor must arrange for Manufacturer's representative to inspect completed installation and provide written report that installation complies with Manufacturer's written instructions. Remove and replace duct system where inspection indicates that it does not comply with specified requirements. Perform additional testing and inspecting, at the Contractor's expense, to determine compliance of replaced or additional work with specified requirements.

Outdoor ducts and fittings must have minimum panel thickness of 1-1/4". Cladding must be minimum as required for specified insulation thickness or 0.038 inch, whichever is greater.

PART 10. DUCT INSULATION WORK (INTERNAL)

10.1. **General:** All work by experienced applicators in accordance with Manufacturer's recommendations and these specifications. Where a conflict exists between these specifications and the Manufacturer's recommendations, the strictest installation must be provided.

Duct liner, mastics and materials must comply with all requirements and other building code requirements. All insulation materials (coatings and mastics) must be fire resistive per NFPA Pamphlet No. 90A and 90B and must be UL listed and must have a fire hazard rating not to exceed 25 for flame spread and 50 for fuel contributed and smoke developed as determined by ASTM E84. Liner materials must conform to the performance based ASTM C1071, which includes ASTM C518 Thermal Conductivity, ASTM C411 Temperature Resistance, ASTM C665 Corrosiveness, ASTM E84 Surface Burning Characteristics, ASTM C1338 Fungi Resistance, ASTM C1304 Odor Emissions and ASTM C1104 Moisture Vapor Sorption.

10.2. **Material:** Liner must be a GreenGuard certified, low VOC, Type I liner as defined by ASTM C1071 and characteristics complying with ASTM E 84, UL 723, NFPA 255, NFPA 259 and ASHRAE 62. It must have an acrylic coating formulated with an immobilized, EPA registered, protective agent to protect against growth of fungi and bacteria as required by ASTM C1071 and tests conducted in accordance with ASTM C 1338, ASTM G21 and ASTM G 22. It must not support microbial growth and have glass fibers bonded with a thermosetting resin. The airstream surface must be protected with a reinforced coating with flexible glass cloth reinforcement. The liner must have a reinforced factory applied edge coating and operate in an environment of a maximum of 250°F and maximum of 6,000 fpm air velocity. Thermal conductivity per ASTM C-518, at its rated thickness, must be not less than k=0.16 BTU·in/ (hr·ft²·°F) and R=6.3 at 75 F mean temperature in accordance with ASTM C18. Sound absorption coefficients for the liner must be per ASTM C 423 and ASTM E 795 test methods and the table below. **Furnish sound characteristics for review with the material submittal.**

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Sound Absorption Coefficient at Frequency

Thickness (In)	(Cycles per Second) 125	250	500	1000	2000	4000	NRC
1.5	0.10	0.47	0.85	1.01	1.02	0.99	0.80
2.0	0.25	0.66	1.00	1.05	1.02	1.01	0.95

10.3. **Manufacturer:** Must be Johns Manville Linacoustic RC or equivalent material by Schuller, Knauf, Pittsburgh, CSG, Owens Corning or CertainTeed.

10.4. **Thickness:** 1.5 inches thickness. Return air platforms/plenums, relief air and transfer air (jumper and ATD) ducts 2.0" thickness.

10.5. **Ducts and Equipment to be Insulated Internally:** Exposed supply air, exposed return air and exposed outside air ducts in areas without ceilings that are not specified as factory fabricated and insulated double wall duct and fittings, return air plenums/platforms, transfer air (jumper and ATD) ducts, all relief air ducts.

10.6. **Acoustical Duct Lining:** Line the first ten (10) linear feet of all single wall, supply air, return air and outside air ducts downstream of all heat pumps, packaged units PHAC, storm shelter supply air fans discharge ducts, classroom exhaust ducts and transfer air (jumper and ATD) ducts with insulation equal to Johns Manville Linacoustic RC and **2.0" thickness.** Sound absorption characteristics must be as specified above.

10.7. **Application:** Sheet metal duct must be clean, dry and tightly sealed at all joints and seams before applying duct installation. Installation must be in strict accordance with the Manufacturers recommendations and these specifications. Adhere insulation to sheet metal with a brush or roller in manufacturer recommended workable sections with a water based, LEED compliant, low VOC liquid, not spray, insulation bonding adhesive. Adhere insulation to the manufacturer's recommended workable section of the sheet metal surface prior to breaking the sheet metal. Cutting of the insulation and then adhering the insulation to the sheet metal is prohibited. Insulation joints must be straight and smooth and must be buttered with the specified adhesive to prevent erosion and improve airflow. The product must have factory applied edge coating to assure sealing of transverse edges per current SMACNA and NAIMA installation standards. Secure all insulation on ducts wider than 23 inches with washers or stud pins and clips 16 inches on center, each way.

The adhesive must be a premium, water-based, brush/roller applicable adhesive designed for bonding fibrous insulation (e.g., fiberglass duct liner) to the interior of HVAC ductwork. It must be UL-723, ASTM E-84, NFPA 90A and 90B, LEED and ASTM C916 compliant, low VOC, moisture and mildew-resistant with suitability for high-humidity environments.

Damage to the liner must be repaired using the specified adhesive products following recommendations provided by the Manufacturer of the adhesive.

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Adhesive must be Design Polymerics DP 2505 Duct Liner and Insulation Adhesive, Hardcast IG-601 Insulation Adhesive, Childers CP-127 or Foster 85-20 Duct Liner Adhesive.

10.8. **Metal Nosings: All exposed leading and trailing edges must be secured with sheet metal nosings to protect insulation edges**. Metal nosings must be securely installed over all transversely oriented liner edges facing the airstream at forward and rear discharge towards coils, dampers, ducts, plenums, changes of insulation thicknesses of adjoining insulation, any exposed insulation ends and at any point where lined duct is preceded by unlined duct. See detail on the plans. All remaining miscellaneous exposed edges must be sealed/coated. There must be no exposed fiberglass insulation.

PART 11. REGISTERS, GRILLES AND DIFFUSERS

11.1. **General:** All grilles, registers and diffusers must be product of a single Manufacturer with baked enamel finish and standard **or** custom color as selected by the Architect. Architect may require painting of the diffusers, grilles, registers, etc., in the field. Where field painting is required, diffusers, grilles and registers must be factory primed for painting in the field. Refer to Architectural Section “Painting”, coordinate requirements and provide finish as required.

Where lay-in ceilings occur, all specified items must have integral 2’ x 2’ or 2’ x 4’ aluminum modular lay-in ceiling panel with finish to match diffuser. Refer to Architectural reflected ceiling plan, check ceiling suspension system, wall and ceiling finishes and provide for proper interface as required.

All ceiling grilles, registers and diffusers not in integral lay-in metal panels and installed in gypsum board or other hard surfaces must be mounted with aluminum-countersunk screws with finish to match respective items.

Where ceiling mounted devices are installed in hard ceilings, provide appropriate trim ring as required such that screws are not visible in the face of the device. Flat countersunk screws are only allowed when concealing them is not an option.

All ceiling diffusers, ceiling return air registers and grilles, ceiling exhaust grilles and registers, and ceiling mounted relief air grilles back panels must be insulated with 1” thickness, foil backed insulation and securely attached. Contractor has the option of insulating manually or furnishing the item with factory furnished insulation from the item Manufacturer. Factory provided insulation must be attached as shown on the plan details.

All grilles, registers and diffusers must be ADC or approved equivalent Agency certified.

11.2. **Square Ceiling Diffusers with Round Neck:** Titus Model TMSA-AA, Price ASCDA, removable core type, aluminum construction, with baked enamel standard or custom finish color selected by the Architect, designed for four-way diffusion complete with Titus AG-85, Price VCR8E steel butterfly blade

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damper. Diffuser face must be 24" x 24" with type frame to interface with ceiling system. Use lay-in type frame where lay-in ceilings occur.

11.3. **Wall Supply Air Registers:** Titus Model 300 FS-5-D-65, Price 620DAL-F-S-D-A-SW all aluminum adjustable 4-way deflection type. Provide with AG 35B aluminum opposed blade damper with worm gear, Allen Key operators and AG-225 extractors with No. 1 operator, auxiliary mounting frame with baked enamel standard or custom finish color selected by the Architect.

11.4. **Wall Return Air and Wall Exhaust Air Registers:** Titus Model 33R-PF, Price Model 91-L-D-A-VCS3 gymnasium heavy duty steel register with 38 degree deflection 14 ga. blades, support bars on 6" centers, Allen key operated aluminum opposed blade damper and auxiliary mounting frame with baked enamel standard or custom finish color selected by the Architect.

11.5. **Double Face Wall Grilles:** Same as wall return air registers except without dampers.

11.6. **Ceiling Mounted Exhaust Air and Return Air Registers:** Titus Model 50-F-0-5-D-25, Price Model 80DAL-F-SW-A all-aluminum fabricated egg-crate type, Allen key operated aluminum opposed blade damper and lay-in type frame with baked enamel standard or custom finish color selected by the Architect.

11.7. **Ceiling Mounted Return Air or Relief Air Grilles and Air Transfer (Jumper Duct) Grilles:** Same as return air registers except without dampers.

11.8. **Brick Vents for Exhaust Fan Discharge:** Extruded aluminum, Reliable RBV, Greenheck BVE, Cook BV, Ruskin BV or United Enertech BE brick and block vent with 1/4" mesh removable aluminum bird screen , integral water stop and 40% minimum free area with Kynar finish. Finish must be factory paint color to be selected by the Architect.

11.9. **Soffit Vents:** Titus Model 50-F-0-5-25 all aluminum egg-crate grille with brushed satin finish.

11.10. **Expanded Metal Grilles:** Provide metal grille equal to McNichols Co., flattened expanded metal, galvanized, hot dipped, 3/4, #16 flattened, minimum 70% open (free) area with U-Edging. Provide grille at all open ends of ductwork, packaged units intake, exhaust or relief openings (if not provided by the equipment manufacturer) and any location required to protect anyone from possible injury or harm. Grille must be factory primed and painted in the field as directed by the Architect.

11.11. **Manufacturers:** Equivalents by Titus, Price and Krueger will be accepted. Titus and Price are basis of design.

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PART 12. FEMA LOUVERS

12.1. **FEMA Louvers:** Louvers indicated to be on the outside/perimeter wall must be furnished and installed by the General Contractor. See Architectural specifications for requirements. Louvers indicated to be within the storm shelter in the penetrations of the shelter lid or partitions which are associated with Mechanical duct work must be furnished and installed by the Mechanical Contractor.

Louvers must be FEMA 361 or FEMA 320 compliant as applicable. Coordinate requirements with FEMA notes on the structural plans and provide accordingly. Louvers must be AMCA 540 and 550 certified and labeled as required. The louver must be a U.L. Classified Windstorm rated assembly in accordance with FEMA Guidelines P-320, P-361, and ICC 500 for static and cyclical design pressures of positive/negative 250 PSF and debris impact of a 15 pound 2"x4" traveling at 100 MPH. The louver must be AMCA certified and bear a metal U.L. Label. **Stick-on type U.L. labels are not allowed.** Louver depth must be as required for the assembly it is mounted in. Louver must be Greenheck or equivalent by Ruskin, Reliable, Carnes or Airolite.

PART 13. CONDENSATE DRAINAGE PIPING

13.1. **General:** Cut accurately to measurements established at site and work into place without springing or forcing, properly clearing all building features. Arrange and install piping systems sizes as shown, as close as practical, straight, properly supported and run as directly as possible forming right angles or running parallel with building lines, true to line and grade, free of sags and bends. Locate piping as high as practical and in parallel groups as close together as practical. Route through previously built-in sleeves and avoid cutting or other weakening of the structure. Ream all pipes to remove burs. Make changes in direction and size with fittings. Bushings are prohibited. Cap or plug open pipe ends during installation to keep out foreign material.

Before installation, piping must be checked, upended, swabbed, and all dirt from storage or from lying on the ground must be removed. **All piping must be clean when it is installed.**

Make all connections to equipment using screwed unions. Install unions in all piping connections to each piece of equipment, including traps, pumps, coils, etc. **Per IMC 307.2.5, condensate drain lines must be configured to permit the clearing of blockages and performance of maintenance without requiring the drain line to be cut.** Refer to plan details for detailed requirements of the assembly.

All piping must be concealed within walls, chases, above ceilings, etc., unless specifically noted otherwise.

13.2. **Condensate Drain Piping and Drain Piping from All Drain Pans to Floor Drains, Hub Drains and Other Miscellaneous Condensate Receivers:** Interior condensate drainage piping material must be Type L hard copper

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tubing with wrot copper solder joint fittings with 45° or 90° offset fittings. **ProPress or similar type fittings/joints are not allowed.**

Outdoor condensate drainage piping must be Schedule 80 solid wall PVC pipe conforming to ASTM Standard D1785. Schedule 80 fittings must be injection mold and must conform to ASTM D 2464. Pipe and fittings must be manufactured from virgin rigid PVC (polyvinyl chloride) vinyl compounds with a cell class of 12454 as identified in ASTM D 1784. PVC Schedule 80 pipe must be Iron Pipe Size (IPS) conforming to ASTM D 1785. Injection molded PVC Schedule 80 fittings must conform to ASTM D 2467. PVC Schedule 80 threaded fittings, where specified, must conform to ASTM D 2464. Pipe and fittings must be manufactured as a system and be the product of one manufacturer. All pipe and fittings must conform to NSF International Standard 61 and the health effects portion of NSF Standard 14. Installation must comply with the latest installation instructions published by piping manufacturer and must conform to all applicable plumbing, fire, and building code requirements. Solvent cement joints must be made in a two-step process with a primer meeting ASTM F 656 and a medium- or heavy-bodied solvent cement conforming to ASTM D 2564. The system must be protected from chemical agents, fire-stopping materials, thread sealant, plasticized vinyl products or other aggressive chemical agents not compatible with PVC compounds. The system must be hydrostatically tested after installation as specified hereinbefore. All Schedule 80 piping and fittings must have factory applied UV protective coating and tested for sunlight resistance according to UL 651 requirements.

All cooling coils and evaporator coils horizontal condensate drainage piping must be sloped a minimum of 1/8” per foot. The condensate drain line size must be full size of unit condensate outlet and in no case, less than 3/4 inch.

The condensate drainage assembly must be made up of materials specified above. The assembly must consist of p-trap, unions, air bleeder/open vent with 1/8” screen over open portion, etc., as required by the equipment Manufacturer. **Running p-traps are not allowed.**

In absence of the Manufacturer’s requirements, condensate drainage assembly must be as shown on the plans. **Per IMC 307.2.5, condensate drain lines must be configured to permit the clearing of blockages and performance of maintenance without requiring the drain line to be cut.** Refer to the details on the plans and the requirements below for unions required in the condensate piping.

Install a UL 508 and UL 2043 (as applicable) conforming electric switch in the secondary drain line of each condensate producing piece of equipment. The switch must automatically shut off the equipment served in the event the primary drain line becomes restricted.

13.3. **Auxiliary Drain Piping from Auxiliary Drain Pans under Equipment Located in Concealed Areas:** Contractor must also provide a 3/4” drain line of materials specified above in the **bottom** of the drain pan with a 3/4” brass,

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hose end connection (hose bibb) to provide manual, gravity draining of the auxiliary pan after the monitoring device has been reset.

Install a UL 508 and UL 2043 (as applicable) conforming electric water level monitoring device in the auxiliary drain pan to automatically shut off the equipment served in the event the primary drain line becomes restricted.

13.4. **Copper Joints:** Make assemblies with tin-antimony (95-5) solder and non-corrosive flux (this does not apply to refrigerant piping). Clean and polish the tube and the inside of the fittings, using No. 60 steel wool. Apply flux and place fitting on the tube. Heat joint evenly but take care not to overheat fitting. Apply solder until a solder line shows completely around the joint. Remove surplus solder and allow joint to cool. **ProPress or similar type fittings/joints are not allowed.**

13.5. **Escutcheons:** Where pipes pass through cabinets, walls and ceilings of finished rooms provide one-piece, cast-brass type with polished, chrome-plated finish and setscrew fastener or stainless steel type securely fastened in place. Pack penetrations with mineral wool insulation, seal with firestopping compound and install escutcheons to prevent passage of fire, smoke and vermin. Do not use split ring type escutcheons.

13.6. **Unions:** Unions must be of the following types:

Copper Lines: Ground joint, copper to copper.

Schedule 80 PVC: Solid wall PVC schedule 80 DWV pipe and fittings as specified hereinbefore.

Dielectric Unions: Provide where copper pipe joins to steel pipe, EPCO or approved equivalent. Contractor must provide a globe valve on each side of each dielectric union to allow for replacement of the union.

13.7. **Expansion:** Provide for expansion and contraction of all piping and make proper provisions so that there must be no undue strain on any pipe or equipment.

13.8. **Sleeves:** Refer to Section 15010, Pipe Sleeves.

PART 14. REFRIGERANT PIPING AND ACCESSORIES

14.1. **General:** All refrigerant piping must be identified. **Note that refrigerant piping will require custom identification.** Refer to Section 15010, Part Identification for requirements.

14.2. **Refrigerant Piping Sleeves:** Refer to Section 15010 and plan details and provide sleeves, firestopping and escutcheons as specified for typical piping. Sleeves for pipe passing through exterior walls that contain refrigerant piping must be Schedule 80, ASTM D1785 PVC pipe, 1/2" larger in diameter than piping and piping covering. Refer to Section 15010 and below for requirements.

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Coordinate wall sleeve sizes required for refrigerant piping with insulation and aluminum jacket requirements. Piping within wall cavities must be seamless with no joints.

14.3. **Piping Diagram:** System must be complete and sized to conform to current ACRMA standards, except that refrigerant suction risers must be sized for a gas velocity not less than 2000 fpm.

Various Manufacturers of heat pump, mini-split, VRF and DX systems have different reasons for the use of loops, traps, accumulators, receivers, etc., in piping arrangements, therefore, submit for review, the air conditioning equipment Manufacturer's recommended, dimensioned plan view and isometric piping diagram proposed for use for each system, showing all valves, loops, pipe sizes and all appurtenances, required for the proper operation of the respective system.

Submit catalog data and Manufacturer's ratings for all valves, catch-alls, etc. with diagram for each system. Identify all items for respective system and list capacities, pressure drops, etc. Secure approval of the heating and air conditioning equipment, and compressor Manufacturer before submitting for review.

Failure to provide the Manufacturers' approved diagram(s) must make the Mechanical Contractor responsible for all required changes to the piping system and equipment without additional cost to the Owner or his Design Professionals should the installation not be as required by the Manufacturers.

Refrigerant piping support spacing must be a maximum of eight (8) feet horizontally and six (6) feet vertically. Cut accurately to measurements established at site and work into place without springing or forcing, properly clearing all building features. Arrange and install piping systems, as close as practical, straight, properly supported and run as directly as possible forming right angles or running parallel with building lines, true to line and grade, **free of sags and bends**. Locate piping as high as practical and in parallel groups as close together as practical. Route through previously built-in sleeves and avoid cutting or other weakening of the structure.

Refrigerant piping for all outdoor units mounted slab on grade must enter the building at the respective building finish floor or crawl space level and at a maximum of 12" above finish floor of the facility. The contractor must coordinate the final refrigerant piping entrance into the building with the Architect's Field Representative prior to installing any refrigerant piping.

All refrigerant piping, including mini-split piping, must be ACR - ASTM B 280, Type L hard drawn, ACR copper refrigerant tubing with ASME B16.22 wrot copper fittings and unions with solder joints of 95-5 tin antimony. **Coiled copper and precharged line sets are NOT allowed unless specifically noted or specified.** All offsets and changes in direction must be made with 90º or 45° elbows.

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Where refrigerant piping is shown rising in the wall cavity and requires modifications to the block wall due to the size of the piping and insulated assembly, the block must be neatly saw cut. Provide reinforcing to the affected portions of the wall as indicated on the structural drawings and details, the same as required at window and door openings. See the structural drawings for specifics. Extreme coordination is required prior to the erection of the structural slab and wall. Coordinate with the General Contractor.

14.4. **Refrigerant Piping Testing:** Two tests are required. The medium used for pressure testing the refrigerant system must be oxygen-free nitrogen, helium or argon. Oxygen, air, combustible gases and mixtures containing such gases must not be used as a test medium. Systems erected on the premises with tubing not exceeding 5/8 inch outside diameter must be allowed to use the refrigerant identified on the nameplate label or marking as the test medium.

The refrigerant piping system must be tested as a whole, or separate tests must be conducted for the low-pressure side and high-pressure side of the piping system. The refrigerant piping system must be tested in accordance with both of the following methods:

Test 1: The system must be pressurized for a period of not less than 60 minutes to not less than the lower of the design pressures or the setting of the pressure relief device(s). The design pressures for testing must be the pressure listed on the label nameplate of the condensing unit, compressor, compressor unit, pressure vessel or other system component with a nameplate. Additional test gas must not be added to
the system after the start of the pressure test. The system must not show loss of pressure on the test pressure measuring device during the pressure test for a minimum of 24 hours.

Test 2: A vacuum of 500 microns must be achieved. After achieving a vacuum, the system must be isolated from the vacuum pump. The system pressure must not rise above 1,500 microns for a period of not less than 60 minutes.

Where using refrigerant as a test medium as specified above, the test pressure must be not less than the saturation dew point pressure at 77°F.

14.5. **Joints: Brazed joints only. Flare joints nor press connect joining type systems are allowed.** Brazed Joints (Nitrogenized ACR Hard Drawn Copper – ASTM B280,) with joints made according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."

Joint surfaces must be cleaned. An approved flux must be applied where required by the braze filler metal Manufacturer. The piping being brazed must be purged of air to remove the oxygen and filled with oxygen-free nitrogen, helium or argon. The piping system must be prepurged with an inert gas for a minimum time corresponding to five volume changes through the piping system prior to brazing. The pre-purge rate must be at a minimum velocity of 100 feet per minute. The inert gas must be directly connected to the tube system being brazed to prevent the entrainment of ambient air.

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After the pre-purge, the inert gas supply must be maintained through the piping during the brazing operation at a minimum pressure of 1.0 psi and a maximum pressure of 3.0 psi. The joint must be brazed with a filler metal conforming to American Welding Society Publication AWS A5.8, Current Edition.

Piping within wall cavities and other inaccessible areas must be seamless type with no joints.

14.6. **Solenoid Valves (Where Required):** Comply with AHRI 760 and UL 429; listed and labeled by an NRTL. Install in liquid refrigerant connection to the evaporators. Valves must be designed for the operating pressure and capacity as listed in the Manufacturer's catalog with a pressure drop not exceeding 2 psi and must be sufficient for the requirements of the installation. Install in horizontal runs with body vertical.

14.7. **Expansion Valves (Where Required):** AHRI 750 compliant, steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets properly sized diaphragm or bellows type, with external superheat adjustment set for 10 degrees F. superheat. Install in the liquid refrigerant supply lines to the evaporators. Expansion valves up to and including 7-1/2 tons capacity must be Sporlan Type "S" or approved equivalent. Expansion valves over 7-1/2 ton capacity must be Sporlan Type "O" or approved equivalent. Install Sporlan full size catch-all filter-drier ahead of valve.

14.8. **Refrigerant Service Valves:** Provide for the proper servicing of the equipment. Per IMC 1101.9, all refrigerant circuit access ports located outdoors must be fitted with color coated, all brass, and locking tamper resistant caps. This requirement must not apply to refrigerant circuit access ports on equipment installed in controlled areas such as on roofs with locked access hatches or doors.

The locking caps must be red or red banded color code for the refrigerant used. Caps must be Novent Series 8668 for R-454B refrigerant with 86698 NV Multikey unlocking mechanism for R-454B refrigerant or equivalent by JB Industries Series Shield and DiversiTech Series Sentry. Provide Owner with minimum of six (6) spare keys.

14.9. **Refrigerant Filter Drier (Catch-all):** AHRI 730 compliant, Sporlan, three desiccants type filter drier or approved equivalent. Filter driers up to and including 10-ton capacity must be sealed type. Filter driers over 10-ton capacity must be replaceable core type. Units must have minimum surface filtering area and capacity not less than that shown in Sporlan Valve Company Bulletin 40-10 or 40-10-8, as applicable, under sizes for "field replacement or field built up sizes". Careful attention must be given to providing the correct type of filter drier as it pertains to the type of refrigerant used in the respective system.

14.10. **Refrigerant Piping Identification: Custom factory fabricated refrigerant piping labels are required. Stick-on, painted, stenciled or hand written type identification is not allowed.** The Contractor is urged to carefully review the extensive requirements of Part Identification in Section 15010 of the

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specifications and in particular the custom labels and installation requirements prior to certain site visits**.**

14.11. Miscellaneous Requirements: Taping or zip tying of liquid lines to suction lines is not allowed. Coordinate wall sleeve sizes required for refrigerant piping with insulation and aluminum jacket requirements.

PART 15. PIPE HANGERS AND SUPPORTS

15.1. General: Refer to Section 15010 for sleeve/firestopping requirements. **This pipe hanger and support section does not apply to refrigerant piping or condensate drainage piping.** Refer to Part Pipe and Miscellaneous Insulation Work below for refrigerant piping support requirements.

15.2. Painting of Hangers and Supports: Galvanized, zinc similar coated items are considered to NOT be coated. All must be painted, powder coated, epoxy coated or plastic coated. Hanger rods and associated bolts, nor clamps on Unistrut assemblies are required to be painted. All non-galvanized and galvanized ferrous metal parts of hangers, piping and related items in mechanical rooms, crawl space, above ceilings, Unistrut and other assemblies used for supporting ducts (except hanger straps and threaded rods), including black steel pipe, uncoated cast iron pipe, hangers, brackets, etc. must be coated.

All finishes and coatings must have a fire hazard rating not to exceed 25 for flame spread and 50 for fuel contributed and smoke developed as determined by ASTM E84. See specification Section 15010, Part Identification for detailed requirements.

PART 16. PIPE INSULATION AND MISCELLANEOUS INSULATION WORK

16.1. General Provisions: All work by experienced applicators in accordance with Manufacturer's recommendations and these specifications. Where the specified installation conflicts with the Manufacturers recommendations, the strictest application must be provided.

Piping must be clean, dry and pressure tested before covering is applied. Size pipe hangers to fit over insulated pipe size. **Hangers and supports must not be in contact with bare pipe and must not penetrate the vapor barrier**. See hangers and supports for requirements. Cover fittings, valves and flanges with insulation material as hereinafter specified to same thickness as adjacent pipe covering except screwed unions in hot and chilled piping and other specifically mentioned items. Neatly bevel covering edges or use prefabricated fittings as specified, adjacent to unions and other points of termination.

All insulation materials including coatings and mastics must have a composite rating for insulation, jacket or facing, including adhesives, not to exceed 25 flame spread and 50 for fuel contributed and smoke developed as determined by ASTM E-84, NFPA 255 and UL 723.

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All piping must be provided with sleeves/firestopping assemblies. Refer to Section 15010 for sleeve and firestopping requirements.

16.2. <u>Refrigerant Suction Lines, All Hot Gas Reheat Coils' Hot Gas Lines, All Exterior Refrigerant Piping Including Liquid Lines and Mini-Split System Liquid Lines:</u> Preinsulated refrigerant piping is not allowed unless insulation meets the requirements specified below. Coiled nor precharged line sets are allowed unless noted or specified otherwise. Refer to other portions of this specification for refrigerant piping requirements. All liquid lines located outdoors must be insulated and installed within the specified aluminum jacket with the insulated refrigerant suction line. i.e., one aluminum jacket for both insulated pipes. Refer to aluminum jacket requirements below for additional information.

Insulate with 1" thickness, UL fire and smoke rated unslit, black, flexible foamed, elastomeric, closed cell pipe insulation by AP Armaflex or equivalent by K-Flex or Aerocel AC EPDM. It must be GreenGuard certified tubular insulation with Microban antimicrobial protection. Insulation must have a 'k' factor of not more than 0.256 at 90°F mean temperature, water absorption percent by volume of 0.2 and a water vapor transmission rate of 0.05 perm-inches or less.

Slip insulation onto pipe prior to erecting. Longitudinal cutting of the insulation is prohibited. Do not stretch or bend insulation at any turn, tee, etc. Insulate sweat/brazed fittings with miter-cut pieces of insulation as recommended in AP Armaflex installation instructions or, provide factory fabricated, made to order prefabricated fittings for tees, elbows, unions, etc. the same size as on adjacent piping and manufactured by AP Armaflex, Aeroflex Aerofit, K-Flex K-Fit or Aerocell.

On piping with screwed fittings, make up fitting covers from Armaflex with an inside diameter large enough to overlap the insulation on the pipe next to the fitting. Fitting cover must be long enough to overlap the pipe insulation by a minimum of one inch on each side. Glue the 1" overlap and seal to the adjacent pipe insulation with same adhesive and tape specified below.

Seal all butt joints of insulation and all butt joints at the specified refrigerant piping clamp with AP Armaflex BLV, Black, low VOC, liquid, air-drying contact adhesive. Do not use aerosol adhesive. After gluing joints, wrap all joints with 2" wide, 1/8" thick AP Armaflex self-adhering tape.

All insulated piping must be continuous without cutting at clamp/support assemblies. All interior refrigerant liquid lines which are <u>not</u> associated with a hot gas reheat coil or liquid lines NOT required to be insulated by the equipment Manufacturer must not be insulated except, they must be provided with insulated insert at clamps to Unistrut assemble as specified below.

Note that Various Manufacturers of mini-split and VRF systems require the insulating of refrigerant liquid lines. When required by the Manufacturer, they must be insulated using materials specified above and in thickness required by the respective Manufacturer. Where the VRF or mini-split system Manufacturer

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requires less than 1” insulation, install thickness recommended with materials specified above using methods specified below.

16.3. **Condensate Drain Lines Insulation:** To include discharge lines on all equipment specified with or provided with air conditioning condensate drainage pumps. Insulate using same methods and materials as specified for refrigerant piping except 3/4” thickness.

16.4. **Refrigerant Pipe Supports and Clamp Assembly: Do not use clevis hangers for refrigerant piping.** Refrigerant piping supports must be provided with an insulated piping clamp assembly attached to a Unistrut assembly. The Unistrut assembly must support the horizontal and vertical refrigerant piping on intervals not exceeding 10 feet. Provide dielectric separation between dissimilar metals. Support piping so that no vibration will be transmitted to the building structure.

The insulated piping clamp assembly must be provided at each Unistrut hanger for each liquid line, suction line and any other bare copper line attached to the assembly. The insulated clamp must provide a crush resistant airtight seal and must consist of a rigid, closed cell, foam insulation to support tubing and absorb vibration. The outer cover must consist of a rubber coating that seals the cushion completely after installation. Clamps must be steel with electrodichromate finish. Rated assembly temperature range must be -50ºF to +250ºF. It must be self-extinguishing as tested under ASTM D 635.

After installing the device, glue each butt joint and tape each joint with 2” wide, 1/8” thick AP Armaflex self-adhering tape AP Armaflex tape.

Insulated lines must use Wesanco ZSI Series Cush-A-Therm, ArmaFix Eco Light, Aerofix by Aeroflex with gold electro-galvanized channel clamp assembly and required hardware. Wesanco ZSi Series Cush-A-Therm is the basis of design.

For units on concrete pad, support piping with rustproof coated, 1-1/2” x 1-1/2” x 1/8” galvanized steel angle supports anchored to pad with stainless steel base plate and bolts.

16.5. **Interior Condensate Drain Lines Pipe Supports and Clamp Assembly: Do not use clevis hangers for condensate drainage piping.** Condensate drain line supports, to include discharge lines on all equipment specified with or provided with air conditioning condensate drainage pumps, must be provided with an insulated piping clamp assembly on a Unistrut assembly. The Unistrut assembly must support the horizontal and vertical condensate drainage piping on intervals not exceeding 10 feet. Provide dielectric separation between dissimilar metals. Support piping so that no vibration will be transmitted to the building structure.

The insulated clamp must provide a crush resistant airtight seal and must consist of a rigid, closed cell, foam insulation to support the tubing. The outer cover must consist of a rubber coating that seals the cushion completely after installation to prevent condensation. Clamps must be steel with

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electrodichromate finish. The assembly must be self-extinguishing as tested under ASTM D 635.

After installing device, glue each butt joint with liquid adhesive and tape each joint with 2” wide, 1/8” thick AP Armaflex self-adhering tape AP Armaflex tape. Spray adhesive is not allowed.

For piping located on the finished floor, support piping with rustproof coated, 1-1/2” x 1-1/2” x 1/8” galvanized steel angle supports anchored to the floor with steel base plate and bolts. Condensate drainage piping must be attached to the support with the insulation assembly specified above. Insulate using same methods and materials as specified for refrigerant piping (small, chilled water piping) except 3/4” thickness.

Combustion chamber condensate drain lines from high efficiency gas fired furnaces are not required to be insulated.

Insulated condensate drain lines must use Wesanco ZSI Series Cush-A-Therm, ArmaFix Eco Light, Aerofix by Aeroflex with gold electro-galvanized channel clamp assembly and required hardware. Wesanco ZSi Series Cush-A-Therm is the basis of design.

16.6. **Refrigerant Piping and Condensate Drainage Piping Aluminum Jacket:** All insulated exterior refrigerant piping, insulated exterior hot gas reheat coils hot gas piping and all insulated condensate drainage piping terminating in janitor sink, floor sink and hub drains in finished areas, and any location that would subject the piping insulation to damage must be covered with an aluminum jacket.

Where refrigerant piping rises within the wall cavity to above the ceiling, attic or similar space, the aluminum jacket must terminate within the exterior wall cavity and sealed weather tight to the sleeve in the wall. Where the refrigerant piping extends from the outside, directly into the mechanical room, the aluminum jacket must terminate a minimum of 8” into the space and sealed weather tight on both sides of the wall and sleeve.

The aluminum jacket must be 18 ga., .04” thick, **smooth finish**, 3003 and 3105 series aluminum conforming to ASTM B-209 standards. Fittings must be 18 ga., .04” thick, die shaped, and **smooth finish**, Type 1100 aluminum jacket meeting ASTM C585. Provide 1/2" wide, 18 ga., .04” thick, Type 3003 aluminum bands on maximum 24" centers but not less than two bands per jacket section. **Venture Clad or similar product is prohibited.**

Do not install aluminum jacket until refrigerant piping insulation installation has been inspected by the Engineer.

16.7. **Painting and Identifying:** Paint and identify after installation is completed as specified in Section 15010, Part Identification. Where piping is specified with an aluminum jacket, painting is not required.

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Provide identification on the insulation covering indicating unions, strainers and check valves. Refer to Section 15010, Part Identification and note special refrigerant piping identification requirements. **Custom factory fabricated refrigerant piping labels are required. Stick-on, painted, stenciled or hand written type identification is not allowed.**

The Contractor is urged to carefully review the extensive requirements of Part Identification in Section 15010 of the specifications and note that certain identification is required to be completed before certain site visits**.**

16.8. **Submittal Data:** Submit for review complete data on materials and application methods proposed.

16.9. **Manufacturers:** Approved equivalents by Pittsburgh Corning, CertainTeed, Baldwin-Ehret-Hill, Manville, Owens Corning, Armstrong Childers and 3M Company will be accepted.

PART 17. VENTILATION

17.1. **General:** All fans must be furnished complete, with ducts, grilles, curbs and required accessories. All fans exhausting shower/bath/tub/dishwashing areas and similar moisture laden areas must be provided with aluminum wheels. All other fan wheels must be steel. No plastic or non-metallic wheels are allowed unless specified otherwise.

All fans must be certified in accordance with AMCA/ANSI Standards 210 and ANSI/ASHRAE 51. Fans wheels must be balanced in accordance with AMCA Standard 204-05. Fans must be listed at UL 705 and must bear the UL Label. Furnish for review capacity and sound power ratings.

All motors 1/2 HP and smaller must have built-in overload protection.

All motors with scheduled capacity of less than 1 HP must be ECM type as required by ASHRAE 90.1 and with minimum motor efficiency of 70% when rated in accordance with DOE 10 CFR 431.

All motors must also be premium efficiency type. Refer to Section Motors for additional requirements.

17.2. **Power:** Contractor must verify all voltage and power requirements with Electrical Contractor, Electrical plans and at the site, prior to ordering equipment.

17.3. **Ceiling Mounted Cabinet Fans:** Penn Ventilator Company Model Zephyr, Series Z-3H thru Z-15H with RA right angle arrangement or TDA arrangement as shown on the plans, or approved equivalent, complete with all accessories, including unit mounted solid state speed control switch, factory baked enamel white metal ceiling grille, metal flanged inlet and outlet connections, acoustically insulated metal housing, direct drive, ECM motors, internally isolated centrifugal fan, integral backdraft damper and terminal cap, cast

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aluminum brick vent, or soffit grille as shown on the plans. Fan wheel must be steel or aluminum. No polypropylene, plastic or other non-metallic wheels. Fan must be supported from the structure with 1/4" hanger rods, rubber in shear vibration isolators and Manufacturer furnished bracket for attaching rods to the fan and structure above. Refer to the plan details for additional requirements.

17.4. **Cabinet In-Line Centrifugal Fans:** Loren-Cook Series SQND-EC or SQND, high pressure as required, in-line centrifugal type fan as shown on the Fan Schedule. Fan must have 18 ga. galvanized steel cabinet with integral duct collars, bolted access doors on 3-sides which are sealed with closed cell neoprene gasketing, disconnect switch, centrifugal, backward inclined extruded aluminum fan wheel and cast aluminum hub, supports for ceiling suspension, permanently lubricated drip proof, premium efficiency motor, gravity or motorized type dampers as shown on the plan details and Manufacturer furnished VFD for EF-D, EF-F, EF-G, SAF-1 and SAF-2 (**NOT a speed controller**).

Bearings must be heavy duty, L50 life in excess of 200,000 hours at maximum cataloged operating speed. Bearings must be regreaseable ball type with extended fittings in a pillow block cast iron housing. Coordinate fan arrangement required (top, side and bottom) at the site, prior to ordering fan.

Where fan is used a supply air fan, Contractor must provide fan with filter frame and 1" thick metal washable filters if access to filter section requires removal of the fan housing panel. Do not provide Manufacturer furnished filter frame unless it is external to the unit and is provided with thumbscrew access. **Filter access requiring the removal of the fan housing is prohibited. The Contractor is responsible for quarterly filter cleaning during the guarantee period.**

17.5. **Acceptable Manufacturers:** Cook, Greenheck, Penn Barry. Cook is basis of design.

PART 18. SPLIT SYSTEM HEAT PUMP UNITS (HP)

18.1. **General:** Furnish and install split system heat pump systems manufactured by the Trane Company. All equipment (condenser/compressors) scheduled cooling capacities are based on 95°F ambient temperature. Indoor units with scheduled cooling capacity of 60 MBH or less must be Trane Series GAM5. Related outdoor units with scheduled cooling capacity of 60 MBH or less must be Trane Series 4TWA4. Indoor units with scheduled cooling capacities greater than or equal to 72 MBH must be Trane Odyssey Series TWE. Related outdoor units with scheduled cooling capacities greater than or equal to 72 MBH must be Trane series TWA. Equivalent units/systems by Carrier or Lennox will be considered. Trane is the basis of design.

Each unit is specified to be provided with UV-C lights. The unit Manufacturer must coordinate with the UV-C Manufacturer the placement of the UV-C lights within the unit. UV-C lights must be placed in number and location as required by the UV-C device Manufacturer for maximum irradiance. The HVAC unit

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Manufacturer must provide equipment such that any part subjected to irradiance from the UV lamp system must be shielded from the UV-C light or constructed of a material that is capable of withstanding UV-C exposure levels expected in provided product without degrading.

Each unit must be completely factory assembled and tested, and must include hermetic compressor, factory installed refrigerant monitors and related safeties, outdoor condenser coil, indoor evaporator coil, primary and secondary condensate drainage stub outs, fan and high static, premium efficiency ECM motor drives (Series GAM5) or belt driven, premium efficiency motor with variable pitch pulley, high static drive and permanently lubricated ball bearing motor (Series TWE), interconnecting wiring, low voltage control transformer, prewired control panel and other necessary components mounted in weather resistant steel cabinet with baked on enamel finish.

External static pressure indicated on the plans is estimated. The equipment Manufacturer must provide additional belt sheaves for all belt driven equipment and/or motors or drives for ECM motors as applicable and as required, to match field conditions for the ductwork as installed.

The unit must be UL or ARL (Applied Research Labs) listed and labeled accordingly. The heat pump must be sound rated by ARI Standard 270 and operation sound level must not exceed acceptable limits. Heating and cooling capacities must not be less than those indicated on the drawings. Indoor unit must be provided with single point power connections (fan and heater). **Contractor must verify all voltage and power requirements with Electrical Contractor, Electrical plans, and at the project site, prior to ordering equipment.**

Each unit must be provided with sweat/brazed connections from the Manufacturer's factory. Flare connections are not allowed unless **specifically** required by the Manufacturer.

18.2. **Special Considerations:** The equipment Manufacturer must size the refrigerant piping for all the units and must furnish all accessories and auxiliaries required for a complete and proper installation for the specific application shown on the drawings and the specified sequence of operation. Refer to Section Refrigerant Piping and Accessories for additional requirements.

18.3. **Condensing Unit Cabinet:** Must be heavy gauge galvanized steel cabinet with weather resistant baked enamel finish. Access to the electrical controls and compressor must be made by removing two service panels. All equipment must be installed level and plumb.

18.4. **Compressor System:** The unit must contain a hermetic compressor. The compressor must have high and low pressure protection, sump heat, compressor overload protection, 24-volt control transformer and magnetic contactors. Refrigerant circuit must include service valves, pressure tap ports, check valves, switch over valve, refrigerant line filter-driers and full factory furnished charge of ASHRAE Safety Classification A2L, R-454B refrigerant.

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All units with scheduled cooling capacity greater than 60 MBH must be provided with multiple compressors, or 2-stage compressors as required by ASHRAE 90.1. Units with more than one compressor must have complete separate/independent refrigerant circuits to the evaporator. Where dual compressors are required for Manufacturer approved use of the hot gas reheat coil, dual compressors must be provided in lieu of a single, two-stage compressor.

18.5. **Refrigerant Service Valves:** Provide for the proper service of the equipment. Per IMC 1101.9, all refrigerant circuit access ports located outdoors must be fitted with color coated, all brass, and locking tamper resistant caps. This requirement must not apply to refrigerant circuit access ports on equipment installed in controlled areas such as on roofs with locked access hatches or doors.

The locking caps must be red or red banded color code for the refrigerant used. Caps must be Novent Series 8668 for R-454B refrigerant with 86698 NV Multikey unlocking mechanism for R-454B refrigerant or equivalent by JB Industries Series Shield and DiversiTech Series Sentry. Provide Owner with minimum of six (6) spare keys.

18.6. **Outdoor Coil:** The outdoor coils must be constructed of aluminum fins or Spine Fin mechanically bonded to seamless aluminum or copper tube and must be protected by a unit Manufacturer furnished, heavy-duty metal hail guard. The outdoor coil must have expansion valve refrigerant control during heating operation, and automatic time and temperature actuated defrost control system. Unit must, as factory shipped, cycle fan motor on outdoor thermostat for low ambient cooling down to 40°F outdoor temperature. Provide heavy-duty metal condenser coil hail guard.

18.7. **Controls:** Indoor units must be provided with programmable touch screen panel. Controls must be factory wired and readily accessible.

18.8. **Air Handler:** Air handler must be heavy duty polymer (1-ton through 5-tons) and heavy gauge galvanized steel cabinet with weather resistant baked enamel finish for all other units. The air handler cabinet must be internally lined with foil laced fiberglass insulation. The indoor coil must be constructed of aluminum plate fins mechanically bonded to seamless copper tubes. The indoor (evaporator) coil must have expansion valve control and be equipped with defrost control and provided with stainless steel drain pan. Refrigerant piping connections must be sweat/brazed connections from the Manufacturer's factory. Flare connections are not allowed unless **specifically** required by the Manufacturer. The air handler must be provided with a low voltage terminal board and fan motor relay.

18.9. **Auxiliary Electric Heater:** Provide electric heater with a total heating output not less than indicated on the drawings. Heater assembly must include power supply fusing, automatic resetting limit switches and heat limiters for thermal protection. Heater must be provided with factory disconnect switch and fusing

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all per National Electrical Code and UL. The auxiliary heater cabinet must be factory-sealed air tight and insulated to prevent condensation.

Units with a specified cooling capacity of less than 40 MBH must use the auxiliary resistance heater for reheat. Where the auxiliary resistance heater is specified for maintaining space temperature during dehumidification, the auxiliary resistance heater must be provided in a minimum of two stages.

18.10. **Hot Gas Reheat Coil:** Each unit with scheduled cooling capacity greater than or equal to 40 MBH must be provided with a refrigerant hot gas reheat coil with modulating reheat coil valve and located in the reheat position. The coil must be of sufficient size to reheat all of the air supply. Provide, complete, with all necessary valves, controls, etc., as required for a complete and properly functioning installation. Provide manual isolation valves for each hot gas and liquid lines. Furnish for review air conditioning equipment Manufacturer approved refrigerant piping and controls diagram, and statement by the air conditioning Manufacturer on company letterhead that use of the hot gas reheat coil with the equipment is acceptable to the Manufacturer and will not affect any warranty or guarantee. **Equipment submittal will not be reviewed without a Manufacturers' approved diagram and referenced statement**. Minimum reheat capacity for supply air must be 10ºF. Maximum coil pressure drop is 0.10" static pressure. All connections to the unit/system must be with sweat/brazed connections from the Manufacturer's factory. Flare connections are not allowed unless **specifically** required by the Manufacturer.

18.11. **Indoor Thermostat:** The manufacturer must provide a combination 7-day programmable, two-stage heating automatic changeover heat pump thermostat. Thermostat must have outdoor thermistor to compensate for thermostat droop, emergency heat switch with indicator light and auxiliary heat light. Thermostat must have sub-base fan switch for "On-Auto" selection and manual "Heat-Cool" switch. The thermostat must be hardwired and be provided with battery backup. Coordinate the thermostat with specified sequence of operation and provide as required.

Provide hinged metal guard with rounded corners, lock and key for each thermostat.

Refer to Section 15920 Building HVAC Controls System (BAS) for additional requirements.

18.12. **Outdoor Thermostat:** Provide a mounting box and one outdoor thermostat for control of second stage of electrical heaters.

18.13. **Humidistat:** Humidistat is specified in "Automatic Controls" at the end of this 15700 Specification. At his option, the Unit Manufacturer may substitute a combined thermostat/humidistat. Verify with the Controls Sub-Contractor that the furnished thermostat/humidistat will perform all sequences of operation else provide separate devices as specified.

18.14. **CO2 Sensors:** Where demand ventilation is specified, the system must be provided with a separate CO2 sensor of the type specified at the end of this

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Section 15700. Combination devices are not allowed due to the required mounting height of the CO2 sensor.

18.15. **Factory Start-Up Service:** The Contractor must provide a factory-trained mechanic, employed by the unit Manufacturer and not a sales representative, to check out all equipment, including hot gas reheat coils and UV-C lights, and furnish written report indicating equipment is installed in strict accordance with Manufacturer's recommendations. Also, provide temperature, pressure and amp readings taken during testing to substantiate unit performance including the range of the refrigerant hot gas reheat coil valve as applicable.

18.16. **Power Wiring:** Unit must be factory wired for power supply indicated on the electrical drawings. Any variation must be the responsibility of the contractor.

18.17. **Filter Frame and Filters:** Provide 2" thick, MERV 11, pleated filters equal to 30/30/ Farr Series. All filters must be common industry standard size filters that are readily available and do not have to be fabricated. Cutting and taping of filter segments to make a proper filter is prohibited. Where the indoor section sits on R.A. platform or is horizontally mounted in an attic space and the Manufacturer does not provide a filter access with thumbscrew access in the bottom of the unit, provide a filter frame that is designed to mount to the bottom (R.A. inlet) of the air unit. Frame must be hinged and have thumbscrews or wing nuts to open the access door. The filter frame must be manufactured by E-Z Filter Base Mfg., Inc., approved equivalent or shop fabricated as specified above. **The Mechanical Contractor must be responsible for quarterly filter changes during the guarantee period and must inscribe onto the filters' casing the date filters were installed/replaced.**

18.18. **Ultraviolet (UV-C) Lights:** Mechanical Contractor is responsible for wiring the devices and providing power for the UV-C lights if not shown on the Electrical plans. Air handling units must be provided with power supply and connections within the unit cabinet for powering the UV-C lights. Mechanical Contractor must be responsible for circuitry to UV-C lighting. UV-C lighting must cycle on and off with the fan or operate continuously as recommended by the UV-C lighting Manufacturer.

Comply with UL / C-UL or ETL for Ultraviolet Fixturing. Store UV-C Fixturing in a clean, dry place and protect from weather, construction traffic and construction debris. UV-C products supplier must provide proof of 100% inbound and outbound testing of equipment. The UV-C Power supply must have been tested, listed and labeled as compliant with UL, CSA and CE. Plenum wiring loom must meet UL Subject 13 and UL 1581, Article 725 of the NEC and meet UL VW-1 material ratings. There must be a metallic Loom cladding, and it must be UL recognized DXUZ2 and constructed of flexible galvanized steel and cover the entire Loom. Each lamp must contain no more than 5 milligrams of mercury consistent with current environmental practices. Lamp Watts must be printed on all lamps, no exceptions. Lamps must not produce ozone and must be hermetically sealed within a layer of UV-C transmissible FEP to protect against lamp breakage and to contain lamp contents should breakage occur.

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Lamps must be installed in sufficient quantity and in such a manner to provide an equal distribution of UV-C energy. When installed, the UV-C energy produced must be of the lowest possible reflected and shadowed-losses and must produce 360-degree UV-C irradiance from the lamps within the UV cavity. Lamp Watts must be printed on all lamps, no exceptions. Each lamp must contain less than 5 milligrams of mercury, consistent with current environmental practices. Lamp useful life must be a minimum of 9,000 hours with no more than a 15% output loss at the end of the lamp's life (12 months of continuous use). Lamps must be constructed with UV-C resistant bases and must not produce ozone. Lamps must produce the specified output in moving air of up to 1000 fpm and temperatures of 0-200°F. Lamps must be hermetically sealed within a layer of UV-C transmissible FEP to provide protection against lamp breakage and to ensure Lamp contents from a broken Lamp are contained.

Fixture modeling must be included in the submittal and must contain the necessary calculations to demonstrate that a minimum of 6 lamp watts, as recommended by ASHRAE, are distributed equally to each square foot of coil surface area to achieve a minimum of 100 microwatts per square centimeter equally distributed to the surfaces at the plenum sides, top and bottom. All calculations are to be at 55 degrees F and 500 fpm air velocity, no exceptions.

The power supply housing must be capable of installation within the air stream, secondary compartment or NEMA enclosure. Lamps must be mounted to irradiate the intended surfaces as well as all of the available line of sight airstream through proper placement, 360° irradiation and incident angle reflection.

To protect personnel, all unit access panels and doors to the UV-C assembly and/or within view of the UV-C assembly must include mechanical interlock switches to ensure that the UV-C assembly automatically de-energizes when any equipment access is opened. All UV-C devices must fit and be installed within the unit cabinet. **Devices must be hardwired, and UL labeled for the installation. Plug-in devices are not allowed per NEC.** The assembly must be powered by 120v circuit or as required by the AC unit Manufacturer. Coordinate requirement and provide as required.

A redundant disconnect service switch must be installed to provide a method to more specifically de-energize the UV-C lamp circuits prior to entering the lamp plenum. If not shown on the Electrical plans, the Mechanical Contractor must provide a redundant disconnect service switch for the UV-C lighting device(s). The disconnect switch must be a manual single pole, single throw switch mounted beside the Electricals' unit disconnect circuit to nearest receptacle circuit in the mechanical space with (2) #12 and (1) #12 Ground in 1/2" conduit.

Provide warning signage on each access point to the UV-C lights and on each side of the unit. Signage materials, methods and colors must be as specified Section 15010, Part Identification. Signage must read as follows: "***DANGER!! UV-C LIGHT SOURCE! DISCONNECT POWER BEFORE***

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SERVICING UNIT OR UV-C LIGHTING!" Do not use stick-on signage provided by the UV-C Manufacturer.

The redundant UV-C disconnect switch specified above must be labeled with materials and methods specified in Section 15010, Part Identification. Signage must read as follows: "***UNIT XX-YY UV-C LIGHTING REDUNDANT SHUT-OFF SWITCH***." XX denotes the unit, and YY is the unit number or type, all as scheduled on the plans.

18.19. **Unit Protection:** All equipment must also be provided with equipment manufacturer factory installed surge protection and phase protection to insure against voltage unbalance, over/under voltage, phase loss, reversal, incorrect sequencing and rapid short cycling. Where manufacturer factory installed devices are not available, protection must be provided for all 3-phase equipment utilizing ICM Controls Model 450 A Plus+ or equivalent. All single phase equipment with horsepower greater than or equal to 1/8 HP must be provided with protection utilizing ICM Controls Model ICM 492 or equivalent. Where phase protection device cannot be mounted within the respective equipment, provide a NEMA 4x or NEMA enclosure appropriate for the installation. The Contractor must consult with the Owner's maintenance personnel and set up all programmable options based on the Owner's requirements, within the device's capabilities.

18.20. **Pad Mounted Supports:** Units shown on finished grade must be anchored to the concrete pad. Concrete pads are specified under Division 2. Where concrete pads are not specified or not shown elsewhere, the Mechanical Contractor must provide a minimum 4" thickness, 5,000-psi concrete pad with rounded edges and corners. Pad must extend a minimum of 12" around three (3) sides of the unit and terminate at the building outside wall. Provide a strip of asphalt expansion joint between the concrete pad and the building exterior wall. Expansion joint must be full width by full depth of concrete pad, 1" thickness, non-absorbing, self-sealing, ASTM D 994 compliant and manufactured by W.R. Meadows Inc. or approved equivalent.

18.21. **Warranty:** General warranties are specified in Section "General Mechanical Provisions". The Mechanical Contractor and equipment Manufacturer must provide a non-prorated, total of five years replacement warranty for this equipment, to include all parts and components, belts, lubricants, compressors, refrigerant, etc., all labor, and shipping of the items required to return the installation to its original operating condition.

The Mechanical Contractor must be responsible for any parts, labor, etc. as specified above that is not provided by the equipment Manufacturer.

The Contractor and/or the Manufacturer must respond within 24 hours upon notification that there has been a failure under the terms of the specified warranty. "Respond" must mean having a Manufacturer certified technician onsite to evaluate the extent of the needed repairs/replacement and ordering of all items required for repair/replacement.

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Shipping of the replacement compressor and any other related unit parts must be via maximum 2-day delivery if the unit is inoperable or cannot maintain a minimum indoor temperature of 78ºF to the affected facility.

The warranty period must begin on the date of substantial completion of the installation, as determined by the Architect, and must continue for the full product warranty period specified above. Refer to Part, Air Cooled Condensing Units for condensing unit and compressor warranty.

PART 19. PACKAGED PAD MOUNTED HEATING AND AIR CONDITIONING UNITS (PHAC)

19.1. **General Description:** One-piece, high efficiency, combination air-to-air DX mechanical cooling system and natural gas fired heating system, premium efficiency motors, powered exhaust, powered relief, complete with automatic controls, condensate overflow switch the condensate line and auxiliary drain pan wired to shut down the unit upon detection of condensate in the auxiliary drain pan or obstruction in the condensate drain line, removable stainless steel IAQ drain pan, factory installed refrigerant monitors and related safeties, and powered GFI convenience power outlet. All equipment (condenser/compressors) scheduled cooling capacities are based on 95°F ambient temperature. Unit must be provided with color touchscreen interface with USB port to indicate data trending, historical alarm messages, real-time sensor measurements, on board system setpoints and customized reports. The unit must be designed for direct, bottom (side) handling of the conditioned air as shown on the plans. **Any unit with arrangement different from shown on the plans requires prior approval.** The equipment must be shipped completely assembled, pre-charged, piped and wired internally ready for field connections. The Manufacturer must test operate the unit before shipment. All units must have factory installed refrigerant monitors and related safeties and must have heavy-duty metal condenser coil hail guards. All equipment and curbs must be installed level and plumb.

Each unit is specified to be provided with UV-C lights. The unit Manufacturer must coordinate with the UV-C Manufacturer the placement of the UV-C lights within the unit. UV-C lights must be placed in number and location as required by the UV-C device Manufacturer for maximum irradiance. The HVAC unit Manufacturer must provide equipment such that any part subjected to irradiance from the UV lamp system must be shielded from the UV-C light or constructed of a material that is capable of withstanding UV-C exposure levels expected in provided product without degrading.

The entire unit must be factory wired for single point power connection. Where units are shown to be located on the roof, do not route power through the curb. Coordinate requirement with the electrical plans and electrical contractor and provide as specified. **The contractor must verify all voltage and power requirements with the Electrical Contractor, Electrical plans, and at the project site, prior to ordering equipment.**

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19.2. **Pad Mounted Supports:** Units shown on finished grade must be provided with factory base rail and must be anchored to the concrete pad. Concrete pads are specified under Division 2. Where concrete pads are not specified or not shown elsewhere, the Mechanical Contractor must provide a minimum 4" thickness, 5,000-psi concrete pad with rounded edges and corners. Pad must extend a minimum of 12" around three (3) sides of the unit and terminate at the building outside wall. Provide a strip of asphalt expansion joint between the concrete pad and the building exterior wall. Expansion joint must be full width by full depth of concrete pad, 1" thickness, non-absorbing, self-sealing, ASTM D 994 compliant and manufactured by W.R. Meadows Inc. or approved equivalent. All equipment and curbs must be installed level and plumb.

19.3. **Economizer Package:** All units must be provided with a 100% outside air economizer. The economizer must be provided complete with all controls, powered exhaust, powered relief, and air mixing damper assembly consisting of an enthalpy controller, fresh air, recirculated air and exhaust air dampers and protective cover over relief/exhaust unit discharge. The fresh air intake section must be equipped with 1" thick washable air filters. The assembly must mount within the confines of the unit casing. The system must be interlocked so that when room thermostat calls for cooling or heating, the outside air dampers must return to minimum position.

19.4. **Cooling System:** Total certified cooling capacity not less than indicated. Coils must be of non-ferrous construction with aluminum fins mechanically bonded to seamless copper tubes. Condenser coils must have sub-cooling rows. The compressors must be resiliently mounted - have built-in three mode crankshaft lubrication, crankcase heater, discharge temperature limiter, current and temperature sensing motor overloads, factory furnished holding charge of ASHRAE Safety Classification A2L, R-454B refrigerant and guarantee as specified below. The system must be protected by high and low pressure switches, a five minute compressor timed off cycle controller, lockable refrigerant charging valves, and head pressure controls down to 40°F ambient.

All units with scheduled cooling capacity greater than 60 MBH must be provided with multiple compressors, or 2-stage compressors as required by ASHRAE 90.1. Units with more than one compressor must have complete separate/independent refrigerant circuits to the evaporator. Where dual compressors are required for Manufacturer approved use of the hot gas reheat coil, dual compressors must be provided in lieu of a single, two-stage compressor.

19.5. **Refrigerant Leak Detection System:** The Leak Detection System (LDS) must consist of one or more refrigerant detection sensors and is required in any system that has more than 3.91 lbs. of A2L refrigerant charge, per safety standard UL 60335-2-40. Equipment with R-454B and charge amounts less than or equal to 3.91 lbs. per circuit, this UL standard does not prescribe a room area limit and does not require a refrigerant leak detection system or any circulation airflow or ventilation airflow mitigation strategies. **The LDS must be factory-installed for all units.**

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When the LDS detects a leak in units with charge amounts greater than 3.91 lbs. per circuit, the following mitigation actions must be automatically initiated until the refrigerant has not been detected for at least 5 minutes:

a. Unit must automatically revert to its outside air economizer mode to deliver 100% outside air.
b. The compressor(s) operation must cease/shutdown.
c. Gas heat must be automatically disabled.

19.6. **Refrigerant Service Valves:** Provide for the proper service of the equipment. Per IMC 1101.9, all refrigerant circuit access ports located outdoors must be fitted with color coated, all brass, and locking tamper resistant caps. This requirement must not apply to refrigerant circuit access ports on equipment installed in controlled areas such as on roofs with locked access hatches or doors.

The locking caps must be red or red banded color code for the refrigerant used. Caps must be Novent Series 8668 for R-454B refrigerant with 86698 NV Multikey unlocking mechanism for R-454B refrigerant or equivalent by JB Industries Series Shield and DiversiTech Series Sentry. Provide Owner with minimum of six (6) spare keys.

19.7. **Gas Heating System:** Output capacity as indicated. Automatic controls furnished must give a minimum of 2-1 turndown operation. Heat exchanger must be constructed of aluminized steel. Heat exchanger must be capable of handling 100 percent outdoor air and any temperature and have a 10-year warranty when handling uncontaminated air. Stainless steel power burner must use 100 percent secondary air and have intermittent spark ignition and 100 percent safety shutoff electronic flame sensing controls. Visual inspection of burner flame must be possible without removing casing panels.

19.8. **Fans and Motors:** Supply air fans must be multi-speed, centrifugal type with premium efficiency motors and permanently lubricated ball bearings, adjustable belt or high static direct drive with cfm capacity as specified.

All units must be provided with belt drives.

All units must be 2-speed as required by ASHRAE 90.1.

External static pressure indicated on the plans is estimated. The equipment Manufacturer must provide additional belt sheaves as applicable and as required to match field conditions for the ductwork as installed.

Condenser fans must be direct driven. All motors must have inherent protection devices on all legs.

19.9. **Ultraviolet (UV-C) Lights:** Mechanical Contractor is responsible for wiring the devices and providing power for the UV-C lights if not shown on the Electrical plans. Air handling units must be provided with power supply and connections within the unit cabinet for powering the UV-C lights. Mechanical Contractor must be responsible for circuitry to UV-C lighting. UV-C lighting must cycle on

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and off with the fan or operate continuously as recommended by the UV-C lighting Manufacturer.

Comply with UL / C-UL or ETL for Ultraviolet Fixturing. Store UV-C Fixturing in a clean, dry place and protect from weather, construction traffic and construction debris. UV-C products supplier must provide proof of 100% inbound and outbound testing of equipment. The UV-C Power supply must have been tested, listed and labeled as compliant with UL, CSA and CE. Plenum wiring loom must meet UL Subject 13 and UL 1581, Article 725 of the NEC and meet UL VW-1 material ratings. There must be a metallic Loom cladding, and it must be UL recognized DXUZ2 and constructed of flexible galvanized steel and cover the entire Loom. Each lamp must contain no more than 5 milligrams of mercury consistent with current environmental practices. Lamp Watts must be printed on all lamps, no exceptions. Lamps must not produce ozone and must be hermetically sealed within a layer of UV-C transmissible FEP to protect against lamp breakage and to contain lamp contents should breakage occur.

Lamps must be installed in sufficient quantity and in such a manner to provide an equal distribution of UV-C energy. When installed, the UV-C energy produced must be of the lowest possible reflected and shadowed-losses and must produce 360-degree UV-C irradiance from the lamps within the UV cavity. Lamp Watts must be printed on all lamps, no exceptions. Each lamp must contain less than 5 milligrams of mercury, consistent with current environmental practices. Lamp useful life must be a minimum of 9,000 hours with no more than a 15% output loss at the end of the lamp's life (12 months of continuous use). Lamps must be constructed with UV-C resistant bases and must not produce ozone. Lamps must produce the specified output in moving air of up to 1000 fpm and temperatures of 0-200°F. Lamps must be hermetically sealed within a layer of UV-C transmissible FEP to provide protection against lamp breakage and to ensure Lamp contents from a broken Lamp are contained.

Fixture modeling must be included in the submittal and must contain the necessary calculations to demonstrate that a minimum of 6 lamp watts, as recommended by ASHRAE, are distributed equally to each square foot of coil surface area to achieve a minimum of 100 microwatts per square centimeter equally distributed to the surfaces at the plenum sides, top and bottom. All calculations are to be at 55 degrees F and 500 fpm air velocity, no exceptions.

The power supply housing must be capable of installation within the air stream, secondary compartment or NEMA enclosure. Lamps must be mounted to irradiate the intended surfaces as well as all of the available line of sight airstream through proper placement, 360° irradiation and incident angle reflection.

To protect personnel, all unit access panels and doors to the UV-C assembly and/or within view of the UV-C assembly must include mechanical interlock switches to ensure that the UV-C assembly automatically de-energizes when any equipment access is opened. All UV-C devices must fit and be installed within the unit cabinet. Devices must be hardwired, and UL labeled for the

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installation. Plug-in devices are not allowed per NEC. The assembly must be powered by 120v circuit or as required by the AC unit Manufacturer. Coordinate requirement and provide as required.

A redundant weatherproof disconnect service switch must be installed to provide a method to more specifically de-energize the UV-C lamp circuits prior to entering the lamp plenum. If not shown on the Electrical plans, the Mechanical Contractor must provide a weatherproof redundant disconnect service switch for the UV-C lighting device(s). The redundant weatherproof disconnect switch must be a manual single pole, single throw switch mounted beside the Electricals' unit disconnect circuit to nearest receptacle circuit with (2) #12 and (1) #12 Ground in 1/2" conduit.

Provide warning signage on each access point to the UV-C lights and on each side of the unit. Signage materials, methods and colors must be as specified Section 15010, Part Identification. Signage must read as follows: "DANGER!! UV-C LIGHT SOURCE! DISCONNECT POWER BEFORE SERVICING UNIT OR UV-C LIGHTING!" Do not use stick-on signage provided by the UV-C Manufacturer.

The weatherproof redundant UV-C disconnect switch specified above must be labeled with materials and methods specified in Section 15010, Part Identification. Signage must read as follows: "UNIT XX-YY UV-C LIGHTING REDUNDANT SHUT-OFF SWITCH." XX denotes the unit, and YY is the unit number or type, all as scheduled on the plans.

19.10. **Frame and Casing:** The frame must be of welded construction. The casing must be of hinged galvanized access panels with a baked on outdoor acrylic finish. The cabinet bottom must be insulated with Styrofoam; cabinet panels must be insulated with 1" fiberglass. All components, wiring and inspection areas must be completely accessible through hinged panels with quarter turn latching handles.

19.11. **Filters:** Provide 1" thick metal washable filters at the unit outside air intake. Provide 2" thick, MERV 11, disposable type filters for each filter location in the return air stream. All disposable filters must be common industry standard size filters that are readily available and do not have to be fabricated. Cutting and taping of filter segments to make a proper filter is prohibited.

The Mechanical Contractor must be responsible for the quarterly filter cleaning of the outside air intake filter and quarterly replacement of the return air filters during the guarantee period. The Mechanical Contractor must inscribe onto the disposable filters' casing the date filters were installed/replaced.

19.12. **Hot Gas Reheat Coil:** Each unit must be provided with a refrigerant hot gas reheat coil with reheat coil valve and located in the reheat position. The coil must be of sufficient size to reheat all of the air supply. Provide, complete, with all necessary valves, controls, etc., as required for a complete and properly functioning installation. Provide manual isolation valves for each hot gas and liquid lines. Furnish for review air conditioning equipment Manufacturer

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approved refrigerant piping and controls diagram, and statement by the air conditioning Manufacturer on company letterhead that use of the hot gas reheat coil with the equipment is acceptable to the Manufacturer and will not affect any warranty or guarantee. **Equipment submittal will not be reviewed without a Manufacturers' approved diagram and referenced statement**. Minimum reheat capacity for supply air must be 10ºF. Maximum coil pressure drop is 0.10" static pressure.

19.13. **Indoor Thermostat:** The Manufacturer must provide a combination 7-day programmable, two-stage heating automatic changeover thermostat. Thermostat must have sub-base fan switch for "On-Auto" selection and manual "Heat-Cool" switch. The thermostat must be hardwired and be provided with battery backup. Coordinate the thermostat with specified sequence of operation and provide as required.

Provide hinged metal guard with rounded corners, lock and key for each thermostat.

19.14. **Humidistat:** Humidistat is specified in "Automatic Controls" at the end of this 15700 Specification. At his option, the Unit Manufacturer may substitute a combined thermostat/humidistat. Verify with the Controls Sub-Contractor that the furnished thermostat/humidistat will perform all sequences of operation else provide separate devices as specified.

19.15. **CO2 Sensors:** Where demand ventilation is specified, the system must be provided with a separate CO2 sensor of the type specified at the end of this Section 15700. Combination devices are not allowed due to the required mounting height of the CO2 sensor.

19.16. **Unit Protection:** All equipment must also be provided with equipment manufacturer factory installed surge protection and phase protection to insure against voltage unbalance, over/under voltage, phase loss, reversal, incorrect sequencing and rapid short cycling. Where manufacturer factory installed devices are not available, protection must be provided for all 3-phase equipment utilizing ICM Controls Model 450 A Plus+ or equivalent. All single phase equipment with horsepower greater than or equal to 1/8 HP must be provided with protection utilizing ICM Controls Model ICM 492 or equivalent. Where phase protection device cannot be mounted within the respective equipment, provide a NEMA 4x or NEMA enclosure appropriate for the installation. The Contractor must consult with the Owner's maintenance personnel and set up all programmable options based on the Owner's requirements, within the device's capabilities.

19.17. **Smoke Detectors:** See Controls at the end of this Section.

19.18. **Warranty:** General warranties are specified in Section "General Mechanical Provisions". The Mechanical Contractor and equipment Manufacturer must provide a non-prorated, total of five years replacement warranty for this equipment, to include all parts and components, belts, lubricants, compressors, refrigerant, etc., all labor, and shipping of the items required to return the installation to its original operating condition.

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The Mechanical Contractor must be responsible for any parts, labor, etc. as specified above that is not provided by the equipment Manufacturer.

The Contractor and/or the Manufacturer must respond within 24 hours upon notification that there has been a failure under the terms of the specified warranty. "Respond" must mean having a Manufacturer certified technician onsite to evaluate the extent of the needed repairs/replacement and ordering of all items required for repair/replacement.

Shipping of the replacement compressor and any other related unit parts must be via maximum 2-day delivery if the unit is inoperable or cannot maintain a minimum indoor temperature of 78ºF to the affected facility.

The warranty period must begin on the date of substantial completion of the installation, as determined by the Architect, and must continue for the full product warranty period specified above. Refer to Part, Air Cooled Condensing Units for condensing unit and compressor warranty.

19.19. **Manufacturers:** Trane Series Precedent, Model YSJ for units with scheduled cooling capacities of 72,000 BTUH up to and including 300,000 BTUH. Trane is the basis of design. Equivalents by Carrier or Lennox will be considered.

PART 20. WALL MOUNTED DUCTLESS SPLIT HEAT PUMP SYSTEM UNIT (DHP)

20.1. **General:** Provide ductless, wall mounted, split system type heat pump unit, equal to Trane/Mitsubishi Electric Series NTXWST/NTXSST for units with specified cooling capacity up to 9 MBH and TPKA/TRUZ units with specified cooling capacity of 12 MBH to 36 MBH complete with all accessories including wall hung evaporator blower unit, pad mounted outdoor condensing unit operating with full factory furnished charge of ASHRAE Safety Classification A2L, R-454B refrigerant, factory installed refrigerant monitor and related safeties, lockable refrigerant charging valves, filter frame, washable filter, fixed, wall mounted, hardwired 7-day programmable, microprocessor electronic thermostat and control module, metal, hinged locking thermostat guard, adjustable discharge louvers, factory installed heavy duty condensate pump (if drainage indicated on plumbing and mechanical plan is not gravity type), low ambient indoor coil thermistor, low ambient control to 14º F, outdoor microprocessor control, heavy duty metal condenser coil hail guard, sweat/brazed connection fittings from the Manufacturer's factory and other accessories required for a complete functional installation. Flare connections are not allowed unless **specifically** required by the Manufacturer. Refer to Part Condensate Drainage Piping of this specification for drainage requirements. Compressors must be warranted for 5 years. Where the indoor unit is powered by the outdoor unit, wiring must be installed as specified in Division 16.

All condensate and refrigerant piping that cannot be concealed in the walls in finished spaces must be provided with Mitsubishi Line-Hide Linset Cover System. Note that this provision must not be used to cover piping that can be otherwise concealed.

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20.2. **Refrigerant Service Valves:** Provide for the proper service of the equipment. Per IMC 1101.9, all refrigerant circuit access ports located outdoors must be fitted with color coated, all brass, and locking tamper resistant caps. This requirement must not apply to refrigerant circuit access ports on equipment installed in controlled areas such as on roofs with locked access hatches or doors.

The locking caps must be red or red banded color code for the refrigerant used. Caps must be Novent Series 8668 for R-454B refrigerant with 86698 NV Multikey unlocking mechanism for R-454B refrigerant or equivalent by JB Industries Series Shield and DiversiTech Series Sentry. Provide Owner with minimum of six (6) spare keys.

20.3. **Refrigerant Piping:** Coiled line sets and preinsulated line sets are not allowed. See other parts of 15700 for piping and insulation requirements. The equipment Manufacturer must size the refrigerant piping for all the units and must furnish all accessories and auxiliaries required for a complete and proper installation for the specific application shown on the drawings and the specified sequence of operation. **Piping connections must be brazed/sweat connections** from the Manufacturer's factory. Flare connections are not allowed unless **specifically** required by the Manufacturer. Refer to Section Refrigerant Piping and Accessories for additional requirements.

20.4. **Condensate Pump:** Where gravity drainage is not indicated on the plans, condensate pumps for all indoor units must be Blue Diamond, Series MaxiBlue or approved equivalent. Pump must be thermally protected, up to 3.7 GPH flow rate, 23 ft. head, 15 ft. suction, self-priming, powered by the indoor unit and maximum 21-db sound level. The pump must be provided with mounting feet, extension cables and multi-tank configuration as required. Mechanical Contractor to coordinate power requirements for pump, prior to bid, and provide as required.

20.5. **Condensate Drainage:** Refer to Part Condensate Drainage Piping of this specification for drainage requirements.

20.6. **Power Wiring Connection:** Coordinate wiring requirements (separate power for each indoor and outdoor unit or indoor unit powered by outdoor unit) with electrical plans and provide as required.

20.7. **Pad Mounted Supports:** The concrete pad is specified under Division 2 for all units mounted on grade. Where concrete pads are not specified or shown, the Mechanical Contractor must provide a minimum 4" thickness, 5,000 psi concrete pad with rounded edges and corners. Pad must extend a minimum of 12" around three (3) sides of the unit and terminate at the building outside wall. Provide a strip of asphalt expansion joint between the concrete pad and the building exterior wall. Expansion joint must be 1" thickness, non-absorbing, self-sealing, ASTM D 994 compliant and manufactured by W.R. Meadows Inc or equivalent. All equipment and curbs must be installed level and plumb.

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20.8. **Unit Protection:** All equipment must also be provided with equipment manufacturer factory installed surge protection and phase protection to insure against voltage unbalance, over/under voltage, phase loss, reversal, incorrect sequencing and rapid short cycling. Where manufacturer factory installed devices are not available, protection must be provided for all single phase equipment with horsepower greater than or equal to 1/8 HP utilizing ICM Controls Model ICM 492 or equivalent. Where phase protection device cannot be mounted within the respective equipment, provide a NEMA 4x or NEMA enclosure appropriate for the installation. The Contractor must consult with the Owner's maintenance personnel and set up all programmable options based on the Owner's requirements, within the device's capabilities.

20.9. **Warranty:** General warranties are specified in Section "General Mechanical Provisions". The Mechanical Contractor and equipment Manufacturer must provide a non-prorated, total of five years replacement warranty for this equipment, to include all parts and components, belts, lubricants, compressors, refrigerant, etc., all labor, and shipping of the items required to return the installation to its original operating condition.

The Mechanical Contractor must be responsible for any parts, labor, etc. as specified above that is not provided by the equipment Manufacturer.

The Contractor and/or the Manufacturer must respond within 24 hours upon notification that there has been a failure under the terms of the specified warranty. "Respond" must mean having a Manufacturer certified technician onsite to evaluate the extent of the needed repairs/replacement and ordering of all items required for repair/replacement.

Shipping of the replacement compressor and any other related unit parts must be via maximum 2-day delivery if the unit is inoperable or cannot maintain a minimum indoor temperature of 78ºF to the affected facility.

The warranty period must begin on the date of substantial completion of the installation, as determined by the Architect, and must continue for the full product warranty period specified above. Refer to Part, Air Cooled Condensing Units for condensing unit and compressor warranty.

20.10. **Manufacturers:** Trane or equivalent by Mitsubishi, Lennox, LG or Carrier. **Trane is the basis of Design.**

PART 21. SPLIT SYSTEM CASSETTE TYPE HEAT PUMP (CCHP)

21.1. **General:** The heat pump air conditioning system must be equal to Trane/Mitsubishi Electric Series TPLA/TRUZ split system operating full factory furnished charge of ASHRAE Safety Classification A2L, R-454B refrigerant. The system must consist of a slim silhouette; compact ceiling mounted packaged evaporator section and matching slim line outdoor unit with lockable refrigerant charging valves, factory installed refrigerant monitors and related safeties, refrigerant piping sweat/brazed connections from the Manufacturer,

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wall mounted, hardwired 7-day programmable thermostat with clear plastic locking cover, occupancy sensor with override, outside air connection (if shown on the plans) and supply air connection (if shown on the plans). whenever possible, the unit must fit within a nominal 2'x2' lay-in ceiling grid. Flare connections are not allowed unless **specifically** required by the Manufacturer. The units must be listed by Electrical Laboratories (ETL) and/or Underwriters Lab (UL) and bear the ETL and/or UL label. All wiring in accordance with the National Electrical Code (N.E.C.). The units must be rated in accordance with ARI Standard 240 and bear the ARI label. All units must be provided with phase protection.

Where the indoor unit is powered by the outdoor unit, installation must be as specified in Division 16.

All condensate and refrigerant piping that cannot be concealed in the walls in finished spaces must be provided with Mitsubishi Line-Hide Linset Cover System. Note that this provision must not be used to cover piping that can be otherwise concealed.

21.2. **Refrigerant Service Valves:** Provide for the proper service of the equipment. Per IMC 1101.9, all refrigerant circuit access ports located outdoors must be fitted with color coated, all brass, and locking tamper resistant caps. This requirement must not apply to refrigerant circuit access ports on equipment installed in controlled areas such as on roofs with locked access hatches or doors.

The locking caps must be red or red banded color code for the refrigerant used. Caps must be Novent Series 8668 for R-454B refrigerant with 86698 NV Multikey unlocking mechanism for R-454B refrigerant or equivalent by JB Industries Series Shield and DiversiTech Series Sentry. Provide Owner with minimum of six (6) spare keys.

21.3. **Occupancy Sensor:** Provide 'I-see Sensor' occupancy sensor.

21.4. **Refrigerant Piping:** Coiled line sets and preinsulated line sets are not allowed. See other parts of 15700 for refrigerant piping and insulation requirements. The equipment Manufacturer must size the refrigerant piping for all the units and must furnish all accessories and auxiliaries required for a complete and proper installation for the specific application shown on the drawings and the specified sequence of operation. Refrigerant piping connections must be sweat/brazed connections from the Manufacturer's factory. Flare connections are not allowed unless **specifically** required by the Manufacturer. Refer to Section Refrigerant Piping and Accessories for additional requirements.

21.5. **Description:** Capacities and characteristics must be as specified on the drawings. The indoor unit must be factory assembled and wired. The casing must be galvanized sheet metal with insulation. Whenever possible, the unit must fit within a nominal 2'x2' ceiling grid. Coordinate unit type required with previously specified requirements of outside air/supply air duct connections required by the plans. The evaporator fan must be a high performance, fan direct driven by a single motor. The fan must be statically and dynamically

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balanced and run on permanently lubricated bearings. The indoor unit must have an adjustable air outlet system with 4-way deflection airflow. Return air must be filtered with factory furnished filter. The coil must be of nonferrous construction with smooth plate fins bonded to copper tubing. All tube joints must be brazed with phos-copper or silver alloy and provided with appropriate **piping connections for brazed/sweat connections from the Manufacturer's factory**. Flare connections are not allowed unless **specifically** required by the Manufacturer. The coil must be pressure tested at the factory. A condensate pan and auxiliary drain pan must be provided and extend under the coil and piping.

Unit must be provided with sensor to shutdown unit and sound alarm if condensate line becomes obstructed. If the BAS system is part of the project, provide output contacts to show alarm at BAS system Operator Console. Coordinate with BAS Contractor and provide as required for proper interface.

The control system must consist of low voltage room thermostat to control heating and cooling. Provide clear plastic thermostat guard with lock and key.

21.6. **Condensate Drainage:** Refer to Part Condensate Drainage Piping of this specification for drainage requirements.

21.7. **Outdoor Unit:** Must be completely factory assembled, piped and wired. The unit must be furnished with one (1) direct drive, propeller type fan arranged for horizontal or vertical. The motors must have inherent protection, be of the permanently lubricated type, and resiliently mounted for quiet operation. The compressor must be of the high-performance rotary type with crankcase heater, accumulator and internal thermal overloads. The refrigeration system must be equipped with high-pressure switch. Refrigerant flow from the condenser must be controlled by means of a capillary tube. The condenser coil must be of nonferrous construction with smooth plate fins bonded to copper tubing. The coil must be protected with smooth plate fins bonded to copper tubing. The condenser coil must be protected with an integral heavy-duty metal hail guard. The unit must be controlled by the microprocessor located in the indoor matching unit. A built-in, low-ambient controller must allow cooling to 0 degrees F outdoor temperature.

21.8. **Power Wiring Connection:** Coordinate wiring requirements (separate connection for each indoor and outdoor unit or indoor unit powered by outdoor unit) with electrical plans and provide as required.

21.9. **Pad Mounted Supports:** Units mounted on finished grade must be provided with concrete pad. Concrete pads are specified under Division 2. Where concrete pads are not specified or shown elsewhere, the Mechanical Contractor must provide a minimum 4" thickness, 5,000-psi concrete pad with rounded edges and corners. Pad must extend a minimum of 12" around three (3) sides of the unit and terminate at the building outside wall. Provide a strip of asphalt expansion joint between the concrete pad and the building exterior wall. Expansion joint must be 1" thickness, non-absorbing, self-sealing, ASTM D 994 compliant and manufactured by W.R. Meadows Inc or equivalent.

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21.10. **Unit Protection:** All equipment must also be provided with equipment manufacturer factory installed surge protection and phase protection to insure against voltage unbalance, over/under voltage, phase loss, reversal, incorrect sequencing and rapid short cycling. Where manufacturer factory installed devices are not available, protection must be provided for all single phase equipment with horsepower greater than or equal to 1/8 HP utilizing ICM Controls Model ICM 492 or equivalent. Where phase protection device cannot be mounted within the respective equipment, provide a NEMA 4x or NEMA enclosure appropriate for the installation. The Contractor must consult with the Owner's maintenance personnel and set up all programmable options based on the Owner's requirements, within the device's capabilities.

21.11. **Warranty:** General warranties are specified in Section "General Mechanical Provisions". The Mechanical Contractor and equipment Manufacturer must provide a non-prorated, total of five years replacement warranty for this equipment, to include all parts and components, belts, lubricants, compressors, refrigerant, etc., all labor, and shipping of the items required to return the installation to its original operating condition.

The Mechanical Contractor must be responsible for any parts, labor, etc. as specified above that is not provided by the equipment Manufacturer.

The Contractor and/or the Manufacturer must respond within 24 hours upon notification that there has been a failure under the terms of the specified warranty. "Respond" must mean having a Manufacturer certified technician onsite to evaluate the extent of the needed repairs/replacement and ordering of all items required for repair/replacement.

Shipping of the replacement compressor and any other related unit parts must be via maximum 2-day delivery if the unit is inoperable or cannot maintain a minimum indoor temperature of 78ºF to the affected facility.

The warranty period must begin on the date of substantial completion of the installation, as determined by the Architect, and must continue for the full product warranty period specified above. Refer to Part, Air Cooled Condensing Units for condensing unit and compressor warranty.

21.12. **Manufacturers:** Trane or equivalent by Mitsubishi, Lennox, LG or Carrier. **Trane is the basis of Design.**

PART 22. ELECTRIC UNIT HEATERS

22.1. **General:** Heaters must be UL listed, have integral safety controls, control transformer, circuit breaker and all required accessories for a complete and functional installation. Capacities must be as scheduled on the plans. All heaters must be installed in accordance with the Manufacturer’s recommendations.

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Heaters must be securely mounted to building structure. Provide any additional structural framing necessary for proper heater installation. Unit heaters must be provided with single point power connections (fan and heater).

The contractor must verify all voltage and power requirements with Electrical Contractor, Electrical plans, and at the project site, prior to ordering equipment.

See below for the basis of design units. Equivalents by Trane, Reznor, Modine, Markel, Chromalox or Indeeco will be considered.

22.2. **Propeller Type:** Heater must be horizontal (vertical) discharge type, complete with integral controls, remote 24-volt thermostat, control transformer, and circuit breaker. The Basis of design is Trane model UHEC.

PART 23. AUTOMATIC CONTROLS

23.1. **General:** Furnish and install a complete system of automatic temperature controls, as specified herein, as shown on the Drawings and as required for a complete installation. All temperature control equipment must be of the electric type. All specified Sequences of Operation are subject to all equipment built-in safety requirements. Equipment and safety requirements must not be overridden.

23.2. **Submittals:** The temperature control contractor must submit a complete set of temperature control diagrams with written "sequence of operation" and factory-printed specification data sheets covering each control device proposed to be used for Engineer's review prior to installation of any equipment or part of system. Submittal data must include a schedule of all devices to be installed.

23.3. **Installation:** By trained and experienced mechanics. All work must be done by an approved, independent HVAC Controls Contractor whose primary business is the installation and servicing of HVAC controls systems. The HVAC Controls Sub-Contractor must have an adequate service facility to provide complete service and maintenance of the facility within 100 miles of the installation.

23.4. **Identification:** Provide permanent nameplates for all control components and for all motor starters. Nameplates must be engraved laminated plastic with letters sufficiently large to be legible under normal operating conditions. Refer to Section 15010, Part Identification for additional requirements, nameplate materials, etc.

23.5. **Conduit, Controls Wiring and Instrumentation Cable:** The HVAC Controls Contractor must be responsible for the furnishing and installation of a complete and functional system as specified, shown on the plans and as required to accomplish the specified sequences of operation.

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All HVAC control cabling and wiring must be in EMT conduit (no “whips”) or on J-hooks. Above accessible lay-in ceilings, control wiring must be installed on J-Hook assemblies. Above all hard, inaccessible ceilings, in all mechanical rooms and in areas with exposed structure (no ceilings), controls wiring must be in conduit. Do not attach any wiring, cabling or conduits to refrigerant piping.

Do not route control wiring through sleeves containing piping. Do not route control wiring through sleeves containing piping. **All control wiring penetrating any exterior wall, interior partition, floor, and similar construction must be in EMT conduit. Through the base control wiring/conduit is not allowed.** EMT control conduit must be as specified in the Electrical Division of the specifications and/or as shown on electrical drawings. Minimum HVAC Controls conduit size must be 3/4” in size. All control conduit, power, relays, contactors, transformers, wiring, etc., required for a complete functional system as specified, shown on the plans, or as required to accomplish the specified sequences of operation, which is not shown or specified by the Electrical Division, must be furnished and installed by the HVAC Controls Contractor. This must include all power, interlock control wiring between the various components of the heating, ventilating and air conditioning system, lighting interlocks and all smoke detection system electrical wiring.

Instrumentation cable must be minimum AWG as specified or heavier AWG as recommended by the controls system Manufacturer.

All thermostat and humidistat boxes must be mounted 46” A.F.F. to the center of the box (ADA height). Where wall mounted CO_2 Sensors are indicated, they must be mounted 58” A.F.F to the center of the box.

23.6. **Space Thermostats:** Space thermostats must be 7-day programmable, microprocessor based, low voltage type with “Heating - Cooling” and fan “On-Off-Auto” switches sub-base. Coordinate thermostat requirements and options with Mechanical Contractor and provide as required to accomplish specified sequence of operation. Each thermostat must have building power supply with transformer and battery back-up power.

Provide hinged metal guard with rounded corners, lock and key for each thermostat. CCHP units shall be provided with clear plastic locking covers.

All thermostat boxes must be mounted 46” A.F.F. to the center of the box (ADA height). All thermostat boxes in walls or partitions must be sealed/caulked to prevent the passage of air and smoke through the device.

23.7. **Carbon Dioxide Sensors:** Must be of the non-dispersive infrared type (NDIR) diffusion sampling, repeatable to +/- 8 PPM with a measurement range 0 – 2000 PPM and be user adjustable. It must have the following accuracy: from 0-1500 PPM +/- 75 PPM; +/- 5% with an operating range of 32 degrees F to 130 degrees F with a response time of less than 90 seconds.

Sensors must be provided with all options, inputs and outputs required to control the motorized return air and outside air dampers to accomplish the specified Sequence of Operation. Duct mounted sensors must be mounted

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where shown on the plans. Wall mounted sensors must be mounted 58” A.F.F to the center of the box.

Duct mounted sensors must be Veris Industries Series CDE or approved equivalent by Johnson Controls or Honeywell. Wall mounted sensors must be Veris Industries Series CWE or approved equivalent by Johnson Controls or Honeywell.

Provide metal guards as specified for thermostats.

23.8. **Humidistats:** Heavy-duty industrial type. Provide metal guard as specified for thermostats.

All humidistat boxes must be mounted 46” A.F.F. to the center of the box (ADA height). All humidistat boxes in walls or partitions must be sealed/caulked to prevent the passage of air and smoke through the device. At his option, the unit Manufacturer/Controls Sub-Contractor may provide a combined thermostat/humidistat device. Coordinate requirement with the equipment manufacturer prior to bidding and provide as required.

23.9. **Smoke Detectors:** Smoke detectors operating on photoelectric principles must be furnished by the Electrical Contractor and installed where shown on the plans by the Mechanical Contractor.

The Mechanical Contractor must provide an access door/panel, watertight where required, adjacent to each smoke detector to allow for maintenance and visual inspection. Access panels must be as specified hereinbefore.

23.10. **Condensate Drainage:** Refer to Part Condensate Drainage Piping of this specification for drainage requirements.

23.11. **Motorized Control Dampers:** Equal to Ruskin Series CD-50, Pottorff CD-52, Greenheck VCD-43, United Enertech CD-110 or Nailor 2020, galvanized steel frame, Class 1A (less than or equal to 3 cfm/sq.ft. at 1" w.g.) leakage, extruded aluminum airfoil, opposed blade dampers, stainless steel or synthetic bearings with heavy-duty Belimo actuator and 24-volt actuators. The dampers must be labeled by an approved agency when tested in accordance with AMCA 500D.

Coordinate power requirements with electrical contractor and provide as required. Damper motors must be located outside of the air stream. Provide weatherproof construction for outdoor installation of dampers and weatherproof enclosure.

23.12. **Typical Split System Heat Pump (HP) Unit Systems with Demand Control Ventilation Sequence of Operation:** Units without demand control ventilation are similar. The control circuit for each unit must be energized by its respective 7-day programmable thermostat. Occupied and unoccupied schedules must be programmed by the Controls/Mechanical Contractor as desired by the Owner.

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The thermostat must be used to control heating and cooling. Provide for each heat pump unit an adjustable outdoor thermostat and wire to control the second stage of the auxiliary electric resistance heater.

Upon a call for the occupied schedule, the outside air damper must open to its minimum scheduled outside air setpoint, and the respective indoor/outdoor unit must start. Upon shutdown of the indoor/outdoor, the motorized outside air damper must close.

Upon a call for the unoccupied schedule, the outside air damper must remain closed, and the unit must start.

A wall mounted or duct mounted CO_2 sensor, monitoring CO_2 levels in the space or return air duct, must modulate the outside air damper, motorized relief air damper (as applicable) and return air dampers, in sequence, as required to maintain CO_2 levels at a maximum of 700 PPM (adj). Refer to the equipment schedules for the minimum CO_2 scheduled outside air setpoint and the maximum CO_2 scheduled outside air setpoint. Upon satisfaction of the CO_2 sensor, the outside air, relief air and return air dampers must return to their minimum scheduled setpoint and normal sequence of operation. Refer to the plans for location of the CO2 sensor type required.

Provide a space humidistat to override the cooling thermostat to provide for dehumidification.

During dehumidification, the heat pump unit reversing valve must be locked out to prevent switching to the heating mode and the compressor must be commanded on for cooling. The space thermostat must then modulate the refrigerant hot gas reheat coil valve or energize the first stage of the 2-stage heater, as specified below, to maintain the required space temperature.

Where specified or humidistats are indicated on the plans, units with a scheduled cooling capacity greater than or equal to 42 MBH must utilize the specified hot gas reheat coil for reheat. Units with a specified cooling capacity of less than 42 MBH must use the auxiliary resistance heater for reheating.

Provide smoke detectors as specified above, and where shown on the plans. Wire the detectors to stop the unit upon smoke detection. Coordinate work with Electrical Contractor and provide required interlocks, wiring, relays, etc., as required for shutdown of the unit as specified.

23.13. <u>Typical Packaged Heating and Air Conditioning Unit (PHAC) With Demand Control Ventilation Sequence of Operation:</u> The control circuit for each unit must be energized by its respective 7-day programmable thermostat. Occupied and unoccupied schedules must be programmed by the Controls/Mechanical Contractor as desired by the Owner.

The thermostat must be used to control heating and cooling.

Upon a call for the occupied schedule, the outside air damper must open to its minimum scheduled outside air setpoint, and the respective indoor/outdoor unit

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must start. Upon the respective indoor/outdoor unit shutdown, the motorized outside air damper must close.

Upon a call for the unoccupied schedule, the outside air damper must remain closed, and the respective indoor/outdoor unit must start.

A wall mounted or duct mounted CO_2 sensor (as shown on the plans), monitoring CO_2 levels in the space or return air duct, must modulate the outside air, relief air motorized dampers (as applicable) and return air dampers, in sequence, as required to maintain CO_2 levels at a maximum of 700 PPM (adj). Refer to the equipment schedules for the minimum CO_2 scheduled outside air setpoint and the maximum CO_2 scheduled outside air setpoint. Upon satisfaction of the CO_2 sensor, dampers must return to their minimum scheduled setpoint and normal sequence of operation. Refer to the plans for location of the CO2 sensor type required.

Provide a space humidistat to override the cooling thermostat to provide for dehumidification. The hot gas reheat coil must be utilized for reheat.

During dehumidification, the heat must be locked out to prevent switching to the heating mode and the compressor must be commanded on for cooling. The space thermostat must then modulate the refrigerant hot gas reheat coil valve as required to maintain the required space temperature.

Provide smoke detectors as specified above and where shown on the plans. Wire the detectors to stop the unit upon smoke detection. Coordinate work with Electrical Contractor and provide required interlocks, wiring, relays, etc., as required for shutdown of the unit as specified.

The packaged heating and air conditioning units are specified to be provided with firestats. Coordinate requirement with equipment Manufacturer. Verify installation and proper settings.

23.14. Packaged Heating and Air Conditioning Unit (PHAC) Economizer Cycle: Units are specified with factory mounted enthalpy based economizer. The sequence of operation is pre-programmed based on ASHRAE requirements. The Controls Sub-Contractor must verify factory plug and play settings for the region of the installation as required. Refer to equipment specifications and coordinate for proper interface as required.

23.15. Exhaust Fan (EF) Controls: Provide interlocks for certain fans as noted on fan schedule, including lighting interlocks if not shown on electrical. Also, provide central HVAC control panel mounted “Hand-Off-Auto” switch for all fans that are interlocked with other equipment to function as follows: With switch in the “Auto” position fan starts with the interlocked equipment. With switch in the “Hand” position, the fan runs continuously.

Provide hinged metal guard with rounded corners, lock and key for each thermostat.

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23.16. **Typical Unit Heaters:** Each unit must be started by the respective 7-day, microprocessor based, programmable thermostat. Space thermostat must control heater contactors and fan as required to maintain space temperature.

Provide hinged metal guard with rounded corners, lock and key for each thermostat.

All unit heaters must be provided with an outdoor temperature sensor on the north facing wall and wired to each unit heater to lock out the heater anytime the outdoor temperature is above 45ºF.

23.17. **Storm Shelter Ventilation:** Refer to Sequence of Operation on plans.

23.18. **Time Delay Controls:** Provide time delay control systems as required to stage units starting to prevent more than three units from starting at the same time.

23.19. **Miscellaneous Controls:** Provide all other miscellaneous controls, wiring, dampers, valves, etc., as required for a complete functional control system.

23.20. **Service and Guarantee:** After completion of the installation, adjust all control equipment and place the complete system in operation subject to the review of the Engineer. Guarantee the control system to be free of defects and adequate to provide required control functions for a period of one year after acceptance of project. Provide free service and maintenance during the guarantee period.

END OF SECTION

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Division 16

Prepared by Kenneth R. Gunn Jr., P.E.

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SECTION 16100
ELECTRICAL

PART 1 - GENERAL

1.01. RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections apply to work specified in this section.

1.02. QUALIFICATIONS OF ELECTRICAL CONTRACTORS:

A. Electrical contractor must be properly established as an electrical contractor by the State of Alabama. Electrical contractor shall have had previous experience in the satisfactory installation of at least three systems of this type and size in the State of Alabama.

1.03. CODES, PERMITS AND INSPECTIONS:

A. Comply with applicable laws of the community, with latest edition of National Electrical Code (NEC), NFC 70, and the International Building Code(IBCC) or the edition adopted by the local authority having jurisdiction, where not in conflict with those laws, and with the service rules of the local utility company.

B. Obtain and pay for all permits and deposits and arrange for inspections as required.

C. After completion of the work, submit certificate of final inspection and approval from the local electrical inspector, certifying that the installation complies with all regulations governing same.

1.04. MATERIALS:

A. All materials shall be new, and UL approved where a standard has been established.

B. Manufacturers' names and model numbers shown on the plans and in the specifications are given to indicate the type and general quality of items to be provided. Equal products by other manufacturers will be accepted.

C. Material substitutions will be considered only when evidence of equality and suitability, satisfactory to the Architect/Engineer has been presented in writing, with samples if requested by the Architect/Engineer. All prior approvals must have the approval of the engineer of record at the offices of Gunn and Associates, P.C. located at 3102 Highway 14, Millbrook, AL 36054, Phone: 334-285-1273

D. All proposed substitutions shall be approved in writing at least ten (10) days prior to the bid date.

E. It shall be understood that the Architect/Engineer has the authority to reject any material or equipment used which is not specified or approved, or showing defects of manufacture or workmanship, before or after such material or equipment is installed.

1.05. WORKMANSHIP:

A. Execute all work so as to present a neat and workmanlike appearance when completed.

1.06. DESCRIPTION OF WORK:

A. Furnish all labor and materials required to complete the electrical work indicated on the drawings or herein specified. Major work included in Section 16 shall be:

B. Prior to bid it is the contractor's responsibility to re-affirm with the power company the service requirements to the facility as indicated on the electrical drawings. If any changes or additions to the service lateral installation indicated on the drawings is required by the utility company the contractor shall include the cost of these changes in his/her bid. Additionally, any/all charges for electrical service to the facility (aid-to-construction) by the utility company shall be included in the contractor's bid price.

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C. Remove or relocate all electrical or electronic services located on or crossing through the project property, either above or below grade, which would obstruct the construction of the project or conflict in any manner with the complete project or any code pertaining thereto.

D. Furnish and install a complete electrical light and power system including but not limited to the connection of all meters, switchboards, panelboards, circuit breakers, power outlets, convenience outlets, lighting fixtures, switches, and/or other equipment forming part of the electrical system.

E. Furnish and install a complete system of outlet boxes, face plates, conduit raceways, backboard, and service entrance conduit for the communications system.

F. Furnish and install a complete system of outlet boxes, face plates, conduit raceways, Category 6 cables, backboards, patch panels, and fiber optic cables and patch panels for the Data System.

G. Connect all electrical equipment whether furnished by this contractor or by others.

H. Furnish and install all disconnect switches not included as an integral part of equipment.

I. Furnish and install a complete Lighting Control System.

J. Furnish and install a complete Fire Alarm System compliant with applicable provisions of the International Building Code (IBC) and the National Fire Protection Association (NFPA) Standard No. 72.

K. Complete the alterations, additions, and renovations to the electrical system in the existing building as specified herein or as shown on the drawings.

L. Procure and pay for permits and certifications as required by local and state ordinances and Fire Underwriters certificate of inspection.

M. Visit the site and determine conditions that affect this contract. Failure to do so will in no way relieve the Contractor of his responsibility under his contract.

N. Submit to the Architect a certificate of final inspection from local and/or state inspection authorities.

O. Establish and maintain temporary electrical services for construction purposes.

1.07. DRAWINGS AND SPECIFICATIONS:

A. This Contractor shall examine drawings and Specifications relating to the work of all trades and become fully informed as to the extent and character of work required and its relation to all other work in the project prior to submission of bid and prior to the start of any construction.

B. Drawings and Specifications shall be considered as complementary each to the other. What is called for by one shall be as binding as if called for by both. Where conflicts occur, secure clarification from the Architect in advance of bidding; otherwise incorporate the more stringent conditions into the bid price.

C. Omissions from the drawings and specifications or the mis-description of details of work which are evidently necessary to carry out the intent of the drawings and specifications, or which are customarily performed, shall not relieve the Contractor from performing such omissions and details of work; they shall be performed as if fully and correctly set forth and described in the drawings and specifications.

D. The drawings indicate diagrammatically the extent, general character, and the approximate location of the work to be performed. In the interest of clearness, the work is not always shown to scale or exact location. Check all measurements, locations of conduit, fixtures, outlets, and equipment with the detailed architectural, structural, and mechanical drawings, and lay out work so as to fit in with ceiling grids, ductwork, sprinkler piping and heads, and other parts. Take finished dimensions at the job site in preference to using scale dimensions.

E. Where the work is indicated but with minor details omitted, furnish and install the work complete so as to perform its intended functions.

F. Where doubt arises as to the meaning of the plans and specifications, obtain the Architect's decision before proceeding with parts affected; otherwise assume liability for damage to other work and for making necessary corrections to work in question.

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G. Except as noted above, make no changes in or deviations from the work as shown or specified except on written order of the Architect.

1.08. EXISTING CONDITIONS:

A. Before submitting a bid, visit the site and ascertain all existing conditions.

B. Make such adjustments in work as are required by the actual conditions encountered.

C. No consideration will be given after bid opening for alleged misunderstandings regarding utility connections, integration of work with existing system, or other existing conditions.

1.09. SUBMITTALS:

A. Follow procedure outlined in Division 1.

B. Submittals shall be bound together and shall include a coversheet indicating the following:
   1. Project name
   2. Trade contractor's name
   3. Supplier's name
   4. Name and phone number of supplier's contact person
   5. A list of each item submitted with manufacturers' names and model numbers.

C. Within 20 days of award of contract and prior to beginning any work on the project submit six (6) copies of manufacturer's drawings/data sheets for the following items to the Engineer for review:
   1. Conductors
   2. Cable Pulling tensions. Provide cable pull tension calculations (lateral and longitudinal) on all underground cable runs over 150 feet for cables sized #1 and larger. Provide one line diagram indicating pulling tensions on each run and number and size of each pull box along anticipated route. Calculations shall include changes in direction or elevation of feeder runs.
   3. Wiring Devices
   4. Conduit Wrapping Tape
   5. Switchboards
   6. Panelboards
   7. Power system breaker coordination. Submit proper breaker settings recommendations with breaker coordination study.
   8. Contractor shall coordinate with mechanical/plumbing shop drawings prior to submitting power package to engineer. Adjust overcurrent devices accordingley.
   9. Disconnect Switches
   10. Dry Type Transformers
   11. Motor Starters
   12. Motor Control Centers
   13. Bus or Busway Assemblies and buss plugs.
   14. Fire Stopping
   15. Lighting Control System: Include conduit and cable layout, terminal to terminal wiring showing color code and wire numbers, and complete technical data on each system component. Furnish the Owner one set of as built drawings at completion of the project. Coordinate with lighting control riser on drawings for further shop drawings requirements.
   16. Lighting Fixtures (include photometric data for each fixture)
   17. Fixture Support Equipment
   18. Lighting Standards (Poles)
   19. Data/Telecommunications System
       a. Cable
       b. Equipment
       c. Installer qualifications
       d. Makes and Model Numbers of Testing Equipment to be used.
   20. Secondary Surge Arresters
   21. Transient Voltage Surge Suppressors(Surge Protective Devices)

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22. **Fire Alarm System: The fire alarm shop drawings shall bear the approval of the fire protection provider to ensure all supervisory valves and flow switches are being monitored by the fire alarm system. Coordinate with fire protection provider prior to bid and provide monitoring for all supervisory valves and flow switches for entire building. Coordinate with sprinkler system designer and provide additional heat detection (if required) and associated circuiting in elevator shafts and equipment rooms to comply with applicable sections of NFPA and ANSI A17.1. Bid accordingly. Include conduit and cable layout, battery calculations, terminal to terminal wiring showing color code and wire numbers, and complete technical data on each system component. Additionally, the contractor or his/her fire alarm system vendor shall provide audibility calculations indicating compliance with all applicable provisions of NFPA 72 and the IBC. The contract drawings indicate a minimum design required to comply with applicable codes. However, since devices vary from manufacturer to manufacturer the contractor shall be responsible for furnishing any/all additional devices as required to provide audibility and visibility levels that comply with applicable sections of NFPA 72 and IBC. Furnish the Owner one set of as built drawings at completion of the project. Provide a copy of the fire alarm contractor's State Fire Marshal's Permit with the submittals for approval.**
23. **Fire Alarm Submittals: Alabama DCM projects will be required to provide a courtesy set of approved fire alarm submittals to the local fire department for their records. Not for review, but only for their records.**
24. J-Hooks

D. Submit samples upon request.

E. The Contractor is responsible for verifying all quantities and for verifying and coordinating dimensional data with the available space for items other than the basis of design.

F. **Provide a ½"= 1'- 0" scale drawing of all electrical rooms containing more than a single panelboard section or containing a panelboard and other electrical and/or mechanical equipment. These drawings shall be submitted along with equipment data sheets. Note we will no longer review submittals that does not have this information. Any delay will be the responsibility of the contractor for not submitting these drawings of the electrical rooms. Power submittals will be returned rejected without these drawings.**

G. The contractor shall review and approve or make appropriate notations on each item prior to submittal to the architect. Submittals without contractor's approval will be rejected.

H. Submittal reviews will be performed up to two times to review material submitted by contractor. Gunn & Associates will charge a review fee of a $1,000 to review submittals starting the third time submitted. If contractor needs Gunn & Associates, P.C. to perform another review of material after submittals have been submitted and approved to change manufacturers. A review cost of $1,000 per review. Payment must be received by Gunn & Associates prior to scheduling any additional reviews.

1.10. COORDINATION OF SERVICE WITH OTHER TRADES:

A. It shall be the responsibility of the Electrical Contractor to coordinate the electrical service characteristics to each piece of electrically operated equipment with all trades providing electrically operated equipment.

B. Within ten (10) working days of notification to proceed with construction from the Architect, the Electrical Contractor shall notify, in writing, all trades providing electrically operated equipment the characteristic of the electrical power being supplied to each piece of electrically operated equipment.

C. A copy of this notification shall be provided to the General Contractor and the Architect.

D. Be informed as to equipment being furnished by other trades, but not liable for added cost incurred by equipment substitutions made by others which require excess electrical wiring or equipment above that indicated on drawings or specified.

E. The contractor providing the equipment shall be responsible for the additional costs.

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1.11. PROGRESS OF WORK:

A. Schedule work as necessary to cooperate with other trades, Do not delay other trades. Maintain necessary competent mechanics and supervision to provide an orderly progression of the work.

1.12. PROTECTION OF PERSONS AND PROPERTY DURING CONSTRUCTION:

A. Take all precautions necessary to provide safety and protection to persons and the protection of materials and property.

B. Protect items of equipment from stains, corrosion, scratches, and any other damage or dirt, whether in storage, at job site or installed. No damaged or dirty equipment, lenses, or reflectors will be accepted.

C. Live panelboards, outlets, switches, motor control equipment, junction boxes, etc., shall be protected against contact of live parts and conductors by personnel.

1.13. CLEANING UP:

A. During the progress of work, keep the Owner's premised in a neat and orderly condition, free from accumulation of debris resulting from this work. At the completion of the work, remove all material, scrap, etc. not a part of this Contract.

1.14. AS-BUILT DRAWINGS, AND OPERATING AND MAINTENANCE INSTRUCTIONS:

A. Prior to the Final Acceptance Inspection the Contractor shall turn over to the Architect one set of reproducible "as built" drawings, including corrected fire alarm system shop drawings, three (3) sets of all equipment catalogs and maintenance data, manufacturers' warranties, and three (3) sets of shop drawings on all equipment.

1.15. TESTING:

A. Upon completion of the work, conduct a thorough test in the presence of Architect or his representative, and demonstrate that all systems are in perfect working condition.

1.16. INSPECTIONS:

A. The contractor shall have all systems ready for operation and an electrician available to remove panel fronts, coverplates, fixture doors, etc., at the final inspection and any other scheduled inspections.

B. It is the contractor's responsibility to have the job ready for inspections when they are scheduled. We will perform inspections as required by our contract. If project is not ready during inspection and requires a re-inspection by Gunn & Associates, then the contractor shall pay Gunn & Associates, P.C. for the re-inspection. The payment shall be made directly to Gunn & Associates, P.C. in the amount to be determined by engineer. Not to exceed $1,500 for single re-inspection fee. Payment must be received by Gunn & Associates prior to scheduling re-inspection.

C. Inspections for Temporary or Permanent Power required by any utility companies are not in our scope of work. If contractor needs Gunn & Associates, P.C. to perform inspections, contractor must include an inspection cost of $1,000 per inspection in their base bid. Payment must be received by Gunn & Associates prior to scheduling inspection.

1.17. DEMONSTRATION:

A. By on-off, stop-start operation, demonstrate to the Owner or his representative, the use, working, resetting, and adjusting of each and every system. Submit statement initialed by the Owner that such demonstration has been made.

1.18. WARRANTY:

A. Warrant the entire electrical system in proper working order. Replace, without additional charge, all work or material that may develop defects (ordinary wear and tear or damage resulting from improper handling excepted) within a period of one year from date of final to general contractor. Provide the owner with two bound copies of all manufacturers' warranties.

B. Data and Telecommunications system cabling shall be warranted for a minimum of 15 years.

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1.19. TEMPORARY SYSTEMS:

A. The Electrical Contractor shall be responsible for furnishing and installing equipment and materials necessary for providing electrical power and lighting where needed for the construction of the project.

B. Electrical Contractor will be responsible for paying for and providing temporary construction power and lighting for entire job site. Coordinate with local jurisdictions and utility companies and pay all fees necessary to get temporary power to the job site. General Contractor shall be responsible for all monthly utility cost for duration of project or date of substantial completion.

1.20. SERVICE INTERRUPTION CLEARANCE WITH OWNER:

A. Before submitting a proposal, check with the Owner concerning interruption of service to the existing electrical systems. No interruption shall be made except at such time and for such duration as approved by the Owner. The Contractor's bid shall include all necessary over-time and weekend work.

1.21. DEFINITIONS:

"AWG" - American Wire Gauge
"ADA" – Americans with Disabilities Act
"As required" - Any and all items required to complete the installation of an item so as to perform its intended function.
"Circuiting" - Conductors, raceways, raceway fittings, and associated hardware.
"EMT" – Electrical Metallic Tubing, "thin wall"
"IBC" – International Building Code
"Install" - furnish, install, and make all necessary connections to and/or for the item(s) indicated or specified.
"NEC" - National Electrical Code, ANSI/NFPA 70, latest edition or the edition adopted by the authority having jurisdiction.
"Necessary" - Any and all items required to complete the installation of an item so as to perform its intended function.
"NEMA"- National Electrical Manufacturers' Association
"NFPA" - National Fire Protection Association
"PVC Conduit" – Rigid Nonmetallic Polyvinyl Chloride conduit
"RGS Conduit" – Rigid galvanized steel conduit
"UL" - Underwriters' Laboratories, Inc.

PART 2 - MATERIALS

2.01. GENERAL:

A. This section includes all basic materials for raceways, fittings, busways, conductors, panelboards, switchboards, lighting fixtures and accessories, etc., as required for a complete installation.

B. All materials shall be new and listed by the Underwriters Laboratories. Material substitutions will be considered only when evidence of equality and suitability, satisfactory to the Architect has been presented in writing, with samples if requested by the Architect.

C. It shall be understood that the Architect/Engineer has the authority to reject any material or equipment used which is not specified or approved, or showing defects of manufacture or workmanship, before or after such material or equipment is installed.

2.02. CONDUITS:

A. Rigid Metal (Galvanized Steel-RGS) Conduit: Rigid metal conduit shall be mild steel piping, galvanized inside and outside, and conform to ASA Specification 080.1 and Underwriters' Laboratories Specifications. By Sprang, Republic, Wheatland, Triangle or Pittsburgh.

B. Intermediate Metal Conduit (IMC): IMC shall be hot dipped galvanized inside and outside and manufactured in accordance with U.L. Standard #6 or #1242. By Allied or approved equal.

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C. Electrical Metallic Tubing (EMT): EMT shall be high grade steel electro-galvanized outside and lacquer or enamel coating inside and conform to ASA Specifications 080.1 and Underwriters' Laboratories Specifications. By Sprang, Republic, Wheatland, Triangle or Pittsburgh.

D. Rigid Nonmetallic Conduit (PVC): PVC conduit where exposed shall be high impact Schedule 80; below grand and below or in slab PVC shall be of high impact Schedule 40 PVC and shall conform to Underwriters' Laboratories Standard UL-651. By Carlon, Kraley Pittsburgh, R.G. Sloan or Southwestern.

E. Rigid Aluminum: Rigid Aluminum conduit shall be manufactured from 6063, t-1 aluminum alloy and shall meet the requirements of Federal Spec. WW-C-540c and ANSI C80.5 and shall be U.L. listed in accordance with UL-6. Equal to products by V.A.W. of America.

2.03. COUPLINGS, FITTINGS, AND CONNECTORS:

A. RGS & IMC: By Appleton, Crouse-Hinds, Efcor, O-Z/Gedney, Raco, or Republic.

B. EMT: EMT fittings shall be all steel type setscrew or insulated throat compression type. Pressure indented or slip fit type will not be accepted. All connectors to be insulated. By Appleton, Efcor, Raco Steel City, or Thomas & Betts.

C. PVC: PVC fittings shall be of high impact PVC Schedule 40 or Schedule 80 to match the installed conduit. Joints shall be made with PVC solvent cement as recommended by manufacturer. By Pittsburgh, R.G. Sloan or Carlon.

D. Rigid Aluminum: Fittings used with Rigid Aluminum conduit shall be formed of the same alloy as the conduit or shall be copper free cast aluminum unless specifically indicated otherwise.

2.04. CONDUIT BODIES:

A. Conduit bodies shall be malleable iron except in kitchen, dishwashing, and waste water treatment areas conduit bodies shall be copper free cast aluminum with stamped aluminum covers.

B. Covers shall be screw retained with wedge nut or threaded body. Covers on bodies installed outdoors shall be approved and rated for installation outdoors.

C. Bodies shall comply with NEC 370 and 373.

D. RGS & IMC: By Appleton, Crouse-Hinds, Efcor, O-Z/Gedney, Raco, or Republic.

E. Conduit cannot be used as ground. Provide separate insulated green grounding wire.

2.05. BUSHINGS:

A. Bushings up to and including 1” shall have a tapered throat.

B. Bushings 1-1/4" and larger shall be the insulating type.

C. Grounding bushings shall be specification grade insulated grounding type bushings with tin plated copper grounding saddles and shall be equal to O-Z/Gedney Type BLG or HBLG.

D. Bushings shall be zinc plated malleable iron or copper free cast aluminum.

E. Bushings for terminating Data, Telecommunications, control, CATV, and similar conduits above ceilings and at backboards may be PVC or Polyethylene insulating bushings equal to those manufactured by Arlington Industries and Bridgeport Fittings.

2.06. EXPANSION FITTINGS:

A. Conduit Expansion Joints shall be UL Listed.

B. Expansion joints in rigid metal conduits shall consist of a threaded malleable iron body, pressure bushing, watertight packing, pressure ring, gasket, insulating bushing, and external grounding jumper, and shall be equal to O-Z Gedney Type AX with Type BJ bonding jumper.

C. Expansion joints for EMT conduit shall be same as above with additional EMT couplings and connectors and shall be equal to O-Z Gedney Type TX with Type BJ bonding jumper.

D. Expansion joints in PVC conduit shall be equal to Carlon Series E945.

E. Expansion joints shall provide a minimum of 4” of conduit movement.

2.07. BELOW GRADE THRU WALL WATER SEALS:

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A. Thru wall water seals for conduits penetrating exterior below grade concrete walls shall be seal systems by O-Z/Gedney or The Metraflex Company.

B. Thru wall water seals for conduits penetrating exterior below grade concrete walls shall be Metraseal thru wall water seals by The Metraflex Company.

2.08. CONDUIT ACCESSORIES:

A. Conduit clamps and supports for metallic conduit shall be galvanized steel by Efcor, Steel City, or Mineralac. Conduit fittings by Appleton, Crouse-Hinds, O-Z/Gedney, Pyle-National or approved equal.

B. Conduit clamps and supports for nonmetallic conduit shall be nonmetallic high impact PVC by Carlon, Pittsburg, or Sloan.

C. Conduit clamps for aluminum conduits shall be stainless steel or cast copper free aluminum with stainless steel fasteners.

2.09. FLEXIBLE CONDUIT:

A. Liqudtight flexible metal conduit:
   1. Neoprene-jacketed liquidtight flexible metal conduit.
   2. Equal to Anaconda Sealtite.

2.10. ELECTRICAL TAPES:

A. General use electrical tape shall be 8 mil (.008”) thick, minimum, premium grade, pressure sensitive, flame retardant, vinyl electrical tape meeting UL 510, ASTM-D-3005, and MIL-I-24391C. The tape shall be equal to 3M No. 88 or Plymouth Premium 85 CW.

B. Rubber tape used as primary tape shall be a 30 mil (.030”) thick, minimum self-amalgamating, low voltage rubber tape rated for use through 600 V. Rubber tape shall be equal to 3M No. 2150 or Plymouth 122 Rubber Tape.

C. Electrical filler tape shall be a 125 mil (.125”) thick, minimum, self-amalgamating, low voltage insulating compound rated for use through 5 kV. Filler tape shall be equal to 3M SCOTCHFILL or Plymouth 125 Electrical Filler Tape.

2.11. PIPE WRAPPING TAPE:

A. Pipe wrapping tape shall be a 10 mil (.010”) thick, minimum, pressure sensitive, vinyl tape manufactured for pipe wrapping applications.

B. The tape shall be UV, bacteria, and fungus resistant.

C. The manufacturer’s name and tape type shall be printed on the back of the tape.

D. Pipe wrapping tape shall be equal to Plymouth Rubber Co. PLYWRAP 11, or 3M No. 50.

2.12. WIRE NUTS:

A. Wire nuts for conductor splicing shall be winged type connectors with a square, plated steel spring and flame-retardant thermoplastic shell.

B. The connector shall be rated for the number and size conductors being connected.

C. The Wire Nuts shall be rated for 105^{o}C. And UL 486C listed.

D. Wire nuts shall be equal to connectors by Ideal/Buchanan, 3M/Scotch, or T & B,

2.13. SPLIT BOLT CONNECTORS:

A. Split bolt connectors for splicing conductors shall be UL 486A listed, shall be tin plated copper, and shall have a hexagonal head and nut.

B. Split bolt connectors for conductors sized AWG #4 and larger shall have a serrated spacer bar between conductors.

C. Split bolt connectors for splicing conductors AWG #12 through #6 shall be equal to Ilsco Type SEL and Type SK for AWG #4 and larger conductors.

2.14. MULTI-TAP CONNECTORS:

A. Multi-tap connectors shall be insulated type

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B. Multi-tap connectors shall be rated for the conductor sizes indicated on the drawings.

C. The connectors shall be provided for the number of conductors indicated, including any future taps shown, plus a minimum of one additional tap.

D. Multi-tap connectors shall be equal to Ilsco Type PCT or Type PED-CP.

2.15. WATERPROOF WIRE JOINTS:

A. Splices made below grade shall be made connectors, UL listed as waterproof, for below grade applications.

B. Waterproof Twist On Connectors for Up to2#6 W/1#12 tap Conductors: Single piece wire nut pre-filled with silicone sealant. Sealant shall be rated for 45-400 degrees F. Connectors shall have same insulation rating as conductors. Sizes shall be available for connecting up to 2 #6 w1#12 tap conductors. Connectors shall be UL listed as waterproof for below grade applications and equal to Ideal Buchannan B-Cap Twist and Seal Wire Connectors, King Safety Products, Tyco/Raychem GelCap SL, or equal.

C. Waterproof Stub Splice Kit for up to #2/0 Conductors: Kit containing connector block, outer waterproof sleeve, and lubricant. Sleeve shall have same insulation rating as conductors. Kit shall be rated for feeder wire sizes #14 through #2/0 and tap wire sizes of #14 through #6. Connectors shall be UL listed as waterproof for below grade applications and equal to Tyco/Raychem GelCap SL.

D. Waterproof In-line Splice Kit for up to #2/0 Conductors: Kit containing connector block, outer waterproof sleeve, and lubricant. Sleeve shall have same insulation rating as conductors. Kit shall be rated for wire sizes #6 through #350 kcm. Connectors shall be equal to Tyco/Raychem GTAP.

E. Waterproof Splice Kit for Conductors above #2/0: Kit containing connector block, outer waterproof sleeve, and lubricant. Sleeve shall have same insulation rating as conductors. Kit shall be rated for wire sizes #14 through #2/0. Connectors shall be equal to Tyco/Raychem GHFC.

2.16. PLASTIC MARKING TAPE FOR MARKING UNDERGROUND CABLES AND CONDUITS:

A. Plastic marking tape shall be acid and alkali-resistant polyethylene film, 6 inches wide with minimum thickness of 0.004 inch.

B. Tape shall have a minimum strength of 1750 psi lengthwise and 1500 psi crosswise.

C. The tape shall be manufactured with integral wires, foil backing or other means to enable detection by a metal detector when the tape is buried up to 3 feet deep.

D. The tape shall be of a type specifically manufactured for marking and locating underground utilities.

E. The metallic core of the tape shall be encased in a protective jacket or provided with other means to protect it from corrosion.

F. Tape color shall be as specified in the table below and shall bear a continuous printed inscription describing the specific utility.

Red:	Electric
Orange:	Data, Telephone, Television,

2.17. FIRE STOPPING:

A. Fire sealant shall be intumescent caulk, putty, sheet and/or wrap/strip as required to attain the proper rating.

B. Caulk shall be equal to 3M CP25 N/S and/or S/L.

C. Putty shall be equal to 3M Fire Barrier Moldable Putty.

D. Sheet equal to 3M CS195.

E. Wrap/strip equal to 3M FS195.

F. Equal products by Dow Corning, Hilti, and Metacaulk will be accepted.

2.18. SPACERS FOR CONCRETE ENCASED ELECTRICAL DUCTS:

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A. Spacers shall be interlocking high impact plastic assemblies, which provide horizontal and vertical spacing, and hold the ducts and re-bar, where applicable, in place.
B. The spacers shall be equal to Carlon Snap-Lok Spacers.

2.19. JUNCTION BOXES (THRU 4-11/16"):

A. Sheet Metal: To be standard type with knockouts made of hot dipped galvanized steel, By Steel City, Raco, Appleton or approved equal.
B. Cast: To be type FS, FD, JB, GS or SEH as required for application.

2.20. JUNCTION AND PULL BOXES (LARGER THAN 4-11/16"):

A. Shall be cast metal for all below grade exterior use and where indicated on plans. All other shall be oil tight, JIC boxes not less than 16 gauge, equal to Hoffman type "CH" boxes.

2.21. PULL BOXES:

A. Galvanized sheet metal screw-cover type with UL label as produced by Austin, B & C Metal Stamping Company, E-Box, Hoffman, Wiegmann, or approved equal.

2.22. JUNCTION AND TERMINAL BOXES FOR AUXILIARY SYSTEMS:

A. Junction boxes for auxiliary system circuiting splicing shall be formed of galvanized steel.
B. Boxes shall have hinged front, locking door(s).
C. Metal back plates shall be provided for mounting terminal strips or other devices.
D. Screw terminal strips shall be provided with a minimum of 25 percent spare terminals.
E. Boxes shall be sized to accommodate the terminal blocks and conductors, providing code required bending space.
F. Boxes for auxiliary systems shall be manufactured by Austin, E-Box, Hoffman, or Wiegmann.
G. Provide complete back boxes for all surface mounted devices. Back box shall have knockout on top and bottom as needed. Surface mounted junction boxes with devices mounted to it will not be accepted. Wiremold boxes will be accepted.

2.23. AUXILIARY GUTTERS (WIRING TROUGHS):

A. Gutters shall be of sizes shown and/or required by the NEC (whichever is larger), constructed of code gauge, galvanized sheet steel, painted ANSI 61 gray.
B. Gutters shall be UL listed and shall be of NEMA 3R construction in wet or damp locations or shall be as indicated on the drawings.
C. Gutters shall be as produced by Austin, B & C Metal Stamping Company, E-Box, Hoffman, Wiegmann, or approved equal.

2.24. STRUT SYSTEM FOR SUPPORT OF ELECTRICAL EQUIPMENT:

A. Strut shall be 1-5/8” except where heavier strut is required to support the load, for rigidity, or where specifically indicated otherwise.
B. Cold-formed steel, ASTM A 570 or A 446 GR A.
C. Stainless Steel Strut: Type 304, ASTM A 240.
D. Hot Dipped Galvanized Steel Strut: Zinc coated after manufacturing operations are complete, ASTM A 123 or A 153
E. Electro-galvanized Steel Strut: Electrolytically zinc coated, ASTM B 633 Type III SC 1.
F. Fittings: Same material as strut, ASTM A 575, A 576, A 36, A 635, or A 240.
G. Zinc Primer: As recommended by strut manufacturer.
H. Strut Systems shall be as manufactured by B-Line, Erico, Globe, Kindorf, MasterStrut, Power Strut, T&B SuperStrut, or Unistrut.

2.25. OUTLET BOXES:

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A. General: Except as noted, boxes shall be standard hot dipped galvanized steel at least 1-1/2" deep, of metal at least 1/16" thick; sized to accommodate devices and conductors per NEC Article 370; product of Appleton, National, Steel City, or approved equal.

B. Ceiling and Wall Bracket Outlets: 4" octagonal boxes with plaster rings appropriate for finish surface.

C. Typical boxes (for switches, receptacles and auxiliary systems):
   1. All junction boxes shall be recessed within the confines of the walls unless otherwise noted. Junction boxes shall be accessible by means of a coverplate or a standard junction box cover whichever is appropriate for the installation.
   2. 4" square boxes ganged as required. Box volume shall be in accordance with NEC Section 370 – provide extensions as required.
   3. Furnish with 3/4" plaster rings where employed in plaster, 1" tile covers where used in ceramic tile, 1" plaster rings where set in exposed concrete, and otherwise appropriate for surface and construction.
   4. Use 4-11/16” square, 2-1/8” deep boxes where more than 10 conductors enter the boxes. Provide extensions as required to provide volume per NEC.
   5. Where existing walls are furred out with shallow hatch channel and sheet rock then the contractor will be required to use a shallow junction as required.
   6. All exposed junction boxes for receptacles, communications devices, switches, and fire alarm devices shall be provided with back boxes. Do not use standard junction boxes when exposed. No exposed edges of devices plates will be allowed. No knockouts on the side of the box. Boxes shall be similar to Wiremold 500 & 700 Series.

D. Boxes in Exposed (or Thin-Coat Plastered) Masonry: Where conduit connections permit, employ solid flush-type, square-cornered, masonry boxes with turned-in device holders; otherwise employ typical box with 1-1/2" square-cut tile cover.

E. Multiple Outlet Floor Boxes:
   1. Floor boxes shall be multi-outlet type providing space for four separate services for duplex outlets and/or Data/Telecommunications outlets.
   2. Floor boxes shall be provided with covers equal to Walker S36CCTCAL(BK)(BS) flush access hatch with carpet trim for carpeted floors and S36BBTCAL(BK(BS) trim for vinyl covered floors.
   3. Floor boxes shall be provided with 20-amp duplex grounding duplex receptacles, isolated ground receptacles, and Data/Telecommunications outlets as indicated on the drawings.
   4. Data outlets shall be modular type capable of housing up to six (6) Cat 5e jacks. Boxes shall be provided with two (2) active jacks unless indicated otherwise on the drawings. Provide with communications bracket(s) equal to Wiremold #RFB4-LPB.
   5. Provide blank plates for all unused openings.
   6. The boxes shall be equal to what is specified on drawings.

F. Boxes used with Exposed Conduit: 4" square utility boxes.

G. Exterior Boxes: Galvanized cast-metal boxes, Crouse-Hinds Type FS or FD as appropriate. Make weatherproof with gasketed covers. Equal products by Appleton, Killark, O-Z/Gedney or approved equal will be accepted.

H. Exterior Boxes: All receptacle boxes shall be recessed unless specifically called out not to be. This includes exterior receptacles in all masonry type walls including but not limited to Pre-cast, Brick, Block, etc.

I. Boxes used with Recessed Lighting Fixtures: Provide a 4" square box with blank cover.

J. Boxes in Dry Wall Construction: Sectional type switch boxes at least 2-1/2" deep may be used instead of typical box (but not where dry wall finish is applied over masonry back-up and not where multi- gang devices occur).

K. Boxes installed exposed in kitchen and dishwashing areas shall be copper free cast aluminum with gasketed cast coverplates, without lift cover, unless specifically indicated otherwise on the drawings.

2.26. CONDUCTORS AND CABLES:

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A. Power Conductors
   1. The ungrounded conductors (phase) and the grounded conductor (neutral) of each voltage system being installed shall be phase identified the full length of the conductor with the color characteristics manufactured in the insulation of cable from the cable manufacturer. Required color cable will then be installed for the specific voltage system as identified in these specifications.
   2. All conductors shall be copper with not less than 98% conductivity and with current carrying capacities per N.E.C. for 60°C. for sizes through #1 AWG and 75°C for conductors #1/0 and above.
   3. All conductors shall have manufacturer's name, type insulation, and conductor size imprinted on jacket at regular intervals.
   4. Conductors of size #10 and smaller shall be solid copper conductors with 600-volt type THHN or THWN insulation.
   5. Conductors of size #8 and larger shall be stranded copper conductors with 600-volt type THHN or THWN insulation.
   6. All motor branch circuits, HVAC, and plumbing equipment shall be stranded copper conductors with 600-volt type RHH-RHW insulation.
   7. All conductors installed in conduit below grade shall be rated for wet location.
   8. Manufacturer: Conductors shall be products of GE, Triangle, Phelps- Dodge, Anaconda, Rome, Habirshaw, General Cable, or approved equal.
   9. Fixture Wire:
      a. Conductors feeding into fixtures, other than fluorescent fixtures, of 300 watts or less shall be #14, 200°C., type SF-2, for fixtures of more than 300 watts #12, 200 °C., type SF-2 shall be used.
      b. Conductors pulled through fluorescent fixtures shall have Type TFN or TFFN fixture wire, rated 90oC.
      c. Conductors shall be by Dodge, Anaconda, Rome General Cable or Southwire.

B. Control and Signal Wire: Conductor type TFF, minimum size #16 copper and fully color-coded, shall be used. Conductors shall be by Anaconda, Houston Wire & Cable, General Cable, Phelps Dodge, Rome, or Southwire.

2.27. WIRING DEVICES:

A. General: Manufacturer's and catalog numbers listed are used to establish style, type and quality. Unless otherwise indicated on drawings, all wiring devices shall be UL listed, side-wired specification grade.

B. Manufacturers: Equal devices by Hubbell, Leviton, Eaton and P & S will be accepted. All devices shall have plaster ears.

C. Wall switches: 120/277V, 20A, AC, flush enclosed, quiet type switches with thermoplastic body and polycarbonate toggles. Switches shall meet Federal Specification WS-896. Switches shall be, Hubbell 1200 series, Leviton 1200 series, Eaton AH1200 series or P & S PS20AC series single pole, 2-pole, 3-way, or 4-way as required.

D. Duplex receptacles (general purpose): 125V/20A flush duplex back and side wired hard use specification grade receptacles, NEMA 5-20R configuration, with nylon face and body, grounding terminal and break-off fins for converting to 2-circuit use. Receptacles shall meet Federal Specification WC-596. Color to match wall switches. Equal to P & S 5362, Hubbell CR20, Eaton 5362 or Leviton 5362.

E. Tamper Resistant Duplex receptacles, 125V/20A flush duplex, hospital grade, tamper resistant receptacles, NEMA 5-20R configuration, with nylon face and body, grounding terminal. Receptacles shall meet Federal Specification WC-596. Color to match wall switches. Equal to P & S TR62-H, Eaton TR8300 or Hubbell HBL8300SGDuplex combination 125/250-volt receptacles: receptacles shall be 20 amp, combination 125 volt (NEMA 5-20R)/250-volt (NEMA 6-20R) grounding receptacles.

F. Isolated Ground Receptacles: 125V/20A, NEMA 5-20R configuration, equal to Hubbell #IG5362, Eaton AHIG5362, Leviton #5362-1g, or P & S IG6300. IG receptacles shall be same

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color as general-purpose receptacles with an orange triangle on the face – fully orange colored receptacles shall not be acceptable.

G. Ground Fault Circuit Interrupt Receptacles: 125V/20-amp ground fault circuit interrupting receptacle for personnel protection, NEMA 5-20R configuration, Equal to Hubbell #GF5362, Leviton #6599, Eaton SGF20 or P & S 2091. Each GFCI symbol on drawing indicates a GFCI type receptacle. Do not through-wire non-GFCI receptacles from GFCI receptacles where ground fault protection is required. All exterior receptacles shall be ground fault interrupting type with weatherproof coverplates.

H. Faceless Ground Fault Circuit Interrupter: 125V, 20-amp ground fault circuit interrupter UL listed for personnel protection, equal to Hubbell GFR5350 Series, Leviton 6490, Eaton SGFD20 or Pass & Seymour Series 2081.

I. Single Receptacles: Flush Bakelite receptacles with side wiring and grounding terminal, voltage, amperage, and configuration as required for circuit indicated.

J. Each single or multi outlet receptacle, other than straight blade, 15 or 20 amp, 120 volts, NEMA 5-15R or NEMA 5-20R, shall be provided with matching cord plugs.

K. Multioutlet Assemblies, Strip outlets, 15 amp, 125V, grounded, outlets on 6” centers, equal to Wiremold V20GBx06. Where x = length indicated on the drawings.

L. Plugs for kitchen equipment to be plugged into wall mounted straight blade receptacles shall be angled type.

M. Wiring devices shall be of color as directed by Architect. Devices must be available in ivory, brown, black, white, and gray. Devices connected to the emergency generator shall be red in color.

N. All receptacles shall be tamper-proof type receptacles where required by the National Electrical Code.

O. Pin and Sleeve Devices:
   1. Pin and Sleeve Devices shall be watertight plugs and receptacles of the ratings shown on the legend and/or schedules.
   2. Devices shall be listed to UL Standard 498 and UL Classified ro IEC Standards 309-1 and 309-2.
   3. Devices shall be furnished as matching plugs and receptacles with cast aluminum angled backbox.
   4. Devices shall be manufactured by Hubbell, Leviton, Eaton or P&S.

2.28. DEVICE PLATES:

A. Type appropriate for the associated wiring device, equal to Sierra Stainless Steel Smoothline. Device plates shall be of color as directed by Architect. Devices must be available in ivory, brown, black, white, and stainless steel. Provide single plate of proper gang where more than one device occurs (do not gang dimmers with rocker switches).

B. Damp Location: 20 amp,125 and 250-volt receptacles - Covers shall be weatherproof when plugs are not installed, provide cast aluminum weatherproof coverplates with single lift cover and gasket equal to Hubbell CWP26H.

C. Wet Locations, 20 amp, 125 and 250-volt receptacles: Covers shall be weatherproof In-Use covers, rated NEMA 3R when in use and shall be constructed of cast aluminum with sealing gasket. Covers shall be equal to products by Hubbell, Leviton, Steel City, T & B, and Taymac.

D. Coverplates for exposed cast aluminum boxes in kitchen and dishwashing areas shall be cast coverplates, without lift cover, unless specifically indicated otherwise on the drawings.

E. Color: Wiring device cover plates shall be of color as indicated on drawings or directed by Architect. Devices must be available in ivory, brown, black, white, gray, and stainless steel.

F. Jumbo and Mini-Jumbo plates will not be accepted.

2.29. OCCUPANCY SENSORS AND ACCESSORIES FOR LIGHTING CONTROL:

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A. Occupancy sensors shall be totally passive in nature, in that the sensors shall not emit of interfere with any other electronic device, or human characteristic. Sensors shall be dual technology, i.e.: Passive Infrared (PIR) and Microphonic.
B. PIR shall initiate an “on” condition and the PIR or microphones shall maintain the load “on”.
C. Upon detection of human activity by the detector the lights shall come on and a time delay shall be initiated to maintain the lights on for a pre-set time period. The time delay shall be factory set and field adjustable from 30 seconds to 20 minutes.
D. All devices shall be factory warranted for 5 years.
E. All sensors shall be low voltage, 12 to 24 volts and shall work in conjunction with remote power packs.
F. Occupancy sensors shall be as shown on drawings.

2.30. GROUNDING:

A. Ground Rods shall be ¾” x 10’ copperclad steel.
B. All grounding conductors shall be copper.

2.31. LIGHTING FIXTURES

A. General:
1. All Lighting Fixtures shall be UL labeled.
2. Fixtures installed in fire rated ceilings or ceiling assemblies shall be rated for installation in fire rated ceilings.
3. Furnish fixtures complete with lamps, ballasts and internal wiring factory installed.
4. Fixtures shall be furnished as specified herein and as shown on the fixture schedule on the plans. Catalog numbers shown are for basic units; furnish all fixtures complete with flexible connections, trim, plaster frames, and all other appurtenances necessary to the installation.
5. Substitutions: Reference to a specific manufacturer's product is made to establish a standard of quality and design, and to give a general description of the basic type desired. Equal products by the listed manufacturers will be accepted subject to the Engineer’s approval.
6. It shall be the responsibility of the contractor to verify the exact type ceiling, type fixture mounting and trim, and recessing depth of all recessed fixtures prior to purchasing any fixtures.
7. Stems on stem mounted fixtures shall be approved ball aligner type, swivel 30 degrees from vertical with swivel below canopy. Paint stems the same color as the fixture trim. Stems in unfinished areas may be unpainted conduit.
8. High and low bay fixtures shall be equipped with safety chains. Every suspended fixture in Gymnasium shall have safety chains.
9. Fixtures installed on the exterior of buildings, on poles, or on pedestals shall be rated for wet location installation.
10. All lighting fixtures installed in gymnasiums, hangars or similar use areas shall be provided with wire guard.

B. Emergency and Exit lighting Fixtures shall be equipped with a Self-testing module which shall perform the following functions:
1. Continuous monitoring of charger operation and battery voltage with visual indication of normal operation and of malfunction.
2. Monthly discharge cycling of battery with monitoring of transfer circuit function, battery capacity and emergency lamp operation with visual indication of malfunction. The battery capacity test may be conducted by using a synthetic load.
3. Manual test switch to simulate a discharge test cycle.
4. Modules shall have low voltage battery disconnect (LVD) and brownout protection circuit.
5. All lighting fixtures and exit signs shown as emergency on drawings shall be provided with a minimum 1100 lumen emergency battery ballast capable of 90 minutes of illumination. No exceptions.

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C. Lamps: Type and Lumen Output as scheduled.
   1. LED bulb shape shall comply with ANSI C79.1. Lamp base shall comply with ANSI C81.61.
   2. Minimum CRI of LED lamps shall be 80 with a color temperature as shown on drawings.
   3. Rated life of all LED lamping shall me a minimum of 50,000 hours failure to 75% of lamp output.
   4. LED lamping shall be capable of dimming from 100% to 0%.

2.32. LIGHTING STANDARDS:

A. Lighting Standards (Poles) shall be as specified on light fixture schedule anchor base poles rated for sustained winds' for the wind chart of this specific job's location and a 1.3 gust factor.

B. Poles shall be of the length required to provide the scheduled fixture mounting height.

C. Poles shall be factory predrilled for arm and fixture mounting.

D. Hand holes shall be provided at the base end of the pole for wiring access. Handholes shall be a minimum of 3" x 5" with gasketed, weatherproof covers and stainless-steel mounting hardware.

E. A grounding lug shall be provided inside the handhole.

F. The poles shall be furnished with a dark bronze, corrosion resistant finish, applied after fabrication.

G. The base plate shall be furnished with slotted holes for pole alignment.

H. A base cover shall be furnished with the pole with matching finish.

I. Anchor bolts shall be 36" long.

J. Contractor shall include concrete bases for all exterior pole mounted and grade mounted lighting.

2.33. PANELBOARDS:

A. General: All panelboards shall be dead front type manufactured and installed in accordance with UL and NEMA standards and shall carry a UL label. Ampacity, service voltage, and configuration shall be as indicated on drawings. Panelboards shall be clearly marked with ampacity, voltage, and maximum short current ratings.

B. Manufacturer: Panelboards shall be as manufactured by Cutler-Hammer, Square D, or Siemens.

C. Enclosure:
   1. Panelboard enclosures shall be as indicated on drawings.
   2. Unless otherwise indicated, all boxes shall be constructed of galvanized (or equivalent rust-resistant) sheet steel with hinged front trim.
   3. Fronts shall be door in door with two lockable latches to open door, lock, and latch. All panelboard locks shall be keyed alike. Piano hinges with screw latches will not be permitted.
   4. Fronts shall be finished with gray baked enamel over a rust-inhibiting phosphatized coating.
   5. All dual section panels shall be equal in size. Sub-Feed circuit breakers will not be allowed to feed second section.
   6. Sub-Feed circuit breakers feeding additional panels or equipment shall be branch mounted.
   7. Provide permanent numbering of the panelboards. Stickers are not considered permanent.
   8. Any panelboard schedule that indicates more than 42 circuits shall be provided in two equally sized panelboards.
   9. Main circuit breakers shall be centered mounted. Main breaker cannot be mounted on buss bars with other circuit breakers.

D. Buss Assembly:
   1. Bussing shall be copper.

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2. The buss assembly A.I.C. shall be rated as indicated on drawings. Ratings shall be established by heat rise tests, in accordance with UL Standard 67.
3. All bussing shall accept bolt on circuit breakers.
4. Current carrying parts of all bussing shall be plated. In lighting and receptacle panels, bussing shall be designed for connection to the branch circuit breakers in the phase sequence format. Distribution panelboards shall be fully bussed.
5. Ground bars shall be provided in all panelboards.
6. Neutral bar shall be fully sized with lugs suitable for incoming and outgoing conductors.
7. Provide insulated ground buss where indicated on the panelboard schedules.

E. Circuit Breakers:
1. Circuit breakers shall be quick-make, quick-break, thermal magnetic, molded case, bolt on type.
2. Circuit Breakers shall be numbered and arranged as indicated on the panelboard schedules and/or single line wiring diagrams. Numbers shall be permanently attached to trim.
3. SWD Circuit Breakers: Single pole circuit breakers rated 15 and 20 amperes and intended to switch 277 volts or less fluorescent lighting loads shall be UL rated for switching duty and shall be marked "SWD".
4. HACR Circuit Breakers: Circuit breakers 60 amperes or below, 240 volts, 1-, 2-, or 3-pole, intended to protect multi-motor and combination-load installations involved in heating, air conditioning, and refrigerating equipment shall be UL listed as HACR type and shall be marked "Listed HACR Type."
5. Circuit breakers serving fire alarm systems, dedicated emergency/exit lighting circuits, and area of rescue communications systems shall be equipped with a screw-on, mechanical handle blocking device which locks the circuit breaker in the “ON” position.
6. Circuit breakers serving circuits in residential bedrooms shall be Arc Fault Interrupting(AFI) type circuit breakers and shall be UL 1699 listed.

F. Directories:
1. Each panelboard shall be equipped with a metal directory frame with a clear cover welded to the inside of the door.

G. Equipment Short Circuit Rating: Short Circuit Interrupting Ratings shall be as indicated on the plans and schedules. Unless specifically indicated otherwise all rating are “Fully Rated” capacities. Where no rating is given, the contractor shall verify the available short current with the serving utility and provide equipment rated accordingly.

H. Lighting panelboard cans shall be a maximum of 20” wide and 5 ¾” deep. Cans of multi-section panelboards shall be the same size.

I. Provide nameplate as called out on drawings.

J. All circuit breakers 1200-amp and up shall comply with NEC Article 240.87 Arc Energy Reduction.

K. All flush mounted panel shall be provided with six (6) ¾” conduit stubbed up above accessible ceiling.

2.34. DISTRIBUTION PANELBOARDS:

A. Furnish and install distribution and power panelboards as indicated in the panelboard schedule(s) or single line wiring diagrams and where shown on the plans.

B. Panelboards shall be dead front, safety type equipped with thermal magnetic, molded case circuit breakers with trip ratings as indicated on the schedule(s).

C. Panelboard bussing shall be copper.

D. Panelboard buss structure and main lugs or main breaker(s) shall have the fault current ratings as indicated on the drawings. Ratings shall be established by heat rise tests conducted according to UL Standard UL67.

E. Circuit breakers shall be equipped with individually insulated, braced and protected connectors. The front faces of all circuit breakers shall be flush with each other.

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F. Main circuit breakers shall be centered mounted. Main breaker cannot be mounted on buss bars with other circuit breakers.

G. An engraved phenolic label shall be permanently attached to the front of the panelboard adjacent to each circuit breaker identifying the load served by the circuit breaker.

H. Automatic tripping shall be clearly shown by the breaker handle taking a position between ON and OFF when the breaker is automatically tripped.

I. Provisions for additional breakers shall be such that no additional connectors or hardware will be required to add breakers.

J. The panelboard assembly shall be enclosed in a steel cabinet. The rigidity and gauge of steel shall be as specified in UL Standards. End walls shall be removable. The size of wiring gutters shall be in accordance with the National Electrical Code, NEMA, and UL Standards for panelboards.

K. Cabinets shall be equipped with four-piece fronts.

L. The panelboard interior assembly shall be dead front with panelboard front removed.

M. Main lugs or main breaker shall be barriered on live sides.

N. The barrier in front of the main lugs shall be hinged to a fixed part of the interior. The end of the buss structure opposite the mains shall be barriered.

O. Circuit breakers serving Fire Alarm Systems, Security Systems, and/or Emergency/Exit lights shall be equipped with mechanical, screw-on type, locking devices. These devices shall not be padlock type devices.

P. Panelboards shall be listed by Underwriters' Laboratories and to bear UL label. Panelboards shall be rated for use as Service Entrance Equipment where required by the National Electrical Code. Panelboards shall be by Cutler-Hammer, Square D, or Siemens.

Q. Provide nameplate as called out on drawings.

R. All circuit breakers 1200-amp and up shall comply with NEC Article 240.87 Arc Energy Reduction.

S. All flush mounted panel shall be provided with six (6) ¾" conduit stubbed up above accessible ceiling.

T. All service entrance main circuit breakers shall be 100% rated.

2.35. SWITCHBOARDS:

A. Construction.

1. The Switchard shall consist of the required number of vertical sections, bolted together to form a rigid assembly. Provide ventilators located on the top of the switchgear over the breaker and bus compartments to ensure adequate ventilation within the enclosure.
2. Each vertical steel unit, forming part of the switchgear line-up, shall be a self-contained housing having one or more individual breaker or instrument compartments, a centralized bus compartment, and a rear cabling compartment.
3. The switchgear shall be suitable for use as service entrance equipment and be labeled in accordance with UL requirements.

B. Bussing

1. Switchboard buss structure and main lugs or main breaker(s) shall have the fault current ratings as indicated on the drawings. Ratings shall be established by heat rise tests conducted according to UL Standard UL67.
2. All bus bars shall be tin-plated copper. Main horizontal bus bars shall be mounted with all three phases arranged in the same vertical plane. Bus sizing shall be based on ANSI standard temperature rise criteria of 65 degrees C over a 40 degrees C ambient (outside the enclosure).
3. Provide a full capacity neutral bus.

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4. A copper ground bus shall be furnished firmly secured to each vertical section structure and shall extend the entire length of the switchgear. The ground bus short time withstand rating shall meet that of the largest circuit breaker within the assembly.
5. All hardware used on conductors shall be high-tensile strength and zinc plated. All bus joints shall be provided with Belleville-type washers.

C. Wiring/Terminations
1. A termination system shall be provided such that no additional cable bracing, tying or lashing is required to maintain the short circuit withstand ratings of the assembly through 200 kA.
2. Lugs shall be provided in the incoming line section for connection of the main grounding conductor. Additional lugs for connection of other grounding conductors shall be provided as indicated on the drawings.

D. An engraved phenolic label shall be permanently attached to the front of the switchboard adjacent to each circuit breaker identifying the load served by the circuit breaker.

E. Automatic tripping shall be clearly shown by the breaker handle taking a position between ON and OFF when the breaker is automatically tripped.

F. Provisions for additional breakers shall be such that no additional connectors or hardware will be required to add breakers.

G. Circuit breakers shall be provided with the ratings indicated on the drawings.

H. Switchboards shall be listed by Underwriters' Laboratories and to bear UL label.

I. Switchboards shall be rated for use as Service Entrance Equipment where required by the National Electrical Code.

J. All circuit breakers 1200-amp and up shall comply with NEC Article 240.87 Arc Energy Reduction.

K. Switchboards shall be by Cutler-Hammer, Square D, or Siemens.

L. Provide electronic metering on the main for voltage, amps, kVA, & KW.

M. All service entrance main circuit breakers shall be 100% rated.

2.36. LIGHTING CONTROL SYSTEM:

A. System description
1. Install a lighting control system consisting of control panel(s), control switches, photocell and other controlling devices connected by low voltage and network wiring. The general operation of lighting and controlled loads shall include:
a. Interior lighting – manual switch control on/off with automatic time scheduled shut off for each space
b. Timed on/off loads – time on, time off
e. Exterior lighting – photocell or astronomic on/time off, time on/photocell or astronomic off.
f. Exterior security lighting – photocell or astronomic on, photocell or astronomic off.
g. Requirements are indicated elsewhere in the specifications for work including, but not limited to, raceways and electrical boxes and fitting required for installation of control equipment and wiring.

B. Submittals
1. Shop Drawings: Submit dimensional drawings of all lighting control system components and accessories.
2. One Line Diagram: Submit a one-line diagram of the system configuration proposed if it differs from that illustrated in the riser diagram included in the contract drawings.
3. Complete drawings: Submit shop drawings showing all components including, but not limited to, lighting control panels, relays, contactors, photocells, swtiches, occupancy sensors, and interconnecting control wiring. Submittals will be rejected without this.

C. Manufacturers
1. Approved manufacturers: Hubbell, Eaton, ILC.

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2. Manufacturer shall have a factory-trained technician within 150 miles of job site.Include in the bid at least three trips by the factory trained technician to the job site.One visit shall be for the beginning of construction. Second visit shall be to insure lighting control system is being installed correctly. The third site visit shall be for final programming and factory training for the Owner. Coordinate with owner representatives for final programming requirements.Coordinate final training with trainees,contractor,and engineer prior to site visit. Manufacturer shall provide additional site visits as needed to get their system working correctly at no additional cost to owner.Bid accordingly.

D. Modular Relay Panels shall be UL listed and consist of the following:
   1. Can: NEMA 1 enclosure that can accept an interior sized to accept up to 24 or 48 mechanically latching relays.
   2. Power Supply: Transformer assembly with two 40VA transformers with separate secondaries. Transformers include internal overcurrent protection with automatic reset and metal oxide varistor protection against power line spikes. Single unit provides either 115 or 277 VAC as required, 60 Hz +/- 10%.
   4. Cover: Surface or Flush as required, with captive screws in a hinged, lockable configuration.
   5. Interior: Bracket and intelligence board backplane with pre-mounted relays. Interiors shall be provided with up to 24 or 48 installed and tested relays.
   6. Panel shall be provided with an integral DIN rail mounting bar for easy installation of other system components.
   7. Features
      a. Relays shall be individual relays with 20 Amp load contacts for ballast (including HID, magnetic or electronic type ballasts), tungsten, and general use, and shall be rated for 200,000 operations at full load. Relays shall use quick connectors and be individually replaceable to facilitate ease of use.
      b. The lighting control panel shall be able to house multi-pole contactors for control of multi-circuit or multi-phase loads. Contactors shall be rated for 20 Amps tungsten, 30 Amps for ballast or general use and shall be compact, rail mount style for easy installation and use.
      c. Lighting control panels shall provide a stagger up delay, override push buttons, pilot light outputs, and LED status light indicators for each relay.
      d. For every 8 relays there shall be 8 standard, 2 master, and 1 after-hour switch inputs. Standard switch inputs shall have a one-for-one default assignment to relays. Master inputs shall be unassigned.
      e. Switch inputs shall be self-configuring and shall not require programming to accept momentary on/ momentary off, push button (cycling), maintained, or 3 to 24VDC signal. Using any of these switch types shall not sacrifice the number of switch inputs available. Switch inputs shall allow switch wiring distances of up to 5000 feet on 20-gauge wire.
      f. After-hour shut off control shall provide a true override time with a warning blink five minutes prior to shutting the relay output off. Any relay output's impending shut off will be canceled and the override period re-initialized through the operation of an assigned switch input. The override function shall be performed by the local control switch or telephone switch module and shall not require turning lights off and back on to reset the override time period regardless of the switch type used. The system shall provide the full after-hour override time period beginning from the moment of switch ON operation. After-hour shut off shall not be accomplished by repetitively sweeping relay outputs off by time schedule.

E. ETHERNET MULTI-USER CONNECTIVITY – Automation Appliance (AA-BASE)
   1. System Description
      a. A network appliance will provide multi-user, simultaneous access to the lighting system using standard TCP/IP and Web-browser software for user interface
      b. The network appliance will include Ethernet, Serial ports and optional 56K BAUD internal modem.

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G. Features
   a. Multiple users will be able to simultaneously connect to the IP address of the AA-BASE.
   b. Users may be connected via an Intranet, or Internet depending upon network security limitations.

F. System Clock
   a. The system time clock shall be installed in the main or central panel of a multiple panel system or in each panel when individual panel time control is desired. The system clock shall provide time-based control with eight-year time back-up, non-volatile memory program storage, automatic daylight savings adjustment, selectable 12/24-hour time formats, and selectable date formats. All clock programming shall be accessible from the clock front display/keypad or via the Lighting Control Software.

G. Features
   1. Control of 32 channels shall be available on the clock for control of any lighting control panel or relay pack connected on the network. Provide status and manual on/off control of each channel from the front display and keypad.
   2. Schedules shall be assigned to any combination of days of the week and/or 3 holiday day types. Other scheduling features shall include:
      a. Temporary schedules – schedules that execute on an assigned day then automatically delete themselves from memory.
      b. Duration on/off – turn channels on or off for a time period adjustable from 1 second to 18 hours.
      c. Repeating schedules – repeat a schedule at intervals that are adjustable from 5 minutes to 10 hours.
   3. 32 perpetual holidays assigned to any one of three holiday day schedules and continuing for 1 to 120 days. Holiday dates shall be specific day/month/year, or perpetual dates including day/month/all years or day of the week in a given month every year, or self-calculating Easter Sunday.
   4. Astronomic capability for calculating sunrise and sunset based on time, latitude, longitude, and time zones. All scheduled astronomic/time operations shall be interlocked so loads are not turned on when astronomic off times are earlier than scheduled on times or astronomic on times are later than scheduled off times. Each schedule shall have an independent astronomic offset of $\pm$ 120 minutes.
   5. Following a power outage, the system clock shall run a start-up process that executes schedules that would have been missed during the power outage.

H. Lighting Control System Software
   1. Lighting control system software that is Windows and PC based shall be provided for system configuration and operation. The software shall have on-line programming and off-line programming for later upload/down load. PC and software are not required to remain on-line with the system for normal operation.
   3. The software shall have password protection (which can be enabled/disabled) and four functional access levels and shall support multiple site operation by either direct connect to the network or via phone line modem dial-in.
   4. Lighting control system software shall be capable of linking switch inputs to relay outputs, retrieving links, viewing relay output status, controlling relay outputs, simulating the operation of switch inputs, setting device addresses, and assigning switch input and relay output personality attributes.
   5. System clock operation from the software shall provide programming of schedules, programming of holidays, setting clock preferences, and controlling clock channels. Multiple clock schedule profiles shall be available allowing easy programming of new clock schedules for changing shifts, special schedules or events.
   6. In the software, system devices, switch inputs, relay outputs, controlled circuits and system clock channels shall have alphanumeric descriptor fields providing user defined labels for easy identification.

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7. Reports from the software shall generate complete device listings including all switch inputs and outputs, switch input to relay output linking report, system clock scheduling report, system clock holiday scheduling report, and control panel schedule reports. All reports shall be easily printed in a readable format.

I. Ethernet Router
   1. Ethernet tunneling router that provides the capability of the lighting control system to communicate over a standard TCP/IP Ethernet system. This system may be a Local Area Network or Wide Area Network that supports standard TCP/IP communication.

2.37. SAFETY SWITCHES:

A. Furnish and install safety switches as indicated on the drawings.

B. Switches installed on 277/480 volts systems shall be rated for 600 volts and those installed on 120/208 volt or 120/240-volt systems shall be rated for 240 volts.

C. Switches shall be NEMA Heavy Duty Type HD and Underwriters' Laboratory listed. Safety switches shall be Cutler Hammer, Siemens, or Square D.

D. General Duty disconnects will not be accepted.

E. Enclosures for switches mounted outdoors shall be NEMA 3R or as indicated on the plans.

F. Enclosures for switches installed in kitchen and dishwashing areas shall be NEMA 4X stainless steel or as indicated on the plans.

G. All safety switches for equipment with remote controls shall be equipped with a control circuit disconnect interlock.

H. Switches shall be lockable in the “ON” and in the “OFF” positions.

I. Provide each disconnect with a nameplate that indicates equipment name, voltage/phase, and feed from location.

J. Provide keyed brass locks on all disconnects that is located on the exterior of the building or in any area that is accessible to children or the public. All the brass locks shall be keyed the same and turn over 10 sets of keys to the owner at substantial completion.

K. Disconnect locations shown on drawings is diagrammatically shown. Disconnects shall be coordinated with other trades and placed in the optimal locations to serve equipment and shall be installed in the least obtrusive location. Disconnects will have to be moved at the cost of the contractor when there is conflicts with NEC clearances, access to space, or servicing of equipment. Architect/Engineer will have final judgment of proper location.

2.38. MANUAL MOTOR STARTERS (TUMBLER SWITCH TYPE WITH OVERLOAD PROTECTION):

A. Starting and thermal overload protection for single phase motors 1/8 Hp to 1 HP shall be provided by manual motor starters with overload units rated as required by the specific motor to be served.

B. Switches installed for site disconnect switches shall be equipped with padlocking provisions.

C. Starters shall be by Cutler Hammer, General Electric, or Siemens with NEMA Type 1 enclosure or NEMA Type 3R enclosure where installed outdoors.

2.39. TRANSIENT VOLTAGE SURGE PROTECTORS (SURGE PROTECTIVE DEVICES):

A. Provide transient voltage surge protectors (Surge Protective Devices) where indicated on the plans. At a minimum provide on all service entrance panelboards/switchboards and any panelboard/switchboards on the secondary side of a dry-type transformer.

B. Service Entrance Panelboards and at Subpanel Protectors shall be listed and labeled and components recognized in accordance with UL 1283 and UL 1449 Second Edition, including highest fault current of Section 37.3.

C. All devices shall meet or exceed the following:
   1. NEMA LS 1-1992.
   2. Minimum surge current capability, single pulse rated, per mode:
      a. Service Entrance – 100 kA (200 kA per phase)

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g. Distribution and branch panelboards – 80 kA (160 kA per phase)

3. UL 1449, Second Edition, Listed and Labeled, and Recognized Component Suppressed Voltage Ratings shall not exceed (1.2x50□s, 6kV open circuit and 8x20□s, 500A short circuit test wave forms at end of 6" lead):

Voltage	L-N	L-G	N-G	L-L
208Y/120v	400	400	330	700
480Y/277V	800	800	800	1500

4. Testing shall be done at the end of 6" leads with the complete unit including any fuses and all other components making up the unit.

D. The devices shall have a minimum EMI/RFI filtering of –50dB at 100kHz with an insertion ratio of 50:1 using MIL-STD-220A methodology.

E. Devices shall utilize MOV's of 25 mm diameter or larger, shall have pilot lights visible on the outside of the enclosure to indicate device operating condition, and shall provide contacts for remote monitoring of device condition.

F. Devices shall be modular in design with individual module fusing and thermal protection.

G. Devices shall incorporate visual alarm signals that indicate the failure of a single MOV and total loss of protection.

H. Wye connected devices shall provide L-L, L-N, L-G, and N-G surge diversion with L-N/L-G bonded at service entrance devices. Delta connected devices shall provide L-L and L-G protection.

I. Data Line Surge Protectors: Data Line Surge Protectors shall be UL 497B listed and labeled. The units shall be heavy duty devices utilizing a combination of silicone diodes and gas tube technology to provide surge protection.

J. All devices shall have a minimum warranty period of five years, incorporating unlimited replacement of suppressor parts if they fail during the warranty period.

K. Transient voltage surge suppressors shall be manufactured by AC Data Systems, Advanced Protection Technologies, Current Technologies, Cutler-Hammer, General Electric, Joslyn, Liebert, or MCG.

2.40. SECONDARY SURGE ARRESTERS:

A. Secondary surge arresters shall be UL listed under UL Classification (Lightning Protection) Surge Arresters (OWHX).

B. Surge arresters shall be rated at same voltage and phase configuration as service.

C. Arresters shall be equal to Cooper Power Systems ASZH Series, Cutler-Hammer, GE Tranquell, Joslyn Electronic Systems, Leviton models as required to match the voltage of the system served.

2.41. FUSES:

A. General: Fuses shall be UL listed time delay types with a minimum interrupting rating of 100,000 amps symmetrical.

B. 200 amps and below: Provide Class RK-5 current limiting, time delay, rejection type as manufactured by Busman Manufacturing, Ferraz Shawmut, or Littlefuse.

C. 201 to 600 amps: Class RK-1, current limiting, time delay, rejection type as manufactured by Bussman, Ferraz Shawmut, or Littlefuse.

D. Above 600 amps: Class L current limiting, time delay, as manufactured by Busman Manufacturing, Ferraz Shawmut, or Littlefuse.

2.42. DRY TYPE TRANSFORMERS:

A. Manufacturer: Transformers shall be as manufactured by Cutler-Hammer, GE, Square D, or Siemens.

B. General: Transformers shall be constructed in conformance with IEEE, NEMA and ANSI standards.

C. Transformers shall be dry type with copper windings, rated as scheduled on drawings.

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D. Transformers rated at 15 KVA and below shall be Class 185 (115 degree Celsius rise); transformers rated above 15 KVA and above shall be Class 200 (150 degree Celsius rise).

E. Transformers shall have ventilated code gauge steel enclosure. Enclosures shall be for indoor installation unless indicated otherwise

F. Units shall be equipped with four (4) 2-1/2% full capacity taps, two above and two below rated primary voltage.

G. Core and coils shall be mounted on vibration pads and sound level of enclosed units shall be in conformance with NEMA standards.

2.43. LABELING:

A. Provide laminated plastic nameplates for each panelboard, equipment enclosure, relay, switch, and device.

B. Each nameplate inscription shall identify the function and, when applicable, the position. Nameplates shall be melamine plastic 0.125-inch thick, white with black center core.

C. Provide red laminated plastic label with white center core where indicated.

D. Surface shall be matte finish. Corners shall be square. Accurately align lettering and engrave into the core.

E. Minimum size of nameplates shall beone by 2.5 inches.

F. Lettering shall be a minimum of 0.25-inch high normal block style.

G. See Panelboard details for proper labeling of all panelboards.

2.44. PHOTOCELLS, TIME SWITCHES AND CONTACTORS:

A. Photocells: Units shall have 1" diameter, hermetically sealed, cadmium sulfide sensing cell with 3-prong NEMA locking plug, rated for wet locations. Units shall have built-in time delay. Units shall be equal to Tork 5231 of correct voltage to match load or use with matching receptacle equal to Tork 2421.

B. Time switches:
   1. Unless otherwise indicated on drawings, time switches shall be 24-hour electromechanical type having synchronous motor drive with two single pole double throw contacts rated 20 amps minimum.
   2. Unit shall have spring back up, with automatic rewind, capable of providing 16 hours minimum of reserve power upon electric power failure.
   3. Units shall be furnished in an enclosure, NEMA 1 indoor and NEMA 3 outdoors. Enclosures shall be flush mount unless otherwise indicated on drawings.
   4. Units shall be Tork 7120L, or equal by Paragon or Sangamo.
   5. Time switch(es) shall be digital, seven day format, two channel time switches with 9v lithium battery 30 day back-up and with metal indoor enclosure. The controllers shall be equal to Tork #DW200A-Y.

C. Contactors: Units shall be electrically held or electrically operated mechanically held, as indicated on drawings, and shall be recommended by manufacturer for type of load served.

D. Contacts shall double-break type of same ampere rating as line side circuit wiring.

E. Contacts shall be field-convertible to normally open or normally closed.

F. Contactor coils shall be encapsulated. Electrically held contactors shall have continuously rated coils. Mechanically held contactors shall be equipped with coil-clearing contacts to energize coils only when switching.

G. Units shall be furnished in an enclosure, NEMA 1 indoor and NEMA 3 outdoors.

H. Units shall be equal to GE CR460 series in NEMA 1 or NEMA 3R enclosure as indicated.

2.45. FIRE ALARM SYSTEM (ADDRESSABLE):

A. General: The contractor shall furnish and install a complete power limited automatic and manual fire alarm system, as specified herein and indicated on the drawings. The system shall include a central control panel, power supply, signal initiating devices, audible and visual alarm

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devices, provisions for connection of remote monitoring, a wiring system, and all necessary devices required to provide a complete operating system. The system shall comply with the applicable provisions of the National Fire Protection Association Standard Number 72 and meet all requirements of the local authorities having jurisdiction. The Underwriter's Laboratories, Incorporated, or approved by the Factory Mutual Laboratories shall list all equipment and devices. The equipment shall be EST, FCI or Notifier. No deviation will be considered unless submittals are received and approved in writing, not less than ten days prior to bid date.

B. Fire Alarm Document Box: The contractor shall furnish and install a fire alarm document enclosure as mandated by NFPA 72 Chapter 7.7.2.1. The system records documents box shall be constructed of 18 gauge cold rolled steel. It shall have a red powder coat epoxy finish. The cover shall be permanently screened with 1" high lettering and read "FIRE ALARM DOCUMENTS" with white indelible ink. The access door shall be locked with a ¾" barrel lock which is keyed the same as the manufacturer's fire alarm panel. The enclosure shall supply 4 mounting holes to securely fasten to the wall. Inside the enclosure will accommodate standard 8.5" x 11" manuals and loose document records that may be placed in a three-ring binder. All documents & software will be protected within the enclosure. A legend sheet will be permanently attached to the door for system required documentation, key contacts, and system information. The fire alarm document will have securely mounted inside the enclosure a minimum of 4 Gigabyte digital flash memory drive with a standard USB type B connector for uploading and downloading electronic information. The drive shall not be accessible without tools to any person who gains access to the enclosure. The enclosure shall also provide 2 Key ring holders with a location to mount standard business type cards for key contact personnel. The password to the fire alarm programming shall be provided to the owner in the fire alarm document box. The password must be provided, fire alarm contractors that refuse to give password will not be accepted. Contractor will be responsible for replacing the entire fire alarm system at their cost and cost of delaying the project if password is not provided.

C. Control Panel: The control panel shall be an addressable type panel capable of handling up to 256 devices, with 60-hour minimum standby battery. The panel shall provide for the connection of alarm circuits as indicated and shall include the following features.
   1. The fire alarm panel shall detect the operation of any initiating device, indicate by annunciator lamps the area of the alarm condition, and operate all alarm auxiliary devices.
   2. A pilot light shall normally be on, indicating that the system is receiving power from the building service supply. A failure of the building service supply shall cause the lights to go out.
   3. A trouble light and trouble buzzer, operating together, shall signal any trouble condition. Failure of the building service supply, disarrangement in the system wiring, or alarm condition shall cause that trouble light to come on and the trouble buzzer to sound. A self restoring silencing switch shall be provided to silence the trouble buzzer, which shall be arranged so the trouble light will remain on until the system is restored to normal.
   4. All notification signals shall be automatically locked in at the control panel until the operating device is returned to its normal condition, and the panel is manually reset. A switch shall be provided on the control panel for silencing the notification devices. The manual reset switch and the alarm-silencing switch shall be of the self-restoring type, which cannot be left in the abnormal position.
   5. The control panel shall provide relay contacts, of quantity as shown on the drawings, for control of heating, ventilation and air conditioning equipment. Such contacts shall be connected to air conditioning equipment, as indicated on drawings, for shutdown of individual units. Unit shutdown shall be initiated by duct-mounted smoke detectors unless otherwise indicated. Operation of any initiating device shall open all control contacts and release all mechanically held doors.
   6. The control panel shall be equipped with a front mounted Drill switch.
   7. Metal oxide varistors (MOV's) shall be provided on the system power supply and the municipal connection circuit to provide transient suppression protection to the control panel.

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8. Power Supply: The power supply shall be 24 Volt DC, filtered and regulated, and shall provide sufficient power for all system functions. The fire alarm system main power supply shall operate at 120 Volt AC obtained from the building service. The 120-volt AC main power shall be converted to low voltage direct current for system operation. The system shall operate on 24 volts DC with trickle charged batteries provided as an emergency source of supply for operating the system in the event of interruption of main power. A changeover relay in the control panel shall transfer to standby power automatically upon main power failure and automatically reconnect to main power upon restoration.

D. Manual Stations: Manual Fire alarm stations shall be an addressable double acting, semi-flush mounted type. Stations with two sets of contacts will not be acceptable.

E. Smoke Detectors: Smoke detectors shall be addressable photoelectric type with base.

F. Heat Detectors: Addressable 135 degree/rate of rise type with base.

G. Duct Mounted Smoke Detectors: Duct detectors shall be addressable photoelectric type with sampling tube.

H. Contractor shall be responsible for coordinating prior to bid with mechanical drawings to confirm all duct mounted smoke detector locations and quantities. Contractor shall include in their base bid price the cost of all additional duct mounted smoke detectors and circuitry needed for locations.

I. Duct Detector Remote Test Station: Test stations shall be keyed with indicator light.

J. Audible/Visual Notification Devices: Audible/visual notification devices shall be four wire, horn/strobe units capable of 90 dB audible output, 100 candela-second output, shall be ADA compliant. Devices using incandescent lamps will not be acceptable.

K. Visual Notification Devices: Visual notification devices shall be strobe units capable of 100 candela-second visual output, shall be ADA compliant. Devices using incandescent lamps will not be acceptable.

L. Voice Control Panel: The Voice Control Panel shall play a digitally recorded message or microphone input for evacuation instructions. The unit shall be installed next to the FACP, shall be equipped with emergency battery power, and shall provide a minimum of 75 watts of amplification.

M. Remote Microphone Panel: Remote Microphone Panels shall have a keyswitch control and shall be supervised.

N. Remote Amplifier: Remote amplifiers shall be 120 watt with battery backup.

O. Speaker/Visual Notification Devices: Speaker/Visual Notification devices shall be semi-flush, wall mounted, combination strobe/speaker assemblies with a minimum strobe output of 100 candella-second equal to Notifier #E70-24110W-FR for wall installation or Notifier #E70-W for speaker only ceiling installations.

P. Interface Relay:
   1. Provide addressable control modules equal to Notifier #CMX-2 or interface relays equal to Notifier #MR-101/CR as required for interface of the Fire Alarm System with HVAC shut down, door holders, kitchen hood fire suppression system, and fan shut down, and any other locations required for proper interface and operation of systems.
   2. A control module or interface relay shall be provided for each duct mounted smoke detector and shall be the point of interface between the Fire Alarm System and the HVAC Control System.
   3. Contacts shall be rated for 10 A at 120 V.

Q. Flow and Tamper switch Monitoring: Individual Addressable Module.

R. Door Holders: Door Holders: Door holders shall be magnetic semi-recessed wall-mounted type, or where indicated to be floor mounted.

S. **UL Fire Listed Cellular Communicator: Terminals and other necessary facilities shall be provided in the control panel to permit automatic transmission of trouble and alarm signals over a UL listed cellular communicator to the fire, police, or other continuously manned facility, so designated for response to fire emergency. Provide 2-years of**

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cellular and monitoring for the fire alarm system in the base bid from the date of substantial completion.

T. Annunciator Panel: Provide and install an annunciator that provides an audible and visual indication of an alarm or trouble condition for each zone, an alarm silence switch, and a key operated test and reset switch.

U. Auxiliary Remote Power Supplies/Notification Appliance Circuit Extenders (NAC Panels):
   1. Provide auxiliary power supplies and/or NAC Panels where required for notification devices, door holders, annunciators, or for other devices requiring supplemental power.
   2. Remote power supplies shall include a filtered and regulated 24 VDC output, provisions for automatic transfer to battery back-up in case of primary power failure, and batteries sized for 60 hours of operation.

V. Wire Guards: Wire guards shall be made of 3/16” minimum steel wire with a corrosion resistant coating equipped with integral mounting rings. Provide wire guards for all devices located in gymnasium.

W. All devices installed on the exterior shall be weatherproof.

X. All A/V devices in gymnasium at bleachers or any other facility with bleachers shall mount the fire alarm devices 80” above top of bleachers.

Y. **Monitoring - Provide 2-years of monitoring for the fire alarm system in the base bid from the date of substantial completion.**

2.46. CONCRETE:

A. Concrete for electrical requirements shall be:
   1. Composed of fine aggregate (sand), coarse aggregate (graded from three-sixteenth (3/16) inch to one (1) inch), Portland cement, and water proportioned and mixed so as to produce a plastic, workable mixture.
   2. Aggregates shall be free from detrimental amounts of dirt, vegetable matter, soft fragments, or other foreign substances.
   3. Water shall be fresh, clean, and free from salts, alkali, organic matter, and other impurities.
   4. Concrete shall have a minimum 3000 psi ultimate twenty-eight day compressive strength and a maximum three (3) inch slump.

PART 3 - EXECUTION

3.01. GENERAL:

A. This section includes the installation of the complete electrical system.

3.02. ELECTRICAL SYSTEM DEMOLITION:

A. Before any new work begins the Contractor shall determine and document in writing to the satisfaction of the Engineer the condition of existing electrical work and auxiliary systems that are to remain in service. After the new work begins any existing electrical work or systems that are found to be inoperative or defective and not so documented shall be repaired or replaced by the Contractor at no additional cost to the Owner.

B. Existing electrical equipment and materials to be reused shall be tested and repaired as required and installed for first class operation.

C. General: The manner-in-which the remaining portions of the electrical system are terminated, supported and generally maintained for permanent use shall comply with all applicable regulations of the National Electrical Code, applicable NFPA codes and any local codes.

D. Refer carefully to construction drawings prior to commencing with demolition to determine the intent of demolition. Contact the Engineer if there appears to be any conflict between the demolition and construction drawings.

E. See "Renovation" Section regarding modification and relocation of circuits.

F. Phasing: Phasing shall be as coordinated by the General Contractor.

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G. Work in Occupied Areas: Coordinate work carefully with General Contractor to provide minimum disruption to occupied portions of project. Provide minimum of 24 hours advance notice to Owner of demolition activities that will affect Owner's normal operation.

H. Protections: Take necessary measures as required for protection of the Owner's personnel and the general-public, as well as Owner's property. Provide temporary barricades, partitions, bracing, and weather protection as needed. Remove all temporary protections at completion of work.

I. Flame Cutting: Do not use cutting torches for removal until work area is cleared of flammable materials. Maintain portable fire suppression equipment during flame-cutting operations.

J. System Protection: Protect and maintain all portions of existing system not indicated for demolition, including but not limited to light fixtures, panelboards and circuits.

K. Fire Protection: Coordinate with general contractor to ensure that all penetrations of fire-rated decks and partitions are properly sealed.

L. Removal of Circuits: All circuits indicated for removal shall be entirely removed, including raceway, back to take-off point or as far as possible without chasing (unless chasing is indicated). Where it is not possible to remove conduit, all conductors shall be removed and the conduit shall be permanently capped. Floor outlets indicated for removal shall be entirely removed, including outlet box, and capped below floor level (minimum 4" below floor level if in slab).

M. Where floor slab is damaged in the course of demolition, it shall be permanently repaired as soon as practicable.

N. Leave existing branch circuits and feeders which run through reworked areas and serve existing equipment to remain in service, continuous and uninterrupted.

O. Where service interruptions are required, obtain approval for interruptions in writing from Architect 14 days prior to interruption. Submit schedule of work to be performed and the time required to accomplish work with request for interruption.

P. Disposition of Material: Where electrical equipment is indicated for removal and not indicated for re-use, the owner shall have the option of taking possession of the equipment, the Contractor shall deliver any such material to a local site designated by the owner. The Contractor shall be responsible for disposing of all other materials in accordance with applicable codes and laws.

3.03. ELECTRICAL SYSTEM RENOVATION:

A. General: Provide renovations as indicated on drawings and specified herein as required for a complete, operational system, even though every item is not indicated.
   1. This Section is intended to serve as a supplement to the applicable sections within this Division, and in no way relieves the contractor from the requirements of any other Section.
   2. All renovations shall comply with all applicable regulations of the National Electric Code, applicable NFPA codes and any local codes

B. Materials and workmanship: Execute all work presenting a neat and workmanlike appearance when completed. Except where otherwise indicated, all materials shall be new, UL approved where a standard has been established. Where specific means and methods for affecting renovations are not covered in drawings and specifications, the contractor shall exercise prudent judgment in following accepted practices.

C. Modifications: All major deviations from the drawings and specifications shall be approved in writing by the Engineer.

D. Inspection:
   1. Inspect all existing electrical system components which are accessible, including fixtures, wiring devices, raceway and panelboards.
   2. Perform minor repairs to loose or damaged connections, damaged or missing supports, replacement of broken devices, replacement of missing plates and junction box covers and other visible damage or disrepair.
   3. Report major damage to Engineer.

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E. Renovation Services: In addition to the scope of work indicated on the drawings and specified herein, it shall be the responsibility of this Division to provide minor modification and repair services made necessary to electrical system components through the normal course of renovation. Such services shall include but not be limited to minor repair or relocation of branch circuits necessitated by the work of other trades, as coordinated by the General Contractor.

F. Penetrations: Coordinate penetrations of existing walls, decks, and roofs required for electrical system with General Contractor. Do not cut structural members without the prior consent of Structural Engineer.

G. Raceway.
   a. Unless specifically indicated otherwise, existing raceway may not be used.
   b. Where existing raceway is indicated for possible re-use, it shall be the responsibility of this Division to verify that the condition and configuration of the raceway is in compliance with the NEC.

H. Panelboards: Where new circuits are run to an existing panelboard, thoroughly inspect the panelboard for any indications of arcing, overheating, or other damage. Report damage to the Engineer. Unless specifically allowed, tandem circuit breakers shall not be utilized.

I. Clearing of Neutral Faults: Any and all neutral faults to ground on existing system shall be corrected.

J. Service Ground: Visually inspect existing service ground electrode system for damage and code compliance. Check continuity from panel to each electrode with a meter. Make repairs as required.

K. Lighting Fixtures: Where existing lighting fixtures are indicated for re-use, they shall be thoroughly cleaned and re-lamped, no exceptions. Where existing lighting fixtures are indicated for replacement, it shall be the responsibility of this Division to verify the compatibility of new fixtures with existing ceiling type, existing penetrations, available support, and other existing conditions prior to submittal of fixtures. Any variances or required modifications shall be clearly indicated on the fixture submittal.

L. Backfilling, Grading, and Sodding:
   1. Restore surface features, including vegetation, at areas disturbed by Work of this Section.
   2. Reestablish original grades, unless otherwise indicated.
   3. If sod has been removed, replace it as soon as possible after backfilling is completed.
   4. Restore areas disturbed by trenching, storing of dirt, cable laying, and other activities to their original condition.
   5. Include application of topsoil, fertilizer, lime, seed, sod, sprig, and mulch. Comply with Division 2 Section "Landscaping." Maintain restored surfaces.
   6. Restore disturbed paving as indicated.

3.04. ELECTRICAL SERVICE:

A. General: Arrange with local electric Utility Company for service to be brought to the building, and for installation of meter. Provide all material and labor not supplied by Utility Company so as to produce a complete installation meeting the Utility regulations.

B. Service requirements: It is the responsibility of this Section, prior to bid, to reaffirm with the Utility Companies involved, that locations, arrangement, Power Company voltage, phase, metering required, and connections to utility service are in accordance with their regulations and requirements. If their requirements are at variance with these drawings and specifications, contract price shall include an additional cost necessary to meet those regulations without extra cost to Owner after bids are accepted.

C. Notify Architect of any changes required before proceeding with work.

D. Fees and deposits:
   1. The Electrical Contractor shall be responsible for verification and payment of all utility fees associated with installation of the electrical service.
   2. The Owner shall pay the cost of establishing an electrical service account and permanent meter deposit.

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E. Metering: Obtain metering equipment from Utility Company and install in compliance with the Utility Company's requirements. The Electrical Contractor shall provide and install all necessary metering raceways, fittings, supports, connectors and ground conductor necessary for a complete installation. Provide 100# pull wire in all metering conduits.

F. Main Service Equipment: Provide UL approved service entrance components as indicated on drawings or specified herein.

G. Provide a full-size copy of the AS-BUILT Power Riser Diagram framed behind plexiglass screwed to the wall near service entrance in main electrical room.

H. Service lateral or feeder: Extend lateral or feeder of the size shown on drawings from service equipment to the point of service as indicated (verify exact location with Utility Company).
   1. For Overhead Service, provide and install service entrance fitting on conduit and leave sufficient slack conductor for connection to utility feeder 10' above finish grade, 12' above drive and 18' above street.
   2. For Underground Service, provide and install underground conduit to utility riser, as directed by Utility Company. Conduit shall be of size and quantity as indicated on drawings. Provide 480# polypropylene pull line in each empty conduit.
   3. For Underground Service, provide and install transformer pad, primary underground conduit to utility riser as directed by Utility Company, underground secondary conduit, and secondary conductors. Conduit shall be of size and quantity as indicated on drawings. Provide spare 4" conduit in transformer pad extending 2' beyond edge of pad with PVC cap. Provide 480# polypropylene pull line in each empty conduit.
   4. On service transformers with multiple taps, it shall be the responsibility of this section to coordinate tap selection with the electric utility to insure the proper nominal voltage.

3.05. GROUNDING:

A. Bond the neutral conductor and various conductive materials in the building per NEC Article 250.

B. Grounding Electrode System: A bare copper grounding conductor shall be bonded to grounding electrodes as specified below. This conductor shall serve as ground for system neutral and for building equipment bonding. Where conductor is #6, or smaller, or is subject to injury, it shall be run in conduit, Schedule 80 PVC or Rigid Galvanized to which the conductor shall be bonded at both ends.
   1. Grounding electrodes shall be as follows:
      a. Cold water piping, if metal and in direct contact with the earth for 10 feet or more, at the point of entry into the building. Attach ground conductor to cold water piping with UL approved bronze clamp.
      b. Building structural steel, if present and accessible.
      c. Grounding electrode shall be attached with exothermic weld connection or irreversible crimp type connector similar to Burndy YGHR connectors. Crimps must be made with Burndy tool approved by the manufacturer for setting irreversible crimp connections.
      d. Foundation reinforcing bar system. Coordinate with General Contractor to provide turned up re-bar (sleeved) near service point for attachment of grounding electrode above grade. Grounding electrode shall be attached with UL approved exothermic weld connector.
      e. Driven ground rod(s).
         1) Three 3/4" x 10' copper weld rods shall be driven into the ground at the lowest point adjacent to the building, spaced a minimum of 10' apart.
         2) Ground rods shall be driven to 12” below grade.
      f. Grounding electrode shall be attached with exothermic weld connection or irreversible crimp type connector similar to Burndy YGHR connectors. Crimps must be made with Burndy tool approved by the manufacturer for setting irreversible crimp connections.
      g. Existing grounding electrode system. If an existing electrical service is in place, it must be bonded to the new grounding electrode system.

C. Connections to grounding rods, building structure, counterpoise, and conductor junctions shall be made by exothermic weld unless specifically noted otherwise.

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D. Electric system (neutral) ground: The current carrying neutral leg of the wiring system shall be of insulated conductor and shall be connected to the grounding electrode conductor only via the neutral connection at the service equipment. Each branch circuit or multi-outlet branch circuit shall be provided with a dedicated neutral conductor.

E. Equipment grounding conductors:
   1. An equipment grounding conductor (copper with green insulation except where bare copper is used) shall be provided in all wiring raceways.
   2. Sizes shall be in accordance with NEC 250.
   3. The equipment grounding conductor shall originate in the same panelboard, panelboard section, as the circuit conductors.
   4. The equipment grounding conductor bonding the sections of multi-section panelboards shall be sized per NEC 250.
   5. The equipment grounding conductor is not included in number of branch circuit conductors indicated on the drawings.

F. Telephone service ground: provide a minimum #6 bare, solid copper grounding conductor from the electrical service grounding connection to the TBB. Leave six (6) feet minimum of free conductor. Install the conductor in PVC conduit where inside the building.

G. Computer backboard ground: provide a minimum #6 bare, solid copper grounding conductor from the electrical service grounding connection to the CBB. Leave six (6) feet minimum of free conductor. Install the conductor in PVC conduit where inside the building.

H. Metal Lighting poles: Provide a grounding electrode at poles supporting outdoor lighting fixtures in addition to installing a separate equipment grounding conductor with supply branch-circuit conductors.

I. Grounding electrode resistance shall be less than 15 ohms. The resistance of the grounding electrode shall be tested by the Fall of Potential Method.

J. Lighting Standards (Poles): Install 10’ driven ground rod at each pole. On non-metallic poles, ground metallic components of lighting unit and foundations. Connect fixtures to grounding system with No. 6 AWG conductor.

K. Each grounding conductors at the service entrance ground bus bar shall be provided with a brass round identifying tag. Tag shall indicate where ground wire is terminated.

3.06. EXCAVATION, CUTTING AND BACKFILLING:

A. Provide cutting and patching, under the supervision of the General Contractor, as required for the work in Section 16.

B. Locate all existing below grade and/or below floor utilities prior to beginning any site excavation or cutting of existing floor slabs. The Contractor shall repair any damage to existing utilities or systems.

C. Saw cut existing concrete slabs and asphalt paving.

D. Trenching:
   1. Dig trenches true to line, with a flat, even bottom.
   2. Width of the trench shall provide not less than 3 inches clearance from the conduit to each side of the trench.
   3. Ensure that foundation walls and footings and adjacent load bearing soils are not disturbed in any way.
   4. Conduits shall be installed below footings where possible. Where a line passes under a footing, make crossing with the smallest possible trench to accommodate the conduits/sleeves.
   5. Where a line must pass adjacent to and below the bottom of a column footing, or the corner of a continuous footing, backfill the trench with concrete up to the level of the footing bottom, for a distance away from the footing equal to the depth of the fill.
   6. Keep excavation free from water, by pumping if necessary.

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7. Where rock, soft spots, or sharp-edged materials are encountered, excavate the bottom for an additional 3 inches, fill and tamp level to proper elevation with sand or earth free from particles that would be retained on a ¼-inch sieve.
8. Remove and relocate existing obstructions as directed.
9. The Contractor shall be responsible for the repair and/or replacement of any damage to existing utilities, structure, or finishes.
10. Coordinate work with other trades as work progresses so cutting and patching will be minimal.
11. Refer to Section “Earthwork” for shoring, sub-soil assumptions and data, work around trees, surplus earth, etc.

E. See Section 16100, “Conduit Installation, Below grade and below slab conduit installation”, for installation of conduits in trenches.

F. Backfilling:
1. Immediately after inspection, cover conduits with 3” of compacted sand or earth free from particles that would be retained on a 1/4inch sieve. Do not to disturb the alignment or joints of the conduits.
2. Carefully backfill with 4” of earth free from clods, brick, etc., firmly puddling and tamping.
3. Thereafter, puddle and tamp every vertical 4” for hand tamping or 8” for heavy duty mechanical tamping.
4. Backfill shall meet the compaction requirements set forth in Division 2.
5. Backfilling Beneath Slabs and Pavement: Trenches beneath future slabs or pavement, including but not limited to buildings, drives, parking areas, sidewalks, playground surfaces, and equipment pads, shall be backfilled, from 3” above top of conduits to final grade, with crushed aggregate, AHD 825, type B, compacted in 4” layers to 100% ASTM 698.
6. Install marking tape above conduits at 12 inches below grade.

3.07. SLEEVES, INSERTS, AND SUPPORTS:

A. Provide and install No. 16 gauge galvanized steel or iron sleeves in all walls, floors, ceilings, and partitions. Sleeves shall have no more than 1/2" clearance around pipes and insulation.

B. The contractor shall furnish to other responsible trades all sleeves, inserts, anchors and other required items which are to be built in by other trades for securing of all hangers or other supports by the Contractor.

C. The contractor shall assume all responsibility for the placing and sizing of all sleeves, inserts, etc., and shall either directly supervise or give explicit instructions to other trades for their installation.

D. The contractor shall seal all conduits through floors, smoke partitions, and floor partitions, with a sealant approved for the application.

E. All sleeves through sound barrier walls and partitions shall be sealed with mineral wool.

F. Through the floor conduit penetrations shall be sealed watertight.

G. Furnish and install steel angles and channels as required for mounting and bracing heavy equipment and conduits. Steel shall be securely bolted or welded to structure and equipment bolted to the steel framework. Obtain the approval of the Architect prior to welding.

3.08. BELOW GRADE THRU WALL WATER SEALS:

A. Each conduit penetrating exterior, below grade, cast cncrete walls shall have the annular space aroung the conduit sealed with an approved Thru Wall Water Seal System.

B. Where the system includes water seal thru wall sleeves, the Electrical shall provide properly sized sleeves to the contractor responsible for constructing the walls and shall be responsible for the proper location of each sleeve.

C. Where openings are to be core drilled, the Electrical Contractor shall be responsible for the core drilling and for coordinating proper sizing and location of each opening.

3.09. FIRE STOPPING:

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A. The Electrical Contractor shall be responsible for firestopping of all penetrations of fire rated partitions made by any and all lighting, power, and auxiliary circuiting, sleeves and/or equipment.
B. The Electrical Contractor shall submit manufacturers' UL System drawings for the systems to be utilized. The systems shall be compatible with the partition ratings as indicated on the Architectural drawings and in accordance with details on the Electrical drawings.
C. Penetrations of fire rated partitions shall be sealed with an approved fire sealant resulting in the completed penetration having the same fire rating as the partition.
D. The installation shall be in accordance with the manufacturer's UL system detail and installation instructions to attain the required fire partition rating.
E. Empty sleeves through 1 and 2 hour rated partitions shall be plugged with mineral wool.
F. Sleeves through 4 hour rated partitions shall be plugged with mineral wool and fire stopping material.

3.10. ROOF PENETRATIONS:

A. Furnish roof flashing for all equipment, installed under Section 16, which penetrates through the roof. Flashing shall be approved by the Architect prior to installation.

3.11. CONDUIT INSTALLATION:

A. Conduits shall be as follows:
   1. Overhead Service Entrance - Rigid Galvanized Steel (RGS) Conduit or IMC.
   2. Underground Service Laterals: Schedule 40 rigid PVC in horizontal runs with rigid galvanized steel elbows turning up to vertical RGS.
   3. Where subject to moisture or mechanical injury - RGS conduit.
   4. ALL conduits exposed to moisture or subject to mechanical damage shall be RGS. Where conduit exits building, the changeover from EMT to rigid shall be inside exterior wall.
   5. In open shop and industrial installations RGS shall be run to 10' A.F.F.
   6. All conduit exposed on the outside of the building envelope shall be Rigid Galvanized Steel (RGS) conduit. This includes all conduits on and/or under canopies or awnings.
   7. In concrete or solid masonry – RGS conduit
   8. Above furred spaces or in cells of hollow masonry - EMT
   9. Concealed inside drywall construction walls and above lay-in ceilings – EMT.
   10. Exposed conduits:
      a. Conduits installed exposed in shop, warehouse, and manufacturing areas shall be RGS up to 12' A.F.F. Conduits in such spaces above 12' A.F.F. may be EMT unless indicated otherwise on the drawings.
      b. Exposed indoors in non-hazardous unfinished areas not subject to physical damage - EMT
      c. Exposed in kitchen and dishwashing areas: Rigid aluminum.
   11. Branch circuits in slab (3/4" and larger) - PVC. Turn up through slab with RGS ells - no exceptions. Extend rigid turn-ups 2" minimum above finish floor level.
   12. Circuits beneath building vapor barrier - PVC. Turn up through slab with RGS ells - no exceptions. All elbows 45° and greater shall be RGS. Extend RGS turn-ups 2" minimum above finish floor level.
   13. Below Grade – PVC with RGS, or rigid aluminum where applicable, elbows turning up to vertical. All below grade elbows 45° and greater shall be RGS.
   14. Motor, HVAC equipment, and vibrating equipment connections - flexible metal conduit, liquid tight flexible metal conduit outdoors, in kitchen and dishwashing area, or in other wet areas. Liquidtight flexible nonmetallic conduit shall be used only where specifically indicated.
   15. IMC may be used where RGS is indicated.
B. Conduit sizes:
   1. Unless specifically indicated otherwise herein or on the drawings, the minimum conduit size shall be 3/4".
      a. All conduits installed below grade or below slab shall be ¾" minimum.

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b. The minimum size for flexible lighting fixture “whips” shall be 3/8” and the maximum length shall be 6 feet. Lighting fixture “whips” shall be defined as flexible conduits with conductors feeding one or more recessed lighting fixtures installed in suspended, lay-in, acoustical ceiling systems from a single junction box.
c. ½” conduit may be for final connections to equipment or fixtures where conduit is less than three (3) feet in length and is extended from a junction box or from a ¾” conduit stub up.

2. Conduits shall be sized in accordance with the National Electrical Code as adopted by the local authority having jurisdiction or as amended to date, except where a larger size is indicated on the drawings or specified herein.

C. Layout:
1. Generally, follow the conduit layout shown on the drawings. However, the layout is diagrammatic only and must be adjusted for structural conditions, built-in equipment and other factors. Offsets are not indicated and must be furnished as required.
2. Install all conduits concealed except in equipment rooms and where exposed runs are specifically indicated.
3. Install conduit runs to avoid proximity to steam or hot water pipes. In no place shall a conduit be run within 6" of such pipes except where crossings are unavoidable, then conduit shall be kept at least 1" from the covering of the pipe crossed.
4. Eliminate trapped runs insofar as possible.
5. Do not chase new work, but instead build in conduit as work progresses.
6. Do not run conduit in cavity of exterior walls.
7. Run concealed conduits in direct line with long sweep bends and offsets where practicable.
8. Install exposed conduit with runs parallel or perpendicular to walls, structural members, or intersections of vertical planes and ceilings, with right-angle turns consisting of cast-metal fittings or symmetrical bends.
9. Where conduits are indicated exposed overhead, runs down to wall outlets shall be concealed in wall.

D. Conduit Installation:
1. Securely fasten conduits to all sheet metal outlets, cabinets, junction and pull boxes with locknuts and bushings, taking care to see that stout mechanical and solid electrical connections are obtained.
2. All conduits shall have bushings with smooth beveled throats installed at both ends prior to installing conductors. Split bushings around conductors shall be taken to indicate that the conductors were pulled into conduit without the proper bushings installed and a basis for requiring the replacing of the conductors.
3. Conduits entering service enclosures (panelboards, disconnect switches, switchboards, motor control centers, etc. used as service entrance equipment) shall be provided with specification grade, insulating, grounding type bushings. Grounding bushing shall be bonded together and bonded to the service grounding buss.
4. Support:
a. Raceways shall be securely and rigidly supported to the building structure in a neat and workmanlike manner, and wherever possible, parallel runs or horizontal conduit shall be grouped together on adjustable trapeze hangers.
b. Support shall be provided at appropriate intervals <u>not</u> exceeding eight (8) feet with straps, hangers, and brackets specifically designed for the application.
c. Channels shall be 1 inch for 18-inch wide trapeze, 1-3/8 inch for 24 to 30 inch, and 1-5/8 inch for over 30-inch wide trapeze.
d. Perforated steel straphangers, “butterfly clips”, or tie-wire supports are <u>not</u> acceptable.
e. Conduits shall not be supported from ceiling support wires.
f. Conduit shall not be supported from mechanical system ducts or piping.
g. Conduits installed along wall surfaces shall be supported with galvanized steel brackets specifically designed for conduits and sized for the conduit used.

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h. PVC conduits shall be supported per the NEC with PVC or stainless clamps and stainless-steel hardware.
h. Attach to supporting devices with screws, bolts, expansion sleeves or other workmanlike means appropriate to the surface.
i. In stud walls, anchors shall be completely rattle proof.
j. For conduits in damp and wet locations, use stainless steel clamps and stand-offs, or galvanized malleable or cast-iron clamps and spacers.
k. All mounting hardware for aluminum conduit shall be stainless steel.
l. Surface mounted conduits installed in kitchen and dishwashing areas shall be supported off walls approximately 3/16".

5. Thread rigid conduits so that the ends meet in couplings; cut ends square, ream smooth and draw up tight.
6. All field cut threads shall be cleaned with a solvent such as mineral spirits and painted with two coats of galvanize primer.
7. Cap conduit ends to keep out water and trash during construction.
8. Field made bends:
   a. Avoid field-made bends where possible, but where necessary, use a proper hickey or conduit-bending machine.
   b. Field made bends in PVC conduit shall be made with a heated PVC conduit bender.
   c. Make no bends with radius less than six times the conduit diameter, nor more than 90 degrees.
9. Make changes in direction with pull boxes, symmetrical bends and/or cast-metal fittings.
10. Total bends in any conduit run shall not exceed the equivalent of four, quarter (90°) bends for a total of 360°, per NEC, between pull boxes.
11. Replace any crushed or deformed conduits.
12. Conduits passing through roofs shall be in place before roof is installed.
13. Conduits installed in concrete/grout filled CMU walls shall be Rigid steel or IMC conduits installed field wrapped with 0.010 inch-thick pipe-wrapping plastic tape applied with a 50 percent overlay. Painted on coating shall not be acceptable.
14. Where conduits pass through or across building expansion joints, provide hot-dipped galvanized expansion fittings with bonding jumpers.
15. Ensure that all penetrations of firewalls are sealed per NEC and IBCC.
16. Right and left couplings shall not be used; conduit couplings of the Erikson type shall be used at location requiring such joints.
17. Paint all conduits exposed in finished spaces. Paint shall consist of one coat of zinc rich primer plus two top-coats of water-based latex paint, color to match adjacent finishes. Verify colors and paint system with Architect.
18. All conduit runs entering the building from outdoors shall be sealed against moisture migration and condensation by filling with insulating type foam.
19. All conduits passing through walls of coolers or freezers shall have seal fitting installed on the outside of the cooler/freezer wall and within 3" of the wall. Fitting shall be sealed per manufacturer's recommendations.
20. Install telephone, data, intercom, and signal system raceways, 2-inch trade size and smaller, in maximum lengths of 150 feet and with a maximum of two 90-degree bends or equivalent. Separate lengths with pull or junction boxes where necessary to comply with these requirements, in addition to requirements above.

E. Below grade and below slab conduit installation:
   1. See Section 16100, "Excavation, Cutting, and Backfilling" for trenching and backfilling requirements.
   2. Rigid steel or IMC conduits installed below slab-on-grade or in the earth shall be field wrapped with 0.010 inch thick pipe-wrapping plastic tape applied with a 50 percent overlay, or shall have a factory-applied polyvinyl chloride, plastic resin, or epoxy coating system. Painted on coatings shall not be acceptable. Wrap shall extend a minimum of 1" above slabs or 3" above finished grade where there is no slab. Alternate methods must be approved by Engineer prior to bids.
   3. Top of the conduit shall be not less than 30 inches below grade.

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4. Run conduit in straight lines except where a change of direction is necessary.
5. Conduits stubbed up from below grade or slab into exterior walls shall be turned toward the interior of the building below slab fill perpendicular to the wall. Conduits shall not be turned out toward the exterior unless specifically indicated to do so.
6. Placing of conduits below slab on grade:
   a. Conduits 1-1/4” and larger shall be installed a minimum of 12” below the bottom of slab in the clay/sand fill below any gravel fill material.
   b. Conduits 1” and smaller may be installed in the porous/gravel fill below the vapor barrier.
7. Multiple Conduits:
   a. Separate multiple conduits by a minimum distance of 2-1/2 inches horizontally and 3 inches vertically, except that light and power conduits shall be separated from control, signal, and telephone conduits by a minimum distance of 3 inches horizontally and vertically.
   b. Where multiple layers of conduits are to be placed in a trench, each layer shall be placed in the trench, straight and parallel, clear fill material (see Excavation, Cutting, and Backfilling) placed and tamped in place to provide the specified spacing, and each subsequent layer placed in the same manner.
   c. Stagger the joints of the conduits by rows and layers to strengthen the conduit assembly.
   d. Conduits shall not be placed haphazardly in the trench.
8. Where conduits pass through footings or foundation walls:
   a. Conduits roughed in beneath slab shall exit the foundation perpendicular to the building spaced approximately 3" apart. Conduits shall be arranged in a single horizontal row where practical.
   b. Secure approval from the Architect and Structural Engineer prior to penetrating any footing or foundation wall.
   c. Schedule 40 PVC sleeves shall be cast in the footings or foundation wall for the conduits to pass through.
   d. Multiple sleeves shall have 3” clearance, vertically and horizontally, between the sleeves unless directed otherwise by the Architect and/or Structural Engineer.
9. Where PVC conduit is installed below grade a PVC to rigid metallic conduit coupling shall be installed in the horizontal run and a rigid galvanized steel conduit elbow installed to turn up to above grade. Where above grade conduits are indicated to be rigid aluminum the elbow turning up to vertical shall be rigid aluminum.
10. Rigid aluminum conduit shall be wrapped same as RGS through concrete from 2” each side of the concrete.
11. Rigid galvanized conduit shall extend a minimum of 6” above the finished floor level.
12. In hazardous areas the coupling shall be below grade and a single section of conduit installed up to 18” A.F.F. to accept the required seal fitting.
13. Wiring shall be extended in rigid threaded conduit to equipment, except that where required, flexible conduit may be used from 6 inches above the floor to the served equipment.
14. Conduits shall exit concrete slabs vertically.
   a. Where adequate support cannot be obtained by wiring to reinforcing steel, obtain support with solid iron stakes (which may be driven through membrane) cut off flush with slab after pouring.
   b. At turn-ups of adjacent runs of exposed conduit, obtain alignment by wiring members to a temporary horizontal member.
15. Empty or spare conduit stub-ups shall be capped with a threaded cap.
16. Encasement Under Roads, Structures, and at other locations indicated on the drawings:
   a. Under roads, paved areas, railroad tracks, and other locations indicated on the plans install conduits in concrete encasement of rectangular cross-section providing a minimum of 3-inch concrete cover around ducts.

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c. Provide plastic duct spacers that interlock vertically and horizontally. Spacer assemblies shall consist of base spacers, intermediate spacers, and top spacers to provide a completely enclosed and locked-in conduit assembly.
d. Install #4 rebar at each corner of the encasement and at not more than 18” on center vertically and horizontally on the sides of the encasement. #4 rebar hoops shall be installed at not more than 18” on center along the length of the encasement.
e. Concrete encasement shall extend at least 5 feet beyond the edges of paved areas and roads, and 12 feet beyond the rails on each side of railroad tracks.

17. Conduits to be installed under existing paved areas, which are not to be disturbed, and under roads and railroad tracks, shall be installed through a zinc coated, rigid steel, sleeve, jacked into place.
18. Conduits installed between handholes, manholes or other accessible areas shall have a minimum slope of 3 inches in each 100 feet away from buildings and toward manholes and other necessary drainage points.
19. The contractor shall provide properly rated and sized junction and pull boxes as required on all underground conduit runs 150 feet and greater so as to minimize pulling tensions on cables to be installed in conduits. In no case shall pull or junction boxes be further than 300 feet apart. Provide pulling tension calculations on all underground runs over 200 feet as required in Paragraph 1.09 Submittals.

F. Conduit Installation in concrete slabs:
1. Conduit installed in concrete slabs shall be rigid steel or IMC. Rigid steel or IMC conduits installed in slabs-on-grade shall be field wrapped with 0.010 inch-thick pipe-wrapping plastic tape applied with a 50 percent overlay, or shall have a factory-applied polyvinyl chloride, plastic resin, or epoxy coating system. Painted on coatings shall not be acceptable.
2. At slabs on grade, conduit, 3/4" maximum, may be run in the slab; larger conduit shall be run below slab.
3. Where adequate support cannot be obtained by wiring to reinforcing steel, obtain support with solid iron stakes (which may be driven through membrane) cut off flush with slab after pouring.
4. At turn-ups of adjacent runs of exposed conduit, obtain alignment by wiring members to a temporary horizontal member.

G. Flexible conduit:
1. At motor or equipment connections:
a. The maximum length allowable for flexible conduit shall be 36 inches except at lighting fixtures.
b. Flexible conduit installed outdoors shall be installed so as to provide an 8 inch minimum drip loop as measured from the lowest end of the conduit.
2. At lighting fixture connections provide flexible steel conduit by one of the manufacturers named for rigid.
a. Maximum length allowable shall be 72 inches.
b. Support flexible conduit such that it does not contact the ceiling system, ductwork, or other equipment above the ceiling. The conduit shall not be attached to a ceiling or ceiling support system.
c. All fixture whips shall be supported within 12” of outlet/junction boxes with single hole clamps.

H. Empty conduit:
1. Install a #14 galvanized fish wire or polypropylene pull cord with 14-inch free ends in all empty power and/or auxiliary conduits.
2. All conduits indicated to be terminated above the ceiling shall have an elbow turned out above the ceiling and shall be terminated with an insulating bushing.
3. Empty conduits stubbed out of buildings below grade:
a. Empty conduits stubbed out of buildings below grade shall extend 5 feet outside of the building foundation.

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b. Install a 12”x 12”x 6” concrete marker at grade, above the end of the conduits, with “ELEC” inscribed on top.
f. Note on as-built drawings the exact location where empty conduit(s) are stubbed out below grade to the building exterior. Indicate conduit sizes and number of each size.
g. The contractor shall provide properly rated and sized junction and pull boxes as required on all underground conduit runs 150 feet and greater. In no case shall pull or junction boxes be further than 200 feet apart.

I. Conduit entries into enclosures, panelboards, and wiring troughs:
1. Layout conduit entries carefully to allow clearances for the number and sizes of conduits, electrical equipment, and future expansion.
2. In sheet metal equipment use Greenlee Knock-Out punch, or equal, to cut holes for conduit installation. Do not drill holes or cut holes out with snips or torch.
3. In cast enclosures and boxes drill conduit openings with correct size drill for tight fit.

J. **All junction box covers above the ceiling shall be labeled to which circuits or systems they contain**.

3.12. CONDUIT BODIES:

A. Conduit bodies shall be sized in accordance with NEC 370, and 373.
1. Conduit bodies for conductor sizes AWG #4 and larger shall be mogul type bodies sized in accordance with NEC 370-28.
2. Conduit bodies for conductor sizes AWG #6 and smaller shall be sized in accordance with NEC 370-16(c).

3.13. JUNCTION AND PULL BOXES:

A. Junction and pull boxes shall be sized per NEC to accommodate the installed number and size of conductors and conduits.

B. Boxes shall be securely fastened in place.

C. Boxes serving lighting fixtures installed in accessible, suspended ceilings:
1. Provide number of boxes as required to maintain fixture whips within the 6’ maximum length.
2. Generally, attach to underside of structure above, in accessible location, to accommodate a maximum 6' flexible conduit connection to each fixture or fixture run.
3. Where the structure above is more than 18” above the ceiling the boxes shall be supported within 18 inches of the ceiling with all thread rod and/or strut.

D. Install galvanized steel utility box plates, by box manufacturer, at exposed conduit fittings or boxes.

E. **All junction box covers above the ceiling shall be labeled to which circuits or systems they contain**.

3.14. WIRE AND CABLE INSTALLATION:

A. No conductor shall be smaller than #12 except where so designated on the drawings or specified elsewhere.

B. Multiwire lighting branch circuits shall be used where indicated.

C. Wiring devices shall be connected such that each device can be removed without interrupting the neutral or equipment grounding conductors serving other outlets on the same circuit(s).

D. Joints and splices in wire shall be made with solderless connectors and covered so that insulation is equal to conductor insulation. Wire nuts shall not be used for conductor #8 and larger.

E. No splices shall be pulled into conduit.

F. Both conductors and conduit shall be continuous from outlet to outlet.

G. No conductor shall be pulled into the conduit until the conduit is cleaned of all foreign matter.

H. When installing parallel conductors, it is mandatory that all conductors making up the feeder be exactly the same length, the same size, and type of conductor with the same insulation. Each

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group of conductors making up a phase or neutral must be bonded together at both ends in an approved manner.

I. MC cable or Romex cable will note be accepted unless specifically called for on drawings.

J. Wiring thru light fixtures and receptacles will not be accepted.

3.15. AUXILIARY GUTTERS (WIRING TROUGHS):

A. Auxiliary Gutters shall be sized per NEC to accommodate the installed number, size, and orientation of conductors and conduits.

B. Conductors serving a gutter shall be extended without reduction in size, for the entire length of the gutter.

C. All taps and splices shall be made with insulated multi-tap connectors.

3.16. CIRCUITS AND BRANCH CIRCUITS:

A. Outlets shall be connected to branch circuits as indicated on the drawings by circuit number adjacent to outlet symbols, and no more outlets than are indicated shall be connected to a circuit.

3.17. WIRE JOINTS:

A. Except for motor circuits, wire joints for #8 and smaller wire shall be made with twist on connectors.

B. Wire joints and splices for motor circuits, for conductors #6 and larger, and for smaller conductors where other connectors are not rated for the number of conductors involved shall be made with split bolt connectors rated for the applicable conductor size, number of conductors, and conductor material.
   1. Properly tape and insulate all joints to attain the same insulation rating as the cable insulation.
   2. Splices for #6 through #1 shall have a minimum or two (2) layers of rubber tape covered by a minimum of three (3) layers of electrical tape.
   3. Splices for #1/0 and larger conductors shall have a minimum of two (2) layers of electrical filler tape covered by a minimum of three (3) layers of electrical tape.

C. Splices in control conductors shall be avoided as much as possible. Stranded control conductor up to #12 may be connected or spliced with hand crimped type compression connectors. The connectors shall be of the proper size for the conductors being connected.

D. Splices and joints made with mechanical/hydraulic type compression connectors:
   1. Connections and splices shall be made with connectors rated for the applicable conductor size and conductor material.
   2. Dies used shall leave the die number embossed in the connector. The Contractor shall provide the Engineer with the Manufacturer’s connector and die chart prior to final inspection.

E. Taps and splices in auxiliary gutters/troughs shall be made with insulated multi-tap connectors.

F. Wire joints and splices made below grade shall be made with UL listed waterproof connectors, wire nuts, or splice kits.

G. All joints and splices shall be made in junction boxes, wiring troughs, or conduit bodies sized per NEC.

H. All connections to switchboards, panelboards, transformers, generators, ATS, or any other type electrical distribution type equipment shall be compression type fittings. Mechanical fittings will not be accepted in these applications.

3.18. STRUT SYSTEM FOR SUPPORT OF ELECTRICAL EQUIPMENT:

A. Strut Systems: Strut shall be utilized to rack exposed piping vertically or horizontally on walls and across slabs (where applicable). Strut may be utilized to support piping above ceilings, for support of equipment, and elsewhere as deemed appropriate.
   1. Strut in conditioned spaces and above accessible ceilings shall be electro-galvanized.

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2. Strut installed outdoors, in mechanical rooms, and in other unconditioned spaces shall be hot-dipped galvanized.
3. Strut installed in waste-water treatment facilities, kitchens, dishwashing spaces, and labs shall be stainless steel.
4. Strut fittings and hardware, including anchors, shall be same material as strut.
5. Saw cut strut square, 6” minimum lengths. Strut on continuous runs of pipe shall be same length. File or grind burrs from saw cuts.
6. After installation, electro-galvanized and hot-dipped galvanized strut shall be painted with two coats of zinc primer.

3.19. OUTLET BOX INSTALLATION:

A. General: The drawings indicate approximate locations only; determine the exact location at the building in view of all structural and architectural conditions. Obtain Architect's verification of final locations.

B. Outlet boxes shall be sized per NEC to accommodate the installed number and size of conductors, wiring devices, and conduits.

C. Ceiling and Wall Bracket Outlets: 4" octagonal boxes with plaster rings appropriate for finish surface.

D. Typical boxes (for switches, receptacles and auxiliary systems): 4" square boxes ganged as required. Furnish with 3/4" plaster rings where employed in plaster, 1" tile covers where used in ceramic tile, 1" plaster rings where set in exposed concrete, and otherwise appropriate for surface and construction.

E. Boxes in Exposed (or Thin-Coat Plastered) Masonry: Where conduit connections permit, employ solid flush-type, square-cornered, masonry boxes with turned-in device holders; otherwise employ typical box with 1-1/2" square-cut tile cover. .

F. Multiple Outlet Floor Boxes:
1. Verify the exact location of the floor boxes with the Architect prior to rough-in.
2. Set the boxes in accordance with the manufacturer’s instructions.
3. Boxes shall be set so that the box is flush with the finished floor; the boxes shall not cause a rise or fall in the floor.
4. The power outlets shall be connected to the circuits indicated by the numbers next to the symbol.
5. For Data outlets, install a 1” C. to above the nearest corridor ceiling.

G. Boxes used with Exposed Conduit: 4" square utility boxes.

H. Exterior Boxes: Cast-metal boxes, Crouse-Hinds Type FS or FD as appropriate. Make weatherproof with gasketed covers. Equal products by Appleton, Killark, O-Z/Gedney, or approved equal will be accepted.

I. Boxes used with Recessed Lighting Fixtures in suspended acoustical tile ceilings:
1. Provide a 4" square box with blank cover adjacent to each fixture or fixture group.
2. Install a flexible metal conduit fixture-”whip” from the box to the fixtures. The “whip” shall not be longer than 72”.
3. Attach the box to the underside of the structure above, in an accessible location, not more than 18” above the lay-in ceiling.
4. Where structure is more than 18” above the ceiling, the boxes shall be supported from all-thread rods, strut, or a combination of rod and strut.

J. Boxes in Dry Wall Construction:
1. Outlet boxes shall be securely fastened in place.
2. Outlet boxes installed in metal stud construction shall be supported by brackets screwed to studs. Clip on brackets shall not be accepted.
   a. Where a single outlet box is installed adjacent to a stud, brackets may attach to a single stud with a brace against the back of the opposite wall. Use a bracket equal to Caddy Fasteners “H” Series.

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b. Where outlets do not fall next to a stud or where more than one outlet is installed between studs use a metal bracket attached to both studs. Brackets shall be equal to Caddy Fasteners “SGB", “TSGB”, or “RBS” series brackets.
c. Outlet boxes three gangs and wider shall be supported with support member screwed to the two adjacent studs. Brackets equal to Caddy Fasteners SGB or TSGB brackets may be used.

K. Sectional type switch boxes at least 2-1/2" deep may be used instead of typical box (but not where dry wall finish is applied over masonry back-up and not where multi- gang devices occur).

L. Outlets in unfinished masonry walls may be slightly adjusted upward or downward to suit masonry courses, provided outlets are mounted at uniform heights throughout the installation.

M. Coordinate installation of outlet boxes in masonry walls with the masonry contractor to insure that boxes are flush with face of wall and grouted smooth around boxes such that covers, fixtures or devices install flush on face of wall.

N. Where outlets at different levels are shown adjacent, install in one vertical line where possible. Avoid conflict with wainscot caps, splash backs and upper cabinets by adjusting height slightly up or down as directed.

O. Back to back boxes shall be staggered with at least 3 inches between boxes.

P. Back to back boxes in fire rated partitions shall have a minimum of 24” horizontal and/or vertical separation between them.

Q. Backs of boxes three gang and larger installed in fire rated partitions shall be wrapped with self adhesive fire stopping tape.

R. Locate switch outlets on the lock side of doors and so that the first switch in a single or gang installation is approximately 6" to 10" from the doorjamb. Verify door swings on Architectural Drawings.

S. Dimmers shall be ganged together in accordance with the manufacturer’s instructions where appropriate but shall not be ganged with toggle switches.

T. Coordinate carefully with appropriate trades the size and orientation (vertical, horizontal) of outlet boxes for thermostats, data outlets, fire alarm equipment, security equipment, and other control and communications outlets.

U. Mounting Heights:

Confirm all mounting height with local codes and authorities prior to bid and adjust as required:

Switches, generally	48" A.F.F. to top of outlet
Safety switches	Center of Switch 48" A.F.F. or as required.
Receptacles, generally	16" A.F.F. to bottom of outlet
Receptacles over counters	Bottom of outlet 6” above countertops or 2” above backsplashes
Data Outlets	16" A.F.F. to bottom of outlet
Wall mounted exit and emergency lights	Bottom of fixture 7’- 6” A.F.F. or 12” below Ceiling whichever is lower
Electric Water Coolers	Coordinate location with plumbing contractor to locate the receptacle(s) concealed within the EWC enclosure per manufacturer’s installation instructions.

V. Install blank coverplates on all unused power and auxiliary outlet boxes. Blank coverplates shall match other cover plates installed in the facility.

W. Furnish blank plates, matching those on the other outlets in the same area, on TV outlets and other outlets installed for future use.

3.20. WIRING DEVICES:

A. Install wall devices vertically’ unless otherwise noted, so that all devices of any given height will align exactly.

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B. Where boxes are not flush or square with the finished wall surface install wiring devices utilizing a leveler and retainer equal to Caddy #RLC or Steel City #SSF-SR.

C. Plates shall be plumb and true with all four edges contacting wall surface.

D. Mount receptacles with grounding terminals down.

E. Do not install devices until plastering or other type wall covering has been completed; install ahead of painting work but protect from paint spatter.

F. Use screw terminal connections only.

G. Do not gang dimmer switches with toggle switches.

H. Each single or multi outlet receptacle, other than straight blade, 15 or 20 amp, 120 volts, NEMA 5-15R or NEMA 5-20R, shall be provided with matching cord plugs and a minimum of 8 feet of Type SOW cable matching the receptacle size and configuration.

I. Pin and sleeve plugs for food service equipment shall be provided with a Type SOW cable connected to the equipment and plug of sufficient length to reach from the equipment to the plug with a minimum of 18" slack cork. Minimum length shall be 6 feet from equipment to plug.

J. Provide "Kellums" type grips at the plug, cord connector, and for overhead support on all overhead cord connector drops.

3.21. OCCUPANCY SENSORS AND ASSOCIATED DEVICES FOR LIGHTING CONTROL:

A. Occupancy sensors and associated devices and circuiting shall be installed in strict accordance with the manufacturer's instructions.

B. Wall, corner mounted sensors shall be mounted as close to the ceiling as possible on the manufacturer'' corner mounting bracket.

C. Power packs shall be mounted above the ceiling. Power packs shall be installed utilizing two(2) 4" x 4" x 2-1/8" deep boxes joined together using the nipple on the powerpack in accordance with the manufacturer's instructions. One of the boxes shall contain the power pack and control wiring and the other shall contain the power wiring.

D. All control and power circuiting shall be in EMT conduit. Where the devices are not equipped with conduit connections the conduit shall be brought up as close as possible to the device and terminated with insulating bushings.

3.22. ELECTRICALLY POWERED EQUIPMENT AND CONTROLS:

A. Provide and install power circuits for all electrically powered equipment and controls.

B. Heating, Ventilating, and Air Conditioning Control Wiring and Conduit:

1. The electrical contractor shall be responsible for installing outlet boxes for flush mounted HVAC system thermostats in dry wall or masonry wall construction and, where called for on the plans, for surface mounted metallic raceway in finished areas. Extend ¾" conduit from the outlet to above nearest accessible ceiling and terminate horizontally. Refer to the Mechanical/HVAC plans for thermostat locations and coordinate exact type outlet required and orientation with the Mechanical/HVAC contractor.
2. The Mechanical Contractor shall be responsible for the installation of all outlets and conduit for surface mounted devices in unfinished areas such as shops, warehouses, industrial facilities, etc.
3. The mechanical contractor shall furnish and install all low and line voltage control wiring required for the temperature control and/or ventilation systems.

C. Where Fire Alarm system duct mounted smoke detectors and HVAC shut down interface relays are provided, the Electrical contractor shall provide wiring from the smoke detectors to the HVAC shut down interface relay. All circuiting from the shut down relay to the HVAC controls and/or starters shall be provided and installed by the Mechanical/Controls contractor.

D. The mechanical contractor shall furnish all motor starters for the temperature control and/or ventilation equipment unless otherwise indicated on the electrical plans or elsewhere in these electrical specifications. The electrical contractor shall install all motor starters, except for equipment with factory installed starters, for the temperature control and/or ventilation equipment.

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E. Where exhaust fans are supplied with field installed speed controllers, the Electrical Contractor shall provide all necessary circuiting to the fan/speed controller and between the fan and the speed controller.

3.23. DISCONNECTING MEANS:

A. Where required by the National Electrical Code and/or other applicable codes or authorities, or where indicated on the electrical plans, the electrical contractor shall furnish and install an approved disconnecting means for all electrically powered equipment and/or controllers for such equipment whether the disconnecting means is or is not shown on the electrical plans.
   1. The location, rating, and enclosure for the disconnecting means shall be as required by the National Electrical Code and/or other applicable codes or authorities.
   2. Manual motor starters with thermal overload protection may be used in lieu of safety switches for individual motors under 1 horsepower.
   3. Motor rated switches may be used for the disconnecting means when supplied of correct voltage, phase, amperage rating, and enclosure type.
   4. The disconnecting means shall be as manufactured by General Electric, Cutler Hammer, or Siemens. Square D will not be accepted.

B. Where the disconnecting means shown on the electrical plans has a rating greater than the required code rating, the greater rating device shall be installed.

C. An approved horsepower rated fusible safety switch shall be installed where the circuit overcurrent protection does not provide overload protection for the equipment served and where required to meet the equipment's listing requirements.

D. Motor rated switches may be used as service disconnect switches when supplied with a pad-lockable, handle locking guard.

E. Install an engraved phenolic nameplate on the front of each switch enclosure identifying the equipment served by the safety switch and source of power (i.e., panel name and circuit number). Plates shall be white with black lettering. The plates shall be permanently installed with stainless steel screws or stainless-steel rivets.

F. All disconnects installed in public areas or in areas readily accessible to the public shall be lockable and shall be furnished with a brass lock. Provide 10 keys for each lock. All disconnect locks furnished on the project shall be keyed alike.

3.24. LIGHTING FIXTURES:

A. The installation and support of all lighting fixtures shall be the responsibility of the Electrical Contractor.

B. Lay out work as shown, and to provide attractive and efficient arrangement.

C. Install fixtures level, plumb, and true with ceiling and walls, and in alignment with adjacent lighting fixtures.

D. Provide adequate and substantial supports for fixtures in accordance with manufacturers' directions and as specified herein.

E. A Re-lock system will not be accepted for installing lights.

F. Wire grid mounted luminaries individually to junction boxes with flexible conduit not more than 6 feet in length. Individual flexible connections shall be 2 #14 and 1 #14 ground THHN in 3/8" flexible conduit. Ground wire shall be bonded at each end.

G. Light fixtures with center baskets shall have all fixtures in a room installed with the center baskets oriented in the same direction.

H. Fixtures mounted in inverted “T” grids:
   1. For round fixtures or fixtures smaller in size than the ceiling grid, provide a minimum of two wires per fixture located within 4 inches of each corner of the ceiling grid in which the fixture is located. Do not support fixtures by ceiling acoustical panels. Fixtures shall be supported independent of the ceiling system or shall be supported by at least two metal channels spanning the grid system, and secured to, the ceiling tees. One support wire shall be attached to the center of the fixture or to each of the metal channels.

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2. Surface mounted fixtures:
    a. Surface mounted fixtures installed on lay-in ceiling systems shall be supported independent of the ceiling system form the building structure with a minimum of two (2) 3/8”, minimum, all-thread rods.
    b. Install nuts and washers on inside and outside of the fixture housing to provide a rigid installation.
    c. Provide cross bracing as required such that fixtures have no lateral movement.

I. All stems on lighting fixtures shall be installed as follows: (except fixtures with slide grip hangers) first and last stem in row in first knockout from end of fixture. One stem shall be installed between each two fixtures, stem shall center joint, where fixtures join, and attach by use of "jointing plates". Nipples with lock nuts and bushings shall connect all fixtures in continuous rows other than recessed grid type.

J. All suspended lighting fixtures shall be provided with chain or cable sway bracing to keep fixtures from swinging.

K. Fixtures installed in fire rated assemblies shall be tented in accordance with the specified assembly.

L. Means shall be provided to keep insulation 4” minimum away from fixtures not rated for direct contact with insulation.

M. Prior to final inspection clean fixtures and lamps with a soft cloth or sponge and detergent (not soap) solution.

N. All lighting fixtures installed in gymnasiums, hangars, high bay or similar use areas shall be equipped with wire guards.

O. All emergency and exit lights designated on drawings shall be provided with an 1100-lumen battery ballast.

P. All light fixtures shall be supported to the structure independent of the ceiling system on two opposite sides. Support wires shall be different color from ceiling support wires. Engage all ceiling mounting clips. If light fixture is not provided with grid support clips, then the contractor will be responsible to support the fixture on all four sides with support wires. See “Typical Lay-In Luminaire Detail” on drawings for further requirements.

3.25. STEEL(ALUMINUM) POLE SETTING:

A. Bases for poles shall be constructed as detailed on the drawings

B. Anchor bolts shall be set plumb and centered in the base with adequate threads left exposed for base plate, backing nuts, washers, and locking nut.

C. Poles shall be set plumb. Adjust backing and locking nuts to plumb pole with pole base held as close to concrete bas as possible.

D. Grout space between pole base plate and concrete base with non shrinking grout to provide a smooth finish.

E. Smooth all nicks, scratches and scrapes and recoat with factory supplied or recommended primer coat and finish coat.

3.26. PANELBOARDS AND SWITCHBOARDS:

A. Panelboards and switchboards shall be installed where shown on the drawings.

B. Ratings and configurations shall be as scheduled and/or indicated on the drawings.

C. The Electrical Contractor shall coordinate installation of equipment in Electrical and Electrical/Mechanical spaces with other trades such that Code required clearances and working space around the electrical equipment is maintained.

D. Conduit termination:
    1. In general use panelboards with blank ends, without knockouts.
    2. Layout conduit entries carefully to allow clearances for drywall or CMU wall thickness, and to accommodate the number and sizes of home run conduits and specified spare conduits.

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3. Use Greenlee Knock-Out punch, or equal, to cut holes in panelboard ends and/or sides for conduit installation. Do not drill holes or cut holes out with snips or torch.

E. Phase arrangement in panelboards shall be per the NEC, phase A, B, C from front to back, top to bottom, or left to right as viewed from the front.

F. In Delta connected systems the “high” leg shall be the B phase and shall be clearly marked with an orange outer finish.

G. Multi-Section Panelboards:
1. Sub-feed conductors shall be the same size as the conductors feeding the main section.
2. Circuiting originating in one section shall not pass through another section.
3. Circuit conductors and grounding conductors shall originate in the same panelboard section.
4. A separate isolated grounding conductor shall be installed from the main section to the sub-feed section(s).
5. Where the panelboard is rated for service entrance equipment the sub-feed section shall have a separate isolated ground buss fed from the main section ground buss.

H. Labeling:
1. Each panelboard shall have an engraved phenolic plate permanently installed on the front of the panel with the panel name, current rating, and voltage rating.
2. Where there is more than one nominal voltage system the panel shall also have an engraved phenolic plate describing the means of identification used to identify the phase and system of each ungrounded conductor of the system served by the panel.
3. Plates shall be white with black lettering.
4. Panelboard circuit numbers shall be as indicated on the panelboard schedules.

3.27. PHOTOELECTRIC CELLS, TIMERS, AND CONTACTORS FOR LIGHTING CONTROL:

A. Install time clocks where accessible.

B. Install photoelectric cells so that lighting fixtures do not affect the cell.

C. Adjust time clock(s) and photoelectric cells as required for proper operation.

3.28. DRY TYPE TRANSFORMERS:

A. Flexible metallic conduit equipped with bare stranded copper ground jumper shall be provided for all transformer primary and secondary connections

B. Transformer secondaries shall be grounded to the building steel and to the primary and secondary side conduit systems.

3.29. IDENTIFICATION AND LABELING:

A. Feeder Designation:
1. Non-ferrous identifying tags or pressure sensitive labels shall be securely fastened to all cables, feeders, and power circuits in vaults, pull boxes, manholes, switch gear and at termination of cables. Tags or labels shall be stamped or printed to correspond with markings on drawings so that feeder or cable number and phase can be readily identified.
2. Where there is more than one nominal voltage system, each ungrounded system conductor shall be identified by phase and system wherever accessible per NEC. The means of identification shall be permanently posted at each branch-circuit panelboard.

B. Color Coding of Conductors:
1. The ungrounded (phase) conductors and the grounded (neutral) conductors of each voltage system shall be identified by the following color coding method:
a. 120/240 Volts, Single Phase, 3 Wire:
1) Grounded (Neutral) Conductor --- White
2) Ungrounded (Phase) Conductors --- Red, Black
a. 120/240 Volts, Three Phase, 4 wire:
1) Grounded (Neutral) Conductor --- White
2) Ungrounded (Phase) Conductors --- Red, Orange, Black
b. 120/208 Volts, 3 Phase, 4 Wire:

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1) Grounded (neutral) Conductor --- White
2) Ungrounded (phase) Conductors --- Black, Blue, Red

c. 277/480 Volts, 3 Phase, 4 Wire:
1) Grounded (neutral) Conductor --- Gray
2) Ungrounded (phase) Conductors --- Brown, Orange, Yellow

2. Green shall be used for equipment grounding conductors only.
3. The insulation color shall be visible for the entire length of wire.

C. Panelboard:
1. Each Lighting and Power Panelboard shall contain a typed circuit directory listing all circuit breakers and the load served by each.
2. Panelboard directories shall be typewritten and shall include adequate descriptions for proper identification of individual circuits. Do not write in or on panelboards.
3. On Distribution panelboards, provide and install an engraved laminated label for each circuit, indicating circuit's number and load served.
4. Each panelboard shall have an engraved phenolic plate permanently installed on the front of the panel with the panel name, current rating, and voltage rating.
5. Where there is more than one nominal voltage system each panelboard shall have an engraved phenolic plate describing the means of identification used to identify each phase, neutral, and grounding conductors of the system served by the panelboard per NEC.
6. Plates shall be white with black lettering.

D. Wall Switches: Where three or more switches are ganged, and elsewhere as indicated, identify each switch with approved legend engraved on the wall plate.

E. Receptacles: Install a label on the face of the coverplate and tags or wire markers inside the outlet box identifying the panelboard and circuit number from which the outlet is served. Use machine-printed, pressure-sensitive, abrasion-resistant label tape on face of coverplate- black print on clear tape on light colored or stainless-steel plates and white print on clear tape on dark colored plates. Embossed tape labels will not be accepted. Use durable wire markers or tags within outlet boxes.

G. Disconnect Switches:
1. Install an engraved phenolic nameplate on the front of each switch enclosure identifying the equipment served by the safety switch and source of power (i.e., panel name and circuit number).
2. Plates shall be white with black lettering.
3. The plates shall be permanently installed with stainless steel screws or stainless-steel rivets. Plates installed with glue or other adhesives will not be accepted.
4. Where motor rated switches are used as service disconnect switches, labeling shall be as described for receptacles.

H. Junction boxes: Identify circuits enclosed in concealed junction boxes on the cover with permanent marking pen.
1. For power and lighting circuits indicate panelboard of origin and panelboard circuit number(s).
2. For auxiliary systems circuiting indicate the system and zone served.

I. Service disconnects:
1. An additional engraved sign shall be permanently attached next to panelboard circuit breakers, on enclosed circuit breaker enclosures, and/or on disconnect switches used as service disconnects to identify each main service disconnect.
2. The sign shall be red with white lettering a minimum of ½" high.
3. Where multiple main disconnects are utilized the labels shall identify each as one of a group, i.e., "Service Disconnect 1 of 3", etc. where there are three service disconnects.

3.30. FIRE ALARM SYSTEM:

A. The installation shall be by a Certified Fire Alarm Contractor who has qualified and received a permit from the State Fire Marshal, with an NICET Level III on staff.

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B. All wiring shall be in accordance with the National Electric Code and the local code having jurisdiction.

C. Unless otherwise specified, minimum wire size shall be 14 gauge for AC and power supply connections, 14 gauge for audible alarm and auxiliary circuits, and 18 gauge for signal initiating circuits. Diagrams shall be provided for device and power wiring. Color coding and permanent numbering shall be used as recommended be the equipment supplier.

D. All system wiring shall be installed in metal raceway in accordance with Section "Raceways".

E. Junction boxes shall have covers painted red with the letters "FA" stenciled on the cover in 2" high white letters.

F. Auxiliary Remote Power Supplies/Notification Appliance Circuit Extender (NAC panel):
   1. Power supplies shall be sized at 133% of proposed load. Fire Alarm submittals shall include power supply capacity and loading data.
   2. Remote power supplies shall be supervised by the FACP.
   3. The power supplies shall be installed, accessible, below ceiling, in electrical rooms or where indicated on the drawings.

G. Provide circuiting as required for the interface with the kitchen hood fire suppression system and the fire alarm system.

H. Where air handler shut down is controlled from the fire alarm system, the fire alarm system installer shall provide circuiting as required between the Duct Mounted Smoke Detectors and the HVAC interface/shut down relays. Circuiting connecting the relay output contacts to the HVAC control system shall be provided and installed by the Mechanical/Controls contractor.

I. Each air handling unit shall be a separate fire alarm initiating zone.

J. Install wire guards on all smoke detectors and notification devices installed in gymnasiums or similar use areas.

K. **Install UL fire listed cellular communicator for monitoring of the fire alarm system. Provide all material and labor as needed for complete functioning system at the completion of construction.**

L. Final connections to the Fire Alarm Control Panel **and Voice Panel** shall be made by a factory certified, NICET Level III, technician.

M. A factory-trained representative of the manufacturer shall supervise connections and final testing of this system and shall complete a Certificate of Completion per NFPA 72. The Certificate of Completion shall be completely filled out and copies delivered to the Owner, Architect, and Engineer prior to the final inspection.

N. On completion of the acceptance tests, the Owner or his representative shall be instructed in the operation and testing of the system.

O. **At the acceptance tests, contractor shall provide engineer with smoke detector diagnostic reports for all smoke detectors. All smoke detectors more than 10% dirty shall be either cleaned or replaced until test show value less than 10%.**

P. The fire alarm system shall be warranted free from defects in workmanship and materials, under normal use and service, for a period of one year from the date of acceptance or beneficial occupancy, whichever is earlier. Any equipment shown to be defective in workmanship or material shall be repaired, replaced, or adjusted free of charge.

Q. Identification and labeling:
   1. Provide a framed building drawing identifying each zone and/or building area.
   2. Each building zone on the Fire Alarm Control panel shall relate to the building drawing in a manner that will direct the fire department to the area of a fire.
   3. On addressable systems each addressable device shall be given a name displayed on the control panel readout that will direct the fire department to the area of the fire, i.e. – South End of Zone(Building) 5; AHU-1 – Mechanical Room 201 – Building 2. Any room number reference shall be to final room numbers assigned to rooms on completion of construction.
   4. Building drawing, schedule of zones, and device identification schedule shall be submitted to the Engineer for approval prior to final inspection and acceptance.

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5. On addressable systems the contactor shall label each device with an alpha-numeric identifier that is unique to that device. This identifier shall correspond to the identifier programmed in the fire alarm control panel such that maintenance personnel may quickly and readily identify the device.

3.31. SECONDARY SURGE ARRESTERS:

A. Secondary surge arresters shall be installed in strict accordance with the manufacturer's recommendations.

B. Arrester may be mounted to the side of a surface mounted panelboard or trough. If such a surface is not available, the arrester shall be mounted on a bracket in its own flush mount enclosure located immediately adjacent to the service panel. Ensure that all leads are attached per manufacturer's recommendations. Excess lead length shall be cut off prior to making connections.

3.32. CONCRETE:

A. The Electrical Contractor shall be responsible for placing concrete for electrical equipment pads, lighting standard bases, electrical equipment supports, and at other locations as indicated on the electrical drawings and/or specified herein.

B. This Contractor shall be responsible for size, location, and orientation of the pads, bases, etc. Any required additions or modifications to concrete due to incorrect size, location, or orientation shall be the responsibility of this contractor.

C. Concrete shall be cured for a period of not less than seven (7) days prior to setting poles, transformers, switchgear, motor control centers, or other pad mounted equipment.

D. Forms shall be completely removed after concrete has cured and prior to setting equipment.

E. A smooth wood float finish shall be given to exposed, unformed concrete.

F. Honeycombed, or otherwise defective areas of concrete shall be repaired by patching with cement mortar.

3.33. SPARE MATERIAL:

A. Provide four exit signs and 50 feet of circuiting in conduit for each device complete with all labor and material for installation in a location as directed by the engineer or architect.

B. Provide four emergency wall packs and 50 feet of circuiting in conduit for each device complete with all labor and material for installation in a location as directed by the engineer or architect.

C. Provide six type NEMA 5-20R receptacles complete with 75 feet of circuiting in conduit . For each device provide complete with all additional labor and materials for installation in a location as directed by the architect or engineer.

D. Provide 4 duplex communications outlets complete with all labor, material, cabling and conduit necessary to install outlet 300 feet from the nearest communications IDF closet and terminate outlet cables on patch panels in rack. Outlets to be installed in a location as directed by architect or engineer.

E. Provide four occupnacy sensor wall switches and their installation.

F. Provide four marked time wall switches and their installation.

G. Provide three of each type of fire alarm notification devices (speaker/strobe units, strobe only units) and 75 feet of circuiting in conduit for each device complete with all labor, programming, and material for installation in a location as directed by the engineer or architect.

H. Provide four of each type of CO detector and 150 feet of circuiting in conduit for each device complete with all labor and material for installation in a location as directed by the engineer or architect.

I. Provide three of each type of fire alarm heat detector devices and 75 feet of circuiting in conduit for each device complete with all labor, programming, and material for installation in a location as directed by the engineer or architect.

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J. Provide three of each type of initiating device (pull station, zone module, duct detector, smoke detector) and 75 feet of circuiting in conduit for each device complete with all labor and material for installation in a location as directed by the engineer or architect.

K. Provide one spare set of fuses for each size and type fuse used.

3.34. EQUIPMENT TOUCHUP AND PAINTING:

A. Clean damaged and disturbed areas on all painted surfaces of enclosures, cabinets, and equipment, sand smooth, and apply primer, intermediate, and finish coats of paint to suit the degree of damage at each location. Paint shall be the manufacturer’s supplied touch up paint or a matching paint. Prep all surfaces to be painted by removing all rust, dirt, oil, and any other material that might inhibit good paint adhesion by mechanical means and/or with solvents.

B. Follow paint manufacturer's written instructions for surface preparation and for timing and application of successive coats.

C. Repair damage to galvanized finishes with two coats of zinc-rich paint recommended by manufacturer.
   1. Paint cut ends.
   2. Paint all drilled and punched holes.
   3. Paint all knicks and scratches.
   4. Paint all field cut conduit threads.

D. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION

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SECTION 16231

ENGINE GENERATORS

PART 1 - **GENERAL**

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes packaged engine-generator sets for standby power supply with the following features:
1. Natural Gas engine.
2. Unit-mounted cooling system.
3. Unit-mounted and remote-mounted control and monitoring.
4. Performance requirements for sensitive loads.
5. Fuel system.
6. Outdoor sound rated enclosure.
7. This installation required ONE (1) engine generator sets operating in parallel.

B. Related Requirements:

1. Section 16415 "Transfer Switches" for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine-generator sets.

1.3 DEFINITIONS

A. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

B. EPS: Emergency power supply.

C. EPSS: Emergency power supply system.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
2. Include thermal damage curve for generator.
3. Include time-current characteristic curves for generator protective device.
4. Include fuel consumption in gallons per hour at 0.8 power factor at 0.5, 0.75 and 1.0 times generator capacity.
5. Include generator efficiency at 0.8 power factor at 0.5, 0.75 and 1.0 times generator capacity.
6. Include air flow requirements for cooling and combustion air in cfm at 0.8 power factor, with air supply temperature of 95, 80, 70, and 50 deg F. Provide drawings showing requirements and limitations for location of air intake and exhausts.
7. Include generator characteristics, including, but not limited to kw rating, efficiency, reactances, and short-circuit current capability.

B. Shop Drawings:

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1. Include plans and elevations for engine-generator set and other components specified. Indicate access requirements affected by height of subbase fuel tank.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Identify fluid drain ports and clearance requirements for proper fluid drain.
4. Design calculations for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
5. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include base weights.
6. Include diagrams for power, signal, and control wiring. Complete schematic, wiring, and interconnection diagrams showing terminal markings for EPS equipment and functional relationship between all electrical components.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer and testing agency.
B. Source quality-control reports, including, but not limited to the following:
1. Certified summary of prototype-unit test report.
2. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.
3. Certified Summary of Performance Tests: Certify compliance with specified requirement to meet performance criteria for sensitive loads.
4. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.
5. Report of sound generation.
6. Report of exhaust emissions showing compliance with applicable regulations.
7. Certified Torsional Vibration Compatibility: Comply with NFPA 110.
C. Field quality-control reports.
D. Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals.
1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
   a. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.
   b. Operating instructions laminated and mounted adjacent to generator location.
   c. Training plan.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Fuses: One for every 10 of each type and rating but no fewer than one of each.
2. Indicator Lamps: Two for every six of each type used, but no fewer than two of each.
3. Filters: One set each of lubricating oil, fuel, and combustion-air filters.
4. Tools: Each tool listed by part number in operations and maintenance manual.

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1.8 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved by manufacturer.
B. Testing Agency Qualifications: Member company of NETA or an NRTL.
1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.9 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.
1. Warranty Period: two (2) years from date of Final Acceptance.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Caterpillar.
2. Onan/Cummins
3. Kohler
B. Source Limitations: Obtain packaged generator sets and auxiliary components through one source from a single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. ASME Compliance: Comply with ASME B15.1.
B. NFPA Compliance:
1. Comply with NFPA 37.
2. Comply with NFPA 70.
3. Comply with NFPA 99.
4. Comply with NFPA 110 requirements for Level 1 emergency power supply system.
C. UL Compliance: Comply with UL 2200.
D. Engine Exhaust Emissions: Comply with EPA Tier 2 requirements and applicable state and local government requirements.
E. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at dispatch area due to sound emitted by generator set including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.
F. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:
1. Ambient Temperature: 5 to 40 deg C.
2. Relative Humidity: Zero to 95 percent.
3. Altitude: Sea level to 1000 feet (300 m.

2.3 ASSEMBLY DESCRIPTION

A. Factory-assembled and -tested, water-cooled engine, with brushless generator and accessories.
B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency acceptable to authorities having jurisdiction, and marked for intended location and application.

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C. EPSS Class: Engine-generator set shall be classified as a Class 2 in accordance with NFPA 110.
D. Induction Method: Turbocharged.
E. Governor: Adjustable isochronous, with speed sensing.
F. Emissions: Comply with EPA Tier 2 requirements.
G. Mounting Frame: Structural steel framework to maintain alignment of mounted components without depending on concrete foundation. Provide lifting attachments sized and spaced to prevent deflection of base during lifting and moving.

1. Rigging Diagram: Inscribed on metal plate permanently attached to mounting frame to indicate location and lifting capacity of each lifting attachment and generator-set center of gravity.

H. Capacities and Characteristics:

1. Power Output Ratings: Nominal ratings as indicated at 0.8 power factor excluding power required for the continued and repeated operation of the unit and auxiliaries[, with capacity as required to operate as a unit as evidenced by records of prototype testing].
2. Output Connections: Three-phase, four wire.
3. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.

I. Generator-Set Performance for Sensitive Loads:

1. Oversizing generator compared with the rated power output of the engine is permissible to meet specified performance.
    a. Nameplate Data for Oversized Generator: Show ratings required by the Contract Documents rather than ratings that would normally be applied to generator size installed.
2. Steady-State Voltage Operational Bandwidth: 1 percent of rated output voltage from no load to full load.
3. Transient Voltage Performance: Not more than 10 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within 0.5 second.
4. Steady-State Frequency Operational Bandwidth: Plus or minus 0.25 percent of rated frequency from no load to full load.
5. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
6. Transient Frequency Performance: Less than 2-Hz variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within three seconds.
7. Output Waveform: At no load, harmonic content measured line to neutral shall not exceed 2 percent total with no slot ripple. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
8. Sustained Short-Circuit Current: For a three-phase, bolted short circuit at system output terminals, system shall supply a minimum of 300 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to winding insulation or other generator system components.
9. Excitation System: Performance shall be unaffected by voltage distortion caused by nonlinear load.
    a. Provide permanent magnet excitation for power source to voltage regulator.
10. Start Time: Comply with NFPA 110, Type 10, system requirements.

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2.4 ENGINE

A. Fuel: Natural Gas
B. Rated Engine Speed: 1800 rpm.
C. Maximum Piston Speed for Four-Cycle Engines: 2250 fpm (11.4 m/s).
D. Lubrication System: The following items are mounted on engine or skid:

1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.

E. Jacket Coolant Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity.
F. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine-generator-set mounting frame and integral engine-driven coolant pump.

1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
2. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
3. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
4. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
5. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, ultraviolet-, and abrasion-resistant fabric.
    a. Rating: 50-psig (345-kPa) maximum working pressure with coolant at 180 deg F (82 deg C), and noncollapsible under vacuum.
    b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

G. Cooling System: Closed loop, liquid cooled, with remote radiator and integral engine-driven coolant pump. Comply with requirements in Section 232113 "Hydronic Piping" for coolant piping.

1. Configuration: Vertical air discharge.
2. Radiator Core Tubes: Nonferrous-metal construction other than aluminum.
3. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
4. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
5. Fan: Driven by totally enclosed electric motor with sealed bearings.
6. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
7. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.

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H. Muffler/Silencer: Critical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.

1. Minimum sound attenuation of 25 dB at 500 Hz.
2. Sound level measured at a distance of 25 feet (8 m) from exhaust discharge after installation is complete shall be 78 dBA or less.

I. Air-Intake Filter: Heavy-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.

J. Starting System 24-V electric, with negative ground.

1. Components: Sized so they are not damaged during a full engine-cranking cycle with ambient temperature at maximum specified in "Performance Requirements" Article.
2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
3. Cranking Cycle: As required by NFPA 110 for system level specified.
4. Battery: Lead acid, with capacity within ambient temperature range specified in "Performance Requirements" Article to provide specified cranking cycle at least three times without recharging.
5. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
6. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater shall be arranged to maintain battery above 10 deg C regardless of external ambient temperature within range specified in "Performance Requirements" Article. Include accessories required to support and fasten batteries in place. Provide ventilation to exhaust battery gases.
7. Battery Stand: Factory-fabricated, two-tier metal with acid-resistant finish designed to hold the quantity of battery cells required and to maintain the arrangement to minimize lengths of battery interconnections.
8. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35 A minimum continuous rating.
9. Battery Charger: Current-limiting, automatic-equalizing and float-charging type designed for lead-acid batteries. Unit shall comply with UL 1236 and include the following features:
    a. Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
    b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 deg F (minus 40 deg C) to 140 deg F (plus 60 deg C) to prevent overcharging at high temperatures and undercharging at low temperatures.
    c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
    d. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.
    e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery

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charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.

f. Enclosure and Mounting: NEMA 250, Type 1, wall-mounted cabinet.

2.5 CONTROL AND MONITORING

A. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of generator set. When mode-selector switch is switched to the on position, generator set starts. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms.

B. Manual Starting System Sequence of Operation: Switching on-off switch on the generator control panel to the on position starts generator set. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms.

C. Provide minimum run time control set for 30 minutes with override only by operation of a remote emergency-stop switch.

D. Comply with UL 508A.

E. Configuration: Operating and safety indications, protective devices, basic system controls, engine gages, instrument transformers, generator disconnect switch or circuit breaker, and other indicated components shall be grouped in a combination control and power panel. Control and monitoring section of panel shall be isolated from power sections by steel barriers. Panel shall be powered from the engine-generator set battery. Panel features shall include the following:

1. Wall-Mounting Cabinet Construction: Rigid, self-supporting steel unit complying with NEMA ICS 6. Power bus shall be copper. Bus, bus supports, control wiring, and temperature rise shall comply with UL 891.
2. Switchboard Construction: Freestanding unit complying with Section 262413 "Switchboards."
3. Switchgear Construction: Freestanding unit complying with Section 262300 "Low-Voltage Switchgear."

F. Indicating Devices : As required by NFPA 110 for Level 1 system, including the following:

1. AC voltmeter.
2. AC ammeter.
3. AC frequency meter.
4. EPS supplying load indicator.
5. Ammeter and voltmeter phase-selector switches.
6. DC voltmeter (alternator battery charging).
7. Engine-coolant temperature gage.
8. Engine lubricating-oil pressure gage.
9. Running-time meter.
10. Current and Potential Transformers: Instrument accuracy class.

G. Protective Devices and Controls in Local Control Panel: Shutdown devices and common visual alarm indication as required by NFPA 110 for Level 1 system, including the following:

1. Start-stop switch.
2. Overcrank shutdown device.

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3. Overspeed shutdown device.
4. Coolant high-temperature shutdown device.
5. Coolant low-level shutdown device.
6. Low lube oil pressure shutdown device.
7. Air shutdown damper shutdown device when used.
8. Overcrank alarm.
9. Overspeed alarm.
10. Coolant high-temperature alarm.
11. Coolant low-temperature alarm.
12. Coolant low-level alarm.
13. Low lube oil pressure alarm.
14. Air shutdown damper alarm when used.
15. Lamp test.
16. Contacts for local and remote common alarm.
17. Coolant high-temperature prealarm.
18. Generator-voltage adjusting rheostat.
19. Run-Off-Auto switch.
20. Control switch not in automatic position alarm.
21. Low-starting air pressure alarm.
22. Low-starting hydraulic pressure alarm.
23. Low cranking voltage alarm.
24. Battery-charger malfunction alarm.
25. Battery low-voltage alarm.
26. Battery high-voltage alarm.
27. Generator overcurrent protective device not closed alarm.

H. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.

I. Common Remote Panel with Common Audible Alarm: Comply with NFPA 110 requirements for Level 1 systems. Include necessary contacts and terminals in control and monitoring panel. Remote panel shall be powered from the engine-generator set battery. Remote generator control/alarm panel shall be located in Mechanical 133.

J. Remote Alarm Annunciator: Comply with NFPA 99. An LED labeled with proper alarm conditions shall identify each alarm event, and a common audible signal shall sound for each alarm condition. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface- or flush-mounting type to suit mounting conditions indicated.

1. Overcrank alarm.
2. Coolant low-temperature alarm.
3. High engine temperature prealarm.
4. High engine temperature alarm.
5. Low lube oil pressure alarm.
6. Overspeed alarm.
7. Low fuel main tank alarm.
8. Low coolant level alarm.
9. Low cranking voltage alarm.
10. Contacts for local and remote common alarm.
11. Audible-alarm silencing switch.

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12. Air shutdown damper when used.
13. Run-Off-Auto switch.
14. Control switch not in automatic position alarm.
15. Fuel tank derangement alarm.
16. Fuel tank high-level shutdown of fuel supply alarm.
17. Lamp test.
18. Low cranking voltage alarm.
19. Generator overcurrent protective device not closed.

K. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.

L. Remote Emergency-Stop Switch: Flush; wall mounted, unless otherwise indicated; and labeled. Push button shall be protected from accidental operation.

2.6 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Overcurrent protective devices for the entire EPSS shall be coordinated to optimize selective tripping when a short circuit occurs. Coordination of protective devices shall consider both utility and EPSS as the voltage source.

1. Overcurrent protective devices for the EPSS shall be accessible only to authorized personnel.

B. Generator Circuit Breaker: Molded-case, electronic-trip type; 100 percent rated; complying with UL 489.

1. Tripping Characteristics: Adjustable long-time and short-time delay and instantaneous.
2. Trip Settings: Selected to coordinate with generator thermal damage curve.
3. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.
4. Mounting: Adjacent to or integrated with control and monitoring panel.

C. Generator Protector: Microprocessor-based unit shall continuously monitor current level in each phase of generator output, integrate generator heating effect over time, and predict when thermal damage of alternator will occur. When signaled by generator protector or other generator-set protective devices, a shunt-trip device in the generator disconnect switch shall open the switch to disconnect the generator from load circuits. Protector performs the following functions:

1. Initiates a generator overload alarm when generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other generator-set malfunction alarms. Contacts shall be available for load shed functions.
2. Under single or three-phase fault conditions, regulates generator to 300 percent of rated full-load current for up to 10 seconds.
3. As overcurrent heating effect on the generator approaches the thermal damage point of the unit, protector switches the excitation system off, opens the generator disconnect device, and shuts down the generator set.
4. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot.

D. Ground-Fault Indication: Comply with NFPA 70, "Emergency System" signals for ground fault.

1. Indicate ground fault with other generator-set alarm indications.
2. Trip generator protective device on ground fault.

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2.7 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

A. Comply with NEMA MG 1.
B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.
C. Electrical Insulation: Class H or Class F.
D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required. Provide 12 lead alternator.
E. Range: Provide broad range of output voltage by adjusting the excitation level.
F. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.
G. Enclosure: Dripproof.
H. Instrument Transformers: Mounted within generator enclosure.
I. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified and as required by NFPA 110.

1. Adjusting Rheostat on Control and Monitoring Panel: Provide plus or minus 5 percent adjustment of output-voltage operating band.
2. Maintain voltage within 15 percent on one step, full load.
3. Provide anti-hunt provision to stabilize voltage.
4. Maintain frequency within 5 percent and stabilize at rated frequency within 5 seconds.

J. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.
K. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.
L. Subtransient Reactance: 12 percent, maximum.

2.8 OUTDOOR GENERATOR-SET ENCLOSURE

A. Description: Vandal-resistant, sound-attenuating, weatherproof steel housing, wind resistant up to 100 mph (160 km/h). Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Panels shall be removable by one person without tools. Instruments and control shall be mounted within enclosure.
B. Description: Prefabricated or pre-engineered galvanized-steel-clad, integral structural-steel-framed, walk-in enclosure, erected on concrete foundation.

1. Structural Design and Anchorage: Comply with ASCE 7 for wind loads up to 100 mph (160 km/h).
2. Seismic Design: Comply with seismic requirements in Section 260548.16 "Seismic Controls for Electrical Systems."
3. Hinged Doors: With padlocking provisions.
4. Space Heater: Thermostatically controlled and sized to prevent condensation.
5. Thermal Insulation: Manufacturer's standard materials and thickness selected in coordination with space heater to maintain winter interior temperature within operating limits required by engine-generator-set components.
6. Muffler Location: External to enclosure.

C. Engine Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for 2 hours with ambient temperature at top of range specified in system service conditions.

1. Louvers: Fixed-engine, cooling-air inlet and discharge. Storm-proof and drainable louvers prevent entry of rain and snow.

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2. Automatic Dampers: At engine cooling-air inlet and discharge. Dampers shall be closed to reduce enclosure heat loss in cold weather when unit is not operating.
3. Ventilation: Provide temperature-controlled exhaust fan interlocked to prevent operation when engine is running.

D. Interior Lights with Switch: Factory-wired, vapor-proof fixtures within housing; arranged to illuminate controls and accessible interior. Arrange for external electrical connection.

1. AC lighting system and connection point for operation when remote source is available.
2. DC lighting system for operation when remote source and generator are both unavailable.

E. Convenience Outlets: Factory wired, GFCI. Arrange for external electrical connection.

2.9 MOTORS

A. Description: NEMA MG 1, Design B, medium induction random-wound, squirrel cage motor.
B. Efficiency: Energy efficient, as defined in NEMA MG 1.
C. Service Factor: 1.15.
D. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
E. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
F. Temperature Rise: Match insulation rating.
G. Code Letter Designation:

1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.

H. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.
I. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in electrical Sections.

2.10 VIBRATION ISOLATION DEVICES

A. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic restraint.

1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 1/4-inch-(6-mm-) thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
2. Outside Spring Diameter: Not less than 80 percent of compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Minimum Deflection: 1 inch (25 mm).

B. Vibration isolation devices shall not be used to accommodate misalignments or to make bends.

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2.11 FINISHES

A. Indoor and Outdoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer.

2.12 SOURCE QUALITY CONTROL

A. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.

1. Tests: Comply with NFPA 110, Level 1 Energy Converters and with IEEE 115.

B. Project-Specific Equipment Tests: Before shipment, factory test engine-generator set and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:

1. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.
2. Test generator, exciter, and voltage regulator as a unit.
3. Full load run.
4. Maximum power.
5. Voltage regulation.
6. Transient and steady-state governing.
7. Single-step load pickup.
8. Safety shutdown.
9. Provide 14 days' advance notice of tests and opportunity for observation of tests by Owner's representative.
10. Report factory test results within 10 days of completion of test.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine-generator performance.

B. Examine roughing-in for piping systems and electrical connections. Verify actual locations of connections before packaged engine-generator installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify Architect no fewer than two working days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without Architect's written permission.

3.3 INSTALLATION

A. Comply with packaged engine-generator manufacturers' written installation and alignment instructions and with NFPA 110.

B. Equipment Mounting:

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1. Install packaged engine generators on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Cast-in-Place Concrete." section
2. Coordinate size and location of concrete bases for packaged engine generators. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
3. Coordinate size and location of roof curbs, equipment supports, and roof penetrations for remote radiators. These items are specified in Section 077200 "Roof Accessories."

C. Install packaged engine-generator to provide access, without removing connections or accessories, for periodic maintenance.

D. Install packaged engine-generator with restrained spring isolators having a minimum deflection of 1 inch (25 mm on 4-inch- (100-mm-) high concrete base. Secure enclosure to anchor bolts installed in concrete bases.

E. Install condensate drain piping to muffler drain outlet full size of drain connection with a shutoff valve, stainless-steel flexible connector, and Schedule 40, black steel pipe with welded joints.

F. Installation requirements for piping materials and flexible connectors are specified in Section 232116 "Hydronic Piping Specialties." Copper and galvanized steel shall not be used in the fuel-oil piping system.

G. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

3.4 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping and specialties.

B. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine-generator to allow service and maintenance.

C. Connect engine exhaust pipe to engine with flexible connector.

D. Connect fuel piping to engines with a gate valve and union and flexible connector.

1. Diesel storage tanks, tank accessories, piping, valves, and specialties for fuel systems are specified in mechanical piping section.

E. Ground equipment according to Section 16100 Electrical.

F. Connect wiring according to Section 16100 Electrical. Provide a minimum of one 90 degree bend in flexible conduit routed to the generator set from a stationary element.

G. Balance single-phase loads to obtain a maximum of 10 percent unbalance between any two phases.

3.5 IDENTIFICATION

A. Install a sign indicating the generator neutral is bonded to the main service neutral at the main service location.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections.

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1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections.

D. Tests and Inspections:

1. Perform tests recommended by manufacturer and each visual and mechanical inspection and electrical and mechanical test listed in the first two subparagraphs as specified in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   a. Visual and Mechanical Inspection
      1) Compare equipment nameplate data with drawings and specifications.
      2) Inspect physical and mechanical condition.
      3) Inspect anchorage, alignment, and grounding.
      4) Verify the unit is clean.
   b. Electrical and Mechanical Tests
      1) Perform insulation-resistance tests in accordance with IEEE 43.
         a) Machines larger than 200 horsepower (150 kilowatts). Test duration shall be 10 minutes. Calculate polarization index.
         b) Machines 200 horsepower (150 kilowatts) or less. Test duration shall be one minute. Calculate the dielectric-absorption ratio.
      2) Test protective relay devices.
      3) Verify phase rotation, phasing, and synchronized operation as required by the application.
      4) Functionally test engine shutdown for low oil pressure, overtemperature, overspeed, and other protection features as applicable.
      5) Conduct performance test in accordance with NFPA 110.
      6) Verify correct functioning of the governor and regulator.
2. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to, single-step full-load pickup test.
3. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.
   a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
   b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
   c. Verify acceptance of charge for each element of the battery after discharge.
   d. Verify that measurements are within manufacturer's specifications.
4. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
5. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine-generator system before and during system operation. Check for air, exhaust, and fluid leaks.
6. Exhaust-System Back-Pressure Test: Use a manometer with a scale exceeding 40-inch wg (120 kPa). Connect to exhaust line close to engine exhaust manifold. Verify that back pressure at full-rated load is within manufacturer's written allowable limits for the engine.
7. Exhaust Emissions Test: Comply with applicable government test criteria.

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8. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.
9. Harmonic-Content Tests: Measure harmonic content of output voltage at 25 percent and 100 percent of rated linear load. Verify that harmonic content is within specified limits.
10. Noise Level Tests: Measure A-weighted level of noise emanating from generator-set installation, including engine exhaust and cooling-air intake and discharge, at four locations 25 feet (7.6 m) from edge of the generator enclosure, and compare measured levels with required values.
11. Perform 8 hour load bank test.
    a. Perform manufacturer's after-starting checks and inspections.
    b. Test the engine generator for six hours of continuous operation as follows:
        1) Two hours while delivering 100% of the specified kW.
        2) Four hours while the engine generator is delivering 80% of its specified kW rating.
        3) If during the 6-hour continuous test, an engine generator failure occurs or the engine generator cannot maintain specified power output, the test(s) are null and void. After repair and/or adjustments, the test(s) shall be repeated at no additional cost to the Government until satisfactory results are attained.
        4) Record the following test data at 30-minute intervals:
            a) Time of day, as well as reading of running time indicator.
            b) kW.
            c) Voltage on each phase.
            d) Amperes on each phase.
            e) Engine RPM.
            f) Frequency.
            g) Coolant water temperature.
            h) Fuel pressure.
            i) Oil pressure.
            j) Outdoor temperature.
            k) Average ambient temperature in the vicinity of the engine generator.
        5) Demonstrate that the engine generator will attain proper voltage and frequency within the specified time limit from a cold start after the closing of a single contact.
        6) Furnish a resistance-type load for the testing of the engine generator. Test loads shall always include adequate resistance to assure stability of the loads and equipment during all of the testing operations. The test load kW rating shall not be less than 100% of the specified kW rating of the engine generator.
        7) Starting System Test:
            a) Demonstrate that the batteries and cranking motor are capable of five starting attempts of 10 seconds cranking each at 10-second intervals with the battery charger turned off.
            b) Remote Annunciator Panel Tests:
                i. Simulate conditions to verify proper operation of each visual or audible indication, interconnecting hardware and software, and reset button.
        8) Fuel systems shall be flushed and tested.

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9) Automatic Operation Tests:
   a) Test the engine generator and associated automatic transfer switches to demonstrate automatic starting, loading and unloading. The load for this test shall be the actual connected loads. Initiate loss of normal source and verify the specified sequence of operation. Restore the normal power source and verify the specified sequence of operation. Verify resetting of controls to normal.
10) At the completion of the field tests, fill the main storage tank and day tank with fuel of grade and quality as recommended by the manufacturer of the engine. Fill all engine fluids to levels as recommended by manufacturer.
11) When any defects are detected during the tests, correct all the deficiencies and repeat all or part of the 6-hour continuous test as requested by the engineer at no cost to the owner.
12) Provide test and inspection results in writing to the engineer for review and acceptance.

E. Coordinate tests with tests for transfer switches and run them concurrently.
F. Test instruments shall have been calibrated within the last 12 months, traceable to NIST Calibration Services, and adequate for making positive observation of test results. Make calibration records available for examination on request.
G. Leak Test: After installation, charge exhaust, coolant, and fuel systems and test for leaks. Repair leaks and retest until no leaks exist.
H. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation for generator and associated equipment.
I. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
J. Remove and replace malfunctioning units and retest as specified above.
K. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.
L. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

3.7 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Final Acceptance, provide 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include quarterly exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Provide parts and supplies same as those used in the manufacture and installation of original equipment.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators.

END OF SECTION

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SECTION 16415
AUTOMATIC TRANSFER SWITCHES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes transfer switches rated 600 V and less, including the following:
   1. Non-automatic transfer switches.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, weights, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Dimensioned plans, elevations, sections, and details showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.

   1. Single-Line Diagram: Show connections between transfer switch, bypass/isolation switch, power sources, and load; and show interlocking provisions for each combined transfer switch and bypass/isolation switch.

C. Qualification Data: For manufacturer.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:

   1. Features and operating sequences, both automatic and manual.
   2. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Maintain a service center capable of providing training, parts, and emergency maintenance repairs within a response period of less than eight hours from time of notification.

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B. Source Limitations: Obtain non-automatic transfer switches through one source from a single manufacturer.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with NEMA ICS 1.

E. Comply with NFPA 70.

F. Comply with NFPA 99.

G. Comply with NFPA 110.

H. Comply with UL 1008 unless requirements of these Specifications are stricter.

1.5 PROJECT CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service:

1. Notify Contracting Officer no fewer than two days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without the government's written permission.

1.6 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Contactor Transfer Switches:
   a. Caterpillar; Engine Div.
   b. Emerson; ASCO Power Technologies, LP.
   c. Generac Power Systems, Inc.
   d. GE Zenith Controls.
   e. Onan/Cummins Power Generation; Industrial Business Group.
   f. Russelectric, Inc.

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2.2 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS

A. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.

B. Tested Fault-Current Closing and Withstand Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.

1. Where transfer switch includes internal fault-current protection, rating of switch and trip unit combination shall exceed indicated fault-current value at installation location.

C. Solid-State Controls: Repetitive accuracy of all settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.

D. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.

E. Electrical Operation: Accomplish by a non-fused, momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions.

F. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.

1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are not acceptable.
2. Switch Action: Double throw; mechanically held in both directions.
3. Contacts: Silver composition or silver alloy for load-current switching. Conventional automatic transfer-switch units, rated 225 A and higher, shall have separate arcing contacts.

G. Neutral Terminal: Solid and fully rated, unless otherwise indicated. Transfer switch to be 4 pole per drawing E7.1.

H. Oversize Neutral: Ampacity and switch rating of neutral path through units indicated for oversize neutral shall be double the nominal rating of circuit in which switch is installed.

I. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, either by color-code or by numbered or lettered wire and cable tape markers at terminations. Color-coding and wire and cable tape markers are specified in Division 26 Section "Electrical Identification."

1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.

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2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.

J. Enclosures: General-purpose NEMA 250, Type 3R complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

2.3 AUTOMATIC TRANSFER SWITCHES

A. Comply with Level 1 equipment according to NFPA 110.

B. Switching Arrangement: Double-throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated.

C. Manual Switch Operation: Under load, with door closed and with either or both sources energized. Transfer time is same as for electrical operation. Control circuit automatically disconnects from electrical operator during manual operation.

D. Manual Switch Operation: Unloaded. Control circuit automatically disconnects from electrical operator during manual operation.

E. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval is adjustable from 1 to 30 seconds.

F. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.

G. Transfer Switches Based on Molded-Case-Switch Components: Comply with NEMA AB 1, UL 489, and UL 869A.

H. Automatic Open-Transition Transfer Switches: Include the following functions and characteristics:

1. Fully automatic make-before-break operation.
2. Load transfer without interruption, through momentary interconnection of both power sources not exceeding 100 ms.
3. Initiation of No-Interruption Transfer: Controlled by in-phase monitor and sensors confirming both sources are present and acceptable.

    a. Initiation occurs without active control of generator.
    b. Controls ensure that open-transition load transfer closure occurs only when the 2 sources are within plus or minus 5 electrical degrees maximum, and plus or minus 5 percent maximum voltage difference.

4. Failure of power source serving load initiates automatic break-before-make transfer.

I. In-Phase Monitor: Factory-wired, internal relay controls transfer so it occurs only when the two sources are synchronized in phase. Relay compares phase relationship and

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frequency difference between normal and emergency sources and initiates transfer when both sources are within 15 electrical degrees, and only if transfer can be completed within 60 electrical degrees. Transfer is initiated only if both sources are within 2 Hz of nominal frequency and 70 percent or more of nominal voltage.

J. Motor Disconnect and Timing Relay: Controls designate starters so they disconnect motors before transfer and reconnect them selectively at an adjustable time interval after transfer. Control connection to motor starters is through wiring external to automatic transfer switch. Time delay for reconnecting individual motor loads is adjustable between 1 and 60 seconds, and settings are as indicated. Relay contacts handling motor-control circuit inrush and seal currents are rated for actual currents to be encountered.

K. Programmed Neutral Switch Position: Switch operator has a programmed neutral position arranged to provide a midpoint between the two working switch positions, with an intentional, time-controlled pause at midpoint during transfer. Pause is adjustable from 0.5 to 30 seconds minimum and factory set for 0.5 second, unless otherwise indicated. Time delay occurs for both transfer directions. Pause is disabled unless both sources are live.

L. Automatic Transfer-Switch Features:

1. Undervoltage Sensing for Each Phase of Normal Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage is adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
2. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals. Adjustable from zero to six seconds, and factory set for one second.
3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
4. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes, and factory set for 10 minutes to automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
5. Test Switch: Simulate normal-source failure.
6. Switch-Position Pilot Lights: Indicate source to which load is connected.
7. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.

    a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
    b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."

8. Provide source indicating annunciator in the dispatch room to indicate sources available for facility as well as current source providing power to the facility.

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9. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
10. Transfer Override Switch: Overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
11. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
12. Engine Shutdown Contacts: Instantaneous; shall initiate shutdown sequence at remote engine-generator controls after retransfer of load to normal source.
13. Engine Shutdown Contacts: Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.
14. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods are adjustable from 10 to 30 minutes. Factory settings are for 7-day exercise cycle, 60-minute running period, and 10-minute cool-down period. Exerciser features include the following:

    a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
    b. Push-button programming control with digital display of settings.
    c. Integral battery operation of time switch when normal control power is not available.

2.4 NONAUTOMATIC TRANSFER SWITCHES

A. Operation: Electrically actuated by push buttons designated "Normal Source" and "Alternate Source." Switch shall be capable of transferring load in either direction with either or both sources energized.

B. Operation: Electrically actuated by push buttons designated "Normal Source" and "Alternate Source." In addition, removable manual handle provides quick-make, quick-break manual-switching action. Switch shall be capable of electrically or manually transferring load in either direction with either or both sources energized. Control circuit disconnects from electrical operator during manual operation.

C. Manually Operated Double-Throw Switching Arrangement: Incapable of pauses or intermediate position stops during switching sequence.

D. Nonautomatic Transfer-Switch Accessories:

1. Pilot Lights: Indicate source to which load is connected.
2. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and alternate-source sensing circuits.

    a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."

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b. Emergency Power Supervision: Red light with nameplate engraved "Alternate Source Available."

3. Unassigned Auxiliary Contacts: One set of normally closed contacts for each switch position, rated 10 A at 240-V ac.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Design each fastener and support to carry load indicated by seismic requirements and according to seismic-restraint details.

B. Identify components according to Division 16 Section "Electrical."

3.2 CONNECTIONS

A. Wiring to Remote Components: Match type and number of cables and conductors to control and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.

B. Ground equipment according to Division 16 Section "Electrical."

C. Connect wiring according to Division 16 Section "Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment as specified below. Refer to Division 1 Section "Demonstration and Training."

B. Coordinate this training with that for generator equipment.

END OF SECTION 16415

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SECTION 16715

STRUCTURED CABLING SYSTEM

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

A. General Requirements/Provisions shall be considered a part of this section and shall have the same force as if printed herein full. In addition, all information related to communications infrastructure that is documented in the architectural, structural, mechanical, and electrical drawings/documents shall be considered as part of the communications documents.

1.02 QUALITY ASSURANCE

A. Specifications, Standards and Codes: All work shall be in accordance with the following:

1. The current edition of the National Electrical Code (NFPA 70)
2. American National Standards Institute (ANSI)
3. National Electrical Manufacturers Association (NEMA)
4. Telecommunications Industries Association (TIA)
5. Electronic Industries Association (EIA)
6. Institute of Electrical & Electronics Engineers (IEEE)
7. Underwriters Laboratories (UL)
8. American Standards Association (ASA)
9. Federal Communications Commission (FCC)
10. Occupational Safety and Health Administration (OSHA)
11. American Society of Testing Material (ASTM)
12. Americans with Disabilities Act (ADA)
13. Local city and county ordinances governing electrical work
14. In the event of conflicts, the more stringent provisions shall apply.

1.03 SCOPE

A. The work under this section of the specifications shall include furnishing labor, material and equipment required to provide a complete installation of the work indicated on the drawings or as specified herein.

B. All material required to provide a fully operational system but not specifically mentioned or shown on the drawings, shall be furnished and installed without any additional charge.

C. The drawings and specifications are complementary to each other and what is called for by one shall be as binding as if called for by both. If a discrepancy exists between the drawings and specifications, the more stringent shall be included, and the engineer shall be notified of the discrepancy.

D. All structured cabling that is routed thru underground conduits shall be outside plant rated.

1.04 WORK INCLUDED

The Communications Infrastructure installed and work performed under this Division of the Specifications shall include but are not limited to the following:

A. Data Cabling Infrastructure
B. Audio Video Cabling Infrastructure System
C. Wireless Access System Cabling

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D. Communications raceways, cable tray, ladder rack, racks and equipment mounting backboards
E. Grounding and Bonding

1.05 DEFINITIONS

A. Terms: The following definitions of terms supplement those of the General Requirements and are applicable to Division 27 - Communications:
B. Provide: As used herein shall mean “furnish, install and test (if applicable) complete.”
C. Infrastructure: As used herein shall mean cable, conduit, raceway, cable tray or j-hooks with all required boxes, fittings, connectors, and accessories; completely installed.
D. Work: As used herein shall be understood to mean the materials completely installed, including the labor involved.

1.06 DRAWINGS

A. Drawings are diagrammatic and show the arrangement and location of pathways, outlets, support structures and equipment. The contractor shall carefully investigate the structural and finish conditions affecting his work and arrange his work accordingly. Should conditions on the job make it necessary to make adjustments to pathways or materials, the contractor shall advise the engineer in writing for approval before proceeding with such work.
B. Materials, equipment or labor not specifically indicated but required to form a complete system shall be provided. Drawings and Specifications do not indicate every item of material, equipment, or labor required to produce a complete and properly operating installation.
C. The right is reserved to make reasonable changes in locations of equipment indicated on drawings prior to rough-in without increase in contract cost.
D. The contractor shall not reduce the size or number of conduit runs indicated on the drawings without the written approval of the Engineer.
E. Any work installed contrary to contract drawings shall be subject to change as directed by the Engineer, and no extra compensation will be allowed for making these changes.
F. The location of equipment, support structures, outlets, and similar devices shown on the drawings are approximate only. Do not scale drawings. Obtain layout dimensions for equipment from Architectural plans unless indicated on communications plans.
G. Verify the ceiling type, ceiling suspension systems, and clearance above ceilings prior to ordering cabling and associated hardware. Notify the engineer of any discrepancies.
H. Review all architectural drawings for modular furniture layouts.

1.07 SUBMITTALS

A. Submit for approval, manufacture specifications of all materials, equipment and systems to be furnished. Work shall not proceed without the Engineer’s approval of the submitted items. Three (3) copies of the following shall be submitted:

1. Submittal specification sheets for individual items for equipment assemblies that consist of more than one item or component shall be submitted. Each specification sheet shall be reviewed and sealed by contractors RCDD. Partial or incomplete submittals will not be considered, reviewed or stored, and such submittals will not be returned except at the request and expense of the contractor.
2. Contractor shall generate shop drawings. Modify reviewed and accepted shop drawings to include revisions based upon completion of work. Submit shop drawings with record drawings on hard copy. Additionally, provide one electronic copy of shop drawings in both AutoCad format (.dwg file) and Visio format(.vsdx

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file). Failure to submit electronic file with drawings will be grounds for immediate rejection.

3. Shop drawings shall include equipment racks, patch panels, termination blocks, connection details, rack mounting details and any other details not included in the construction drawings. All Submittal drawings shall be prepared and sealed by the contractors RCDD for approval.

B. Any materials and equipment listed that are not in accordance with specification requirements may be rejected.

C. The approval of material, equipment, systems and shop drawings is a general approval subject to the drawings, specifications and verification of all measurements at the job. Approval does not relieve the Contractor from the responsibility of shop drawing errors. The contractor shall carefully check and correct all shop drawings prior to submission for approval.

1.08 QUALITY ASSURANCE

A. Equipment and materials required for installation under these Specifications shall be the current model and new (less than one [1] year from the date of manufacture), unused and without blemish or defect.

B. Equipment shall bear labels attesting to Underwriters Laboratories, where subject to label service. Manufacturers of equipment and materials pertinent to these items shall have been engaged in the manufacture of said equipment a minimum of three (3) years and be able to furnish proof of their ability by submitting affidavits and descriptive data about their product including size and magnitude comparable to requirements specified herein.

1.09 CONTRACTOR QUALIFICATIONS

A. The contractor shall have total responsibility for the coordination and installation of the work shown and described in the drawings and specifications. The contractor shall be a company specializing in the design, fabrication and installation of integrated communications systems.

B. Communication systems specified shall be installed under the direction of a qualified Contractor. Qualification requirements shall include submittal by the contractor to the engineer of the following:

1. List of five [5] previous projects of this scope, size and nature; including names and sizes of projects, description of work, time of completion and names of contact persons for reference.

2. Certification of contractor’s manufacturer-authorization to provide material, perform installation and provide a minimum 25 year manufactures warranty for work to be performed under this contract. <u>This must be provided with submittals for approval.</u>

C. Contractor must have a Registered Communications Distribution Designer (RCDD) on staff. This individual must be a W-2 employee of data contractor. Various types RCDD contractors are not allowed for this project.

D. Submit copy of contractor’s RCDD Certificate and resume for verification and approval at time of submittal.

E. All submittal documentation shall be prepared, sealed and signed by the contractors RCDD for approval.

F. Contractor shall have a certified BICSI Technician present at all times during the installation and/or testing of the entire Structured Cabling System.

G. Contractor must have an office regularly staffed on a daily basis with certified service and installation technicians within a 100 mile radius of the project site.

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1.10 COORDINATION WITH OTHER TRADES

A. The Contractor shall coordinate communications work with that of other sections as required ensuring that the entire communications work will be carried out in an orderly, complete and coordinated fashion.

1.11 PERMITS

A. Obtain all permits and inspections for the installation of this work and pay all charges incident thereto. Deliver to the Owner all certificates of said inspection issued by authorities having jurisdiction.

PART 2 - PRODUCTS

2.01 SUBSTITUTIONS

A. Where equipment is identified by manufacturer and catalog number, it shall be as the base of requirements for quality and performance. Where manufacturers for equipment are identified by name, the Contractor may submit for approval, similar equipment of other manufacturers as substitution. The Engineer's decision as to whether the submitted equipment is acceptable shall be final and binding.
B. All changes necessary to accommodate the substituted equipment shall be made at the contractor's expense, and shall be as approved by the Engineer. Detailed drawings indicating the required changes shall be submitted for approval at the time the substitution is requested.
C. If substitutions are made in lieu of devices specified; form, dimension, design and profile shall be submitted to the Engineer for approval.
D. Submit request for approval of substitute materials in writing to the Engineer at least ten (10) days prior to bid opening for review.

2.02 MATERIALS

A. All materials used in this work shall be new and shall bear the inspection label of Underwriters' Laboratories Inc. or certification by other recognized laboratory.
B. The published standards and requirements of the Telecommunications Industries Association (TIA), National Electrical Manufacturers Association (NEMA), the American National Standard Institute (ANSI), the Institute of Electrical and Electronic Engineers (IEEE), and the American Society of Testing Materials (ASTM), are made a part of these Specifications and shall apply wherever applicable.
C. Materials and equipment furnished shall be of current production by manufacturers regularly engaged in the manufacture of such items, for which replacement parts are available.
D. When more than one unit of the same class of equipment or material is required, such units shall be the products of a single manufacturer or partner manufacturers that offer a certified solution.
E. Components shall be compatible with each other and with the total assembly for the intended service.

PART 3 - EXECUTION

3.01 EXAMINATION OF CONDITIONS

A. Prior to the start of work, the Contractor shall carefully inspect the installed work of other trades and verify that such work is complete to the point where installation may properly commence. Start of work indicates acceptance of conditions.

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B. Install equipment in accordance with applicable codes and regulations, the original design and the referenced standards.
C. In the event of a discrepancy, immediately notify the engineer in writing.
D. Do not proceed with installation until unsatisfactory conditions and discrepancies have been fully resolved.

3.02 PROTECTION OF SYSTEMS AND EQUIPMENT

A. Protect materials and equipment from damage during storage at the site and throughout the construction period. Equipment and materials shall be protected during shipment and storage against physical damage, dirt, theft, moisture, extreme temperature and rain.
B. During installation, equipment shall be protected against entry of foreign matter on the inside and be vacuum cleaned both inside and outside before testing, operating or painting.
C. As determined by the engineer, damaged equipment shall be fully repaired or shall be removed and replaced with new equipment to fully comply with requirements of the contract documents.
D. Damaged paint on any equipment or material shall be repainted to the same quality of paint, color, finish and workmanship as used by the manufacturer.

3.03 ACCESS TO EQUIPMENT

A. Equipment shall be installed in a location and manner that will allow convenient access for maintenance and inspection.
B. Working spaces shall be not less than specified in the National Electrical Code (NEC) for voltages specified.
C. Where the engineer determines that the contractor has installed equipment not conveniently accessible for operation and maintenance, equipment shall be removed and reinstalled, one time only, as directed by the engineer, at no additional cost to the Owner. “Conveniently accessible” is defined as being capable of being reached without the use of ladders or without climbing or crawling under or over obstacles such as motors, pumps, belt guards, transformers, piping and duct work.

3.04 CLEANING

A. During construction, and prior to Owner acceptance of the building, remove from the premises and dispose of all packing material and debris caused by communications work.
B. Remove dust and debris from interiors and exteriors of all communications equipment.

3.05 COMPLETION

A. General: Upon completion of the work, remove excess debris, materials, equipment, apparatus, tools and similar items. Leave the premises clean, neat and orderly.
B. Results Expected: Systems shall be complete and operational and controls shall be set and calibrated. Testing, start-up and cleaning work shall be complete.
C. Maintenance Materials: Special tools for proper operation and maintenance of the equipment provided under this specification shall be delivered to the Owner.

PART 4 – HORIZONTAL CABLING

4.01 APPROVED PRODUCTS

A. Approved Horizontal Copper Cable Manufacturer(s)

1. Berk-Tek

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2. Systimax (Uniprise Not Excepted)
3. Nexans
4. Hubbell

4.02 HORIZONTAL COPPER CABLE

A. Category 6 Balanced Twisted Pair Cable

1. The horizontal balanced twisted pair cable shall meet or exceed the Category 6 transmission characteristics per issue of ANSI/TIA-568-C.2.
2. Cable jacket shall be CMR or CMP rated (according to the space it occupies).
3. All Category 6 cabling shall be equal to Berk-Tek LANmark-1000 Category 6 cabling
4. Jacket color shall be:
   A. As detailed in drawing chart.

4.03 HORIZONTAL CABLES

A. Cable shall be installed in accordance with manufacturer's recommendations and best industry practices.
B. A plastic or nylon pull cord with a minimum test rating of 90 Kg (200 lb.) shall be co-installed with all cable installed in any conduit.
C. Cable raceways shall not be filled greater than the ANSI/TIA-569-B maximum fill for the particular raceway type.
D. Cables shall be installed in continuous lengths from origin to destination (no splices) except for transition points, or consolidation points.
E. Riser rated cable shall be installed in metallic conduit when installed in a plenum space.
F. Where transition points or consolidation points are allowed, they shall be located in accessible locations and housed in an enclosure intended and suitable for the purpose.
G. The cable's minimum bend radius and maximum pulling tension shall not be exceeded. Refer to manufacturer's requirements.
H. If a J-hook or trapeze system is used to support cable bundles all horizontal cables shall be supported at a maximum of 48 to 60 inch (1.2 to 1.5 meter) intervals. At no point shall cable(s) rest on acoustic ceiling grids, conduit, pipes, duct work or panels.
I. Horizontal distribution cables shall be bundled in groups of no more than 50 cables. Cable bundle quantities in excess of 50 cables may cause deformation of the bottom cables within the bundle and degrade cable performance.
J. Cable shall be installed above fire-sprinkler systems and shall not be attached to the system or any ancillary equipment or hardware. The cable system and support hardware shall be installed so that it does not obscure any valves, fire alarm conduit, boxes or other control devices.
K. Cables shall not be attached to ceiling grid or lighting fixture wires. Where support for horizontal cable is required, the Contractor shall install appropriate carriers from the building structure to support the cabling.
L. Any cable damaged or exceeding recommended installation parameters during installation shall be replaced by the Contractor prior to final acceptance at no cost to the Owner.
M. Cables shall be dressed and terminated in accordance with the recommendations made in the ANSI/TIA-568-C.2 document, manufacturer's recommendations and best industry practices.
N. Leave a minimum of 12" of slack for twisted pair cables at the outlet. Cables shall be coiled in the outlet box, surface-mount box or modular furniture raceway if adequate space is present to house the cable coil without exceeding the manufacturers bend radius. Excess slack shall be loosely coiled and stored in the ceiling above each drop location when there is not enough space present in the outlet box to store slack cable.
O. Cables shall be neatly bundled and dressed to their respective termination device. Each

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terminating device shall be fed by an individual bundle separated and dressed back to the point of cable entrance into the rack or frame.

P. Each cable shall be clearly labeled on the cable jacket behind the termination device at a location that can be viewed without removing the bundle support ties. Cables labeled within the bundle, where the label is obscured from view shall not be acceptable.

PART 5 – BACKBONE FIBER OPTIC CABLING

5.01 APPROVED PRODUCTS

A. Approved Optical Fiber Backbone Cable (Inside Plant) Manufacturer(s)

1. Berk-Tek
   a) 12 Strand OS2
2. Systimax (Uniprise Not Excepted)
3. Nexans

B. Approved Optical Fiber Backbone Cable (Outside Plant) Manufacturer(s)

1. Berk-Tek
   a) 12 Strand OM4 OSP Part #OPD012FB3010/F5
   b) 12 Strand OS2 OSP Part #OPD012AB0403
   c) 24 Strand OM4 OSP Part #OPDD12B024FB3010/F5
   d) 24 Strand OS2 OSP Part #OPDD12B024AB0403
2. Systimax (Uniprise Not Excepted)
3. Nexans

C. Approved Optical Splice Cassettes Manufacturer(s)

1. Leviton
   a) Splice Cassette OM4 Part #SPLCS-12A
   b) Splice Cassette OS2 Part #SPLCS-12L
   c) Splice Cassette OS2/APC Part #SPLCS-12V
2. Systimax (Uniprise Not Excepted)
3. Nexans

5.02 OPTICAL FIBER BACKBONE CABLE (INSIDE PLANT)

A. Indoor Distribution 850nm Laser-Optimized 50/125 Multimode Optical Fiber Conductive (OFCP) Loose Tube Cable (OM4)
   1. Generic Characteristics
      A. The indoor optical fiber cable shall be available with up to twelve 250-micron fibers placed in a color-coded sub-unit bundle with aramid strength elements.
      B. The indoor optical fiber cable shall meet or exceed the performance criteria found in ANSI/TIA-568-C.3.
      C. The indoor optical fiber cable shall have sequential length marking printed on the cable jacket.
      D. Maximum attenuation dB/Km @ 850/1300 nm: 3.0/1.0
      E. Minimum overfilled modal bandwidth: 3500 MHz-km @ 850 nm.
      F. Minimum overfilled modal bandwidth: 500 MHz-km @ 1300 nm.
      G. Minimum effective modal bandwidth: 4700 MHz-km @ 850nm.

5.03 OPTICAL FIBER BACKBONE CABLE (OUTSIDE PLANT)

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A. Outdoor 850nm Laser Optimized 50/125 Multimode Optical Fiber Non Conductive (OFNR) Loose Tube Cable (OM4)

1. Generic Characteristics
   A. The indoor/outdoor optical fiber cable with up to twelve 250-micron coated fibers placed in a color-coded sub-unit bundle with moisture-blocking gel.
   B. The indoor/outdoor optical fiber cable shall meet or exceed the performance criteria found in ANSI/TIA-568-C.3.
   C. The indoor/outdoor optical fiber cable shall have sequential length markings printed on the cable jacket.
   D. Maximum attenuation dB/Km @ 850/1300 nm: 3.0/1.0
   E. Minimum overfilled modal bandwidth: 3500 MHz-km @ 850 nm.
   F. Minimum overfilled modal bandwidth: 500 MHz-km @ 1300 nm.
   G. Minimum effective modal bandwidth: 4700 MHz-km @ 850nm

B. Outdoor 8.3/125-micron, Singlemode Optical Fiber Non Conductive (OFNR) Loose Tube cable (OS2)

1. Generic Characteristics
   A. The indoor/outdoor optical fiber cable with up to twelve 250-micron coated fibers placed in a color-coded sub-unit bundle with moisture-blocking gel.
   B. The indoor/outdoor optical fiber cable shall meet or exceed the performance criteria found in ANSI/TIA-568-C.3.
   C. The indoor/outdoor optical fiber cable shall have sequential length markings printed on the cable jacket.
   D. All singlemode fibers shall be pigtail spliced into a rack mounted optical fiber enclosure or wall-mounted enclosure.
   E. The loss of fiber shall not exceed 0.5 dB per kilometer @ 1550 nm and 0.5 dB per kilometer @ 1310 nm.

5.04 OPTICAL FIBER PIGTAIL ASSEMBLIES

A. Singlemode Fiber Connectivity

1. The optical fiber pigtail assemblies shall be factory terminated LC for installation onto singlemode 8.3/125-micron fiber.
2. The optical fiber pigtail connectors shall meet or exceed the performance criteria found in ANSI/TIA-568-C.3.
3. The optical fiber pigtail connectors shall be compatible with 900-micron buffered fibers or 250-micron loose-tube fibers.
4. All singlemode fiber pigtail assemblies shall be installed by fusion splicing method only (No Exceptions).
5. Pigtails shall be factory terminated to a color-coded 900-micron buffer tube 3 meters in length. All fiber enclosure shall be equipped with slack storage splice trays that shall be used for housing all pigtail-splicing.
6. The fusion splice loss of each pigtail connector shall not exceed 0.05 dB.
7. The optical fiber adapter module that occupies the faceplate shall be equipped with zirconia ceramic sleeve.
8. Singlemode fiber connector boot color shall be Blue for OS2 and Green for OS2/APC.

B. Multimode Fiber Connectivity

1. The optical fiber pigtail assemblies shall be factory terminated LC for installation

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onto multimode 50/125-micron fiber.

2. The optical fiber pigtail connectors shall meet or exceed the performance criteria found in ANSI/TIA-568-C.3.
3. The optical fiber pigtail connectors shall be compatible with 900-micron buffered fibers or 250-micron loose-tube fibers.
4. All multimode fiber pigtail assemblies shall be installed by fusion splicing method only (No Exceptions).
5. Pigtails shall be factory terminated to a color-coded 900-micron buffer tube 3 meters in length. All fiber enclosure shall be equipped with slack storage splice trays that shall be used for housing all pigtail-splicing.
6. The fusion splice loss of each pigtail connector shall not exceed 0.05 dB.
7. The optical fiber adapter module that occupies the faceplate shall be equipped with zirconia ceramic sleeve.
8. Multimode fiber connector boot color shall be Aqua.

5.05 FIBER OPTIC ENCLOSURE SPLICE TRAYS

A. Splice Tray

1. Splice trays shall be capable of housing a maximum of 24 strands of fiber. No more than 24 stands of fiber shall be installed in each splice tray.
2. All splice trays, seals and hardware shall be from the same manufacturer as the rack or wall mount fiber optic enclosure.
3. Splice trays shall utilize heat-shrink seals.

5.06 BACKBONE FIBER OPTIC CABLES (INSIDE PLANT)

A. Cables shall be dressed and terminated in accordance with the recommendations made in ANSI/TIA-568-C.0 and/or ANSI/TIA-568-C.1, manufacturer's recommendations and best industry practices.
B. Backbone cables shall be installed separately from horizontal distribution cables
C. A plastic or nylon pull cord with a minimum test rating of 90 Kg (200 lb.) shall be co-installed with all cable installed in any conduit.
D. Where cables are housed in conduits, the backbone and horizontal cables shall be installed in separate conduits
E. Exposed cables must be OFCP rated if installed in an air return plenum. Riser rated cables shall be installed in metallic conduit if installed in an air return plenum.
F. Where backbone cables and distribution cables are installed in a cable tray or wire way, backbone cables shall be installed first and bundled separately from the horizontal distribution cables.
G. Leave 10' of slack on each end of fiber backbone cable.
H. Backbone cables spanning more than three floors shall be securely attached at the top of the cable run with a wire mesh grip and on alternating floors or as required by local codes.
I. Vertical runs of cable shall be supported to messenger strand, cable ladder, or other method to provide proper support for the weight of the cable.
J. Large bundles of cables and/or heavy cables shall be attached using metal clamps and/or metal banding to support the cables.
K. The cable's minimum bend radius and maximum pulling tension shall not be exceeded. Refer to manufacturer's requirements.
L. Each optical fiber cable shall be individually attached to the respective enclosure by mechanical means. The cables strength member shall be securely attached the cable strain relief bracket in the enclosure.
M. Each optical fiber cable shall be clearly labeled at the entrance to the enclosure. Cables labeled within the bundle shall not be acceptable.
N. Each fiber bundle shall be stripped upon entering the splice tray and the individual fibers

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routed in the splice tray.

O. A maximum of 24 strands of fiber shall be spliced in each tray

P. Fiber slack shall be neatly coiled within the fiber splice tray or enclosure. No slack loops shall be allowed external to the fiber panel.

5.07 BACKBONE FIBER OPTIC CABLES (OUTSIDE PLANT)

A. All OSP cables brought to the Entrance Facilities shall have 15ft of slack coiled and secured to the wall in the proximity of the fiber enclosure.

B. All cables shall be tagged and identified within each hand-hole/maintenance hole.

C. Place initial cables in bottom conduits to facilitate easy subsequent cable placement.

D. Place leader guard in the duct before placing cable to prevent damaging the cable sheath on the sharp edge of the duct.

E. Ventilate maintenance where gas has been detected before entering the maintenance hole.

F. To ensure that the optical fiber cable's qualities and characteristics are not degraded during installation, excessive pulling tensions and short bending radii will not be allowed. The maximum pulling tension is 600 lbs. The minimum bending radius for cable under tension is 20 times the outside diameter of the cable and for cable at rest is 10 times the outside diameter of the cable.

G. A 600 lb. break-away swivel, along with a slip clutch capstan winch that shows the dynamometer (pulling tension) reading, shall be used at all times during pulling.

H. Reels shall be continuously manned during cable installation.

I. Cable coils shall have at least two points of support on the optical fiber racking system.

J. When mounting the optical fiber slack coils, the minimum bend radius shall not be exceeded; this radius is equal to 10 times the outside diameter of the cable in a static application and 20 times the outside diameter in a dynamic application. At any time during the entire handling process of the optical fiber cable, as much care as possible should be maintained and all the manufacturer's recommendations should be followed.

5.08 OPTICAL FIBER CONNECTIVITY / SPLICING

A. Optical fiber pigtails shall be installed as per the requirements specified by the manufacturer's installation guidelines.

B. All splicing shall be of the fusion type made under Light Injection and Detection Mode. The Contractor shall provide certified and experienced personnel for splicing.

C. Contractor's tools and equipment shall be in excellent working order. Any worn or improperly working tools shall be discarded and not used on this project. All fusion splicers shall be calibrated and labeled according to the manufacturer's specifications. Contractor shall submit certification of calibration for the fusion splicers to the Engineer.

PART 6 – FACEPLATES AND CONNECTORS

6.01 APPROVED PRODUCTS

A. Approved Copper Connectivity Manufacturer(s)

1. Leviton
2. Systimax (Uniprise Not Excepted)
3. Nexans

B. Approved Faceplate Manufacturer(s)

1. Leviton
2. Systimax (Uniprise Not Excepted)
3. Siemon

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6.02 AUDIO VISUAL APPROVED PRODUCTS

A. Approved Faceplate Module Manufacture(s)

1. Quiktron Rapid Run
2. Extron
3. Or Approved Equal

B. Approved Faceplate Modules

1. HDMI Module: Quiktron Part #42419
2. USB Transmitter Module: Extron Part #60-1252-13
3. USB Receiver Module: Extron Part #60-1252-73

6.03 COPPER CONNECTIVITY

A. Voice/Data Jacks

1. Category 6, 8-Position, 8-Contact (8P8C) Modular Jack
   A. The connector module shall meet or exceed the Category 6E performance criteria per ANSI/TIA-568-C.2.
   B. The eight-position connector module shall accommodate six-position modular plug modular cords without damage to either the cord or the module.
   C. The connector module shall be designed for use at the work area (WA), communications room (TR) and/or equipment room (ER) without modification.
   D. The connector module shall be available in both the T568A and T568B wiring configurations within the same module.
   E. The connector module shall have an insulation displacement connection featuring insulation slicing of 22 to 24 AWG plastic-insulated solid copper conductors forming a gas-tight connection.

6.04 FACEPLATES

A. Faceplates

1. The faceplate housing the connector modules shall have no visible mounting screws.
2. The faceplate shall have a labeling capability using built-in labeling windows, to facilitate outlet identification and ease network management.
3. The faceplate shall provide flexibility in configuring multimedia workstation outlets that respond to present or future network application needs.
4. Each faceplate shall have a minimum of (4) ports per each outlet location. Each unpopulated port shall have a blank module installed that matches the color of the faceplate.
5. Faceplates shall be stainless steel unless noted otherwise. All faceplates shall match electrical outlet covers. Verify color and size of each faceplate prior to ordering.

6.05 COPPER CONNECTIVITY

A. Modular jacks shall be installed in accordance with manufacturer's recommendations and installation guides, and best industry practices.

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B. Pair untwist at the termination shall not exceed 13 mm (0.5 inch).
C. All outlet locations shall have color-coded 8P8C modular jacks installed. No cable shall be left unterminated.

6.06 FACEPLATES

A. Blank inserts shall be installed where ports are not used.
B. The same orientation and positioning of jacks and connectors shall be utilized throughout the installation.
C. Faceplates shall be installed straight and level.
D. Faceplates shall be installed at the same heights as electrical outlets.

PART 7 – PATCH PANELS AND FIBER OPTIC ENCLOSURES

7.01 APPROVED PRODUCTS

A. Approved Patch Panel Manufacturer(s)

1. Leviton
   a) 24 Port Patch Panel Part #49255-L24
   b) 48 Port Patch Panel Part #49255-L48
2. Systimax (Uniprise Not Excepted)
3. Nexans

B. Approved Optical Fiber Enclosure Manufacturer(s)

1. Leviton
   a) 1RU Rack Mount Fiber Enclosure Part #5R1UH-S03
   b) 2RU Rack Mount Fiber Enclosure Part #5R1UH-S06
   c) 4RU Rack Mount Fiber Enclosure Part #5R1UH-S12
2. Systimax (Uniprise Not Excepted)
3. Nexans

C. Approved Termination Block Manufacturer(s)

1. Leviton
2. Systimax (Uniprise Not Excepted)
3. Nexans
4. Siemon

D. Category 6 Patch Panel

1. The Category 6 patch panel shall be compatible with 19" equipment racks, cabinets or wall mount brackets.
2. The Category 6 patch panels shall be 24 or 48 port unloaded patch panels.
3. The Category 6 patch panels shall be sized to accommodate one port for each cable installed plus 25% spare capacity for future growth. All ports shall be filled with a removable 8-position color coded modular jacks for each system. No port shall be left empty or blank.
4. The Category 6 patch panel shall be equipped with removable 8-position modular jacks color coded for each system and shall allow for termination of both T568A and T568B wiring schemes.
5. Cabling shall not occupy the same patch panel. All cabling for each system shall be installed in separate patch panels with color coded modular jacks to match as specified.

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6. The Category 6 patch panel shall be equipped with front labeling windows to facilitate port identification.
7. The connector module shall meet or exceed the Category 6 performance criteria per ANSI/TIA-568-C.2.

7.02 OPTICAL FIBER PANELS/ENCLOSURES

A. Rack Mount Optical Fiber Enclosure

1. The rack mount optical fiber enclosure shall be equipped with a sliding drawer to access fibers.
2. The rack mount optical fiber enclosure shall be capable of terminating tight-buffered or loose tube optical fiber cable.
3. The rack mount optical fiber enclosure shall provide for bend radius control throughout the panel as well as storage space for slack cabling.
4. The panel/enclosure shall meet or exceed the performance criteria per ANSI/TIA-568-C.3.
5. The rack mount optical fiber panel/enclosure shall be equipped with optical fiber cassettes.
   A. The optical fiber adapter panels shall accommodate either multimode or singlemode terminated optical fiber.
   B. The optical fiber adapter panels shall be compatible with LC OM4, OS2, and OS2/APC connectors.
   C. Single-mode adaptors shall be blue or green in color and equipped with zirconia ceramic sleeves.

7.03 PATCH PANELS

A. Cables shall be dressed and terminated in accordance with the recommendations made in ANSI/TIA-568-C.0 and/or ANSI/TIA-568-C.1, manufacturer's recommendations and best industry practice.
B. Pair untwist at the termination shall not exceed 13 mm (0.5 inch).
C. Bend radius of the cable in the termination area shall not exceed 4 times the outside diameter of the cable.
D. Cables shall be neatly bundled and dressed to their respective patch panel. Each patch panel shall be fed by an individual bundle separated and dressed back to the point of cable entrance into the rack or frame.
E. Each cable shall be clearly labeled on the cable jacket behind the patch panel at a location that can be viewed without removing the bundle support ties. Cables labeled within the bundle, where the label is obscured from view shall not be acceptable.

7.04 OPTICAL FIBER PANELS/ENCLOSURES

A. Cables shall be dressed and terminated in accordance with the recommendations made in ANSI/TIA-568-C.0 and/or ANSI/TIA-568-C.1, manufacturer's recommendations and best industry practices.
B. Each cable shall be individually attached to the respective splice enclosure by mechanical means. The cables strength member shall be securely attached the cable strain relief bracket in the enclosure.
C. Bend radius of the optic fiber cable in the enclosure shall not exceed 10 times the outside diameter of the cable.
D. Each fiber bundle shall be stripped upon entering the splice tray and the individual fibers routed in the splice tray.
E. Each cable shall be clearly labeled at the entrance to the splice enclosure. Cables labeled within the bundle shall not be acceptable.
F. A maximum of 24 strands of fiber shall be spliced in each tray

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G. Fiber slack shall be neatly coiled within the fiber splice tray or enclosure. No slack loops shall be allowed external to the fiber panel.

PART 8 – PATCH CORDS

8.01 APPROVED PRODUCTS

A. Approved Copper Patch Cord Manufacturer(s)

1. Leviton
2. Systimax (Uniprise Not Excepted)
3. Nexans

B. Approved Fiber Patch Cord Manufacturer(s)

1. Leviton
2. Systimax (Uniprise Not Excepted)
3. Nexans

8.02 COPPER PATCH CORDS

A. Category 6 Patch Cords

1. Copper patch cords shall be installed as per the requirements specified by the manufacturer's installation guidelines.
2. The Category 6 patch cord shall be 4-pair, with 24 AWG solid or stranded copper conductors and 8-position modular plug.
3. The Category 6 modular cord cable shall be UL Listed as Type CMR.
4. The Category 6 patch cord shall meet or exceed the requirements of ANSI/TIA-568-C.2.
5. Lengths shall be 3’, 5’, 7’ and/or 10’ as required by the Owner.
6. Provide one patch cord for every cable installed that will be utilized for patching between patch panel and switches. Verify length and color with Owner prior to ordering.
7. Provide one patch cord for every cable installed at each work area outlet. Verify length and color with Owner prior to ordering.

8.03 FIBER PATCH CORDS

A. Singlemode Fiber Patch Cords

1. 8.3/125-micron singlemode fiber patch cord:
   A. Fiber patch cords shall be installed as per the requirements specified by the manufacturer's installation guidelines.
   B. The 8.3/125-micron fiber used in the singlemode fiber patch cord shall have a maximum attenuation of 1.0 dB/km @ 1310 nm and 1.0 dB/km @ 1550 nm.
   C. The optical fiber cord connector shall have a maximum insertion loss of 0.5 dB and a reflectance of -30 dB.
   D. The 8.3/125-micron singlemode fiber patch cord shall meet or exceed the requirements of ANSI/TIA-568-C.3.
   E. The optical fiber cord connector shall be LC to LC duplex.
   F. The singlemode fiber patch cord assembly shall be dual zip jacketed yellow in color.
   G. Lengths shall be 1m, 2m, and/or 3m as required by the application. Verify length with Owner prior to ordering.

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H. Provide a minimum of (3) OS2 LC to LC fiber optic patch cords per each IDF and a minimum of (12) OS2 LC to LC fiber optic patch cords in the MDF. Verify length with Owner prior to ordering.
I. Provide a minimum of (2) OS2/APC LC to SC fiber optic patch cords per each IDF requiring fiber terminated with OS2/APC fiber connectors and a minimum of (4) OS2/APC LC to SC fiber optic patch cords in the MDF. Verify length with Owner prior to ordering.

2. 50/125-Micron 850nm Laser Optimized Multimode Fiber Patch Cord (OM4)
A. Fiber patch cords shall be installed as per the requirements specified by the manufacturer's installation guidelines.
B. The 50/125-micron fiber used in the multimode fiber patch cord shall have a maximum attenuation of 3.0dB/km@ 850 nm and 1.0 dB/km @1300 nm.
C. The 50/125-micron 850nm laser optimized multimode fiber patch cord shall meet or exceed the requirements of ANSI/TIA-568-C.3.
D. The optical fiber cord connector shall be LC to LC duplex.
E. The multimode fiber cord assembly shall be dual zip jacketed.
F. Lengths shall be 1m, 2m, and/or 3m as required by the application.
G. Provide a minimum of (6) OM4 LC to LC fiber optic patch cords per each IDF and a minimum of (34) OM4 LC to LC fiber optic patch cords in the MDF. Verify length with Owner prior to ordering.

PART 9 – EQUIPMNET RACKS AND ENCLOSURES

9.01 APPROVED PRODUCTS

A. Approved Equipment Rack/Cabinet Manufacturer(s)

1. Chatsworth Products, Inc.
   a) 2-Post Floor Mounted Equipment Racks Part #48353-703
   b) 4-Post Adjustable Server Rack Part #15213-703
2. Hoffman
3. Eaton
4. Middle Atlantic

9.02 EQUIPMENT RACKS/CABINETS

A. Equipment Racks

1. The equipment rack shall be constructed of high strength, lightweight aluminum.
2. The vertical rails of the equipment rack shall be equipped with the EIA hole pattern.
3. 2 Post rack shall be: 7'H x 19"W floor mounted. Vertical channels shall be drilled and taped.
4. 4 Post rack shall be: 7’H with adjustable depth of 26-inches to 38-inches. Vertical channels shall have square punched mounting holes. Provide additional equipment mounting hardware, per each rack installed, to owner upon completion of the installation.
5. Provide a minimum of (50) 12X24 cage nuts with (50) 12X24 rack screws per each 4-Post rack and a minimum of (50) 12X24 rack screws per each 2-Post or wall mount rack provided/installed.
6. Rack color shall be black.

9.03 EQUIPMENT RACKS/CABINETS

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A. Equipment racks shall be securely attached to the concrete floor using minimum 3/8" hardware or as required by local codes.
B. Equipment racks shall be installed as per the requirements specified by the manufacturer's installation guidelines.
C. Equipment racks shall be placed with a minimum of 36-inch clearance from each of the corresponding walls: front, rear and one side of the rack or as indicated on Drawings.
D. All equipment racks shall be grounded to the telecommunications ground bus bar.
E. Mounting screws not used for installing patch panels and other hardware shall be bagged and left with the rack or turned over to the owner upon completion of the installation.

9.04 BACKBOARDS

A. Backboards shall be 3/4" void free plywood. Size of backboard shall be 4' x 8' mounted vertically 18” A.F.F. unless otherwise noted differently on Drawings. Backboards shall be painted with two (2) coats of gray fire-retardant paint.

PART 10 – CABLE MANAGEMENT AND LADDER RACK

10.01 APPROVED PRODUCTS

A. Approved Horizontal Cable Management Manufacturer(s)

1. Chatsworth Products, Inc.
   a) 2RU Horizontal Cable Manager Part #35441-702
2. Leviton
   a) 2RU Horizontal Cable Manager Part #492RU-HFR
3. Systimax (Uniprise Not Excepted)

B. Approved Vertical Cable Management Manufacturer(s)

1. Chatsworth Products, Inc.
   a) 6” Vertical Cable Manager Part #35521-703
   b) 8” Vertical Cable Manager Part #35522-703
2. Leviton
   a) 6” Vertical Cable Manager Part #4980L-VFR
   b) 8” Vertical Cable Manager Part #8980L-VFR
3. Systimax (Uniprise Not Excepted)

C. Approved Ladder Rack System Manufacturer(s)

1. Chatsworth Products, Inc.
   a) 12” Ladder Rack Part #11275-712
   b) 18” Ladder Rack Part #11275-718
2. Hoffman
3. Middle Atlantic

D. Approved Tie Wrap/Velcro Strap Manufacturer(s)

1. Leviton
2. Or Approved Equal

10.02 CABLE MANAGEMENT - HORIZONTAL

A. Horizontal Cable Management

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1. The horizontal wire manager shall be compatible with 19-inch equipment racks, cabinets or wall mount brackets.
2. The horizontal cable manager shall be double-sided to provide support/management for patch cords at the front of the panel and support/management of cables at the rear of the panel.
3. The horizontal cable manager shall be equipped with removable front and covers
4. The horizontal cable manager shall be 2 rack-units in height, installed above and below each patch panel and each switch as indicated on drawings.
5. Horizontal cable managers shall be black.

10.03 CABLE MANAGEMENT - VERTICAL

A. Vertical Cable Management

1. The vertical cable manger shall be 80” high double-sided, installed on both sides of all racks.
2. The vertical cable manager shall provide support/management for patch cords at the front of the rack and support/management of cables at the rear of the rack.
3. Vertical cable managers shall be installed on both sides of a single equipment rack. Where two (2) or more racks are positioned in a row, vertical cable managers shall be installed between each rack and each end of the row.
4. The vertical cable manager shall be a minimum width of 6".
5. Vertical cable manager color shall be black.

10.04 LADDER RACK

A. Ladder Rack System

1. See Drawings for ladder rack system details.
2. The ladder rack system shall be securely mounted with hardware (triangle brackets, top mounting plates, junction splice kits, butt splice kits, end caps, radius drop kits, etc.) designed for use with ladder rack systems per manufactures recommendations.
3. Ladder rack shall be 12” or 18” wide as indicated on drawings.
4. End caps shall be installed on the exposed ends of the ladder racks and channel supports. Protective covers shall be installed on threaded rods that come in contact with cabling plant.
5. All sections of ladder rack shall be properly grounded to the corresponding telecommunications ground bus bar in each communications room.
6. Ladder Rack System color shall be black.

10.05 TIE WRAPS AND VELCRO STRAPS

A. Tie Wraps and Velcro Straps

1. Tie wraps/Velcro straps installed in air handling spaces must be plenum rated.
2. Backbone cables shall be fastened to support structures with tie wraps/Velcro straps.
3. Horizontal cables shall be fastened to support structures with Velcro straps.
   A. Tie Wraps shall be plenum rated red in color.
   B. Velcro Strap color shall be black.
4. Tie wraps/Velcro straps shall be installed around cables at intervals of 12" minimum.
5. Tie wraps shall secure cables to ladder racks using an “X” pattern.
6. Do not over-cinch cables.

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10.06 D-RINGS

A. D-rings

1. D-Rings shall be used on backboards to support cables, patch cords and cross-connect wire.
2. D-Rings shall be made of high-strength, fire-retardant material with rounded edges to prevent damage to cable and wire insulation.
3. Provide D-Rings of appropriate size and quantity for proper cable management and support as required.
4. D-Rings shall be installed on 3/4" backboard, straight and level.

10.07 LADDER RACKS

A. Ladder rack system shall be installed straight, level and perpendicular to walls and ceiling slabs.
B. Ladder racks shall be supported at 4' intervals maximum.
C. Provide all hardware, accessories, fasteners, anchors, threaded rods and support channels required to provide a complete ladder rack system.
D. Provide ladder rack system at minimum on (2) adjacent walls in each communications room or as indicated on drawings.
E. See Drawings for ladder rack system details.

PART 11 – PATHWAYS

11.01 APPROVED PRODUCTS

A. Innerduct Conduit Manufacturer(s)

1. MaxCell
   a) 3-Cell Part #MXC4003XX
2. Carlon
   a) Plenum-Gard Flexible Conduit Part #CG4X4C-XXX
3. Or Approved Equal

B. Approved Cable Tray System Manufacturer(s)
1. Hoffman Quick Tray Pro Part #QTP4X18
2. Wire Basket Tray Part #WBT4X18
3. Or Approved Equal

C. Approved Cable Hanger Manufacturer(s)

1. Erico Products – Caddy HP Series
2. Hoffman
3. Or Approved Equal

D. Innerduct/Inner-Conduit Channel

1. Innerduct shall be corrugated PVC equipped with mule tape.
2. Inner-conduit channel (MaxCell) shall be 3-cell with each cell equipped with mule tape. Provide a minimum of (2) (Max Cell) 3-cell fabric duct per each underground conduit as indicated on drawings.
3. See Drawings for innerduct/inner-conduit channel (MaxCell) details.

11.02 COMMUNICATIONS OUTLET BOXES

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A. Outlet boxes and device covers shall be galvanized steel not less than 1/16" thick.
B. The dimensions of the outlet box shall be 4" x 4" square with a minimum depth of 2-1/8".
C. Outlet boxes shall be equipped with single gang device covers. Where installed in plaster, gypsum board, etc., covers shall be raised to compensate for the thickness of the wall finish.
D. Where outlet boxes are to be empty for future use, blank cover plates shall be used.

11.03 CABLE TRAY

A. Cable Tray System

1. Cable tray shall be aluminum construction.
2. Cable tray cross members shall be factory welded at 12" intervals maximum.
3. Cable tray shall be equipped with one (1) or two (2) support rails that run the length of each segment.
4. End caps shall be installed on the exposed ends of the cable tray, channel supports and bolts. Protective covers shall be installed on threaded rods that come in contact with cabling plant.
5. Wall mount cable tray used in limited clearance areas shall be hook style and constructed of aluminum.
6. Provide all cable tray hardware accessory assemblies required to properly install cable tray system per manufactures requirements.
7. See Drawings for cable tray dimensions.

11.04 CABLE HANGERS

A. J-Hooks

1. J-hooks shall provide sufficient width to comply with required bend radii of high-performance cables. J-hook shall be cULus Listed.
2. J-hooks shall have flared edges to prevent damage while installing cables.
3. J-hooks sized 1 5/16" and larger shall have a cable retainer strap to provide containment of cables within the hanger. The cable retainer strap shall be removable and reusable and be suitable for use in air handling spaces.

11.05 CABLE TRAY SYSTEM

A. Install trays in accordance with recognized industry practices, to ensure that the cable tray equipment complies with requirements of the NEC.
B. All open trays shall be installed a minimum of six (6) inches away from any light fixture.
C. Provide external grounding strap at expansion joints, sleeves, crossover and other locations where tray continuity is interrupted.
D. Support all pathways from building structure. Do not support pathways from ductwork, piping or equipment hangers.
E. Install cable tray level and straight.
F. Provide all hardware, accessories, fasteners, anchors, threaded rods and support channels required to provide a complete cable tray system.
G. Cable trays shall not be used to house both low voltage and power cables unless cables are separated by a grounded physical barrier.
H. Cable tray system shall be grounded in accordance with ANSI/TIA-607-B.

11.06 CABLE HANGERS

A. Installation and configuration shall conform to the requirements of ANSI/TIA-568-C.0, ANSI/TIA-568-C.1 & ANSI/TIA-569-B, NFPA 70 (National Electrical Code), applicable local codes, and to the manufacturer's installation instructions.

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B. Install cables using techniques, practices, and methods that are consistent with Category 6 or higher requirements and that supports Category 6 or higher performance of completed and linked signal paths, end to end.
C. Install cables without damaging conductors, shield, or jacket.
D. Do not bend cables, in handling or in installing, to smaller radii than minimums recommended by manufacturer.
E. Pull cables without exceeding cable manufacturer's recommended pulling tensions. Use pulling means that will not damage media.
F. Do not exceed load ratings specified by manufacturer.
G. Adjustable non-continuous support sling shall have a static load limit of 100 lbs.
H. To avoid electromagnetic interference (EMI), pathways shall provide minimum clearances of four feet from motors or transformers, one foot from conduit and cables used for electrical power distribution, and five inches from fluorescent lighting. Pathways shall cross perpendicular to fluorescent lighting and electrical power cables or conduits.

PART 12 – GROUNDING AND BONDING

12.01 APPROVED PRODUCTS

A. Approved Grounding Lug Manufacturer(s)

1. Harger
   a) 2 Hole Compression Lugs Part #GECLB62A
2. Hoffman
   a) 2 Hole Compression Lugs Part #DGCL61
3. Or Approved Equal

B. Approved Grounding Busbar Manufactures(s)

1. Harger
   a) Wall Mount TMGB Ground Bar Part #GBI14412TMGB
   b) Wall Mount TGB Ground Bar Part #GBI14212TGB
   c) Rack Mount Ground Bar Part #RGBHKIT14119.25
2. Hoffman
3. Or Approved Equal

C. Approved OSP Cable Shield Bond Connector Manufacturer(s)

1. 3M
   a) Shield Bond Connector Part #4460-S
2. Or Approved Equal

12.02 GROUNDING CONDUCTORS

A. Grounding Conductor

1. Construction shall be Type THHN copper conductors, insulated with heat and moisture resistant PVC over which a UL listed jacket is applied.
2. Jacket color shall be green.

12.03 GROUNDING LUGS

A. Grounding Lugs and Hardware

1. Grounding lugs shall be 2-hole compression type irreversible. Stainless steel bolts and washers shall be used to install lugs to equipment and grounding bus

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bars.

12.04 GROUNDING BUSBARS

A. Grounding Busbar

1. The grounding busbar shall be made of 1/4" thick solid copper.
2. The grounding busbar shall be installed with minimum clearance, 1" offsets and 1-1/2" insulators.
3. The grounding busbar shall accommodate 2-hole compression lugs.
4. The grounding busbar shall meet or exceed ANSI/TIA-607-B requirements.

12.05 GROUNDING

A. The facility shall be equipped with a Telecommunications Bonding Backbone (TBB). This backbone shall be used to ground all communications cable shields, equipment, racks, cabinets, raceways, and other associated hardware that has the potential to act as a current carrying conductor. The TBB shall be installed independent of the building's electrical and building ground and shall be designed in accordance with the recommendations contained in the ANSI/TIA-607-B Telecommunications Bonding and Ground Standard.
B. The main entrance facility/equipment room (EF/ER or MDF) in each building shall be equipped with a telecommunications main grounding busbar (TMGB). Each telecommunications room (TR or IDF) shall be provided with a telecommunications ground busbar (TGB). The TMGB shall be connected to the building electrical entrance grounding facility.
C. All racks, metallic backboards, cable sheaths, metallic strength members, splice cases, cable trays, etc. entering or residing in the EF, ER, or TR shall be grounded to the respective TGB or TMGB using a minimum #6 AWG stranded copper bonding conductor and compression lugs.
D. All wires used for communications grounding purposes shall be identified with a green insulation. Non-insulated wires shall be identified at each termination point with green tape. All cables and busbars shall be identified and labeled in accordance with the ANSI/TIA-606-A.

PART 13 - LABELING

13.01 LABELING REQUIREMENTS

A. Labeling shall be done in accordance with the recommendations made in the ANSI/TIA-606-A document, manufacturer's recommendations and best industry practices.
B. All spaces, pathways, outlets, cables, termination hardware, grounding system and equipment shall be labeled with machine-generated labels.
C. All labels shall be clear with black text.
D. All cables shall be labeled with machine generated, wrap around labels. Handwritten labels will not be accepted.
E. A total of three (3) labels per horizontal cable are required at the following intervals: 6" from outlet; 18" from outlet' 12" from termination block/patch panel.
F. Labeling scheme shall be alphanumeric. Verify labeling scheme requirements with Owner prior to installation.

PART 14 - TESTING

14.01 TESTING REQUIREMENTS

A. General

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1. All cables and termination hardware shall be 100% tested for defects in installation and to verify cabling system performance under installed conditions according to the requirements of ANSI/TIA-568-C.0, ANSI/TIA-568-C.1 and/or ANSI/TIA-1152. All conductors/strands of each installed cable shall be verified prior to system acceptance. Any defect in the cabling system installation including but not limited to cable, connectors, feed through couplers, patch panels, and connector blocks shall be repaired or replaced in order to ensure 100% useable conductors/strands in all cables installed.

B. Copper Testing

1. All twisted-pair copper cable links shall be tested for continuity, pair reversals, shorts, opens and performance as indicated below. Additional testing is required to verify Category 6 performance. Horizontal balanced twisted pair cabling shall be tested using a level IIe, III, or IV test unit for category 6 performance compliance.
2. Continuity - Each pair of each installed cable shall be tested using a test unit that shows opens, shorts, polarity and pair-reversals, crossed pairs and split pairs. The test shall be recorded as pass/fail as indicated by the test unit and referenced to the appropriate cable identification number and circuit or pair number. Any faults in the wiring shall be corrected and the cable re-tested prior to final acceptance.
3. Length - Each installed cable link shall be tested for installed length using a TDR type device. The cables shall be tested from patch panel to patch panel, block to block, patch panel to outlet or block to outlet as appropriate. The cable length shall conform to the maximum distances set forth in the ANSI/TIA-568-C.2 Standard. Cable lengths shall be recorded, referencing the cable identification number and circuit or pair number. For multi-pair cables, the shortest pair length shall be recorded as the length for the cable.

C. Fiber Testing

1. All fiber testing shall be performed on all fibers in the completed end-to-end system. There shall be no splices unless clearly defined in the RFP and/or Drawings. These tests also include continuity checking of each fiber.

2. Singlemode

A. Test the optical fiber cable bi-directionally with an OTDR and uni-directionally with a power meter/light source. Fiber must be tested at both 1310nm and 1550nm. Maximum attenuation dB/Km @ 1310nm/1550nm shall be 0.5/0.5 for outside plant and 1.0/1.0 for inside plant. Maximum attenuation per connector pair shall be .75 dB. Attenuation testing shall be performed with a stable launch condition using one-meter or two-meter jumpers to attach the test equipment to the cable plant. The light source shall be left in place after calibration and the power meter moved to the far end to take measurements. Test set-up and performance shall be conducted in accordance with ANSI/TIA-568-C.3 and to the manufacturer's application guides.

B. All fiber optic stands shall be tested utilizing the “Method B” one jumper reference.

3. Multimode

A. Test the optical fiber cable bi-directionally with an OTDR and uni-

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directionally with a power meter/light source. Fiber must be tested at both 850nm and 1300nm. Maximum attenuation dB/Km @ 850nm/1300nm shall be 3.5/1.5. Maximum attenuation per connector pair shall be .75 dB. Attenuation testing shall be performed with a stable launch condition using a one-meter or two-meter jumper, equipped with an built in Encircled Flux module provided by the test equipment manufacture, to attach the light source to the cable plant. The Encircled Flux jumper assembly shall remain connected to the light source after calibration and during all test measurements. Test set-up and performance shall be conducted in accordance with ANSI/TIA-568-C.3, TIA-TSB-4979 and to the manufacturer's application guides.

B. All fiber optic stands shall be tested utilizing the “Method B” one jumper reference.

D. Coaxial Testing

1. Sweep testing of each reel of coaxial cable shall be performed over the 5 MHz through 1 GHz range by the cable manufacturer for transmission and structural return loss and be so certified in writing by the cable manufacturer.
2. Verification testing with a verification field test instrument will determine shorts, continuity, termination location and length of cable.
3. Approved testers are as follows:
    1. Fluke DTX
4. Signal strength measurement shall be performed with a field strength meter.
5. Signal level at each outlet will be +5 dBmv, + 3 dB.
6. Approved signal strength meters are as follows:
    1. Acterna
    2. Sadelco
    3. Promax

E. Test Results

1. Test documentation shall be provided on disk as part of the as-built package. The disk shall be clearly marked on the outside front cover with the words “Project Test Documentation,” the project name, and the date of completion (month and year). The results shall include a record of test frequencies, cable type, conductor pair (or strand) and cable (or outlet) I.D., measurement direction, reference setup, and crew member name(s). The test equipment name, manufacturer, model number, serial number, software version and last calibration date will also be provided at the end of the document. Unless the manufacturer specifies a more frequent calibration cycle, an annual calibration cycle will be required on all test equipment used for this installation. The test document shall detail the test method used and the specific settings of the equipment during the test as well as the software version being used in the field test equipment.
2. The field test equipment shall meet the requirements of ANSI/TIA-568-C.2, ANSI/TIA-568-C.3, and/or ANSI/TIA-1152.
3. Printouts generated for each cable by the wire (or fiber) test instrument shall be submitted as part of the documentation package. Alternately, the Contractor may furnish this information in electronic form (CD). These CDs shall contain the electronic equivalent of the test results as defined by the Specification and be of a format readable from Microsoft Word.
4. When repairs and re-tests are performed, the problem found and corrective action taken shall be noted, and both the failed and passed test data shall be documented.

PART 15 – DOCUMENTATION, AS-BUILTS, TRAINING AND RECORDS

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15.01 DOCUMENTATION & AS-BUILTS

A. As-Built record documentation for communications work shall include:

1. Cable routing and identification
2. System function diagrams
3. Manufacturers' description literature for equipment
4. Connection and programming schedules as appropriate
5. Equipment material list including quantities
6. Spare parts list with quantities if required.
7. Details not on original Contract Documents
8. Test results
9. Warranties
10. Release of liens

B. The Contractor shall provide and maintain at the site a set of prints which shall accurately show the actual installation of all work under this section, indicating any variation from contract drawings, including changes in pathways, sizes, locations and dimensions. All changes shall be clearly and completely indicated as the work progresses.

C. Progress prints shall be available for inspection by the Owner or any of his representatives and may be used to determine the progress of communications infrastructure work.

D. At the completion of the work, prepare a new set of as-built drawings, of the work as actually noted on the marked-up prints, including the dimensioned location of all pathways.

E. Furnish as-built drawings and documentation to the Project Manager. As-built drawings shall be generated in AutoCad 2006 or later and Visio formats. Submit as-built drawings electronically on C.D. and hard copy.

15.02 OPERATIONS AND MAINTENANCE MANUAL

A. After completion of the work, the Contractor shall furnish and deliver to the Engineer three (3) copies of a complete Operations & Maintenance Manual. A system wiring diagram shall be furnished for each separate system.

B. The manual shall be subdivided into separate sections with tab dividers to identify subsystems of the integrated system. Reference appropriate Specification sections.

C. Provide the following additional information for each electronic system. Information shall be edited for this project where applicable.

1. Point-to-point diagrams, cabling diagrams, construction details and cabling labeling details

15.03 TRAINING

A. The Contractor shall be responsible for training of facility personnel. Training shall take place after occupancy and before acceptance and shall include programs for on-site operations and maintenance of technology and communications systems. Training shall be held at the Owner's site and shall be of sufficient duration and depth to ensure that the trained personnel can operate the installed systems and can perform usual and customary maintenance actions.

15.04 WARRANTY

A. General

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1. All equipment is to be new and warranted free of faulty workmanship and damage.
2. Replacement of defective equipment and materials and repair of faulty workmanship within 24 hours of notification, except emergency conditions (system failures), which must be placed back in service within eight (8) hours of notification, all at no cost to the Owner.
3. The minimum warranty provisions specified shall not diminish the terms of individual equipment manufacturer's warranties.

B. Voice & Data Structured Cabling

1. Manufacturer(s) shall provide a minimum 25-year warranty for components used in the installed Structured Cabling System. Defective and/or improperly installed products shall be replaced and/or correctly installed at no cost to the Owner.
2. Contractor shall provide a 1 year material, labor and workmanship warranty on all products installed under this contract against any defects. Defective and/or improperly installed products shall be replaced and/or correctly installed at no cost to the Owner.

C. Audio-Visual Systems

1. Manufacturer(s) shall provide a minimum 1-year warranty for components used in the installed Audio-Visual Systems. Defective and/or improperly installed products shall be replaced and/or correctly installed at no cost to the Owner.
2. Contractor shall provide a 1 year material, labor and workmanship warranty on all products installed under this contract against any defects. Defective and/or improperly installed products shall be replaced and/or correctly installed at no cost to the Owner.

END OF SECTION

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