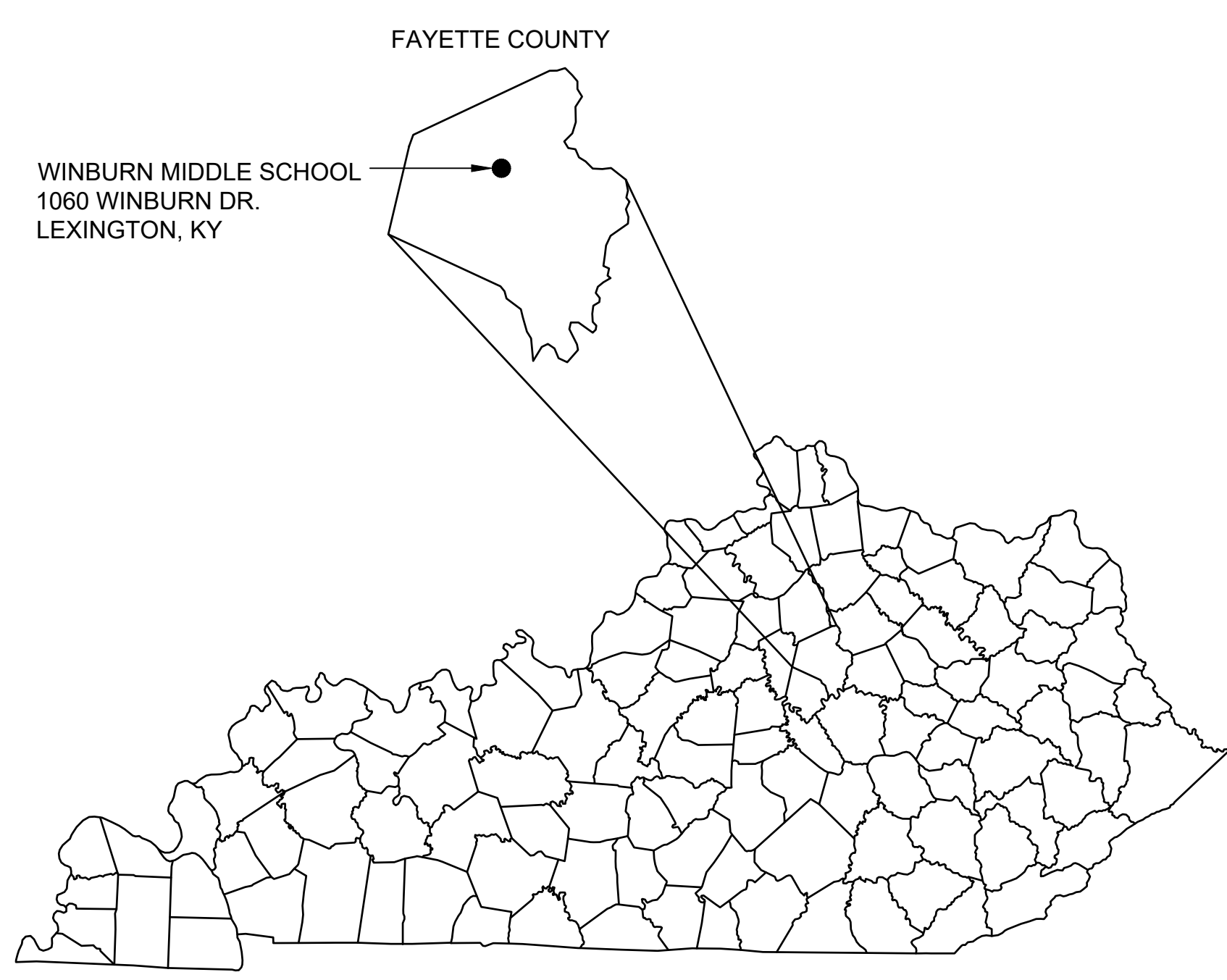


WINBURN MIDDLE SCHOOL  
HVAC REPLACEMENT  
FAYETTE COUNTY PUBLIC SCHOOLS

LEXINGTON, KENTUCKY

"CONSTRUCTION DOCUMENTS"  
BG #25-323  
FCPS BID #41-25



SUBMITTAL SHEET INDEX	
SHEET #	SHEET NAME
G-001	COVER
M-001	MECHANICAL LEGEND AND GENERAL NOTES
MD101	FIRST FLOOR PLAN - WING "A" - HVAC - DEMOLITION
MD102	FIRST FLOOR PLAN - WING "B" - HVAC - DEMOLITION
MD103	ROOF PLAN - HVAC - DEMOLITION
M-101	FIRST FLOOR PLAN - WING "A" - HVAC - NEW WORK
M-102	FIRST FLOOR PLAN - WING "B" - HVAC - NEW WORK
M-103	ROOF PLAN - HVAC - NEW WORK
M-401	ENLARGED MECHANICAL ROOM PLANS
M-501	MECHANICAL DETAILS AND SCHEDULES
M-601	MECHANICAL CONTROLS
E-001	ELECTRICAL LEGEND AND GENERAL NOTES
ED101	ROOF PLAN - ELECTRICAL - DEMOLITION
E-101	FIRST FLOOR PLAN - WING "A" - ELECTRICAL - NEW WORK
E-102	FIRST FLOOR PLAN - WING "B" - ELECTRICAL - NEW WORK
E-103	ROOF PLAN - ELECTRICAL - NEW WORK
E-401	ENLARGED MECHANICAL ROOM PLANS - ELECTRICAL

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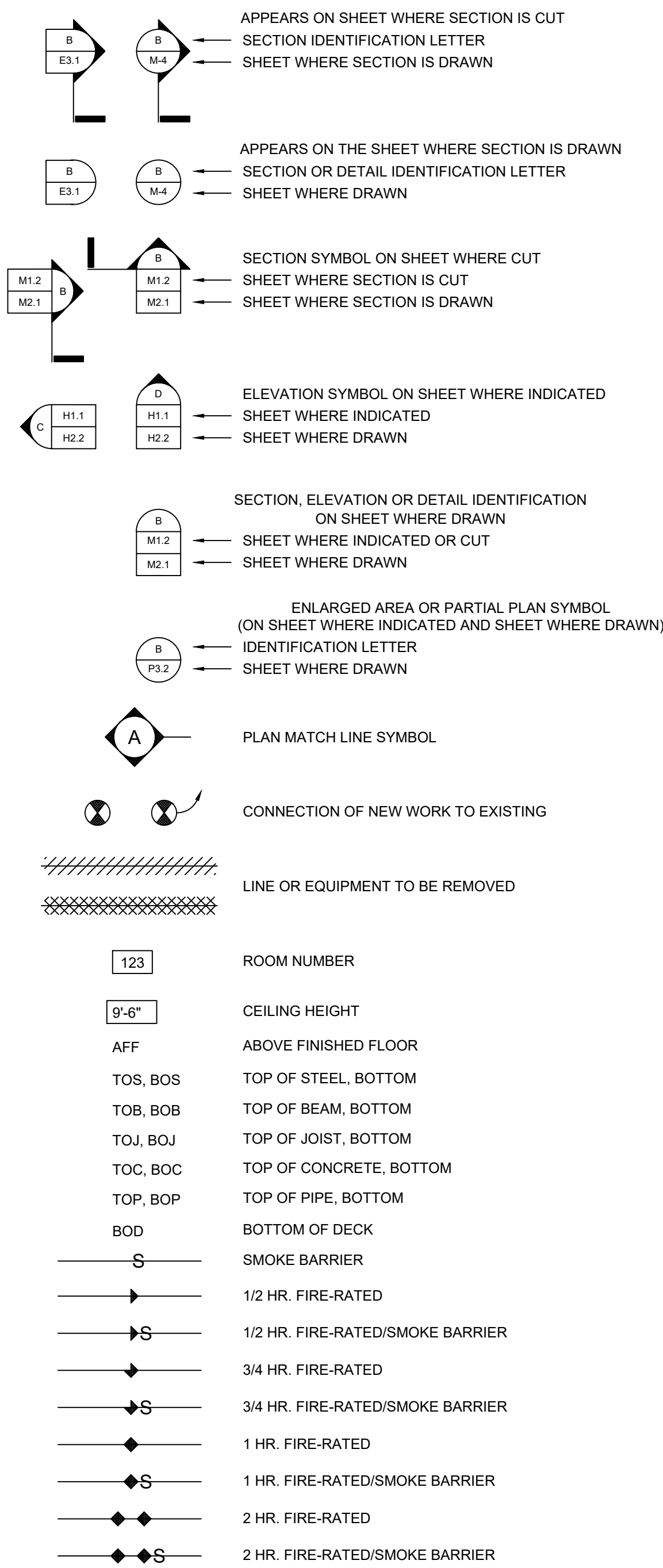
COVER SHEET  
WINBURN MIDDLE SCHOOL - HVAC REPLACEMENT  
1060 WINBURN DRIVE, LEXINGTON, KY

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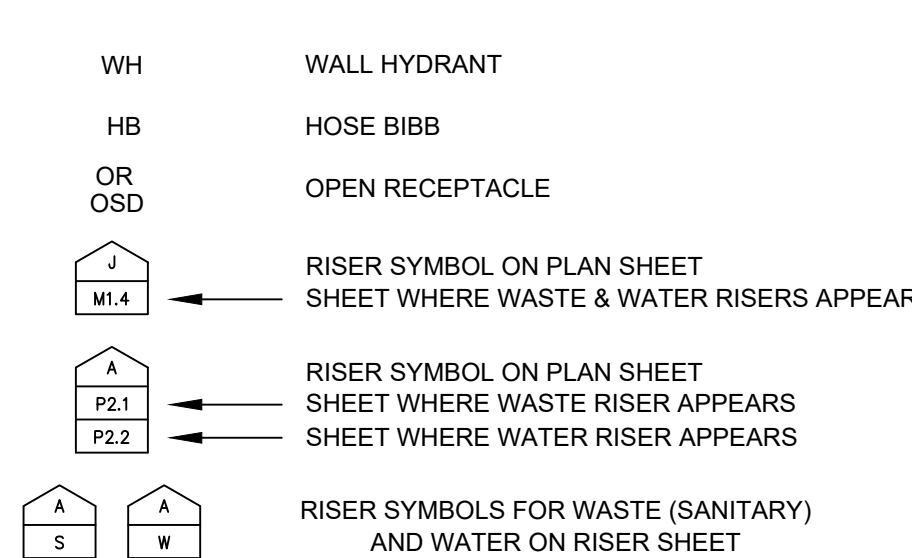
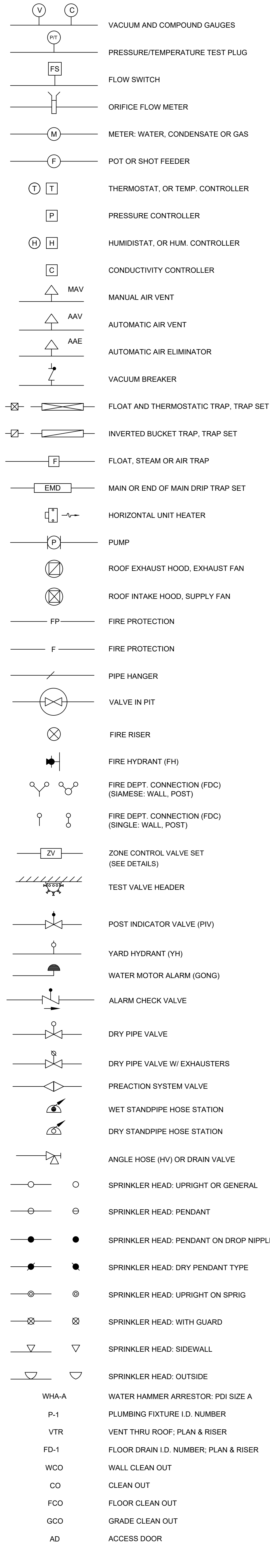
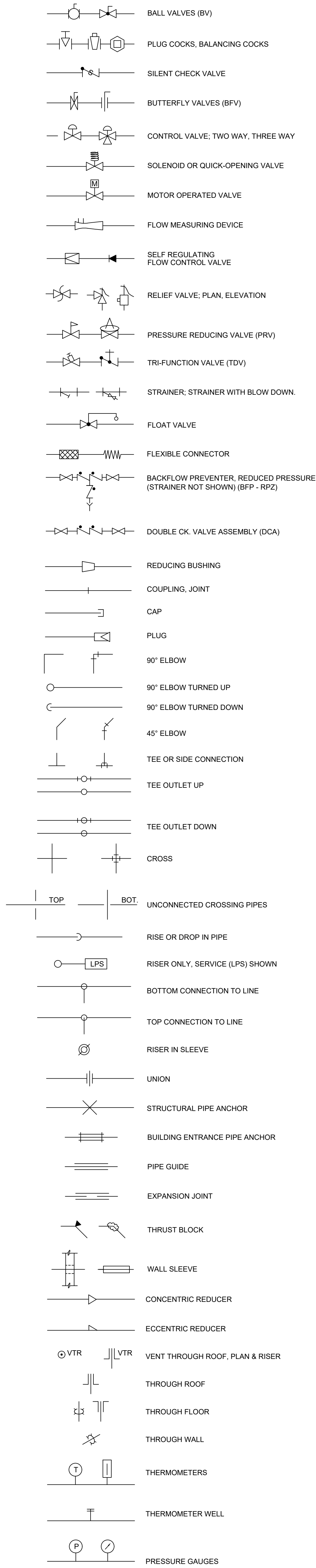
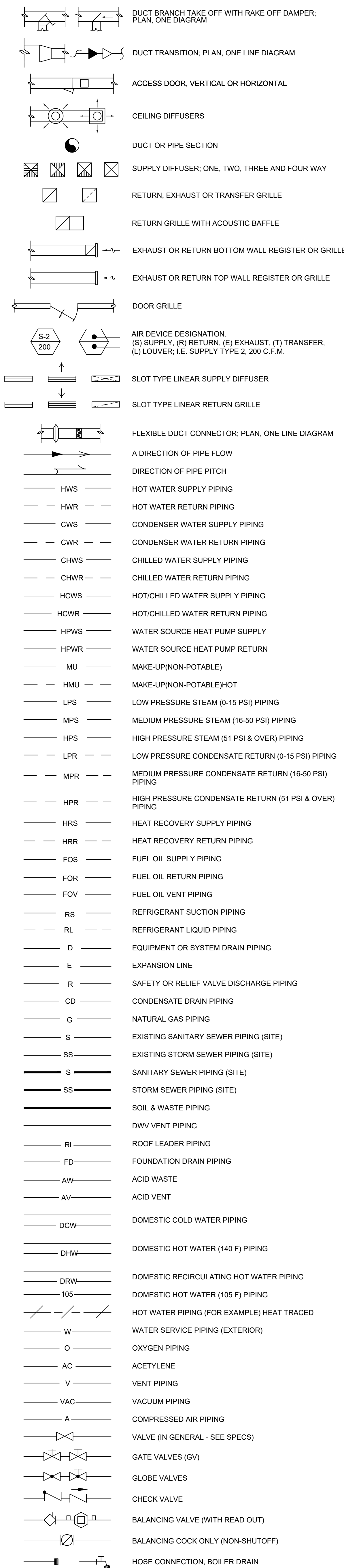
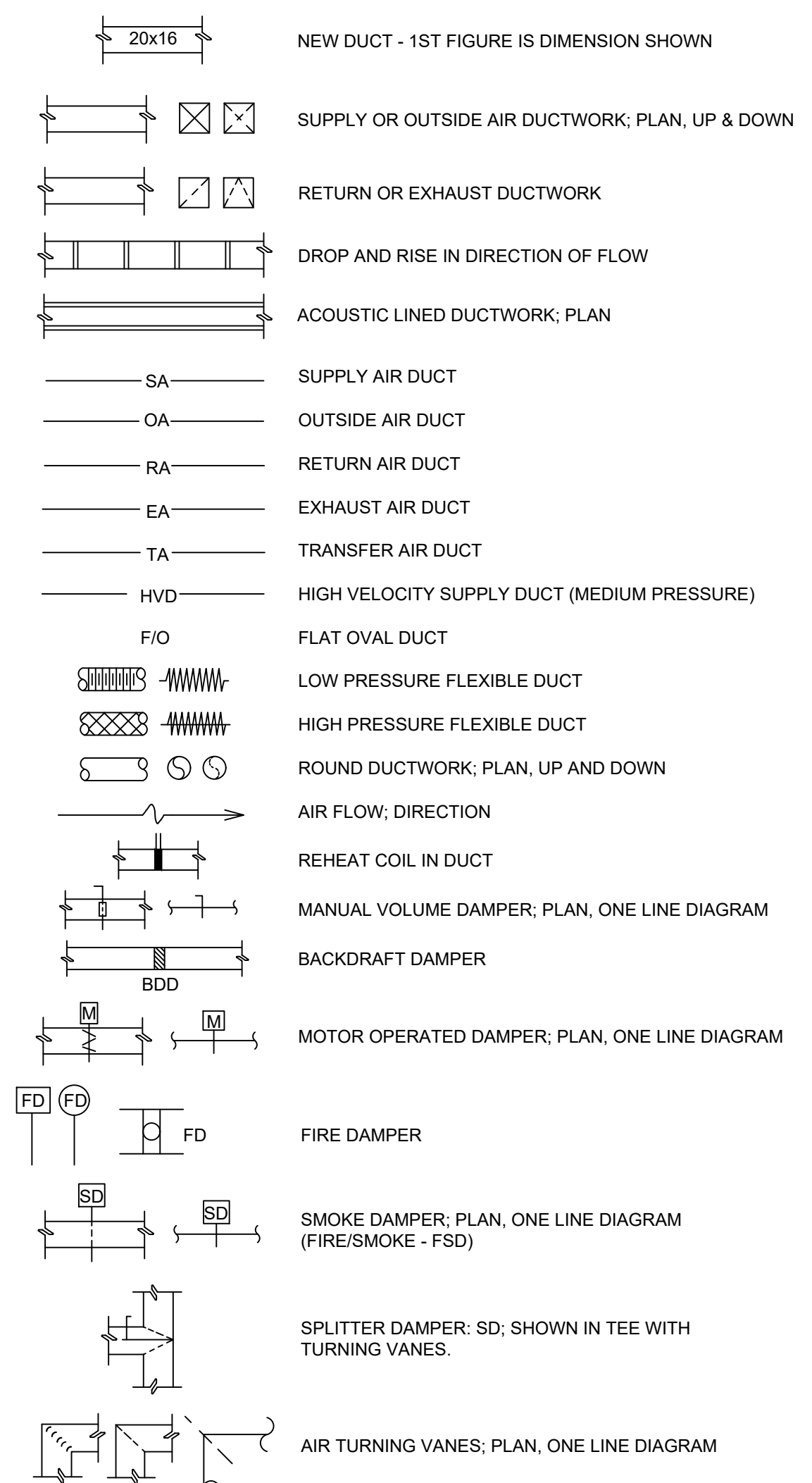
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## GENERAL LEGEND



NOTE: LEGENDS ALSO APPEAR ON  
INDIVIDUAL PLANS, SCHEDULES  
AND DETAILS.

## MECHANICAL LEGEND HVAC, PLUMBING & FIRE PROTECTION



## GENERAL NOTES:

- GENERAL NOTES, WHEREVER THEY ARE FOUND, APPLY TO ALL WORK IN THE PROJECT, UNLESS OTHERWISE INDICATED. SHEET NOTES, UTILIZING NOTE SYMBOLS, APPLY ONLY TO THE SHEET ON WHICH THEY ARE FOUND, UNLESS OTHERWISE STATED. THE MEANING OF NOTE SYMBOLS AND NUMBERS VARIES FROM SHEET TO SHEET.
- CONTRACTOR SHALL UTILIZE ALL INFORMATION IN THE CONTRACT DOCUMENTS FOR PROVIDING THE WORK. CONTRACTOR SHALL UTILIZE DETAILS AND FLOW DIAGRAMS FOR THE WORK WHERE APPROPRIATE, WHETHER OR NOT THEY ARE SPECIFICALLY REFERENCED ON THE PLANS OR SUPPORTING DRAWINGS.
- CONTRACTOR SHALL FIELD VERIFY ALL EXISTING CONDITIONS. ANY DISCREPANCIES BETWEEN EXISTING CONDITIONS AND CONTRACT DOCUMENTS ARE TO BE BROUGHT TO THE ATTENTION OF THE ENGINEER BEFORE ANY WORK RELATING TO THOSE CONDITIONS IS PERFORMED.
- LEGENDS OR LISTS OF SYMBOLS AND ABBREVIATIONS ARE GENERAL IN NATURE AND MAY CONTAIN ITEMS NOT USED IN THE CONTRACT DOCUMENTS, IF ANY SUCH ITEMS ARE FOUND WHICH ARE NOT DEFINED ON THE PLANS OR IN THE SPECIFICATIONS, THE ENGINEER SHALL BE CONTACTED FOR CLARIFICATION BEFORE THE BID.
- CONTRACTOR SHALL MAINTAIN A SET OF PROJECT RECORD DRAWINGS AT THE JOB SITE AND SHALL BE RESPONSIBLE FOR MAKING CLEAR, NEAT CHANGES TO THE DRAWINGS, REFLECTING CHANGES TO THE WORK AND VARIANCE IN EXISTING CONDITIONS.
- PROVIDE ALL MISCELLANEOUS STEEL, AS REQUIRED, TO SUPPORT ALL MECHANICAL DUCT AND PIPING SYSTEMS AND EQUIPMENT. HANG ALL EQUIPMENT FROM STRUCTURE WITH MINIMUM OF TWO TRAPEZE ASSEMBLIES OR FOUR INTEGRAL MOUNTING POINTS WITH VIBRATION ISOLATORS ON ALL FOUR SUPPORTS. DO NOT HANG ANYTHING FROM STEEL, COMPOSITION OR WOODEN DECKS. NON-ROOF CONCRETE DECKS MAY BE USED ONLY WITH PERMISSION OF THE ENGINEER. DO NOT HANG ANYTHING FROM MECHANICAL OR ELECTRICAL ITEMS.
- NO STEEL STRUCTURAL MEMBERS SHALL BE CUT, BURNED, WELDED OR DRILLED WITHOUT SPECIFIC PERMISSION OF THE ENGINEER.
- NO WOODEN STRUCTURAL MEMBERS SHALL BE CUT OR DRILLED EXCEPT AS INDICATED IN THE CONTRACT DOCUMENTS OR AS APPROVED BY THE ENGINEER.
- ALL EQUIPMENT, ACCESSORIES, PIPING, WIRING, DUCT AND OTHER WORK, WHICH IS INSTALLED IN FINISHED SPACES SHALL BE CONCEALED IN WALLS, FLOORS, FURRED CHASES OR SUSPENDED CEILINGS, EXCEPT FOR INDICATED TERMINAL UNITS, CONTROLS, AIR INLETS AND OUTLETS, AS SHOWN.
- DUCT DAMPERS IN INACCESSIBLE CEILINGS MAY BE PROVIDED WITH APPROVED REMOTE OPERATORS INSTEAD OF ACCESS DOORS.
- DO NOT CHANGE PATH OF PIPING OR DUCT RUNS, ADD TURNS OR OFFSETS OR CHANGE DUCT DIMENSIONS OR PIPE SIZE WITHOUT FIRST CONSULTING THE ENGINEER. PIPE SIZES SHOWN ON DRAWINGS ARE NOMINAL UNLESS OTHERWISE INDICATED. ALL DUCT SIZES SHOWN ON PLANS ARE CLEAR INSIDE DIMENSIONS FOR SHOP OR FIELD-FABRICATED DUCT AND NOMINAL SIZES FOR FACTORY FABRICATED DUCT.
- FOR TYPICAL STEAM, WATER, REFRIGERANT AND AIR CONNECTIONS TO EQUIPMENT, SEE STANDARD DETAILS.
- ALL COPPER PIPING SHALL BE ASSEMBLED WITH WROUGHT COPPER OR CAST COPPER ALLOY FITTINGS AND 95/5 TIN ANTIMONY SOLDER OR SILVER BRAZING. NO SOLDER CONTAINING LEAD SHALL BE USED.
- ALL CHECK VALVES IN PUMP DISCHARGES SHALL BE SPRING-LOADED OR SILENT TYPE OR FOR LARGE WASTE: LEVER-WEIGHTED TYPE.
- ALL EXISTING EQUIPMENT SHUTDOWNS OR INTERRUPTIONS OF UTILITY SERVICE REQUIRED FOR COMPLETION OF THE WORK SHALL BE SCHEDULED IN ADVANCE, AS REQUIRED BY THE OWNER.
- COORDINATE ALL PIPING AND DUCTWORK WITH BOTH NEW AND EXISTING MECHANICAL AND ELECTRICAL WORK, INCLUDING HVAC, PLUMBING, ELECTRICAL, FIRE ALARM, SPRINKLER AND COMMUNICATIONS.
- CONTRACTOR IS RESPONSIBLE FOR MAKING ALL REQUIRED CONNECTIONS FOR A COMPLETE SYSTEM. CONNECTIONS OF NEW WORK TO EXISTING IS USUALLY INDICATED BY SPECIAL SYMBOL (SEE LEGEND). SYMBOLS MISSING FROM THE DRAWINGS DO NOT EXCLUDE THE CONTRACTOR FROM PROVIDING THE WORK.
- ANY AND ALL DAMAGE DUE TO DEMOLITION OR CONSTRUCTION IS TO BE REPAIRED OR REPLACED AS APPROPRIATE, SUBJECT TO ENGINEER'S APPROVAL, AND AT NO ADDITIONAL COST TO THE OWNER.
- THE CONTRACTOR SHALL NOT REMOVE OR DISTURB ANY SUSPECTED HAZARDOUS MATERIALS, INCLUDING ASBESTOS-CONTAINING MATERIALS (ACM), LEAD-BASED PAINTS, ELECTRICAL GEAR CONTAINING PCB'S OR ANY OTHER, EXCEPT AS INSTRUCTED IN THIS CONTRACT. IF ANY MATERIAL NOT COVERED BY THE CONTRACT IS ENCOUNTERED, NOTIFY THE ENGINEER AT ONCE.
- ALL DEMOLISHED OR REMOVED EQUIPMENT, PIPING, DUCTWORK, SUPPORTS, CONTROLS AND THE LIKE SHALL BECOME THE PROPERTY OF THE CONTRACTOR AND SHALL BE REMOVED FROM THE SITE UNLESS OTHERWISE NOTED.
- REINSULATE ALL DUCTWORK AND PIPING WHERE EXISTING INSULATION HAS BEEN REMOVED OR DAMAGED DURING THE PROJECT.
- EXISTING OUTLETS (EXS) ARE SHOWN FOR BALANCING PURPOSES ONLY. NO MODIFICATIONS ARE REQUIRED.
- ALL DUCTWORK AND SHEET METAL SHALL BE PROVIDED AS INDICATED AND SHALL BE MANUFACTURED AND SHOP-OR FIELD-FABRICATED, AS A MINIMUM, IN ACCORDANCE WITH THE RECOMMENDATIONS AND DETAILS OF SMACNA, UNLESS SPECIFICALLY INDICATED OTHERWISE.
- FANS SHALL BE PROVIDED AS INDICATED BY GREENHECK, CARNES, COOK OR APPROVED EQUAL. GRILLES, REGISTERS AND DIFFUSERS SHALL BE PROVIDED AS INDICATED BY TITUS, TUTTLE AND BAILEY, PRICE, CARNES OR APPROVED EQUAL. LOUVERS, HOODS AND PENTHOUSES SHALL BE PROVIDED AS INDICATED BY GREENHECK, AIRSTREAM, LOUVERS AND DAMPERS, CARNES, RUSKIN OR APPROVED EQUAL. PROVIDE FIRE AND SMOKE DAMPERS IN ACCORDANCE WITH THE REQUIREMENTS OF NFPA AND THE KY BUILDING CODE.
- ALL HVAC PIPING SHALL BE IN ACCORDANCE WITH ASME STANDARDS AND PRACTICES AND THE REQUIREMENTS OF THE KY BUILDING CODE. HVAC PIPING SHALL BE FLANGED AND WELDED STEEL 3" AND ABOVE, TYPE 1, COMPETE FOR 2" AND BELOW AND EITHER FOR 2" 12". ALL WELDING SHALL BE IN ACCORDANCE WITH AWS STANDARDS.
- PROVIDE ALL HVAC EQUIPMENT AND ACCESSORIES AS INDICATED. INSTALL IN COMPLIANCE WITH ALL REQUIREMENTS OF THE KY BUILDING CODE.
- MOUNT ALL ROOM THERMOSTATS OR ADJUSTABLE SENSORS AT HEIGHTS ABOVE FINISHED FLOOR, AS DIRECTED BY THE ENGINEER.
- ALL HYDRONIC PIPING SYSTEMS SHALL BE PITCHED UP 1" IN 40 FT. IN DIRECTION OF FLOW.
- ALL HIGH POINTS IN HYDRONIC PIPING SYSTEMS SHALL CONTAIN AIR CHAMBERS WITH AUTOMATIC AIR VENTS, PIPED PER DETAILS.
- ALL LOW POINTS IN HYDRONIC PIPING SYSTEMS SHALL CONTAIN A 3/4" DRAIN BALL VALVE WITH HOSE CONNECTION.
- PIPING TO HEATING AND COOLING WATER COILS SHALL BE MADE TO PROVIDE COUNTERFLOW BETWEEN WATER AND AIR.
- DO NOT USE BULL-HEADED TEE FITTINGS, EITHER ON PIPE OR ON DUCT, UNLESS SPECIFICALLY SHOWN, OR IN THE CASE OF DUCT, UNLESS INTERNAL TURNING VANES PER SMACNA ARE PROVIDED.
- CONSULT ARCHITECTURAL REFLECTED CEILING PLAN FOR PLACEMENT OF AIR TERMINALS. COORDINATE WITH MECHANICAL WORK AND WORK OF OTHER TRADES.
- SUPPLY AND RETURN DUCT RUNS SHOWN AS SINGLE-LINE DIAGRAM ON PLANS SHALL BE EXTERNALLY INSULATED GALVANIZED RECTANGULAR DUCT, CONSTRUCTED PER SMACNA STANDARDS, OR SINGLE WALL ROUND PIPE AS SPECIFIED. APPROPRIATELY RATED FLEX DUCT MAY BE SUBSTITUTED FOR A MAXIMUM OF FIVE FEET OF MORE OR LESS STRAIGHT (MAX 90 DEGREE BEND) RUN ON EITHER HIGH OR LOW VELOCITY DUCT.
- PROVIDE MANUAL DAMPERS IN ALL SUPPLY AND EXHAUST BRANCHES CONTAINING GRILLES, REGISTERS OR DIFFUSERS WHETHER SHOWN ON PLANS OR NOT AND PROVIDE DAMPERS IN RETURNS WHERE SHOWN. PROVIDE ADJUSTABLE TAKE-OFF FITTINGS WITH GRIDS IN LIEU OF MANUAL DAMPERS FOR ALL ROUND TAKE-OFFS FROM RECTANGULAR MAINS OR PLENUMS. DAMPERS IN DUCT DO NOT REPLACE DAMPERS SPECIFIED AS PART OF THE AIR TERMINAL ASSEMBLY OR VICE VERSA.
- USE TURNING VANES, PER SMACNA CONSTRUCTION GUIDELINES, FOR ALL MITERED RECTANGULAR TURNS OF 45 DEGREES OR MORE.
- CONTRACTOR SHALL MAKE MINOR OFFSETS AND LOCATION CHANGES IN PIPE AND DUCT AND IN DUCT ASPECT RATIO AS REQUIRED IN CONGESTED CEILING OR MECHANICAL SPACES. GENERALLY, THESE WILL BE AT NO COST TO THE OWNER AND APPROVED BY THE ENGINEER WITHOUT FORMAL DOCUMENTS. MAJOR REROUTING OF LINES OR MAJOR ADDITION OF FITTINGS WILL BE REVIEWED AND APPROVED AS A CHANGE ORDER OR A FORMAL DIRECTIVE. ENGINEER ALONE SHALL CLASSIFY CHANGES AS MAJOR OR MINOR.
- PROVIDE ALL CONTROLS NECESSARY TO OPERATE EQUIPMENT AS SHOWN OR DESCRIBED, INCLUDING VALVES, ACTUATORS, THERMOSTATS, DAMPERS, ALL ACCESSORY DEVICES, POWER AND/OR PNEUMATIC SERVICE.
- PROVIDE ADDITIONAL INPUT/OUTPUT POINTS REQUIRED TO IMPLEMENT CONTROL SEQUENCES SPECIFIED.
- PROVIDE ALL WORK NECESSARY FOR THE COMPLETE FIRE PROTECTION SYSTEM AS INDICATED AND NOTED, INCLUDING ALL CONNECTIONS TO EXISTING WORK, NEW PIPING AND ACCESSORIES AND FINAL FINISH MOUNTING OF SPRINKLERS IN LOCATIONS INDICATED AND TESTING, ALL AS REQUIRED TO MEET ALL PROVISIONS OF NFPA-13 AND THE KY BUILDING CODE. WORK SHALL BE PERFORMED BY A LICENSED SPRINKLER CONTRACTOR AND SHALL BE ACCOMPANIED BY CERTIFICATIONS OF INSPECTION AND APPROVAL BY THE DEPT. OF HOUSING, BUILDINGS AND CONSTRUCTION. ALL SCREWED PIPING SHALL BE MINIMUM SCH 40 STEEL. ALL VICTAULIC TYPE PIPING SHALL BE MINIMUM SCH 40 STEEL.
- PROVIDE ALL WORK NECESSARY FOR THE COMPLETE FIRE PROTECTION SYSTEM AS INDICATED AND NOTED, INCLUDING ALL CONNECTIONS TO EXISTING WORK, NEW PIPING AND ACCESSORIES AND FINAL FINISH MOUNTING OF SPRINKLERS IN LOCATIONS INDICATED AND TESTING, ALL AS REQUIRED TO MEET ALL PROVISIONS OF NFPA-13, NFPA-14, NFPA-20 AND THE KY BUILDING CODE. WORK SHALL BE PERFORMED BY A LICENSED SPRINKLER CONTRACTOR.
- ALL FIRE PROTECTION COMPONENTS, INCLUDING BUT NOT LIMITED TO PUMPS, VALVES, PIPE & FITTINGS, CONTROL SYSTEMS AND TRIM SHALL BE UL AND/OR FM LISTED FOR FIRE SERVICE, WHERE SUCH LISTING EXISTS.
- PROVIDE LISTED AIR RELEASE FOR ALL TRAPPED RUNS OF FIRE PROTECTION PIPING.
- ALL FERROUS FIRE PROTECTION PIPING SHALL BE PAINTED RED WHERE EXPOSED TO VIEW; SHADE TO BE APPROVED BY ENGINEER.
- ALL FIRE PROTECTION SHUTOFF VALVES SHALL BE SUPERVISED BY THE ALARM SYSTEM EXCEPT ON JOCKEY PUMP AND BYPASS.
- FIRE PROTECTION PIPING CONNECTIONS MAY BE WELDED, FLANGED, SCREWED OR GROOVE-JOINT TYPE PER NFPA 13, 14, 20 AND THE SPECIFICATIONS FOR THIS PROJECT. NO SCREWED PIPING LARGER THAN 2 INCHES. PITCH ALL PIPING TO DRAIN.
- SPRINKLER HEADS SHOWN IN FIRE PROTECTION DRAWINGS ARE LOCATED APPROXIMATELY. CONSULT ARCHITECTURAL REFLECTED CEILING PLAN FOR PLACEMENT OF SPRINKLER HEADS IN FINISHED CEILINGS AND CEILING GRIDS. CONTRACTOR SHALL PROVIDE HYDRAULICALLY-DESIGNED PIPING SYSTEMS AND SHALL MODIFY LOCATION OF SPRINKLER HEADS ONLY AS REQUIRED TO CONFORM WITH CODE AND PREVENT BLOCKAGE OF PATTERN. [PROVIDE HEADS AS SHOWN UNLESS IN VIOLATION OF CODE]
- SPRINKLER HEADS SHALL BE CENTERED IN 2' x 2' SPACE IN EITHER 2' x 2' OR 2' x 4' GRID LAYOUT.
- COORDINATE ALL WORK. DO NOT MOUNT SPRINKLER HEADS OR HANG PIPING SUCH AS TO BLOCK ACCESS TO HVAC OR ELECTRICAL EQUIPMENT OR THE CHANGEOUT OF EQUIPMENT WHEN NECESSARY.
- PROVIDE SPECIAL HEADS AS REQUIRED FOR COMPLETE DESIGN. PROVIDE HIGH TEMPERATURE HEADS FOR AREAS NEAR SPACE HEATING OUTLETS AND EQUIPMENT.

## MECHANICAL LEGEND AND GENERAL NOTES

WINBURN MIDDLE SCHOOL - HVAC REPLACEMENT  
1060 WINBURN DRIVE, LEXINGTON, KY

REVISIONS	DESCRIPTION	DATE	BY	CNS	SPB	CNS	CNS
NO							

DATE	APRIL 2025
SCALE	NOT TO SCALE
SHEET NO.	M-001

GRV PROJECT NO. 4073-08

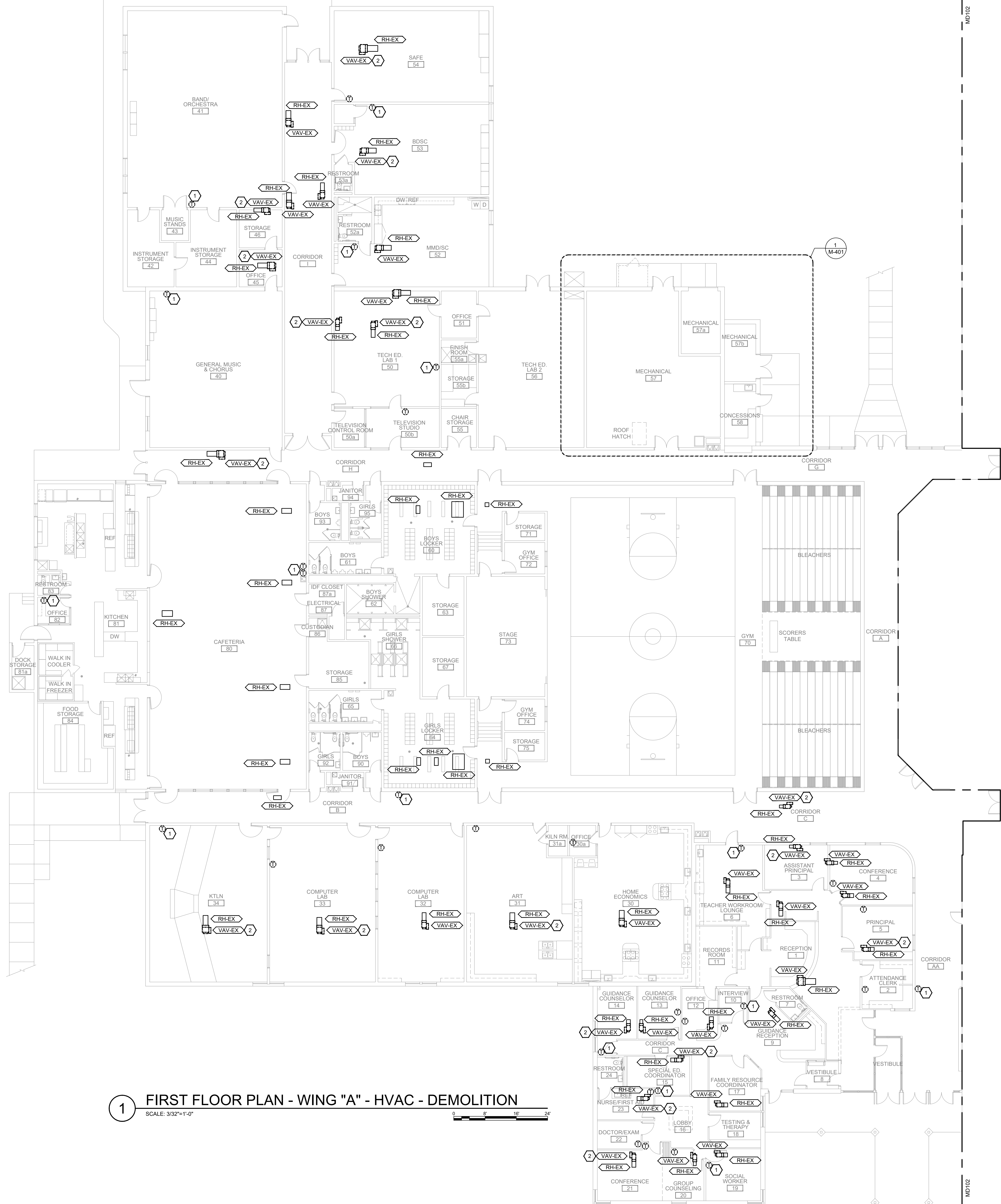
BC #25-323

FOPS BID #41-25

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DESIGN DOCUMENTS



1 FIRST FLOOR PLAN - WING "A" - HVAC - DEMOLITION  
SCALE: 3/32"=1'-0"

DEMOLITION GENERAL NOTES:

- DEMOLITION PLAN HAS BEEN DEVELOPED FROM EXISTING PLANS AND VISITING SITE. SOME MECHANICAL EQUIPMENT, DUCTWORK, REGISTERS AND PIPING SIZES MAY NOT BE INDICATED.
- IT SHALL BE THE RESPONSIBILITY OF ALL CONTRACTORS WHO SUBMIT BIDS FOR THIS PROJECT TO VISIT THE JOB PREMISES PRIOR TO BIDDING IN ORDER THAT THEY MAY DETERMINE THE TYPE, QUANTITY, LOCATIONS AND ANY HARDSHIPS INVOLVED WITH THE REMOVAL OF EQUIPMENT.
- CONTRACTOR UNDER THIS DIVISION IS FINANCIALLY RESPONSIBLE TO REPAIR AND PATCH FLOORS, WALLS, CEILING AND ROOF TO MATCH EXISTING CONDITION WHERE DEMOLITION WORK HAS BEEN DONE. COORDINATE ALL WORK WITH OWNER/ENGINEER.
- THE EXISTING HVAC SYSTEM SHALL REMAIN FULLY FUNCTIONAL THROUGHOUT PHASED CONSTRUCTION.
- IF THE EXISTING HVAC SYSTEM SHALL EVER REQUIRE SHUTTING DOWN TEMPORARILY IN OCCUPIED AREAS DURING CONSTRUCTION, THE CONTRACTOR SHALL COORDINATE THE TIMING OF THE SHUT DOWN PERIOD WITH THE OWNER AND ARCHITECT PRIOR TO DISABLING THE EXISTING SYSTEM. THE EXISTING HVAC SYSTEM SHALL REMAIN FUNCTIONAL IN ALL OCCUPIED AREAS DURING NORMAL SCHOOL OPERATION PERIODS.
- ALL EXISTING THERMOSTATS AND EXISTING CONTROL WIRING SHALL BE REMOVED FROM ALL EQUIPMENT THAT IS BEING REMOVED IN THE BUILDING IN DEMOLISHED AREAS UNLESS OTHERWISE NOTED.

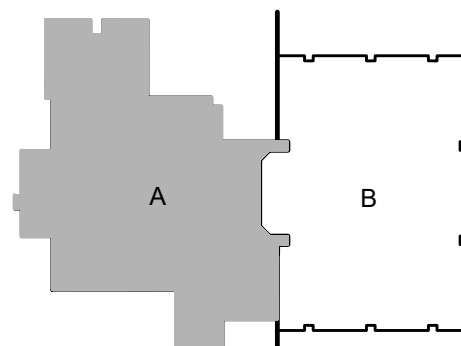
SHEET KEYNOTES:

- EXISTING THERMOSTAT LOCATION, NEW THERMOSTAT TO BE INSTALLED IN SAME LOCATION AS EXISTING. EXISTING THERMOSTATS HAVE BEEN TAKEN FROM FIELD MEASURING AND EXISTING PLANS. CONTRACTOR TO FIELD VERIFY LOCATIONS. SEE NEW WORK PLANS FOR MORE INFORMATION. TYPICAL OF ALL.
- EXISTING VAV BOX LOCATION, NEW ACTUATOR SHALL BE INSTALLED AT EXISTING VAV BOX FOR NEW DDC CONTROLS FOR THE BUILDING. EXISTING BOXES HAVE BEEN TAKEN FROM EXISTING DRAWINGS. CONTRACTOR TO FIELD VERIFY LOCATIONS. SEE NEW WORK PLANS FOR MORE INFORMATION. TYPICAL OF ALL.

SPECIAL NOTES

- ALL EXISTING HVAC SYSTEMS SHALL REMAIN OPERATIONAL DURING THIS PROJECT. EXISTING EQUIPMENT SHALL BE DISABLED ONLY WHEN NEW EQUIPMENT IS ONSITE AND READY TO BE INSTALLED.
- AS UNITS ARE INSTALLED, THERMOSTATS SHALL BE INSTALLED AND PLACED IN STAND ALONE OPERATION MODE.
- ALL NEW EQUIPMENT INSTALLED SHALL CONNECT TO NEW DDC CONTROL SYSTEM TIED INTO FAYETTE COUNTY SCHOOLS CONTROL NETWORK. ALL OTHER EXISTING EQUIPMENT FOR THE SCHOOL SHALL REMAIN ON THE EXISTING CONTROL SYSTEM AND SHALL REMAIN SEPARATE FROM NEW EQUIPMENT CONTROLS.

KEY PLAN



GRW PROJECT NO. 4073-08  
BG #25323  
FCPS BID #4125

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FIRST FLOOR PLAN - WING "A"  
HVAC - DEMOLITION

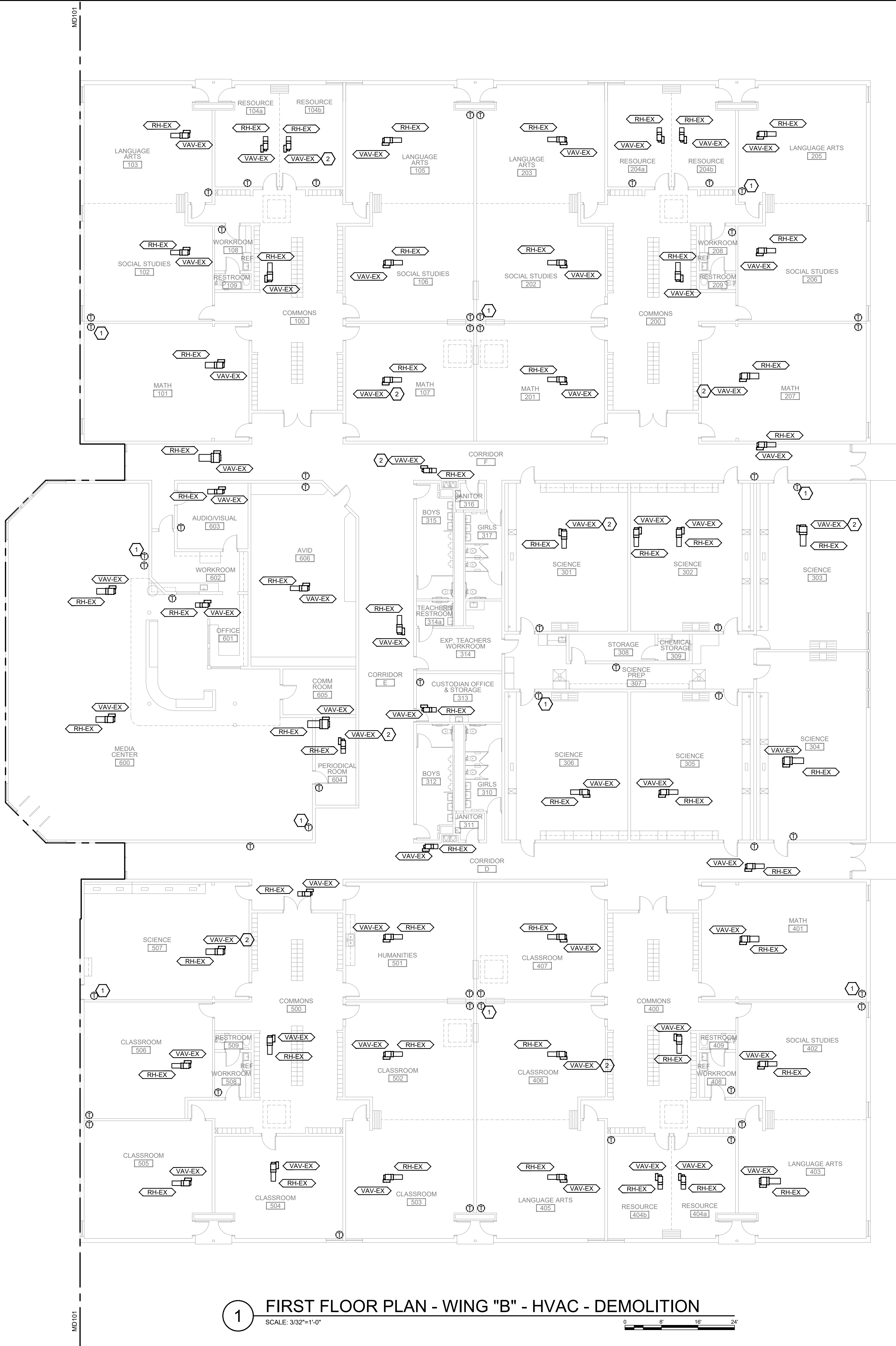
WINBURN MIDDLE SCHOOL - HVAC REPLACEMENT  
1060 WINBURN DRIVE, LEXINGTON, KY

REVISIONS	DATE	BY	CVS
DESCRIPTION			

DATE: APRIL 2025  
SCALE: 3/32" = 1'-0"  
SHEET NO.

MD101





DEMOLITION GENERAL NOTES:

- A. DEMOLITION PLAN HAS BEEN DEVELOPED FROM EXISTING PLANS AND VISITING SITE. SOME MECHANICAL EQUIPMENT, DUCTWORK, REGISTERS AND PIPING SIZES MAY NOT BE INDICATED.
- B. IT SHALL BE THE RESPONSIBILITY OF ALL CONTRACTORS WHO SUBMIT BIDS FOR THIS PROJECT TO VISIT THE JOB PREMISES PRIOR TO BIDDING IN ORDER THAT THEY MAY DETERMINE THE TYPE, QUANTITY, LOCATIONS AND ANY HARDSHIPS INVOLVED WITH THE REMOVAL OF EQUIPMENT.
- C. CONTRACTOR UNDER THIS DIVISION IS FINANCIALLY RESPONSIBLE TO REPAIR AND PATCH FLOORS, WALLS, CEILING AND ROOF TO MATCH EXISTING CONDITION WHERE DEMOLITION WORK HAS BEEN DONE. COORDINATE ALL WORK WITH OWNER/ENGINEER.
- D. THE EXISTING HVAC SYSTEM SHALL REMAIN FULLY FUNCTIONAL THROUGHOUT PHASED CONSTRUCTION.
- E. IF THE EXISTING HVAC SYSTEM SHALL EVER REQUIRE SHUTTING DOWN TEMPORARILY IN OCCUPIED AREAS DURING CONSTRUCTION, THE CONTRACTOR SHALL COORDINATE THE TIMING OF THE SHUT DOWN PERIOD WITH THE OWNER AND ARCHITECT PRIOR TO DISABLING THE EXISTING SYSTEM. THE EXISTING HVAC SYSTEM SHALL REMAIN FUNCTIONAL IN ALL OCCUPIED AREAS DURING NORMAL SCHOOL OPERATION PERIODS.
- F. ALL EXISTING THERMOSTATS AND EXISTING CONTROL WIRING SHALL BE REMOVED FROM ALL EQUIPMENT THAT IS BEING REMOVED IN THE BUILDING IN DEMOLISHED AREAS UNLESS OTHERWISE NOTED.

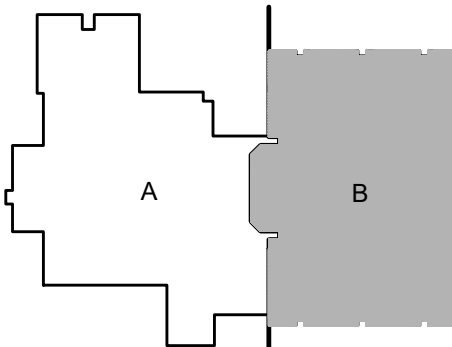
SHEET KEYNOTES:

- 1. EXISTING THERMOSTAT LOCATION. NEW THERMOSTAT TO BE INSTALLED IN SAME LOCATION AS EXISTING. EXISTING THERMOSTATS HAVE BEEN TAKEN FROM FIELD MEASURING AND EXISTING PLANS. CONTRACTOR TO FIELD VERIFY LOCATIONS. SEE NEW WORK PLANS FOR MORE INFORMATION. TYPICAL OF ALL.
- 2. EXISTING VAV BOX LOCATION. NEW ACTUATOR SHALL BE INSTALLED AT EXISTING VAV BOX FOR NEW DDC CONTROLS FOR THE BUILDING. EXISTING BOXES HAVE BEEN TAKEN FROM EXISTING DRAWINGS. CONTRACTOR TO FIELD VERIFY LOCATIONS. SEE NEW WORK PLANS FOR MORE INFORMATION. TYPICAL OF ALL.

SPECIAL NOTES

- 1. ALL EXISTING HVAC SYSTEMS SHALL REMAIN OPERATIONAL DURING THIS PROJECT. EXISTING EQUIPMENT SHALL BE DISABLED ONLY WHEN NEW EQUIPMENT IS ONSITE AND READY TO BE INSTALLED.
- 2. AS UNITS ARE INSTALLED, THERMOSTATS SHALL BE INSTALLED AND PLACED IN STAND ALONE OPERATION MODE.
- 3. ALL NEW EQUIPMENT INSTALLED SHALL CONNECT TO NEW DDC CONTROL SYSTEM TIED INTO FAYETTE COUNTY SCHOOLS CONTROL NETWORK. ALL OTHER EXISTING EQUIPMENT FOR THE SCHOOL SHALL REMAIN ON THE EXISTING CONTROL SYSTEM AND SHALL REMAIN SEPARATE FROM NEW EQUIPMENT CONTROLS.

KEY PLAN



1 FIRST FLOOR PLAN - WING "B" - HVAC - DEMOLITION  
SCALE: 3/32"=1'-0"

CRW PROJECT NO. 4073-08

BC #25-323

FCS BID #41-25

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FIRST FLOOR PLAN - WING "B"  
HVAC - DEMOLITION

WINBURN MIDDLE SCHOOL - HVAC REPLACEMENT  
1060 WINBURN DRIVE, LEXINGTON, KY

REVISIONS	DATE	BY	C/S	
			DESIGNED	DRAWN
DESCRIPTION			SPB	REVIEWED
			C/S	APPROVED
			C/S	

NO

DATE

APRIL 2025

SCALE

3/32" = 1'-0"

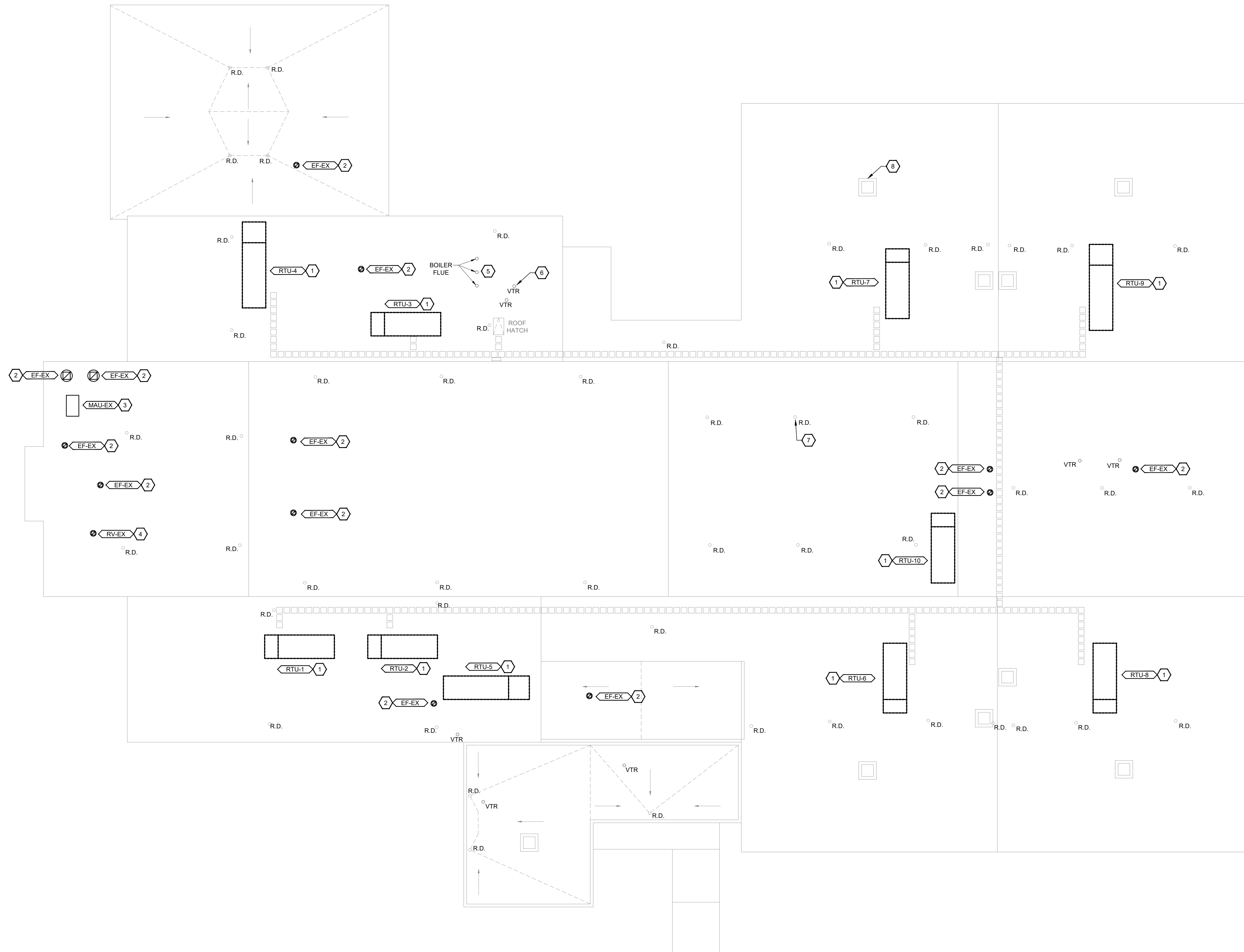
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MD102

- A. DEMOLITION PLAN HAS BEEN DEVELOPED FROM EXISTING PLANS AND VISITING SITE. SOME MECHANICAL EQUIPMENT, DUCTWORK, REGISTERS AND PIPING SIZES MAY NOT BE INDICATED.
- D. IT SHALL BE THE RESPONSIBILITY OF ALL CONTRACTORS WHO SUBMIT BIDS FOR THIS PROJECT TO REVIEW THE PROJECT PRIOR TO BIDDING IN ORDER THAT THEY MAY DETERMINE THE TYPE, QUANTITY, LOCATIONS AND ANY HANDSHIPS INVOLVED WITH THE REMOVAL OF EQUIPMENT.
- C. CONTRACTOR UNDER THIS DIVISION IS FINANCIALLY RESPONSIBLE TO REPAIR AND PATCH FLOORS, WALLS, CEILING AND ROOF TO MATCH EXISTING CONDITION WHEN DEMOLITION OF THIS SYSTEM HAS BEEN DONE. COORDINATE ALL WORK WITH OWNER/ENGINEER.
- D. THE EXISTING HVAC SYSTEM SHALL REMAIN FULLY FUNCTIONAL THROUGHOUT PHASED CONSTRUCTION.
- E. IF THE EXISTING HVAC SYSTEM SHALL EVER REQUIRE SHUTTING DOWN TEMPORARILY IN OCCUPIED AREAS DURING CONSTRUCTION, THE CONTRACTOR SHALL COORDINATE WITH THE TEAMING AND SHUT DOWN PERIOD WITH THE OWNER AND ARCHITECT PRIOR TO DISABLING THE EXISTING SYSTEM. THE EXISTING HVAC SYSTEM SHALL REMAIN FUNCTIONAL IN ALL UNOCCUPIED AREAS OF THE BUILDING THROUGHOUT THE PROJECT.
- F. ALL EXISTING THERMOSTATS AND EXISTING CONTROL WIRING SHALL BE REMOVED FROM ALL EQUIPMENT THAT IS BEING REMOVED IN THE BUILDING IN DEMOLISHED AREAS UNLESS OTHERWISE NOTED.

1. EXISTING ROOFTOP UNIT SHALL BE REMOVED AND A NEW ROOFTOP UNIT TO BE INSTALLED IN ITS PLACE. THE EXISTING ROOF CURBS SHALL REMAIN IN PLACE AND BE REUSED FOR NEW ROOFTOP INSTALLATION. DISCONNECT EXISTING DUCTWORK AND ELECTRICAL WIRING. NEW CONNECTIONS SHALL BE INSTALLED BACK IN SAME LOCATIONS. SEE NEW WORK PLAN FOR MORE INFORMATION.
2. EXISTING EXHAUST FAN SHALL REMAIN IN PLACE.
3. EXISTING KITCHEN MAKEUP AIR UNIT SHALL REMAIN IN PLACE.
4. EXISTING RELIEF VENT SHALL REMAIN IN PLACE.
5. EXISTING BOILER VENT STACK SHALL REMAIN IN PLACE.
6. EXISTING VENT THRU ROOF PIPING LOCATIONS SHALL REMAIN IN PLACE. TYPICAL OF ALL.
7. EXISTING ROOF DRAIN SHALL REMAIN IN PLACE. TYPICAL OF ALL.
8. EXISTING SKYLIGHT SHALL REMAIN IN PLACE. TYPICAL OF ALL.

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1 ROOF PLAN - HVAC - DEMOLITION  
SCALE: 1/16"=1'-0" 0 8' 16' 32'

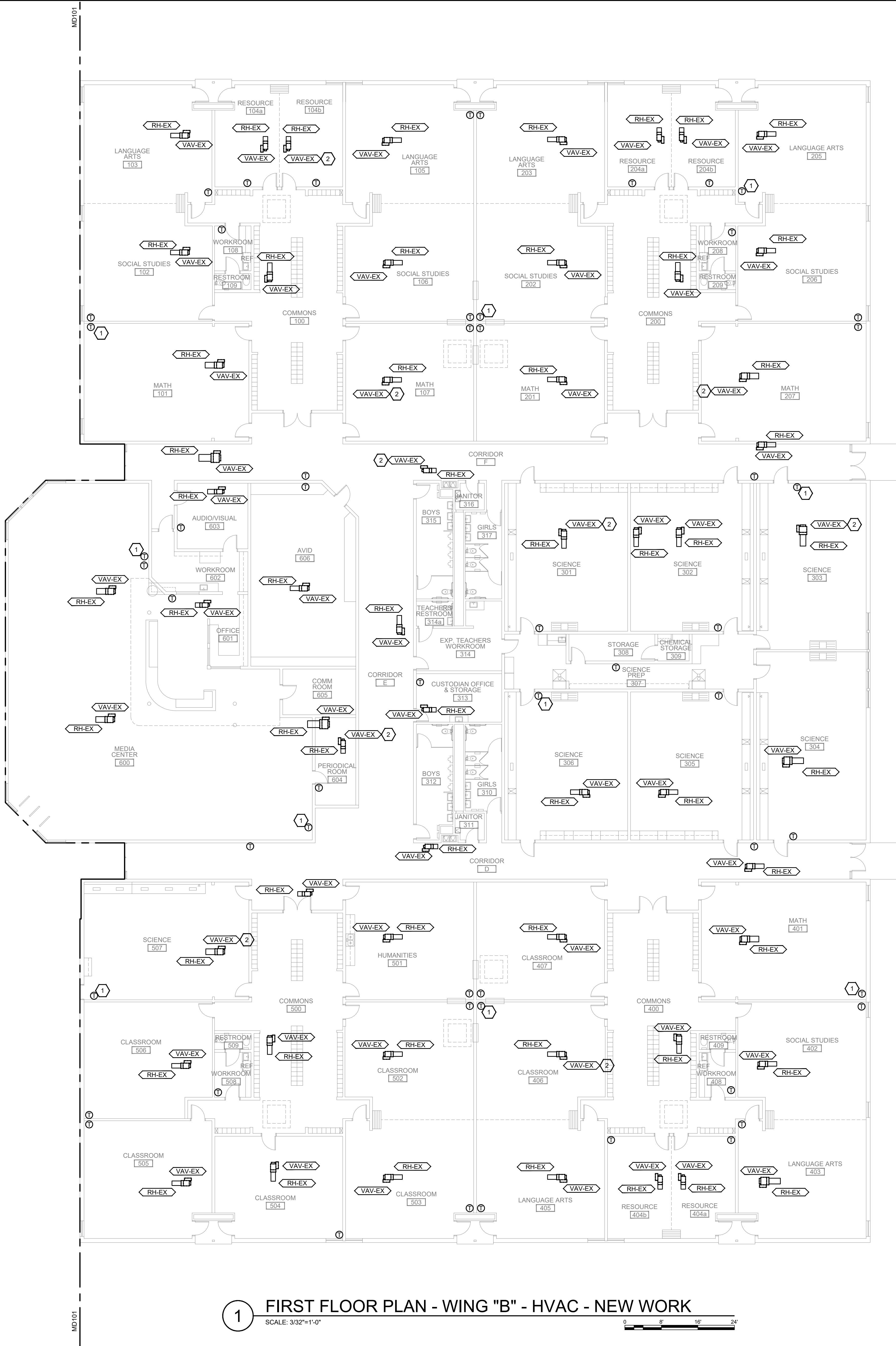


1. NEW THERMOSTAT TO BE INSTALLED IN SAME LOCATION AS EXISTING. NOTE THAT LOCATION IS APPROXIMATE. INSTALL NEW CONTROL WIRING TO EACH THERMOSTAT. REUSE PATHWAYS AS MUCH AS POSSIBLE. TYPICAL OF ALL.
2. EXISTING VAV BOX LOCATION. NEW ACTUATOR SHALL BE INSTALLED AT EXISTING VAV BOX FOR NEW DDC CONTROLS FOR THE BUILDING. EXISTING BOXES HAVE BEEN TAKEN FROM EXISTING DRAWINGS. CONTRACTOR TO FIELD VERIFY LOCATIONS. TYPICAL OF ALL.

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SHEET KEYNOTES:

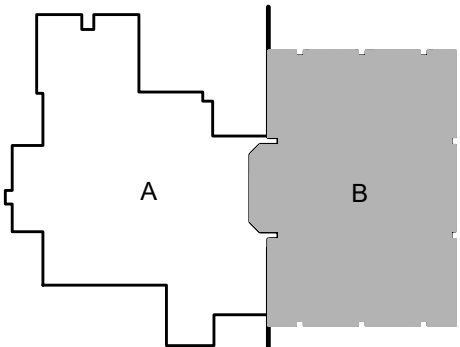
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1 FIRST FLOOR PLAN - WING "B" - HVAC - NEW WORK  
SCALE: 3/32"=1'-0"

KEY PLAN



CRW PROJECT NO. 4073-08

BC #25323

FCPS BID #4125

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DESIGN DOCUMENTS

FIRST FLOOR PLAN - WING "B"

HVAC - NEW WORK

WINBURN MIDDLE SCHOOL - HVAC REPLACEMENT

1060 WINBURN DRIVE, LEXINGTON, KY

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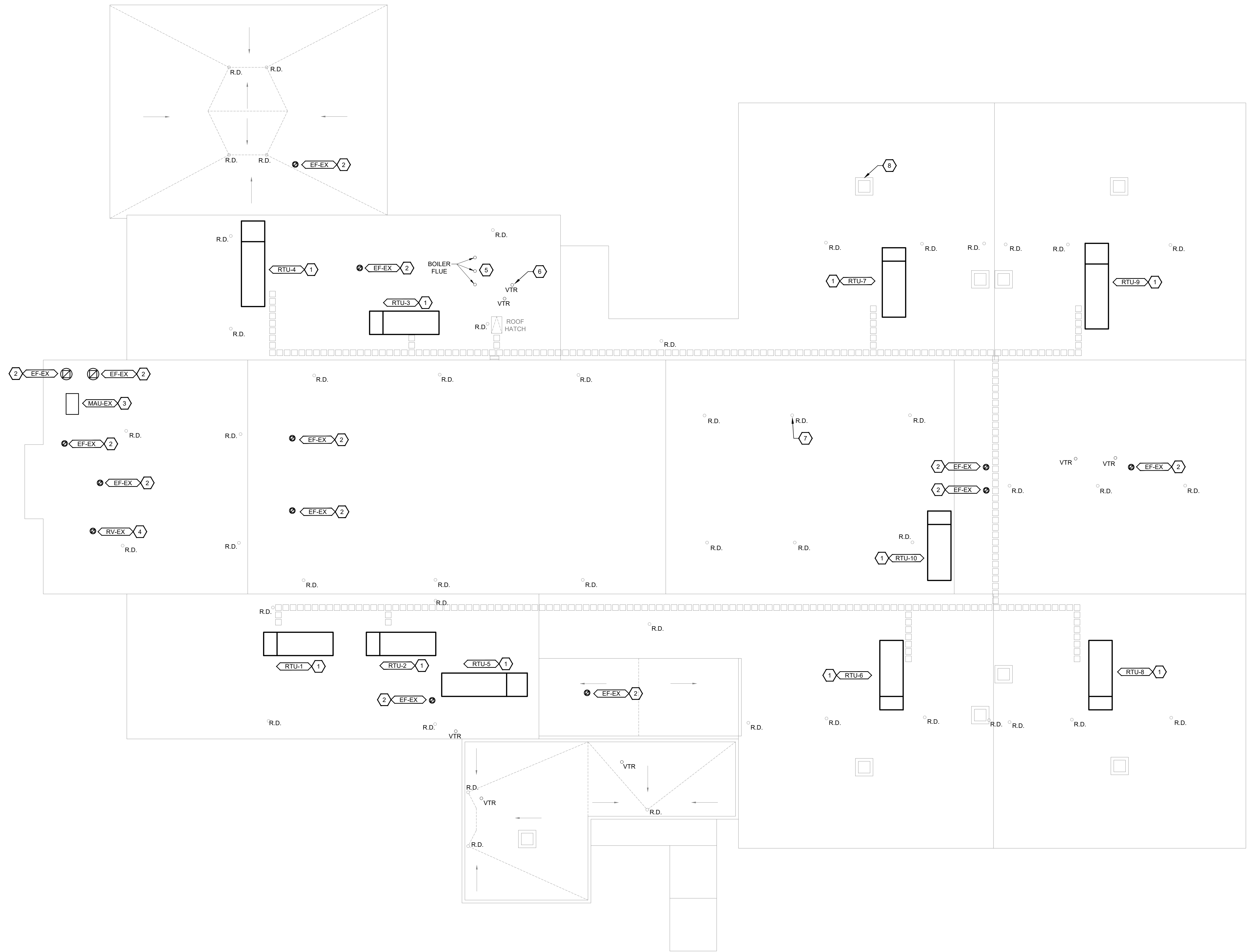
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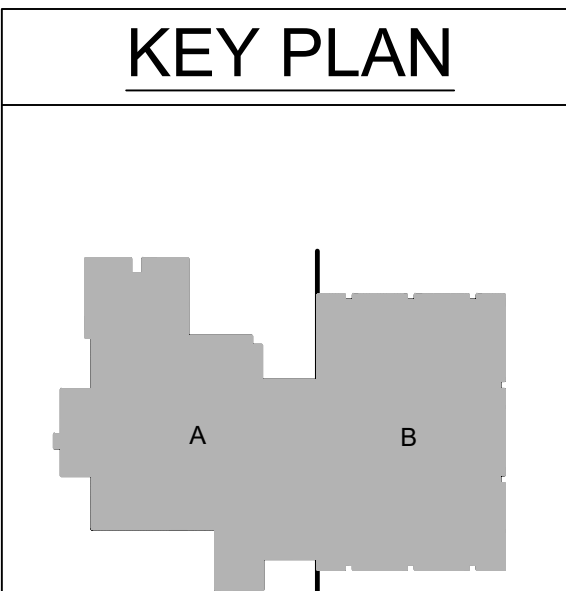
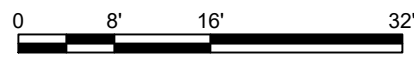
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1 ROOF PLAN - HVAC - NEW WORK  
SCALE: 1/16"=1'-0"



SHEET KEYNOTES:

- EXISTING ROOFTOP UNIT SHALL BE REMOVED AND A NEW ROOFTOP UNIT TO BE INSTALLED IN ITS PLACE. THE EXISTING ROOF CURB SHALL REMAIN IN PLACE AND BE REUSED FOR NEW ROOFTOP INSTALLATION. DISCONNECT EXISTING DUCTWORK AND ELECTRICAL WIRING. NEW CONNECTIONS SHALL BE INSTALLED BACK IN SAME LOCATIONS. SEE SCHEDULES AND DETAILS FOR MORE INFORMATION. INSTALL PER MANUFACTURER'S RECOMMENDATION.
- EXISTING EXHAUST FAN SHALL REMAIN IN PLACE.
- EXISTING KITCHEN MAKEUP AIR UNIT SHALL REMAIN IN PLACE.
- EXISTING RELIEF VENT SHALL REMAIN IN PLACE.
- EXISTING BOILER VENT STACK SHALL REMAIN IN PLACE.
- EXISTING VENT THRU ROOF PIPING LOCATIONS SHALL REMAIN IN PLACE. TYPICAL OF ALL.
- EXISTING ROOF DRAIN SHALL REMAIN IN PLACE. TYPICAL OF ALL.
- EXISTING SKYLIGHT SHALL REMAIN IN PLACE. TYPICAL OF ALL.

SPECIAL NOTES

- ALL EXISTING HVAC SYSTEMS SHALL REMAIN OPERATIONAL DURING THIS PROJECT. EXISTING EQUIPMENT SHALL BE DISABLED ONLY WHEN NEW EQUIPMENT IS ONSITE AND READY TO BE INSTALLED.
- AS UNITS ARE INSTALLED, THERMOSTATS SHALL BE INSTALLED AND PLACED IN STAND ALONE OPERATION MODE.
- ALL NEW EQUIPMENT INSTALLED SHALL CONNECT TO NEW DDC CONTROL SYSTEM TIED INTO FAYETTE COUNTY SCHOOLS CONTROL NETWORK. ALL OTHER EXISTING EQUIPMENT FOR THE SCHOOL SHALL REMAIN ON THE EXISTING CONTROL SYSTEM AND SHALL REMAIN SEPARATE FROM NEW EQUIPMENT CONTROLS.

CRW PROJECT NO. 4073-08  
BG #25323  
FCPS BID #4125

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DESIGN DOCUMENTS

REVISIONS

NO	DATE	BY	DESCRIPTION

APPROVED

DESIGNED	CVS
DRAWN	SPB
REVIEWED	CVS
APPROVED	CVS

DATE

APRIL 2025

SCALE

1/16" = 1'-0"

SHEET NO.

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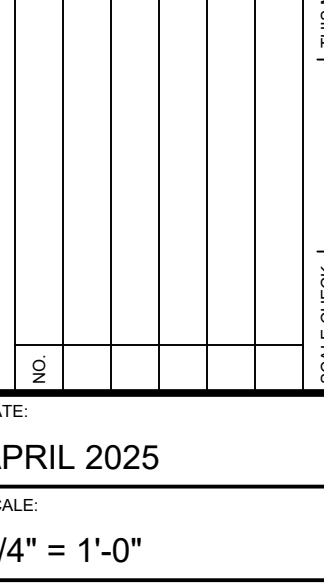


1. EXISTING GAS FIRED BOILER TO REMAIN IN PLACE.
2. EXISTING INLINE CIRCULATING PUMP FOR EXISTING BOILER SHALL REMAIN IN PLACE.
3. REMOVE EXISTING GAS FIRED BOILER AND REPLACE WITH NEW. SEE NEW WORK PLAN FOR MORE INFORMATION.
4. REMOVE EXISTING INLINE CIRCULATING PUMP FOR EXISTING BOILER AND REPLACE WITH NEW. SEE NEW WORK PLAN FOR MORE INFORMATION.
5. REPLACE EXISTING BASE MOUNTED ZONE PUMP WITH NEW PUMP IN SAME LOCATION. SEE NEW WORK PLAN FOR MORE INFORMATION.
6. EXISTING UNIT HEATER SHALL REMAIN IN PLACE.

1. ALL EXISTING HVAC SYSTEMS SHALL REMAIN OPERATIONAL DURING THIS PROJECT. EXISTING EQUIPMENT SHALL BE DISABLED ONLY WHEN NEW EQUIPMENT IS ONSITE AND READY TO BE INSTALLED.
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- A. DEMOLITION PLAN HAS BEEN DEVELOPED FROM EXISTING PLANS AND VISITING SITE. SOME MECHANICAL EQUIPMENT, DUCTWORK, REGISTERS AND PIPING SIZES MAY NOT BE INDICATED.
- I. IT SHALL BE THE RESPONSIBILITY OF THE CONTRACTORS WHO SUBMIT BIDS FOR THIS PROJECT TO VISIT THE PREMISES PRIOR TO BIDDING IN ORDER THAT THEY MAY DETERMINE THE TYPE, QUANTITY, LOCATIONS AND ANY HANDSHIPS INVOLVED WITH THE REMOVAL OF EQUIPMENT.
- C. CONTRACTOR UNDER THIS DIVISION IS FINANCIALLY RESPONSIBLE TO REPAIR AND PATCH FLOORS, WALLS, CEILINGS AND ROOF TO MATCH EXISTING CONDITION WHEN THE WORK HAS BEEN DONE.
- D. COORDINATE ALL WORK WITH OWNER/ENGINEER.
- D. THE EXISTING HVAC SYSTEM SHALL REMAIN FULLY FUNCTIONAL THROUGHOUT PHASED CONSTRUCTION.
- E. IF THE EXISTING HVAC SYSTEM SHALL EVER REQUIRE SHUTTING DOWN TEMPORARILY IN OCCUPIED AREAS DURING CONSTRUCTION, THE CONTRACTOR SHALL COORDINATE WITH THE SHUT DOWN PERIOD WITH THE OWNER AND ARCHITECT PRIOR TO DISABLING THE EXISTING SYSTEM. THE EXISTING HVAC SYSTEM SHALL REMAIN FUNCTIONAL, IN ALL OCCUPIED AREAS DURING NORMAL SCHOOL OPERATION PERIODS.
- F. ALL EXISTING THERMOSTATS AND EXISTING CONTROL WIRING SHALL BE REMOVED FROM ALL AREAS BEING REMOVED OR BEING REWired IN THE BUILDING IN DEMOLISHED AREAS UNLESS OTHERWISE NOTED.

1. EXISTING GAS FIRED BOILER TO REMAIN IN PLACE.
2. INSTALL NEW GAS FIRED BOILER. CONNECT NEW HOT WATER PIPING BACK TO EXISTING HOT WATER LOOP PIPING. CONNECT NEW BOILER VENT BACK TO EXISTING FLUE. CONNECT NEW COMBUSTION AIR DUCT BACK TO EXISTING COMBUSTION AIR DUCT.
3. INSTALL NEW IN-LINE CIRCULATING PUMP FOR NEW BOILER. CONNECT HOT WATER PIPING BETWEEN NEW BOILER AND CIRCULATING PUMP.
4. INSTALL NEW BASE MOUNTED ZONE PUMP IN EXISTING LOCATION. CONNECT NEW HOT WATER PIPING BACK TO EXISTING HOT WATER LOOP PIPING.
5. EXISTING UNIT HEATER SHALL REMAIN IN PLACE.
6. NEW HVAC CONTROL PANEL TO BE INSTALLED IN THIS LOCATION.







HOT WATER SYSTEM POINT LIST									
TAG	POINT DESCRIPTION	UNITS	DI	DO	AI	AO	ALARM	TREND	
BA-EX	B-EX ALARM	ALARM		X			X		
BC-EX	B-EX ENABLE COMMAND	ON/OFF		X				X	
BHWS-EX	B-EX HW SUPPLY TEMP	DEG F (DEG C)			X				6 MO
BSP-EX	B-EX HW SUPPLY TEMP SETPOINT	DEG F (DEG C)			X				
BHWR-EX	B-EX HW ENTERING TEMP	DEG F (DEG C)			X				6 MO
BVC-EX	B-EX CONTROL VALVE COMMAND	%				X			
BCS-EX	B-EX CONTROL VALVE STATUS	OPEN/CLOSE	X						
BA-1	B-1 ALARM	ALARM		X			X		
BC-1	B-1 ENABLE COMMAND	ON/OFF		X					
BHWS-1	B-1 HW SUPPLY TEMP	DEG F (DEG C)			X				6 MO
BSP-1	B-1 HW SUPPLY TEMP SETPOINT	DEG F (DEG C)			X				
BHWR-1	B-1 HW ENTERING TEMP	DEG F (DEG C)			X				6 MO
BVC-1	B-1 CONTROL VALVE COMMAND	%				X			
BCS-1	B-1 CONTROL VALVE STATUS	OPEN/CLOSE	X						
BLG-1	BOILER LEAD LAG	LEAD/LAG	X						
BRT-1	BOILER RUN TIME	HOURS			X				
BS-1	BOILER STATUS	ON/OFF	X						6 MO
BSW-1	BOILER SAFETY SWITCH STATUS	ENABLE	X						
GV-1	GAS VALVE	% OPEN				X			
HWDP-1	HOT WATER DIFFERENTIAL PRESSURE	PSI		X					
HWF-1	HOT WATER FLOW	GPM		X					6 MO
HPA-1	HOT WATER PUMP P-1 ALARM	ALARM		X			X		
HPC-1	HOT WATER PUMP P-1 COMMAND	ON/OFF		X					
HPLG-1	HOT WATER PUMP P-1 LEAD LAG	LEAD/LAG	X						
HPRT-1	HOT WATER PUMP P-1 RUN TIME	HOURS			X				
HPS-1	HOT WATER PUMP P-1 STATUS	ON/OFF	X						6 MO
HWJ-1	HOT WATER PUMP P-1 VFD CURRENT	A			X				
VCO-1	HOT WATER PUMP P-1 VFD COMMAND	ON/OFF		X					
VOP-1	HOT WATER PUMP P-1 VFD OUTPUT FREQUENCY	HZ		X					
VIP-1	HOT WATER PUMP P-1 VFD INPUT POWER	W			X				
VSP-1	HOT WATER PUMP P-1 VFD SPEED %	%				X			
HPA-2	HOT WATER PUMP P-2 ALARM	ALARM		X			X		
HPC-2	HOT WATER PUMP P-2 COMMAND	ON/OFF		X					
HPLG-2	HOT WATER PUMP P-2 LEAD LAG	LEAD/LAG	X						
HPRT-2	HOT WATER PUMP P-2 RUN TIME	HOURS			X				
HPS-2	HOT WATER PUMP P-2 STATUS	ON/OFF	X						6 MO
HWJ-2	HOT WATER PUMP P-2 VFD CURRENT	A			X				
VCO-2	HOT WATER PUMP P-2 VFD COMMAND	ON/OFF		X					
VOP-2	HOT WATER PUMP P-2 VFD OUTPUT FREQUENCY	HZ		X					
VIP-2	HOT WATER PUMP P-2 VFD INPUT POWER	W			X				
VSP-2	HOT WATER PUMP P-2 VFD SPEED %	%				X			
HWR-1	HOT WATER RETURN TEMPERATURE	DEG F (DEG C)			X				6 MO
HWS-1	HOT WATER SUPPLY TEMPERATURE	DEG F (DEG C)			X				6 MO
OA-1	GLOBAL OUTSIDE AIR TEMPERATURE	DEG F (DEG C)			X				6 MO
RH-1	GLOBAL OUTSIDE AIR HUMIDITY	% RH			X				6 MO

Note 1: Outside air temperature, and humidity readings can be a global point.

## SEQUENCE OF OPERATION - HEATING HOT WATER SYSTEM

### HOT WATER BOILERS

- A BAS SHALL BE PROVIDED TO CONTROL, MONITOR, AND AUTOMATE THE OPERATION OF THE HOT WATER BOILERS AND PUMPS IN CONJUNCTION WITH THE FACTORY BOILER CONTROLS. THE FACTORY BOILER CONTROLLER SHALL SEND DATA POINTS TO THE BAS SUCH AS IDENTITY OF BOILERS, HOT WATER SUPPLY AND RETURN TEMP, CONTROL VALVE OPERATION, HOT WATER FLOW, BOILER RUN HOURS, ETC.
- THE BOILER ARRAY SHALL BE OPERATED BY THE FACTORY CONTROL SYSTEM PROVIDED BY THE BOILER MANUFACTURER. THE FACTORY CONTROLLER SHALL HANDLE EQUIPMENT LEVEL PARAMETERS SUCH AS FIRING RATE, BLOWER CONTROL, SAFETIES, AND PUMP CONTROL. THE BOILER CONTROLLER SHALL BE CAPABLE OF HANDLING MULTIPLE BOILERS IN THE ARRAY TO DETERMINE THE OPTIMAL MODE OF OPERATION FOR EFFICIENCY AND LONGEVITY. THE BOILER CONTROLLER SHALL RECEIVE INPUTS FROM THE BAS FOR PARAMETERS INCLUDING BUT NOT LIMITED TO THE FOLLOWING:
  - BOILER CONTROL SYSTEM ENABLE/DISABLE.
  - HOT WATER SUPPLY TEMPERATURE SETPOINT
  - BOILER IN/OUT OF SERVICE
  - OPERATOR DESIGNATION OF BOILER ORDER IN LINEUP.
- THE HOT WATER BOILER PLANT CONSISTS OF TWO (2) BOILERS WITH LEAD/LAG/STANDBY CONTROL. ONE (1) BOILER SHALL ALWAYS BE ENABLED ON TO PROVIDED REHEAT CAPABILITY FOR SUMMER TIME. THE HOT WATER PLANT ALSO CONSISTS OF TWO LEAD/LAG/STANDBY PUMPS.
- THE MAINTENANCE STAFF SHALL SCHEDULE LEAD/LAG CONTROL OF THE BOILERS AND PUMPS AS PROGRAMMED BY THE DDC GRAPHIC OWNER INTERFACE. THE LOCAL DIRECT DIGITAL CONTROLLER (DDC) SHALL TRACK RUN HOURS AND LEAD/LAG THE BOILERS AND THE PUMPS AS DETERMINED BY WEEKLY RUN TIME SCHEDULE. THE BAS SHALL TRACK AND DISPLAY THE RUN HOURS OF EACH BOILER AND PUMP. IN THE EVENT OF LEAD FAILURE, THE DDC SHALL AUTOMATICALLY START THE SELECTED LAG BOILER AND/OR PUMP.
- WHENEVER A BOILER IS ENABLED ON, THE DDC SHALL OPEN THE ASSOCIATED BOILER ISOLATION VALVE, ENABLE THE COMBUSTION AIR DAMPER AND START THE LEAD PUMP. THE COMBUSTION AIR DAMPER SHALL CYCLE WITH THE BURNER TO REMAIN SHUT DURING OFF PERIODS. ISOLATION VALVE PROOF SWITCH SHALL INTERLOCK ON THE SELECTED BOILER. PUMP STATUS AND COMBUSTION AIR DAMPER PROOF SWITCH SHALL ALLOW TOGETHER A BOILER BURNER TO START. IF A FAILURE OCCURS AN ALARM SHALL BE RECORDED AT THE DDC GRAPHIC OWNER INTERFACE.
- THE BAS SHALL MONITOR THE HOT WATER SUPPLY TEMPERATURE, HOT WATER RETURN TEMPERATURES, BOILER GAS FLOW, AND TOTAL HOT WATER FLOW.
- IF THE LEAVING HOT WATER TEMPERATURE SET POINT IS NOT MET FOR 10 MINUTES (ADJ.), THE BAS SHALL ENABLE THE BOILER CONTROLLER TO BEGIN THE LEAD BOILER STARTUP PROCEDURE, WHICH SHALL INCLUDE OPENING THE CONTROL VALVE PRIOR TO STARTING BOILER.
- IF THE LEAD BOILER FAILS TO START WITHIN ITS TIME LIMIT (PREDETERMINED BY THE MANUFACTURER) OR IF THE LEAD BOILER STATUS IS NOT RECEIVED FOLLOWING THE COMMAND, THE CONTROLLER WILL FAIL THAT BOILER, ALARM AT THE BAS OPERATOR PANEL, AND START THE STANDBY BOILER. IF ANY ISOLATION VALVE FAILS TO OPEN, THE CONTROLLER WILL FAIL THAT BOILER AND INITIATE THE PROCESS FOR STARTING THE NEXT BOILER IN SEQUENCE.
- HOT WATER TEMPERATURE SETPOINT AND RESET

OUTDOOR TEMP	HOT WATER TEMP SETPOINT
55°F (ADJ.) AND BELOW	180°F (ADJ.)
70°F (ADJ.) AND ABOVE	150°F (ADJ.)
- THE LAG BOILER SHALL BE STARTED WHEN THE BOILER CONTROLLER ALGORITHM DETERMINES IT IS MORE EFFICIENT TO RUN WITH ANOTHER BOILER ONLINE. IF A BOILER FAILS TO START OR FAILS TO CONTINUE RUNNING ON COMMAND, THE CONTROLLER SHALL IMMEDIATELY INITIATE THE STARTING SEQUENCE FOR THE NEXT LAG BOILER IN THE LINEUP AS PROGRAMMED, WHICH SHALL INCLUDE OPENING THE CONTROL VALVE PRIOR TO STARTING BOILER.
- WHEN THE FIRST BOILER IS ENERGIZED, NO ADDITIONAL BOILERS SHALL BE ADDED OR REMOVED FOR AN ADJUSTABLE LENGTH OF TIME (30 MINUTES) TO ALLOW THE SYSTEM TO STABILIZE. AFTER A LAG BOILER IS ADDED OR REMOVED, NO ADDITIONAL BOILERS SHALL BE ADDED OR REMOVED FOR AN ADJUSTABLE LENGTH OF TIME (15 MINUTES) TO ALLOW THE SYSTEM TO STABILIZE.
- THE LAG BOILERS ISOLATION VALVE SHALL BE SLOWLY OPENED OVER A PERIOD OF 2 MINUTES (ADJ.) TO AVOID LARGE FLOW VARIATIONS TO THE OPERATING BOILERS. ONCE THE VALVE IS PROVED OPEN, THE RUNNING BOILER SHALL UNLOAD AND THE LAG BOILER SHALL ENERGIZE, MATCH CAPACITY, AND OPERATE IN PARALLEL WITH THE LEAD BOILER TO MAINTAIN HOT WATER SUPPLY TEMPERATURE SETPOINT.
- THE LAST LAG BOILER SHALL BE STOPPED WHEN THE BOILER CONTROLLER DETERMINES IT IS BENEFICIAL TO RUN WITH ONE FEWER BOILER ONLINE.
- AT THAT TIME, THE LAG BOILER SHALL BE DISABLED AND ITS ISOLATION VALVE SLOWLY MODULATED CLOSED TO AVOID SUDDEN VARIATION IN WATER FLOW. THE LAG BOILERS SHALL BE DISABLED IN REVERSE ORDER AS DICTATED BY THE BAS LINEUP.
- THE FIRST BOILER STARTED IN THE LEAD/LAG SEQUENCE SHALL BE DISABLED IF THE TEMPERATURE OF THE WATER RETURNING TO THE BOILER PLANT IS WITHIN 2°F (ADJ.) OF THE HOT WATER LEAVING WATER TEMPERATURE SETPOINT. AT THAT TIME, THE LEAD BOILER SHALL BE DE-ENERGIZED.
- THE HOT WATER PUMPS ARE ENERGIZED MANUALLY THROUGH THE ACTION OF AN H-O-A SWITCH WHEN IT IS IN THE HAND POSITION OR BY THE BUILDING AUTOMATION SYSTEM (BAS) WHEN THE H-O-A IS IN THE AUTOMATIC POSITION. THE BAS SHALL MONITOR THE BUILDING SUPPLY AND BOTH RETURN HOT WATER TEMPERATURES AND THE BUILDING HOT WATER FLOW.
- THE MINIMUM FLOW RATE SHALL BE PREPROGRAMMED INTO THE BAS FOR EACH BOILER BASED ON INFORMATION TO BE PROVIDED BY THE MANUFACTURER. THE BAS SHALL DYNAMICALLY SET THE MINIMUM FLOW RATE FOR THE BUILDING HOT WATER PUMPS AS THE TOTAL FLOW FOR THE ENERGIZED BOILERS.
- THE HOT WATER PUMP SPEED SHALL BE MAINTAINED THROUGH A PID LOOP CONTROL. THE SPEED OF THE HOT WATER PUMP SHALL BE MODULATED BY THE VFD TO MAINTAIN THE HOT WATER SYSTEM DIFFERENTIAL PRESSURE AS SENSED BY THE DIFFERENTIAL PRESSURE SENSOR INSTALLED AS SHOWN ON THE DRAWINGS.
- IF THE LEAD PUMP VFD REACHES 95% OF MAX SPEED FOR 10 MINUTES (ADJ.), THE SECOND (LAG) HOT WATER PUMP SHALL BE STARTED. IF A HOT WATER PUMP FAILS TO START OR TO RUN ON COMMAND, THE NEXT LAG HOT WATER PUMP SHALL START IMMEDIATELY. AN ALARM SHALL BE REPORTED TO THE BAS GRAPHICS, AND THE FAILED PUMP IS TO BE MARKED AS "OUT OF SERVICE".
- ONCE THE LAG HOT WATER PUMP HAS STARTED, BOTH THE LEAD AND LAG HOT WATER PUMPS SHALL BE MODULATED TOGETHER TO MAINTAIN THE HOT WATER DIFFERENTIAL PRESSURE AT SET POINT. THE HOT WATER DIFFERENTIAL PRESSURE TRANSMITTER SHALL BE WIRED TO THE SAME BAS CONTROLLER THAT IS CONTROLLING THE HOT WATER PUMPS. THE OPERATION OF THE HOT WATER PUMPS SHALL NOT BE DEPENDENT ON THE CONTROLS NETWORK LEVEL COMMUNICATIONS.
- THE LAG HOT WATER PUMP SHALL BE STOPPED WHEN DOING SO WOULD STILL KEEP THE REMAINING ENERGIZED PUMPS OPERATING AT OR BELOW 80% FOR AN ADJUSTABLE PERIOD OF TIME (10 MIN.).
- MAKE UP WATER FOR CLOSED LOOP SYSTEM. DDC SHALL CONNECT TO WATER METER AND SEND AND ALARM TO DDC GRAPHIC OWNER INTERFACE IF METER RUNS CONTINUOUSLY FOR A PERIOD OF TIME (ADJ.) TO ALERT A POTENTIAL LEAK IN SYSTEM.
- UPON DETECTION OF FIRE, COMBUSTIBLE GAS IN THE BOILER ROOM OR UPON PANIC BUTTON ACTIVATION FUEL FLOW TO THE BOILERS AND DOMESTIC WATER HEATERS SHALL CEASE BY CLOSING AUXILIARY GAS VALVES AND DISABLING THE PUMP SET. PROVIDE CONTROL GAS VALVES ON GAS PIPING SERVING BOILERS AND DOMESTIC WATER HEATERS.
- THE CONTROL CONTRACTOR SHALL PROVIDE TWO BOILER EMERGENCY SHUT OFF BUTTONS LOCATED BY THE MECHANICAL ROOM EXITS AND IN ACCORDANCE WITH PARAGRAPH HG-634, ARTICLE 6, SECTION 4 OF THE ASME HEATING BOILER CODE. PROVIDE WITH COVER AND LABEL "BOILER/WATER HEATER EMERGENCY SHUT DOWN". THE ACTIVATION OF THIS SWITCH SHALL SHUT DOWN THE GAS TRAINS TO THE BOILERS AND WATER HEATERS. THE PUSH BUTTONS SHALL BE "RED MUSHROOM" TYPE TO AVOID ANY CONFUSION WITH LIGHT SWITCHES. PROVIDE CONTROL GAS VALVES ON GAS PIPING SERVING BOILERS AND DOMESTIC WATER HEATERS.

## SEQUENCE OF OPERATION - ROOFTOP UNITS - SINGLE ZONE

- OCCUPIED MODE:** THE UNIT CAN BE PLACED IN THE OCCUPIED MODE BY A 7-DAY PROGRAMMABLE SCHEDULE IN THE DDC CONTROLLER, ACCESSIBLE THROUGH THE KEYPAD. A DIGITAL INPUT SHALL BE AVAILABLE TO OVERRIDE ANY OTHER COMMAND AND TURN THE UNIT ON EVEN WHEN THE SCHEDULE FOR THE UNIT TO BE OFF (UNOCCUPIED MODE). THE DIGITAL INPUT CAN BECOME THE PRIMARY MEANS OF ENABLING THE UNIT BY NOT HAVING ANY ON/OFF TIMES IN THE SCHEDULE. IF A BUILDING AUTOMATION SYSTEM (BAS) IS USED TO INTERFACE WITH THE UNIT(S), THE CONTROLS CONTRACTOR SHOULD CONTACT SEASONS 4 FOR ADDITIONAL INFORMATION.
- UNOCCUPIED MODE:** THE SUPPLY AIR BLOWER AND EXHAUST AIR FAN SHALL BE DE-ENERGIZED. THE OUTDOOR AIR DAMPER WILL BE FULLY CLOSED, AND THE RETURN AIR DAMPER WILL BE FULLY OPEN. NO COOLING OR HEATING FUNCTION WILL BE ALLOWED.
- SUPPLY AIR BLOWER:** THE SUPPLY AIR BLOWER WILL RUN CONTINUOUSLY IN OCCUPIED MODE. THE SUPPLY AIR BLOWER WILL BE A CONSTANT AIR VOLUME TYPE CONTROLLED BY VARIABLE SPEED DRIVE. THE VSD IS USED TO SET THE REQUIRED BLOWER SPEED. THE VSD IS USED FOR BLOWER BALANCING PURPOSES AND WILL BE SET BY THE TEST AND BALANCING CONTRACTOR.
- EXHAUST AIR FAN:** THE EXHAUST AIR FAN WILL BE VARIABLE AIR VOLUME TYPE CONTROLLED BY A VARIABLE SPEED DRIVE AND WILL BE ENERGIZED AND CONTROLLED BASED ON BUILDING PRESSURE.
- SMOKE DETECTOR:** THE UNIT WILL HAVE A RETURN AIR SMOKE DETECTOR. UPON DETECTION OF SMOKE, THE SUPPLY AIR FAN WILL DE-ENERGIZE. THE OUTDOOR (AND EXHAUST) AIR DAMPERS(S) WILL DRIVE TO A FULLY CLOSED POSITION. THE RETURN AIR DAMPER WILL DRIVE TO A FULLY OPEN POSITION. A TERMINAL BLOCK SHALL BE PROVIDED FOR FIELD WIRING CONNECTIONS TO A REMOTE LOCATION IF DESIRED.
- COMPRESSOR & COOLING SECTION:** A CALL FOR COOLING WILL BE INITIATED WHEN THE SPACE TEMPERATURE RISES ABOVE THE COOLING SET POINT OF THE TEMPERATURE CONTROL. THE CALL FOR COOLING WILL CONTINUE UNTIL THE TEMPERATURE CONTROL IS SATISFIED. THE COLD DECK DAMPER WILL OPEN AND THE HOT DECK DAMPER WILL CLOSE. THE UNIT IS EQUIPPED WITH AN EVAPORATOR COOLING COIL AND SCROLL COMPRESSORS, INCLUDING A VFD SCROLL LEAD COMPRESSOR CAPABLE OF MODULATING CAPACITY FOR CAPACITY CONTROL. THE COMPRESSORS WILL STAGE BASED ON A CALL FOR COOLING AND SHALL MAINTAIN A DISCHARGE AIR TEMPERATURE OF 50°F (ADJUSTABLE). THE LEAD VFD SCROLL COMPRESSOR HAS A DESIGN OPERATING SPEED OF 7200 RPM. THE RANGE OF OPERATION SHOULD BE LIMITED TO A MINIMUM SPEED OF 35% (APPROXIMATELY 2500 RPM) FOR PROTECTION OF THE SYSTEM COMPRESSOR STAGING SEQUENCE WILL BE: COMPRESSOR 1 ON, COMPRESSOR 2 ON, ETC. COMPRESSOR STAGING MUST BE RE-STARTED BEGINNING WITH STAGE 1 UPON RESET OF ANY SAFETY DEVICE. ONCE THERE IS A CALL FOR COOLING, THE DDC CONTROLLER WILL ENABLE COMPRESSOR 1 AND PROVIDE A DEMAND SIGNAL BASED ON DISCHARGE AIR TEMPERATURE. EACH SUBSEQUENT COMPRESSOR WILL HAVE AN ONDELAY OF 5 MINUTES TO ALLOW THE LEAD VFD COMPRESSOR TO MODULATE TO MEET SET POINT BEFORE ANY OTHER COMPRESSORS ARE TURNED ON/OFF. IF AFTER 5 MINUTES THE VFD COMPRESSOR IS AT FULL CAPACITY AND THE DISCHARGE AIR TEMPERATURE IS STILL ABOVE THE DISCHARGE AIR TEMPERATURE DEADBAND, THE NEXT COMPRESSOR WILL BE STAGED ON. IF AFTER 5 MINUTES THE VFD COMPRESSOR IS AT MINIMUM OUTPUT AND THE DISCHARGE AIR TEMPERATURE IS STILL BELOW THE DEADBAND, THE NEXT COMPRESSOR WILL BE STAGED OFF. THE VFD COMPRESSOR MUST REACH FULL CAPACITY ON AN INCREASE IN DEMAND OR MINIMUM OUTPUT ON A DECREASE IN DEMAND BEFORE STAGING ANY OTHER COMPRESSORS ON/OFF. EACH COMPRESSOR WILL RUN FOR A MINIMUM OF 3 MINUTES ONCE ENERGIZED TO ENSURE PROPER OIL RETURN TO THE COMPRESSOR. EACH COMPRESSOR HAS A SOLID STATE 5 MINUTE TIMER TO PREVENT SHORT CYCLING. MECHANICAL COOLING IS DISABLED IF THE COIL LEAVING TEMPERATURE DROPS BELOW 38°F DB (ADJUSTABLE). COOLING WILL REACTIVATE ONCE THE FREEZE STAT DOWNSTREAM OF EVAPORATOR COIL IS SATISFIED. THE UNIT WILL HAVE A LOW AMBIENT LOCKOUT SET AT 50°F (ADJUSTABLE).
- HEATING SECTION:** IN HEATING MODE THE ELECTRIC HEAT UNIT SHALL BE ENABLED TO MAINTAIN DISCHARGE TEMPERATURE SETPOINT.
- HOT GAS REHEAT COIL:** THE HOT GAS REHEAT (HGR) COIL IS PROVIDED ON THE SPECIFIED COMPRESSOR CIRCUIT(S) (TYPICALLY THE LEAD CIRCUIT) TO PROVIDE "NEUTRAL" AIR LEAVING THE UNIT. THE HGR COIL IS ONLY AVAILABLE WHEN THE COMPRESSOR IS RUNNING AND CAN BE USED AS REHEAT FOR DEHUMIDIFICATION. THE HOT GAS REHEAT COIL IS CONTROLLED BY A MODULATING 3-WAY VALVE TO MAINTAIN A UNIT LEAVING AIR SET POINT OF 70°F (ADJUSTABLE). UPON INITIAL REHEAT CALL, THE HGR VALVE IS SET TO THE FULLY OPEN (100% THROUGH THE HGR COIL) POSITION FOR ONE (1) MINUTE. AFTER ONE MINUTE, THE VALVE IS MODULATED TO ACHIEVE THE REQUIRED LEAVING AIR TEMPERATURE SET POINT. IF THE COMPRESSOR IS ACTIVE AND THE HGR VALVE IS OPEN TO THE HGR COIL (GREATER THAN 0%) FOR MORE THAN AN ACCUMULATED TIME OF 50 MINUTES, THE HGR VALVE IS SET TO THE FULLY OPEN (100%) POSITION FOR ONE (1) MINUTE TO "FLUSH" THE HGR COIL. AFTER THIS FLUSH TIME, THE VALVE IS RETURNED TO NORMAL MODULATING OPERATION TO ACHIEVE THE REQUIRED LEAVING AIR TEMPERATURE SET POINT. IF THERE IS A CALL FOR COOLING ONLY (NO HGR) WHILE THE HGR COIL IS ACTIVE, THE HGR VALVE IS SET TO THE FULLY OPEN (100%) POSITION FOR TWO (2) MINUTES. AT THE END OF TWO MINUTES, THE HGR VALVE IS CLOSED (0%), THE HGR COIL IS COMPLETELY BYPASSED, IF THE COMPRESSOR DE-ENERGIZES, THE HGR VALVE IS SET TO THE FULLY OPEN (100%) POSITION.
- ECONOMIZER (OUTSIDE, RETURN & EXHAUST DAMPERS):** THE ECONOMIZER WILL HAVE AN ENTHALPY CHANGEOVER CONTROL WHICH WILL ENABLE THE ECONOMIZER ANYTIME THERE IS A CALL FOR COOLING AND THE AMBIENT ENTHALPY IS BELOW THE CHANGEOVER SET POINT OF 22 BTU/LB (ADJUSTABLE). THE OUTDOOR AND RETURN AIR DAMPERS WILL MODULATE TO MAINTAIN A MIXED AIR TEMPERATURE OF 55°F (ADJUSTABLE). WHEN THE ECONOMIZER IS DISABLED AND THE UNIT IS IN OCCUPIED MODE, THE OUTDOOR AIR DAMPER WILL BE SET AT MINIMUM POSITION. WHEN THE ECONOMIZER IS DISABLED AND THE UNIT IS IN UNOCCUPIED MODE, THE OUTDOOR AIR DAMPER WILL BE CLOSED. THE EXHAUST AIR DAMPER IS A GRAVITY DAMPER. THE OUTDOOR AND RETURN AIR DAMPER ACTUATORS WILL BE ELECTRIC.
- CONDENSER FAN CONTROL:** THE CONDENSER FAN MOTORS WILL BE CONTROLLED BY A VARIABLE FREQUENCY DRIVE. THE VARIABLE FREQUENCY DRIVE WILL RAMP UP AND DOWN BASED UPON INPUT SIGNALS COMING FROM PRESSURE TRANSDUCERS MOUNTED ON THE DISCHARGE LINES. THE CONDENSER FAN SPEED WILL MODULATE TO MAINTAIN A CONSTANT HEAD PRESSURE OF 320 PSIG. 320 PSIG. IF AT ANY TIME THE DISCHARGE PRESSURE OF ANY OF THE COMPRESSOR CIRCUITS THAT ARE RUNNING FALLS BELOW 280 PSIG, THE CONTROLLER WILL REDUCE THE CONDENSER FAN SPEED TO MAINTAIN A MINIMUM DISCHARGE PRESSURE OF 240 PSIG AND ALLOW THE HIGHEST DISCHARGE PRESSURE TO RISE ABOVE THE 320 PSIG SETPOINT. THE CONTROLLER WILL CONTINUE TO REDUCE THE CONDENSER FAN SPEED AS NEEDED TO MAINTAIN THE MINIMUM DISCHARGE PRESSURE UNTIL THE DISCHARGE PRESSURE OF ANY OTHER COMPRESSOR CIRCUIT REACHES A MAXIMUM PRESSURE OF 475 PSIG.
- FILTER PRESSURE DROP:** UNIT IS EQUIPPED WITH A DIFFERENTIAL STATIC PRESSURE SWITCH ACROSS THE FILTER BANK. AN ALARM SHALL BE PROVIDED VIA THE UNIT CONTROLLER TO THE OPERATOR INTERFACE WHEN THE DIFFERENTIAL STATIC PRESSURE EXCEEDS 1.0" W.C. (ADJUSTABLE).
- NIGHT SETBACK:** DURING THE UNOCCUPIED MODE IF A ZONES' TEMPERATURE FALLS BELOW 60°F (ADJUSTABLE), THE UNIT CONTROLLER SHALL RESTART THE SUPPLY FAN. THE OUTSIDE AIR DAMPER WILL DRIVE TO COMPLETELY CLOSED POSITION, AND THE RETURN AIR DAMPER WILL DRIVE TO A COMPLETELY OPEN POSITION. THE SUPPLY AIR FAN WILL REMAIN ON UNTIL THE TEMPERATURE REACHES 60°F (ADJUSTABLE). DURING THIS MODE HEATING CAPABILITIES SHALL REMAIN ENABLED. DURING THE UNOCCUPIED MODE IF A ZONES' TEMPERATURE RISES ABOVE 80°F (ADJUSTABLE), THE UNIT CONTROLLER SHALL RESTART THE SUPPLY FAN. THE OUTSIDE AIR DAMPER WILL DRIVE TO COMPLETELY CLOSED POSITION, AND THE RETURN AIR DAMPER WILL DRIVE TO A COMPLETELY OPEN POSITION. THE SUPPLY AIR FAN WILL REMAIN ON UNTIL THE TEMPERATURE REACHES 80°F (ADJUSTABLE). DURING THIS MODE COOLING CAPABILITIES SHALL REMAIN ENABLED.
- MORNING WARM UP:** IN THE MORNING WARM UP MODE, AS DETERMINED BY THE TIME OF DAY SCHEDULE, OUTDOOR AIR DAMPER SHALL BE FULLY CLOSED AND RETURN AIR DAMPER SHALL BE FULLY OPENED UNTIL THE RETURN AIR TEMPERATURE REACHES 65°F (ADJUSTABLE). ONCE THE MIXED AIR TEMPERATURE REACHES ITS SET POINT, OUTDOOR AIR DAMPER SHALL BE OPENED TO A MINIMUM VENTILATION POSITION. DURING THIS MODE HEATING CAPABILITIES SHALL REMAIN ENABLED.

## SEQUENCE OF OPERATION - DDC CONTROL SYSTEM

PROVIDE ALL NEW GRAPHICS FOR ENTIRE BUILDING FOR DDC CONTROL SYSTEM. DDC CONTRACTOR SHALL PROVIDE NEW GRAPHICS FOR EITHER CONTROL COMPANY LISTED IN SPECIFICATIONS.

## SEQUENCE OF OPERATION - EXTERIOR LIGHTS

LIGHTING CONTROLS SHALL BE DETERMINED BY PHOTOCELL STATUS AND DDC SCHEDULE.

PROVIDE LIGHTING STATUS TO DDC MONITORING SYSTEM. DDC CONTRACTOR SHALL PROVIDE ALL DEVICES, RELAYS, SWITCHES, ETC. TO ACCOMMODATE OPERATION.

## SEQUENCE OF OPERATION - GENERATOR

EMERGENCY GENERATOR SHALL BE CONNECTED TO DDC MONITORING SYSTEM.

PROVIDE GENERATOR STATUS TO DDC MONITORING SYSTEM. DDC CONTRACTOR SHALL PROVIDE ALL DEVICES, RELAYS, SWITCHES, ETC. TO ACCOMMODATE OPERATION.

## SEQUENCE OF OPERATION - ROOFTOP UNITS - VAV

- OCCUPIED MODE:** THE UNIT CAN BE PLACED IN THE OCCUPIED MODE BY A 7-DAY PROGRAMMABLE SCHEDULE IN THE DDC CONTROLLER, ACCESSIBLE THROUGH THE KEYPAD. A DIGITAL INPUT SHALL BE AVAILABLE TO OVERRIDE ANY OTHER COMMAND AND TURN THE UNIT ON EVEN WHEN THE SCHEDULE FOR THE UNIT TO BE OFF (UNOCCUPIED MODE). THE DIGITAL INPUT CAN BECOME THE PRIMARY MEANS OF ENABLING THE UNIT BY NOT HAVING ANY ON/OFF TIMES IN THE SCHEDULE. IF A BUILDING AUTOMATION SYSTEM (BAS) IS USED TO INTERFACE WITH THE UNIT(S), THE CONTROLS CONTRACTOR SHOULD CONTACT SEASONS 4 FOR ADDITIONAL INFORMATION.
- UNOCCUPIED MODE:** THE SUPPLY AIR BLOWER AND EXHAUST AIR FAN SHALL BE DE-ENERGIZED. THE OUTDOOR AIR DAMPER WILL BE FULLY CLOSED, AND THE RETURN AIR DAMPER WILL BE FULLY OPEN. NO COOLING OR HEATING FUNCTION WILL BE ALLOWED.
- SUPPLY AIR BLOWER:** THE SUPPLY AIR BLOWER WILL RUN CONTINUOUSLY IN OCCUPIED MODE. THE SUPPLY AIR BLOWER WILL BE A CONSTANT AIR VOLUME TYPE CONTROLLED BY VARIABLE SPEED DRIVE. THE VSD IS USED TO SET THE REQUIRED BLOWER SPEED. THE VSD IS USED FOR BLOWER BALANCING PURPOSES AND WILL BE SET BY THE TEST AND BALANCING CONTRACTOR.
- EXHAUST AIR FAN:** THE EXHAUST AIR FAN WILL BE VARIABLE AIR VOLUME TYPE CONTROLLED BY A VARIABLE SPEED DRIVE AND WILL BE ENERGIZED AND CONTROLLED BASED ON BUILDING PRESSURE.
- SMOKE DETECTOR:** THE UNIT WILL HAVE A RETURN AIR SMOKE DETECTOR. UPON DETECTION OF SMOKE, THE SUPPLY AIR FAN WILL DE-ENERGIZE. THE OUTDOOR (AND EXHAUST) AIR DAMPERS(S) WILL DRIVE TO A FULLY CLOSED POSITION. THE RETURN AIR DAMPER WILL DRIVE TO A FULLY OPEN POSITION. A TERMINAL BLOCK SHALL BE PROVIDED FOR FIELD WIRING CONNECTIONS TO A REMOTE LOCATION IF DESIRED.
- COMPRESSOR & COOLING SECTION:** A CALL FOR COOLING WILL BE INITIATED WHEN THE SPACE TEMPERATURE RISES ABOVE THE COOLING SET POINT OF THE TEMPERATURE CONTROL. THE CALL FOR COOLING WILL CONTINUE UNTIL THE TEMPERATURE CONTROL IS SATISFIED. THE COLD DECK DAMPER WILL OPEN AND THE HOT DECK DAMPER WILL CLOSE. THE UNIT IS EQUIPPED WITH AN EVAPORATOR COOLING COIL AND SCROLL COMPRESSORS, INCLUDING A VFD SCROLL LEAD COMPRESSOR CAPABLE OF MODULATING CAPACITY FOR CAPACITY CONTROL. THE COMPRESSORS WILL STAGE BASED ON A CALL FOR COOLING AND SHALL MAINTAIN A DISCHARGE AIR TEMPERATURE OF 50°F (ADJUSTABLE). THE LEAD VFD SCROLL COMPRESSOR HAS A DESIGN OPERATING SPEED OF 7200 RPM. THE RANGE OF OPERATION SHOULD BE LIMITED TO A MINIMUM SPEED OF 35% (APPROXIMATELY 2500 RPM) FOR PROTECTION OF THE SYSTEM COMPRESSOR STAGING SEQUENCE WILL BE: COMPRESSOR 1 ON, COMPRESSOR 2 ON, ETC. COMPRESSOR STAGING MUST BE RE-STARTED BEGINNING WITH STAGE 1 UPON RESET OF ANY SAFETY DEVICE. ONCE THERE IS A CALL FOR COOLING, THE DDC CONTROLLER WILL ENABLE COMPRESSOR 1 AND PROVIDE A DEMAND SIGNAL BASED ON DISCHARGE AIR TEMPERATURE. EACH SUBSEQUENT COMPRESSOR WILL HAVE AN ONDELAY OF 5 MINUTES TO ALLOW THE LEAD VFD COMPRESSOR TO MODULATE TO MEET SET POINT BEFORE ANY OTHER COMPRESSORS ARE TURNED ON/OFF. IF AFTER 5 MINUTES THE VFD COMPRESSOR IS AT FULL CAPACITY AND THE DISCHARGE AIR TEMPERATURE IS STILL ABOVE THE DISCHARGE AIR TEMPERATURE DEADBAND, THE NEXT COMPRESSOR WILL BE STAGED ON. IF AFTER 5 MINUTES THE VFD COMPRESSOR IS AT MINIMUM OUTPUT AND THE DISCHARGE AIR TEMPERATURE IS STILL BELOW THE DEADBAND, THE NEXT COMPRESSOR WILL BE STAGED OFF. THE VFD COMPRESSOR MUST REACH FULL CAPACITY ON AN INCREASE IN DEMAND OR MINIMUM OUTPUT ON A DECREASE IN DEMAND BEFORE STAGING ANY OTHER COMPRESSORS ON/OFF. EACH COMPRESSOR WILL RUN FOR A MINIMUM OF 3 MINUTES ONCE ENERGIZED TO ENSURE PROPER OIL RETURN TO THE COMPRESSOR. EACH COMPRESSOR HAS A SOLID STATE 5 MINUTE TIMER TO PREVENT SHORT CYCLING. MECHANICAL COOLING IS DISABLED IF THE COIL LEAVING TEMPERATURE DROPS BELOW 38°F DB (ADJUSTABLE). COOLING WILL REACTIVATE ONCE THE FREEZE STAT DOWNSTREAM OF EVAPORATOR COIL IS SATISFIED. THE UNIT WILL HAVE A LOW AMBIENT LOCKOUT SET AT 50°F (ADJUSTABLE).
- HOT GAS REHEAT COIL:** THE HOT GAS REHEAT (HGR) COIL IS PROVIDED ON THE SPECIFIED COMPRESSOR CIRCUIT(S) (TYPICALLY THE LEAD CIRCUIT) TO PROVIDE "NEUTRAL" AIR LEAVING THE UNIT. THE HGR COIL IS ONLY AVAILABLE WHEN THE COMPRESSOR IS RUNNING AND CAN BE USED AS REHEAT FOR DEHUMIDIFICATION. THE HOT GAS REHEAT COIL IS CONTROLLED BY A MODULATING 3-WAY VALVE TO MAINTAIN A UNIT LEAVING AIR SET POINT OF 70°F (ADJUSTABLE). UPON INITIAL REHEAT CALL, THE HGR VALVE IS SET TO THE FULLY OPEN (100% THROUGH THE HGR COIL) POSITION FOR ONE (1) MINUTE. AFTER ONE MINUTE, THE VALVE IS MODULATED TO ACHIEVE THE REQUIRED LEAVING AIR TEMPERATURE SET POINT. IF THE COMPRESSOR IS ACTIVE AND THE HGR VALVE IS OPEN TO THE HGR COIL (GREATER THAN 0%) FOR MORE THAN AN ACCUMULATED TIME OF 50 MINUTES, THE HGR VALVE IS SET TO THE FULLY OPEN (100%) POSITION FOR ONE (1) MINUTE TO "FLUSH" THE HGR COIL. AFTER THIS FLUSH TIME, THE VALVE IS RETURNED TO NORMAL MODULATING OPERATION TO ACHIEVE THE REQUIRED LEAVING AIR TEMPERATURE SET POINT. IF THERE IS A CALL FOR COOLING ONLY (NO HGR) WHILE THE HGR COIL IS ACTIVE, THE HGR VALVE IS SET TO THE FULLY OPEN (100%) POSITION FOR TWO (2) MINUTES. AT THE END OF TWO MINUTES, THE HGR VALVE IS CLOSED (0%), THE HGR COIL IS COMPLETELY BYPASSED, IF THE COMPRESSOR DE-ENERGIZES, THE HGR VALVE IS SET TO THE FULLY OPEN (100%) POSITION.
- ECONOMIZER (OUTSIDE, RETURN & EXHAUST DAMPERS):** THE ECONOMIZER WILL HAVE AN ENTHALPY CHANGEOVER CONTROL WHICH WILL ENABLE THE ECONOMIZER ANYTIME THERE IS A CALL FOR COOLING AND THE AMBIENT ENTHALPY IS BELOW THE CHANGEOVER SET POINT OF 22 BTU/LB (ADJUSTABLE). THE OUTDOOR AND RETURN AIR DAMPERS WILL MODULATE TO MAINTAIN A MIXED AIR TEMPERATURE OF 55°F (ADJUSTABLE). WHEN THE ECONOMIZER IS DISABLED AND THE UNIT IS IN OCCUPIED MODE, THE OUTDOOR AIR DAMPER WILL BE SET AT MINIMUM POSITION. WHEN THE ECONOMIZER IS DISABLED AND THE UNIT IS IN UNOCCUPIED MODE, THE OUTDOOR AIR DAMPER WILL BE CLOSED. THE EXHAUST AIR DAMPER IS A GRAVITY DAMPER. THE OUTDOOR AND RETURN AIR DAMPER ACTUATORS WILL BE ELECTRIC.
- CONDENSER FAN CONTROL:** THE CONDENSER FAN MOTORS WILL BE CONTROLLED BY A VARIABLE FREQUENCY DRIVE. THE VARIABLE FREQUENCY DRIVE WILL RAMP UP AND DOWN BASED UPON INPUT SIGNALS COMING FROM PRESSURE TRANSDUCERS MOUNTED ON THE DISCHARGE LINES. THE CONDENSER FAN SPEED WILL MODULATE TO MAINTAIN A CONSTANT HEAD PRESSURE OF 320 PSIG. 320 PSIG. IF AT ANY TIME THE DISCHARGE PRESSURE OF ANY OF THE COMPRESSOR CIRCUITS THAT ARE RUNNING FALLS BELOW 280 PSIG, THE CONTROLLER WILL REDUCE THE CONDENSER FAN SPEED TO MAINTAIN A MINIMUM DISCHARGE PRESSURE OF 240 PSIG AND ALLOW THE HIGHEST DISCHARGE PRESSURE TO RISE ABOVE THE 320 PSIG SETPOINT. THE CONTROLLER WILL CONTINUE TO REDUCE THE CONDENSER FAN SPEED AS NEEDED TO MAINTAIN THE MINIMUM DISCHARGE PRESSURE UNTIL THE DISCHARGE PRESSURE OF ANY OTHER COMPRESSOR CIRCUIT REACHES A MAXIMUM PRESSURE OF 475 PSIG.
- FILTER PRESSURE DROP:** UNIT IS EQUIPPED WITH A DIFFERENTIAL STATIC PRESSURE SWITCH ACROSS THE FILTER BANK. AN ALARM SHALL BE PROVIDED VIA THE UNIT CONTROLLER TO THE OPERATOR INTERFACE WHEN THE DIFFERENTIAL STATIC PRESSURE EXCEEDS 1.0" W.C. (ADJUSTABLE).
- NIGHT SETBACK:** DURING THE UNOCCUPIED MODE IF A ZONES' TEMPERATURE FALLS BELOW 60°F (ADJUSTABLE), THE UNIT CONTROLLER SHALL RESTART THE SUPPLY FAN. THE OUTSIDE AIR DAMPER WILL DRIVE TO COMPLETELY CLOSED POSITION, AND THE RETURN AIR DAMPER WILL DRIVE TO A COMPLETELY OPEN POSITION. THE SUPPLY AIR FAN WILL REMAIN ON UNTIL THE TEMPERATURE REACHES 60°F (ADJUSTABLE). DURING THIS MODE HEATING CAPABILITIES SHALL REMAIN ENABLED. DURING THE UNOCCUPIED MODE IF A ZONES' TEMPERATURE RISES ABOVE 80°F (ADJUSTABLE), THE UNIT CONTROLLER SHALL RESTART THE SUPPLY FAN. THE OUTSIDE AIR DAMPER WILL DRIVE TO COMPLETELY CLOSED POSITION, AND THE RETURN AIR DAMPER WILL DRIVE TO A COMPLETELY OPEN POSITION. THE SUPPLY AIR FAN WILL REMAIN ON UNTIL THE TEMPERATURE REACHES 80°F (ADJUSTABLE). DURING THIS MODE COOLING CAPABILITIES SHALL REMAIN ENABLED.
- MORNING WARM UP:** IN THE MORNING WARM UP MODE, AS DETERMINED BY THE TIME OF DAY SCHEDULE, OUTDOOR AIR DAMPER SHALL BE FULLY CLOSED AND RETURN AIR DAMPER SHALL BE FULLY OPENED UNTIL THE RETURN AIR TEMPERATURE REACHES 65°F (ADJUSTABLE). ONCE THE MIXED AIR TEMPERATURE REACHES ITS SET POINT, OUTDOOR AIR DAMPER SHALL BE OPENED TO A MINIMUM VENTILATION POSITION. DURING THIS MODE HEATING CAPABILITIES SHALL REMAIN ENABLED.

## SEQUENCE OF OPERATION - VAV

### VARIABLE AIR VOLUME TERMINAL (VAV) CONTROL

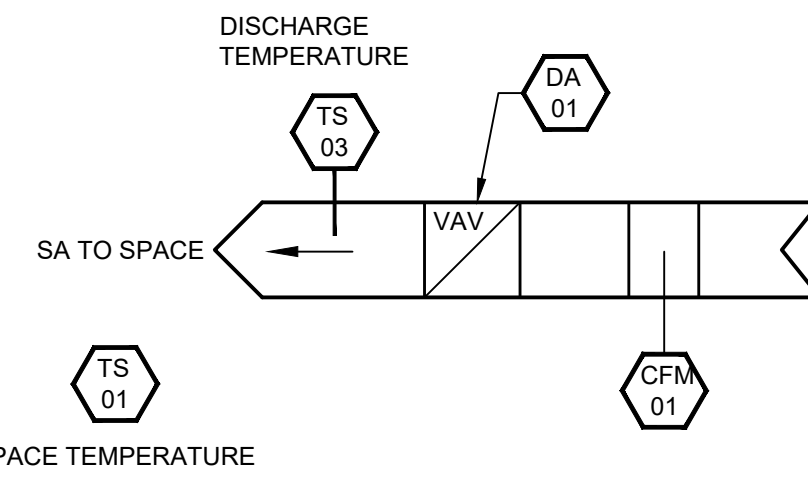
A WALL MOUNTED THERMOSTAT OR DUCT MOUNTED TEMPERATURE SENSOR SHALL CONTROL VAV BOX. REFER TO DRAWINGS.

WHEN IN COOLING MODE, THE VARIABLE AIR INLET DAMPER SHALL MODULATE BETWEEN MINIMUM AND MAXIMUM AIR FLOW RATES TO MAINTAIN THE DESIRED SPACE TEMPERATURE SETPOINT. THE HOT WATER CONTROL VALVE SHALL BE FULLY CLOSED.

WHEN IN HEATING MODE, THE VARIABLE AIR INLET DAMPER SHALL OPERATE AT THE SPECIFIED HEATING AIRFLOW AND THE HOT WATER CONTROL VALVE SHALL MODULATE TO MAINTAIN SPACE TEMPERATURE SETPOINT.

VERIFY WITH OWNER IF ANY CLASSROOMS / MULTIPURPOSE ROOMS SHALL OPERATE WITH A NIGHT SETBACK TEMPERATURE.

PRIMARY AIR CFM SHALL BE MONITORED BY THE DDC CONTROL SYSTEM.



## VAV BOX DIAGRAM

NOT TO SCALE

## VAV BOX POINTS LIST

TAG	POINT DESCRIPTION	UNITS	DI	DO	AI	AO	ALARM	TREND
TS-01	SPACE TEMPERATURE	DEG F (DEG C)			X		X	6 MO
TS-02	ROOM SETPOINT	DEG F (DEG C)			X			
HW-01	HOT WATER VALVE ACTUATOR POSITION	% OPEN				X		
CFM-01	PRIMARY AIR CFM	CFM				X		
DA-01	VAV DAMPER ACTUATOR POSITION	% OPEN				X		
TS-03	DISCHARGE AIR TEMPERATURE	DEG F (DEG C)			X			

MECHANICAL CONTROLS

WINBURN MIDDLE SCHOOL - HVAC REPLACEMENT

1060 WINBURN DRIVE, LEXINGTON, KY

CRW PROJECT NO. 4073-08

BG #25-323

FCPS BID #4-25

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DESIGN DOCUMENTS

NO

BY

DATE

REVISIONS

DESCRIPTION

NO

BY

DATE

REVISIONS

DESCRIPTION

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DATE

REVISIONS

DESCRIPTION

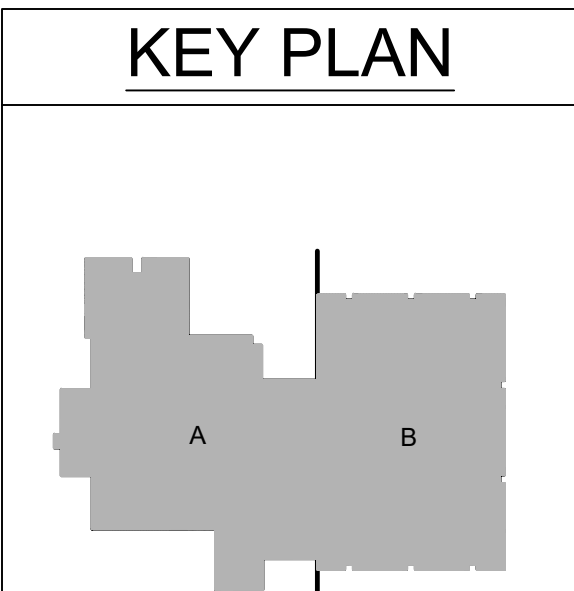
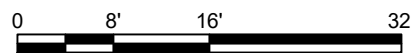
NO







1 ROOF PLAN - HVAC - ELECTRICAL - DEMOLITION  
SCALE: 1/16"=1'-0"



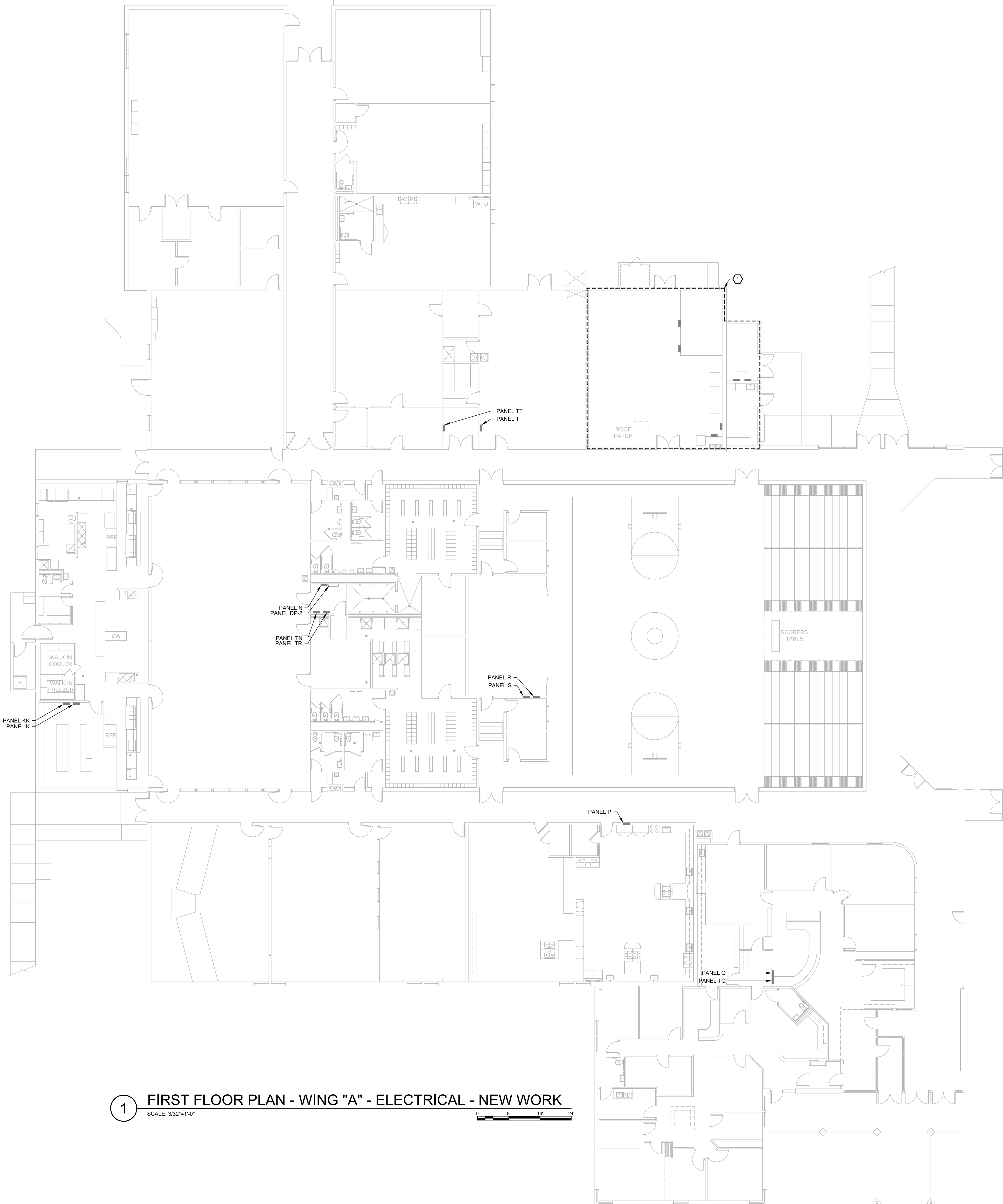
### GENERAL NOTES:

- FOR LOCATIONS WHERE EXISTING EQUIPMENT IS BEING DISCONNECTED AND REMOVED, CONTRACTOR SHALL MAINTAIN INTEGRITY OF EXISTING POWER AND FIRE ALARM WIRING FOR RECONNECTION TO NEW UNIT AND SMOKE DETECTION EQUIPMENT. NOTE THAT IN CERTAIN INSTANCES EXISTING WIRING MAY REQUIRE REPLACEMENT. IN THESE LOCATIONS EXISTING CONDUIT MAY BE REUSED FOR NEW WIRE INSTALLATION.
- REFER TO SHEETS E-101, E-102, AND E-401 FOR LOCATION OF EXISTING SWITCHBOARDS, PANELBOARDS AND FIRE ALARM MAIN CONTROL PANEL.
- DEMOLITION PLANS HAVE BEEN DEVELOPED FROM SITE VISITS AND EXISTING BUILDING DRAWINGS. SOME DEVICES MAY NOT BE INDICATED.
- IT SHALL BE THE RESPONSIBILITY OF ALL CONTRACTORS WHO SUBMIT BIDS FOR THIS PROJECT TO VISIT THE JOB PREMISES PRIOR TO BIDDING IN ORDER THAT THEY MAY DETERMINE THE TYPE, QUANTITY, LOCATIONS AND ANY HARDSHIPS INVOLVED WITH THE REMOVAL OF EQUIPMENT.
- CONTRACTOR UNDER THIS DIVISION IS FINANCIALLY RESPONSIBLE TO REPAIR AND PATCH FLOORS, WALLS, CEILING AND ROOF TO MATCH EXISTING CONDITION WHERE DEMOLITION WORK HAS BEEN DONE. COORDINATE ALL WORK WITH OWNER/ENGINEER.
- REMOVE ALL WIRING AND EXPOSED CONDUIT ASSOCIATED WITH DEMOLISHED ELECTRICAL EQUIPMENT / DEVICES UNLESS CIRCUIT IS INDICATED TO BE REUSED. REMOVE BACK TO SOURCE. MAINTAIN ALL ELECTRICAL CONNECTIONS TO DEVICES AND EQUIPMENT THAT REMAIN.

### SHEET KEYNOTES:

- EXISTING ROOFTOP UNIT TO BE DISCONNECTED AND REMOVED ALONG WITH EXISTING DUCT SMOKE DETECTOR. EXISTING POWER AND FIRE ALARM WIRING TO REMAIN FOR RECONNECTION TO NEW EQUIPMENT.
- EXISTING ROOFTOP UNIT TO BE DISCONNECTED AND REMOVED ALONG WITH EXISTING DUCT SMOKE DETECTOR. EXISTING POWER SUPPLY WIRING AND CONDUIT TO BE REPLACED. EXISTING FIRE ALARM WIRING TO REMAIN FOR RECONNECTION TO NEW DEVICE. EXISTING CONDUIT MAY BE REUSED IF ADEQUATE SIZE AND IN SATISFACTORY CONDITION.
- EXISTING CONVENIENCE OUTLET TO BE DISCONNECTED AND REMOVED. EXISTING POWER WIRING AND CONDUIT TO REMAIN. REWORK/EXTEND EXISTING CONDUIT AND WIRE TO NEW CONVENIENCE OUTLET. SEE SHEET E-102 FOR NEW WORK.
- CONTRACTOR TO FIELD VERIFY LOCATION OF EXISTING CIRCUIT. ASSOCIATED PANELBOARD CIRCUIT DIRECTORY IS NOT CORRECT.

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ROOF PLAN HVAC - DEMOLITION WINBURN MIDDLE SCHOOL - HVAC REPLACEMENT 1060 WINBURN DRIVE, LEXINGTON, KY					
DESIGNED	CTC	BY	CHW	STAFF	
DATE		DATE		REVIEWED	
REVISIONS		NO			
DESCRIPTION		THIS DRAWING SHOULD BEASURED EXACTLY AS SHOWN/NOTED			
DATE		APRIL 2025			
SCALE		1/16" = 1'-0"			
SHEET NO.		ED101			



**1 FIRST FLOOR PLAN - WING "A" - ELECTRICAL - NEW WORK**  
SCALE: 3/32"=1'-0"

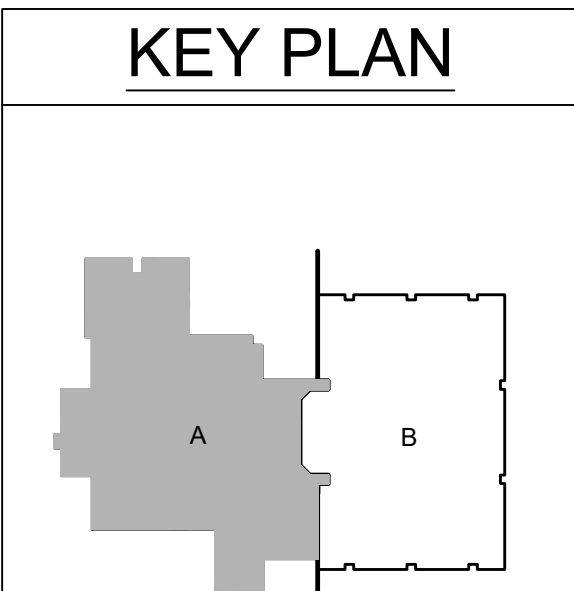


**GENERAL NOTES:**

1. DUCT SMOKE DETECTORS SHALL BE FURNISHED FOR ALL AIR HANDLING EQUIPMENT WITH DESIGN CAPACITY GREATER THAN 2000 CFM. DUCT SMOKE DETECTORS SHALL BE INSTALLED IN RETURN AIR SYSTEMS UPSTREAM OF ANY FILTERS, EXHAUST OR OUTDOOR AIR CONNECTIONS. UPON ACTIVATION, THE FIRE ALARM SYSTEM SHALL SHUTDOWN ALL OPERATIONAL CAPABILITIES OF THE AIR HANDLING EQUIPMENT.

**SHEET KEYNOTES:**

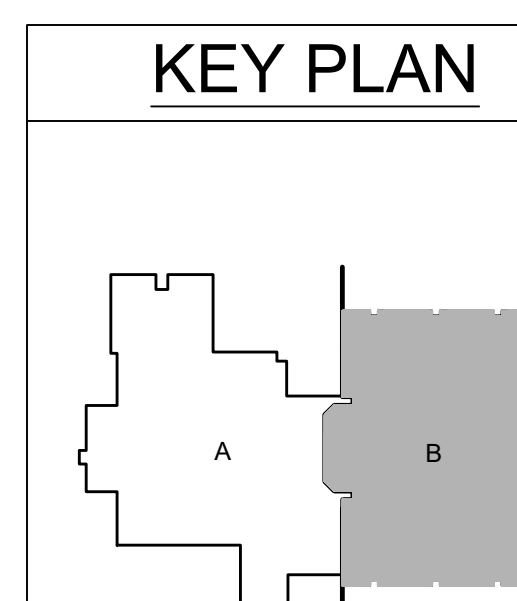
1. REFER TO SHEET E-401 FOR ENLARGED PLANS.



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<b>FIRST FLOOR PLAN - WING "A" ELECTRICAL - NEW WORK</b> WINBURN MIDDLE SCHOOL - HVAC REPLACEMENT 1060 WINBURN DRIVE, LEXINGTON, KY							
REVISIONS DESCRIPTION	DESIGNED	CTC	BY	DATE	REVIEWED	STAFF	APPROVED
FOOTNOTES: THIS DRAWING SHOULD BE USED EXACTLY AS WHEN ADAPTED							
DATE: APRIL 2025 SCALE: 3/32" = 1'-0" SHEET NO. <b>E-101</b>							



1. DUCT SMOKE DETECTORS SHALL BE FURNISHED FOR ALL AIR HANDLING EQUIPMENT WITH DESIGN CAPACITY GREATER THAN 2000 CFM. DUCT SMOKE DETECTORS SHALL BE INSTALLED IN RETURN AIR SYSTEMS UPSTREAM OF ANY FILTERS, EXHAUST OR OUTDOOR AIR CONNECTIONS. UPON ACTIVATION, THE FIRE ALARM SYSTEM SHALL SHUTDOWN ALL OPERATIONAL CAPABILITIES OF THE AIR HANDLING EQUIPMENT.



FIRST FLOOR PLAN - WING "B"  
ELECTRICAL - NEW WORK

GRW PROJECT NO. 4973-08

BG #25-323

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## DESIGN DOCUMENTS

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E-102

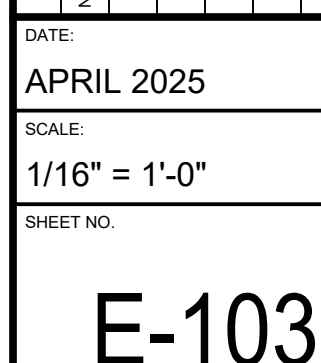
1. REFER TO SHEETS E-101, E-102, AND E-401 FOR LOCATION OF EXISTING SWITCHBOARDS, PANELBOARDS AND FIRE ALARM MAIN CONTROL PANEL.

2. SMOKE DETECTOR SHALL BE FURNISHED FOR ALL AIR HANDLING EQUIPMENT WITH DESIGN CAPACITY GREATER THAN 2000 CFM. DETECTOR SHALL BE INSTALLED IN EACH AIR HANDLING SYSTEMS UPSTREAM OF ANY FILTERS, EXHAUST OR OUTDOOR AIR CONNECTIONS. UPON ACTIVATION, THE FIRE ALARM SYSTEM SHALL PROVIDE THE OPERATIONAL CAPABILITIES OF THE AIR HANDLING EQUIPMENT.

3. FOR LOCATIONS WHERE EXISTING POWER WIRING IS REQUIRED TO FEED NEW HVAC EQUIPMENT, CONTRACTOR SHALL INSTALL JUNCTION BOX, POWER BLOCKS, CONDUIT AND WIRE AS REQUIRED TO SERVE CIRCUIT. NEW POWER ENTRANCE LOCATION ON ROOF TOP UNIT.

4. FOR LOCATIONS WHERE EXISTING FIRE ALARM WIRING IS BEING REUSED TO SERVE NEW ROOF TOP UNIT DET SMOKE DETECTORS, CONTRACTOR SHALL INSTALL NEW WIRING. NEW WIRE AS REQUIRED TO EXIST WIRING TO NEW DEVICE.

1. NEW GFI RECEPTACLE WITH WEATHERPROOF WHILE-IN-USE COVER. CONNECT/EXTEND EXISTING DUCT TO NEW DETECTOR AS REQUIRED.
2. CONTRACTOR TO FIELD VERIFY LOCATION OF EXISTING PANELBOARD AND CIRCUIT SERVING EXISTING ROOM MOUNTED RECEPTACLE.
3. NEW DUCT SMOKE DETECTOR BY FIRE ALARM CONTRACTOR. INSTALL IN RETURN AIR SYSTEM OR MAIN FLOW LINE RETURN AIR DUCT. CONTRACTOR TO RECONNECT/EXTEND EXISTING FIRE ALARM SIGNALING LINE CIRCUIT TO NEW DUCT SMOKE DETECTOR FOR PROPER FUNCTION. CONTROL/MONITORING MODULES AS REQUIRED FOR CORRECT OPERATION. PROVIDE AIR HANDLING UNIT INTERLOCK WIRING TO DETECTOR TO SHUT DOWN ALL OPERATIONAL CAPABILITIES OF THE AIR HANDLING EQUIPMENT UPON ACTIVATION OF SMOKE DETECTOR.
4. FURNISH AND INSTALL NEW REMOTE TEST STATION WITH RESET AND ALARM INDICATION FOR DUCT SMOKE DETECTOR IN ROOM BELOW. PROVIDE 8-1/2"x6"x3/4" BOX WITH 1/2" DIA. HOLES IN CEILING TILE AND INSTALL DESCRIBED NAMEPLATE. FURNISH AND INSTALL FIRE ALARM WIRING IN 3/4".
5. CONTRACTOR TO FIELD VERIFY LOCATION OF EXISTING CIRCUIT. IF EXISTING CIRCUIT IS NOT IN BOARD CIRCUIT DIRECTORY IS NOT CORRECT.
6. NEW ROOF TOP UNIT. RECONNECT EXISTING POWER SUPPLY CIRCUIT. EXISTING 150A RATING PLUS IN CIRCUIT BREAKER IN MAIN DISTRIBUTION SWITCHBOARD HDP TO BE REPLACED WITH 125A RATING PLUG. EXISTING SWITCHBOARD IS EATON POW-LINE SERIES AND BREAKER IS MODEL 150F150BP10. SEE SHEET E-101 FOR LOCATION. CONTRACTOR MAY REUSE EXISTING CONDUIT IF ADEQUATE SIZE.
7. NEW ROOF TOP UNIT. RECONNECT EXISTING POWER SUPPLY CIRCUIT. EXISTING 150A RATING PLUS IN CIRCUIT BREAKER IN MAIN DISTRIBUTION SWITCHBOARD HDP TO BE REPLACED WITH 80A RATING PLUG. EXISTING SWITCHBOARD IS SIEMENS POW-LINE SERIES AND BREAKER IS MODEL DF150BP10. SEE SHEET E-101 FOR LOCATION. CONTRACTOR MAY REUSE EXISTING CONDUIT IF ADEQUATE SIZE.
8. NEW ROOF TOP UNIT. RECONNECT EXISTING POWER SUPPLY CIRCUIT. EXISTING 150A RATING PLUS IN CIRCUIT BREAKER IN MAIN DISTRIBUTION SWITCHBOARD HDP TO BE REPLACED WITH 125A RATING PLUG. EXISTING SWITCHBOARD IS SIEMENS. SEE SHEET E-101 FOR LOCATION. CONTRACTOR MAY REUSE EXISTING CONDUIT IF ADEQUATE SIZE.







## Table of Contents

Division	Section Title
<b>DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)</b>	
230100	GENERAL PROVISIONS FOR MECHANICAL
230130.51	HVAC AIR DISTRIBUTION SYSTEM CLEANING
230517	SLEEVING, CUTTING, PATCHING AND REPAIRING FOR MECHANICAL
230530	METAL FABRICATIONS AND STRUCTURAL STEEL
230548	VIBRATION CONTROL FOR HVAC
230553	IDENTIFICATION OF HVAC PIPING AND EQUIPMENT
230593	TESTING, ADJUSTING, AND BALANCING FOR HVAC
230600	MECHANICAL SYSTEMS DEMONSTRATION AND TRAINING
230900	INSTRUMENTATION AND CONTROLS
232113	HYDRONIC PIPING AND VALVES
232116	HYDRONIC PIPING SPECIALTIES
232123	HYDRONIC PUMPS
232500	HVAC SYSTEM WATER TREATMENT
233113	DUCTWORK AND DUCTWORK INSULATION
233300	DUCTWORK ACCESSORIES
235216	CONDENSING BOILERS
237433	DEDICATED OUTDOOR-AIR UNITS
239500	MECHANICAL SYSTEM TESTING, START-UP AND COMMISSIONING
<b>DIVISION 26 - ELECTRICAL</b>	
260000	BASIC ELECTRICAL MATERIALS AND METHODS
260100	ELECTRICAL DEMOLITION
260519	CONDUCTORS AND CABLES
260529	SUPPORTING DEVICES AND HANGERS
260533	RACEWAYS
260534	BOXES
260553	ELECTRICAL IDENTIFICATION
262413	LOW VOLTAGE SWITCHBOARDS (SWITCHGEAR)
262416	PANELBOARDS
262700	WIRE CONNECTIONS AND CONNECTING DEVICES
262816	SAFETY SWITCHES
<b>DIVISION 28 - ELECTRONIC SAFETY AND SECURITY</b>	
283103	FIRE ALARM SYSTEM MODIFICATIONS

END OF TABLE OF CONTENTS