AT&T Practices

Engineering Guide for Ventilation and Air-Conditioning Design Parameters and General Planning Information

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1. About this Document

Overview

1.1 This practice discusses design parameters and information for use in the design of environmental control of Heating, Ventilating, and Air-Conditioning (HVAC) systems. The parameters and information are provided for use in the planning and design of new buildings, building additions, building retrofits, Mechanical Equipment Room upgrades, and buildings that are intended to house telecommunication equipment that meets the requirements of AT&T 800-610-164. Further, this practice discusses Mechanical Equipment Rooms with regard to physical size considerations, location of the Equipment Room, auxiliary ventilation equipment considerations, duct and piping penetrations, access, and required refrigerant vapor detectors or oxygen depletion sensors.

1.2 This practice supersedes all previous practices related to design parameters for HVAC systems and Mechanical Equipment Room requirements. This practice does not supersede, however, any applicable Federal, State and local code, law and regulation to which any related work shall comply.

Scope

1.3 Environmental control of telecommunications buildings is required to provide an environment that permits good equipment performance and a comfortable working environment. The environmental control system should be engineered for appropriate degrees of reliability and adaptability of changing conditions. Both initial and operating costs should be reasonable.

1.4 Presently, there is a need to place greater emphasis on energy conservation in the design of new buildings and facilities. The recommendations described in this section should result in reduced energy consumption and lower life-cycle costs by designing the mechanical systems closer to the actual loads.

1.5 Further, this section discusses the Mechanical Equipment Room. Recommendations include MER locations in various building types, physical dimensions, proper ventilation and required refrigerant sensors. These recommendations should result in compliance with ASHRAE Standard 15-1994.

Reason for Reissue

1.6 This practice is being reissued to reflect all current standards, incorporate ASHRAE Standard 15-1994, and discuss relevant refrigerant sensing requirements. Whenever this practice is further reissued or revised, the reason(s) shall be listed in this paragraph.

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2. Outdoor Design Parameters

2.1 The recommended outdoor temperatures to be used as a basis for design may be found in the following references:

- American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE), 1993, Fundamentals Handbook.
- Department of the Air Force Manual, AFM 88-29, "Engineering Weather Data."

Summer Design Conditions

2.2 Summer design conditions are listed in the 1993 ASHRAE Fundamentals Handbook; Chapter 24, Table 1. These data are the dry- and wet-bulb temperatures (˚F) that are equaled or exceeded 1, 2-1/2, and 5 percent of the time, on the average, during the warmest 4 consecutive months. For design, use the values listed under the 2-1/2 percent frequency for attended buildings and the 5 percent for unattended buildings. For example, use the following design frequencies for building occupancies shown:

Occupancy	Design Frequency (%)
Offices	2-1/2
#4 ESS	2-1/2
#5 ESS	2-1/2

2.3 The outdoor design conditions for an office building located in Newark, New Jersey (Newark Airport Data) are determined from the reference, under the 2-1/2 percent frequency, as 91˚F1 dry bulb and 73˚F wet bulb.

2.4 For the purpose of this document, an attended building is one which is occupied by at least one person for a minimum of one work shift, 5 days per week.

Winter Conditions

2.5 The winter design dry-bulb temperature is obtained from column 5 of Table 1 previously referenced. Use the value listed under 97.5 percent frequency for all buildings. For Newark, New Jersey, the winter design dry-bulb temperature is 14˚F.

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3. Interior Design Parameters

3.1 Table 1 lists the recommended interior design parameters for the various occupancies shown.

Table 1. Recommended Interior Design Parameters

Space	Summer Dry-Bulb Temp	% RH	Winter Dry-Bulb Temp	% RH	Notes
Power Rooms (a) air conditioned	80 Occupied 95 Unoccupied	—	65 Occupied 50 Unoccupied	—	
(b) ventilated (outdoor air)	Δ T = 15˚F	—	65	—	1
Computer Rooms	—	—	—	—	2
Emergency Engine Room	Δ T = 15˚F	—	65	—	1
Garages	—	—	—	—	3
Mechanical Equipment Room	Δ T = 15˚F	—	60	—	
Telephone Equipment	80	50	65	20	
Operator Rooms and other occupied spaces	78	50	65	29	

Notes:
1. Interior temperature = outdoor ambient temperature + 15˚F or 100˚F maximum.
2. Refer to AT&T 760-250-150 for specific design requirements.
3. Refers to vehicle storage areas.

4. Ventilation Requirements

4.1 Energy efficient mechanical systems (HVAC) control the amount of outdoor air introduced into buildings to the minimum amount required for ventilation.

4.2 It is recommended that ventilation rates for all occupancies be derived from ASHRAE Standard 62, dated 1989. Where local regulations require higher rates of ventilation, these regulations must be followed.

5. Wideband Temperature Operation

5.1 The environmental conditions in most telecommunications equipment spaces can be satisfactorily maintained under Wideband Temperature Operations. Significant energy and cost savings will result as energy for the building mechanical systems

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serving central office areas is expended only to keep the average space temperature from exceeding 85-90ºF in the cooling cycle and to prevent the average temperature from going below 65ºF (occupied) or 55oF (unoccupied) when heating is required.

5.2 The design features of the control system should include the following:

a. The operation of the mechanical refrigeration and heating systems is to be controlled by space thermostats. Return-air thermostats are not recommended.

b. Where permissible, the fan system is to be operated only upon demand for heating or cooling. This method is not permissible for equipment areas.

c. The control system shall prevent cooling down to the heating set point or heating up to the cooling set point.

5.3 It is recommended that fans serving electronic solid state switching equipment be operated continuously. Cycling supply air fans is also not recommended for D1 and D2 channel banks.

5.4 Fans serving all other telephone switching systems can be cycled under control of space-mounted thermostats. Return-air thermostats are not recommended for fan cycling control.

5.5 Fan operation during periods when space temperature requirements are satisfied may be required to meet local ventilation codes (when space is occupied) or to meet the requirements of special telephone equipment.

6. Equipment and Lighting Heat Release and Humidification Requirements

6.1 A detailed study plan prepared by the Central Office Planner (COP), showing an accurate layout of telecommunication equipment to be installed must be furnished to the Building Engineer so that proper design evaluations can be made. The plan should show future equipment additions and when these additions can be expected. Where possible, the heat dissipation per unit of equipment should be marked on the equipment layout for each unit of equipment. These heat dissipations should be summarized per equipment row to indicate the locations of high heat concentrations. As a guide for planning purposes, the following average heat dissipation in watts per square foot may be used to estimate air-conditioning loads for a given equipment space. These values should not be used for the design and sizing of air-conditioning and refrigeration equipment.

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Equipment	Watts per Square Foot
No. 4 ESS No. 5 ESS	Heat release is dependent upon the equipment configuration and may range from 20 watts per square foot for the overall area to 50 watts per square foot in some equipment aisles.
TSPS No. 1	30
RIP	47

6.2 The use of excessive values for the telecommunications equipment heat dissipation will result in air-conditioning equipment that is oversized and inefficient.

6.3 For comparison, the former electromechanical step-by-step and crossbar systems used 0.9 watts per line. The earlier ESS switching equipment consumed 2.2 watts per line as compared with the present analog switching equipment that uses approximately 1 watt per line. The present digital ESS switching equipment consumes approximately 2 watts per line.

6.4 Refer to specific equipment descriptions and standards for heat dissipation information and individual space humidification requirements.

6.5 The **lighting demand** coincident with the equipment heat release must be added to the latter when estimating air-conditioning loads. The lighting demand can vary from 50 to 80 percent of the **connected** lighting load. The following heat release from lighting may be used if actual walkdown data cannot be obtained.

Area	Watts per Square Foot
Telephone Equipment Areas	2.0
Administrative Areas	1.5

6.6 Consideration should also be given to miscellaneous office equipment such as computers, copiers, facsimile machines, etc. when estimating air-conditioning loads.

7. Load Estimating

7.1 During the early planning and/or preliminary design of a project, an estimate of the refrigeration and air volume required to air-condition a given space or building is required for electric service considerations and mechanical equipment room space requirements.

7.2 Also, load estimating is required to enable evaluation of building construction and orientation alternatives which impact upon the building energy forecast.

7.3 To minimize energy consumption and energy costs, the conductance of heat (U factor) through the exposed surfaces of the building, such as walls, roof, and fenestration should be optimized, consistent with the local climatic conditions and the internal heat load. This is called the optimum U.

7.4 The current ASHRAE Fundamentals Handbook should be used as the source of all data required to calculate air-conditioning and/or heating loads.

7.5 Safety factors should not be used when calculating the exterior building envelope load. The telecommunications equipment can tolerate any minor effect on the building temperature caused by temperature above outside design conditions.

8. Space Requirements for Mechanical Equipment

8.1 Space requirements for air-handling equipment may be estimated from the following guidelines:

a. One or two air-handling casings - 35 to 40 square feet per 1000 CFM.

b. Three or more air-handling casings - 40 to 45 square feet per 1000 CFM.

NOTE:

An air-handling casing is defined as an enclosure housing filters, cooling coils, heating coils, fans and motors. Additional space may be required for high efficiency filters, humidification equipment and other accessories.

8.2 Estimated floor space for duct shafts:

- square foot per 850 CFM up to 5100 CFM.
- square foot per 1000 CFM over 5100 CFM.

8.3 Space for refrigeration equipment, including pumps, is difficult to relate to cubic feet per minute. Consideration must be given to the type of equipment, maintenance and especially to tube punching requirements. Very often, small direct expansion (DX) systems (up to 40 or 50 tons) can be incorporated with the air-handling equipment room without the need for additional floor space. This is usually accomplished by locating the compressor unit under the ductwork.

a. Estimated floor space for refrigeration equipment and associated pumps are shown in Table 2. The space allocation for two units assumes the units are adjacent to each other (i.e., parallel). The dimensions include space for one condenser-water pump and one chilled-water pump per refrigeration unit. The headroom for units through 500 tons should be 12 feet (minimum) and 15 feet (minimum) for the larger sizes. Serious attention should be given to column locations. The space dimensions listed above are predicated on regular column spacing on a 20- by 20-foot grid. If the column spacing is irregular, the floor areas will have to be increased.

Table 2. Estimated Floor Space for Refrigeration Equipment and Associated Pumps

Equipment	Size	Space Requirements (feet)
Reciprocating Chiller	Up to 100 tons - 1 unit	20 X 15
Reciprocating Chillers	Up to 100 tons - 2 units	20 X 20
Reciprocating Chiller	100 to 240 tons - 1 unit	25 X 15
Reciprocating Chillers	100 to 240 tons - 2 units	25 X 20
Centrifugal Chiller	150 to 500 tons - 1 unit	35 X 20
Centrifugal Chillers	150 to 500 tons - 2 units	35 X 30
Centrifugal Chiller	500 to 1500 tons - 1 unit	45 X 30
Centrifugal Chillers	500 to 1500 tons - 2 units	45 X 45
Screw Chiller	100 to 650 tons - 1 unit	35 X 20
Screw Chillers	100 to 650 tons - 2 units	35 X 40
Single-Stage Absorption Chiller	100 to 300 tons - 1 unit	40 X 20
Single-Stage Absorption Chillers	100 to 300 tons - 2 units	40 X 30
Single-Stage Absorption Chiller	300 to 500 tons - 1 unit	50 X 20
Single-Stage Absorption Chillers	300 to 500 tons - 2 units	50 X 30
Single-Stage Absorption Chiller	500 to 750 tons - 1 unit	60 X 25
Single-Stage Absorption Chillers	500 to 750 tons - 2 units	60 X 35
Single-Stage Absorption Chiller	750 to 1500 tons - 1 unit	80 X 30
Single-Stage Absorption Chillers	750 to 1500 tons - 2 units	80 X 50
Two-Stage Absorption Chiller	400 to 600 tons - 1 unit	50 X 30
Two-Stage Absorption Chillers	400 to 600 tons - 2 units	50 X 50
Two-Stage Absorption Chiller	600 to 1000 tons - 1 unit	80 X 30
Two-Stage Absorption Chillers	600 to 1000 tons - 2 units	80 X 50
Direct-Fired Absorption Chiller	100 to 300 tons - 1 unit	35 X 20
Direct-Fired Absorption Chillers	100 to 300 tons -2 units	35 X 30
Direct-Fired Absorption Chiller	300 to 500 tons - 1 unit	50 X 20
Direct-Fired Absorption Chillers	300 to 500 tons - 2 units	50 X 30
Direct-Fired Absorption Chiller	500 to 1000 tons - 1 unit	70 X 25
Direct-Fired Absorption Chillers	500 to 1000 tons - 2 units	70 X 40

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9. Location of Mechanical Equipment Rooms (MER)

9.1 The proper location of the air handling and refrigeration rooms (designated as MER) is critical to the successful design of a building. The final layout will have a significant effect on:

a. Future growth of the building.

b. Present and future telecommunications equipment layouts.

c. Acoustic sound levels inside and outside the building.

d. Economic evaluations of the building, related mechanical equipment, and services.

9.2 Two types of buildings that will be considered are:

a. Central Office (CO) buildings that have telecommunications equipment and few occupants

b. Office buildings that have office-type equipment and many occupants.

9.3 The mechanical designer must work closely with the architect during the initial design stages to develop the best MER layout consistent with the type of building taking into account the present installation and future expansions. The requirements for MER layouts differ for each type of building. Some of the common features and important differences will be described in the following material.

General Features

9.4 General features that must be considered for either type of building are:

- Air intakes and exhausts including those within proximity to loading docks, CFC vents and other potential exhaust fumes
- Duct work and piping passage
- Physical entry space for mechanical equipment
- Acoustic isolation
- Thermal insulation
- Maintenance.

Air Intakes and Exhausts

9.5 The layout location should ensure a plentiful supply of uncontaminated air for supply and permit air to be exhausted. Uncontaminated air refers to air that is free from auto exhausts, chimney emissions, emergency engine exhausts, and noxious industrial odors. The MER should be adjacent to an outside wall. Air intakes and exhausts must be separated as much as possible, and the prevailing wind direction must be checked to prevent recirculation.

9.6 Air intakes and exhausts must be positioned so that noise from the MER, or the intakes themselves, will not cause problems in adjacent and opposite spaces through windows or walls. Special care must be taken in residential areas to avoid complaints from nearby residents.

9.7 The air intake and exhaust openings must be located so they can be protected from vandals or persons intent on causing damage. Openings should be above the street level and away from the building property line. The locations of air intake and exhaust openings must be checked for compliance with local building codes, and Indoor Air Quality Guidelines (see AT&T 010-160-170)

Duct Work and Piping Passage

9.8 Avoid blocking off the access space for duct work and piping into and out of the MER by not locating it next to a stairway, an elevator shaft, an electrical equipment room, or a telephone closet. At least two interior walls should be left free for piping and duct work to enter and leave. In a CO building, the floor plan is based on the most efficient layout of equipment frames for present usage and future growth. The MER must be located so that the duct work and piping passage does not interfere with the CO equipment layout. Proposed growth must be considered since the telephone equipment is set up in rigid, predefined patterns.

NOTE:

Fire protection compartmentation integrity shall be maintained whenever fire-rated partitions penetrate up to the rating of the original wall or floor.

Entry Space

9.9 It is poor practice to locate and lay out an MER without consideration to space for maintenance, additions, and removal of equipment. Adequate aisle space must be provided not only in but also for access to the MER. In the office-type building, a passage can be made by temporarily removing interior partitions as required. In CO buildings, telephone equipment and permanent interior partitions will not allow a passage to be made. Pre-planning for equipment access is important.

Acoustic Isolation

9.10 Acoustic isolation and control is important in both types of buildings.

a. **Central Office Buildings:** The noise generated within most CO spaces will usually mask out all but the most severe mechanical equipment noise. Internal duct lining must not be used in duct systems serving equipment areas because of the possibility of material flaking in the air stream and depositing on switching equipment. Avoid placing heavy reciprocating or rotating machinery on upper floors of the building. This not only creates noise problems but also means extra reinforcement for the floors and columns associated with the equipment area. Equipment within the MER should be mounted on vibration isolators. Piping connected to reciprocating or rotating equipment should be supported by vibration isolation mountings, and separated from the equipment with vibration isolators. For seismic design requirements, refer to AT&T Practices 770-200-024 and 770-200-025.

b. **Office Buildings:** The acoustic problems are the most difficult to handle due to the variations in space occupancy and the occupants themselves. The MER should be located remotely from areas which must be "quiet" by the nature of their occupancy (e.g., private offices, quiet rooms, lounges, medical departments, legal departments or sensitive electronic equipment). During the initial design stages, consideration should be given to the isolation of the mechanical equipment spaces by placing buffer zones composed of corridor space, storage areas, or repair spaces adjacent to the machinery room. If occupied office spaces or electronic equipment are above or below the equipment room, the floor and ceiling must be treated to prevent the transmission of sound. Even with concrete flooring, a suspended ceiling on the floor below may be needed to achieve adequate sound transmission reduction. If the ducts pass through spaces which must have low ambient sound level, the duct work entering and leaving the mechanical equipment room can be internally lined. Sound attenuators may also be provided. Duct work, piping, and conduit should be sealed as described in paragraph 9.10(a). In addition, the equipment room door should be gasketed. The mechanical equipment should be mounted on vibration eliminators, and piping should be hung on isolation hangers to prevent vibration transmission to other areas of the building. Avoid placing heavy reciprocating or rotating machinery on upper floors of the building. This not only creates noise problems but means extra reinforcement for the floors and columns associated with the equipment area.

Thermal Insulation

9.11 In a normal installation, the mechanical equipment room is heated in the winter and ventilated during the summer. Additional thermal insulation will not be required unless the adjacent spaces must have special treatment with regard to temperature and humidity. Only for special cases should an evaluation of insulation for walls, ceilings, etc., be made to determine if excessive heat losses, heat gains, or moisture migration will affect adjacent spaces.

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Preferred Location for MER in CO Equipment Building — One MER Per Floor

9.12 The most desirable layout is a separate MER on each floor housing the air-handling supply and exhaust equipment for that floor only. The room location must be predicated on the present and future telephone equipment layouts. The refrigerating and pumping equipment is located at the lowest level in the building with provisions for future expansion.

NOTE:

If the building has an MER per floor as described above, it will usually require no more total floor space than will one central mechanical room with one central plant with separate air-handling equipment for each floor and the related duct shafts up and down the building to serve each floor.

9.13 The MER must also meet the following criteria:

a. Appropriately sized and protected air intake and exhaust openings meeting all local codes.

b. At least two interior walls for each MER will be left free for passage of ductwork and piping for present and future growth (no interference with telephone equipment).

c. Entry space inside MER and adjacent to room to permit maintenance and removal.

d. All rotating and reciprocating machinery on vibration isolators.

e. All piping inside MER on vibration isolators (only if connected to rotating or reciprocating equipment).

f. No electrical interference with electronic switching equipment.

Advantages of Separate MERs Per Floor

9.14 The advantages of separate MERs per floor are as follows:

a. Flexibility for future revisions and expansion.

b. Modifications can be made on one floor - does not disturb another MER.

c. Space occupancies requiring different conditions can be accommodated more easily.

d. Fire protection, as ductwork does not penetrate floors.

e. Heavy refrigeration and pumping equipment will be kept at lowest level, especially in buildings located in critical seismic zones.

f. Building can expand upward as an MER is on each floor.

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g. Smaller outside air openings instead of one large opening.

h. Shorter duct runs.

Disadvantages of Separate MERs Per Floor

9.15 The disadvantages of separate MERs per floor are:

a. More than one mechanical equipment room to service.

b. Leaks in water lines on upper floors can cause damage on lower levels.

c. Longer piping runs.

Acceptable Location for MER in CO Equipment Building — Central MER

9.16 See Figures 3 and 4.

9.17 This layout has one MER for all the air-handling equipment servicing the building. The air-handling equipment consists of a separate supply and return unit servicing each floor. The refrigeration equipment should be located at the lowest level in the building. The air-handling MER can be located in either of the following locations:

a. At the lowest level in the building where it can be either a separate space or combined with the refrigeration equipment.

b. On the roof, as a penthouse, with the refrigeration equipment remaining at the lowest level. Shafts are required for the vertical ductwork and horizontal branch ducts serve each floor. Note that the duct shafts must not interfere with CO equipment growth.

9.18 The MER locations must also meet the following previously described criteria:

a. Appropriately sized and protected air intake and exhaust openings meeting all local codes.

b. Two or more interior walls should be left free for duct and piping passage if the vertical shafts are outside the confines of the mechanical equipment room. When the shafts originate in the equipment room, this requirement can be relaxed to meet the job conditions.

c. Ample space must be left around air-handling and refrigeration equipment to facilitate maintenance. A penthouse MER should have outside roof access so equipment can be lifted to and from the roof. A lower level MER should have access to the street level for removing equipment.

d. The penthouse MER should have all rotating and reciprocating machinery and piping on vibration isolators. The lower level MER should have appropriate treatment of equipment and piping for both air-handling and refrigeration equipment.

e. Extra thermal insulation, if necessary.

f. Freeze protection on water lines.

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Advantages of a Central Equipment Room with Individual Supply and Exhaust Units Supplying Each Floor

9.19 The advantages of a Central Equipment Room with individual supply and exhaust units supplying each floor are as follows:

a. All equipment can be served at one time.

b. MER in a penthouse would have a good protected source of outdoor air.

c. A lower level room would eliminate piping and water services that would in some cases be located above the telephone equipment.

d. Heavy refrigeration and pumping equipment will be kept at lowest level.

e. Building can expand upward if all equipment is on lower level.

f. Space occupancies requiring different conditions can be more easily accommodated.

g. Air handling and refrigeration rooms on lower level would require shorter pipe runs and less pump horsepower.

h. There would be less chance of electrical interference with electronic switching equipment.

Disadvantages of a Central Equipment Room with Individual Supply and Exhaust Units Supplying Each Floor

9.20 The disadvantages of a Central Equipment Room with individual supply and exhaust units supplying each floor are as follows:

a. Future revision could require work in duct shafts that would disturb other systems. Disturbing ductwork would cause entrapped dirt to be released into telephone spaces.

b. Not enough space is left in duct shafts to accommodate future changes.

c. A building expansion upward may block air intakes and exhausts if a penthouse for air handling equipment is used. This depends on the location of the penthouse.

d. Fire protection is difficult because the duct shafts penetrate floors.

e. A penthouse air-handling room presents a hazard due to potential water leakage.

f. Layout of vertical shafts for services might interfere with equipment floor layouts.

g. Air intakes and exhausts may be difficult to protect. It may also be difficult to meet local code requirements.

h. The fan horsepower is higher.

i. Penthouse floor must be waterproofed at additional cost.

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Disadvantages of using a Single Air-Handling System Configuration — CO Equipment Building

9.21 The previous paragraphs have been based on the philosophy of one air-handling system per floor regardless of the location of the air-handling equipment. It is often proposed that one air handling system be used to supply several floors, rather than an individual system per floor. This particular configuration should be discouraged for the following reasons:

a. Although unacceptable, regardless of the configuration, the size of the motor and the emergency generator will depend on the volume of air to be handled.

b. Fire protection becomes difficult when ductwork connects one floor to another. There is always the possibility of smoke being transmitted from floor to floor unless additional smoke-actuated dampers are installed.

c. One system is acceptable for CO equipment requirements. However, buildings which house more than CO equipment (i.e., operating rooms, etc.) would require at least two systems: one for CO equipment and one for personnel requirements. This method does not apply where a multi-zone system is being utilized

9.22 The preceding paragraphs have stated the major objections to one central air-handling system for a CO building. However, there are advantages that may outweigh the disadvantages.

a. The total installed horsepower is less.

b. The capability of manipulating air quantities and redistributing them from floor to floor as occupancy requirements change is greatest with this configuration.

c. The first cost and space requirements are less than for individual systems.

Location of MERs in Suburban -Type Office Buildings

9.23 Suburban-type buildings are two to three stories in height with a horizontal layout and are staffed primarily by telecommunications personnel. The preferred location for the MER is in the lowest building level (Fig. 5). The air-handling equipment consists of a perimeter system and an all-air system for the interior spaces. These two types of systems service all spaces in the building, unless non-typical conditions exist in which case a separate system will be required. The refrigeration equipment is located on the lowest level and generally the two spaces are combined into one common room.

9.24 The MER location must meet the following criteria:

a. Appropriately sized and protected air intake and exhaust openings must meet all local codes.

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b. Two or more interior walls must be left free for duct and piping passages if the vertical shafts are outside the confines of the MER. When the shafts originate in the equipment room, this requirement can be relaxed.

c. Ample space must be left around air-handling and refrigeration equipment to facilitate maintenance. The MER must have access to the street for removal of air-handling and refrigeration equipment.

d. Rotating and reciprocating machinery and piping must be located on vibration isolators for both air handling and refrigeration spaces.

e. Extra thermal insulation, if necessary.

Advantages of a Lower Level Central Equipment Room

9.25 The advantages of a lower level Central Equipment Room are as follows:

a. All equipment can be serviced at one time.

b. Noisy equipment can be serviced at one time.

c. Service personnel do not enter occupied areas.

d. Building can expand upward if ample duct and equipment room space is provided.

e. Air-conditioning capabilities can be shifted from one area to another by varying air quantities.

f. Pipe runs will be shorter with less pump horsepower if air-handling rooms are located near the refrigeration room.

Disadvantages of a Lower Level Central Equipment Room

9.26 The disadvantages of a lower level Central Equipment Room are as follows:

a. Fire protection is difficult because duct shafts penetrate floors.

b. Air intakes and exhausts may be difficult to protect. It may also be difficult to meet local code requirements.

Location of MERs in High-Rise Office Buildings

9.27 High-rise buildings are of multi-storied construction. They are designed for telecommunication company equipment installation with a provision for on-site maintenance and personnel. The air-handling equipment consists of a type of perimeter system(s) and an all-air system(s) for the interior spaces. These two types of systems will service all spaces in the building unless non-typical conditions exist, in which separate systems will be required.

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9.28 There are many variables to consider when locating MERs in office-type buildings — the most significant being usable space. Experience has indicated that central air-handling rooms (feeding up, down or both ways) with the required duct shafts provide the best usable-to-gross area ratio. Similarly, the break point for reasonable duct shaft space is for one central equipment room to service approximately 8 to 12 floors in either direction. For the purposes of this discussion, high-rise buildings are divided into two categories:

1. Up through ten floors.
2. Over ten floors.

High-Rise Buildings — Up Through Ten Floors

9.29 See Figure 6.

9.30 The preferred layout is to have two air-handling equipment rooms and one refrigeration/pump room. One air-handling room is to be at the lowest level and the other at the top-most level. The low-level room with its equipment services the below-grade areas and occupied spaces in the lower half of the building. The refrigerating and pumping equipment located at the lowest level serves the entire building. The upper air-handling room serves all spaces in the upper half of the building. Shafts are provided to enclose ductwork and piping.

9.31 The MER locations must meet the following general criteria:

a. The penthouse makes it convenient to satisfy the outside and exhaust air requirements.

b. The lower level MER must have the air intakes and exhausts protected, and it must meet all local codes.

c. Floor area must be left in the penthouse in order to provide duct and piping space to carry services to lower levels.

d. Space must be left around air-handling and refrigeration equipment. The penthouse MER must have outside access so equipment can be lifted from the roof. The lower level refrigeration room must have access to the street level for removing equipment.

e. The penthouse MER must not be located over executive-type spaces because of potential noise problems. Rotating machinery and piping must be put on vibration isolators. The lower level refrigeration pump and air-handling MER would have normal treatment of equipment and piping.

Advantages of Central Fan Rooms

9.32 The advantages of Central Fan Rooms are as follows:

a. All air-handling equipment can be serviced at one time.

b. The penthouse MER has a good protected source of outdoor air, if located away from exhaust generator.

c. Potential noise problems can be avoided by keeping refrigeration and pumping equipment on the lowest level.

d. Street level occupied spaces can have their own independent air-handling systems.

e. Maintenance personnel do not have to enter occupied areas.

f. Prime space on individual floors is not taken by MERs.

Disadvantages of Central Fan Rooms

9.33 The disadvantages of Central Fan Rooms are as follows:

a. The breakdown of equipment (i.e., interior system supply fan) will affect large areas of the building.

b. Security may be difficult on intakes for lower level MERs.

c. The penthouses MERs require special consideration to reduce sound transmission.

d. Smoke control is more difficult because of duct shafts.

High-Rise Buildings — Over Ten Floors

9.34 See Figure 7.

9.35 The mechanical equipment spaces required for a multi-story building over ten floors are a function of the building height. Common to all systems would be a refrigeration/pumping system at the lowest level. In instances of very tall buildings, it is not unusual to have refrigeration equipment located at the uppermost level since the piping runs can be held to a minimum. If the refrigeration equipment is to be located in the lower building levels, a review of pressure ratings is required.

9.36 Considering a 20-, 30-, and 40-floor building as being most likely to be within the scope of AT&T requirements, then the following guidelines may be applied:

a. For a 20-floor building, an air-handling equipment floor located at the intermediate level and feeding ten floors up and ten floors down, would be a reasonable solution.

b. A 30-floor building would be in the category of two air-handling rooms: one at the intermediate level between the first and the twentieth floors and one penthouse equipment room serving the twenty-first through the thirtieth floors.

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c. For a 40-floor building, intermediate equipment rooms located at the eleventh and thirtieth floors would be a logical solution, considering ten floors up and down as reasonable criterion.

d. All of the foregoing is broad in scope and must be evaluated with each particular building configuration as a specific instance. There is no magic to the tenth floor designation, but rather, it falls back to the amount of shaft space required for the ductwork.

9.37 All of the criteria for equipment room layouts for high-rise buildings previously listed apply to this category.

NOTE:

In critical seismic zones, heavy refrigeration and pumping equipment should be located at the lowest level of the building. Refer to AT&T 760-200-026, Seismic Zone Classification for Critical Central Offices.

10. Sizing Of Mechanical Systems for Telecommunications Equipment

10.1 It is recommended that refrigeration capacity be installed to handle the initial cooling load plus the 5-year growth forecast. Additional refrigeration should be added when required on a measured load basis.

10.2 Ductwork should be installed for the ultimate full building load. Dampers or blanking devices should be installed to shut off air from initially vacant areas.

10.3 The main air-handling unit fan should be sized for the ultimate air delivery required. Its speed should be reduced by changing sheaves to properly balance the initial system load.

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11. Mechanical System Selection

Life Cycle Costing

11.1 Life Cycle Costing is a process that takes first costs, operating costs, maintenance costs, and life expectancy into account for various alternative systems and compares the systems on a present worth basis.

Load Matching

11.2 It is important to analyze alternative systems in the appropriate range of the required cooling capacity. For example, a chilled-water system can be engineered and installed to handle a 20-ton cooling load. However, in most locations, the chilled-water system does not prove economical on a life cycle cost basis until a cooling tower can be used in lieu of air-cooled condensers. This is generally in the 80- to 100-ton range. AT&T 760-550-212 discusses various types of refrigeration systems.

12. Mechanical Rooms Containing Refrigerating Equipment

General Design Requirements

12.1 Design requirements for refrigerants vary by Safety Group. Refrigerant classifications are based on the toxicity (Group A or B) and the flammability (Groups 1, 2, or 3) for each individual refrigerant or mixture of refrigerants. See ASHRAE Standard 34-1989 for the Safety Group Matrix. As data on refrigerants is subject to revision, consult the latest issue of ASHRAE Standard 34 for the correct classification. Alternative refrigerants are also discussed in AT&T 010-160-292, AT&T Refrigerant Management Plan.

12.2 The design, installation and operation of the MER containing the refrigeration system shall meet the requirements outlined in ASHRAE Standard 15-1994, Section 11, as a minimum design criteria.

12.3 Access to the MER shall be restricted to authorized personnel only.

12.4 An adequate number of doors shall be provided to ensure easy escape for occupants in an emergency. Doors shall be tight-fitting and shall open outward. Further, they shall be self-closing if they open into the building. Other than doors, there shall be no openings in the MER that will allow escaping refrigerant into other parts of the building.

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12.5 No open flames or any equipment that uses combustion air from the MER shall be permitted in the MER. If necessary, combustion air may be ducted directly from outside the MER to the point of use.

12.6 At least one approved self-contained breathing apparatus (SCBA) shall be provided outside of, but close to, the MER. The availability of a second SCBA for back up is strongly recommended. The SCBA shall be stored in a brightly colored, durable case to protect it from dirt and damage.

Ventilation

12.7 Mechanical Equipment Rooms shall be vented to the outdoors using mechanical ventilation. Mechanical ventilation shall be provided by one or more power driven fans capable of exhausting air from the MER in quantities as specified in paragraph 12.12.

12.8 The MER ventilation system shall be separate from all other building ventilation systems. That is, fans and ductwork used to ventilate the MER must not be used to ventilate any other part of the building. Further, the discharge must not interfere with any outside air intakes.

12.9 Make-up or outside air for the MER shall be properly conditioned to avoid damaging rapid temperature swings or freezing temperatures.

12.10 The mechanical ventilation shall be operated when the MER is occupied. Minimum ventilation rate shall be 0.5 cfm per square foot of MER area or 20 cfm per person.

12.11 Alternatively, the mechanical ventilation shall be operable for operator comfort. The minimum volume shall be required to maintain a maximum temperature rise of 15˚F based on the heat produced by the machinery in the MER.

12.12 The exhaust fan shall be capable of purging refrigerant from the MER. The minimum mechanical ventilation rate required to exhaust an accumulation of refrigerant due to leaks or a rupture of the system shall be the following quantity:

$$Q = 100 \times G0.5$$

where

Q = the airflow in cubic feet per minute.

G = the mass of refrigerants in pounds in the largest system, any part of which is located in the MER.

NOTE:

Thus, two distinct ventilation rates have been established. One for normal ventilation and one for purging the MER of refrigerant. The ventilation system shall operate at the higher rate, and shall be activated either by ventilation requirements or by the refrigerant/ monitoring alarm. If the purge rate is significantly higher than the ventilation rate, multiple fans, multiple-speed fans, or other modulation devices may be used. It is suggested that for any automatically initiated ventilation system, a switch shall also be provided to manually start the system.

12.13 Inlet(s) to the exhaust fan(s) shall be located near the refrigeration equipment and at a minimum of 18 inches and a maximum of 5 feet above the finished floor, because refrigerants, which are heavier than air, tend to drop to the floor and fill the room from the bottom.

12.14 Special care shall be given to ventilate the lowest points in the room, such as pits, stairwells, or trenches where refrigerant may accumulate.

12.15 The ventilation shall provide an “air sweep” across all refrigeration equipment. The inlet(s) to the exhaust fan shall be located near the potential leak source and away from the outside air intake(s), producing a “sweeping” action that draws outside air across the machinery to the exhaust fan. Stagnant areas created by lack of airflow shall be avoided. See Figures 8, 9, and 10. Arrangement A in both Figure 8 and 9 are suggested MER layouts, while Arrangement B in both figures are not recommended due to areas of air stagnation. Figure 10 shows an acceptable elevation view of an MER.

12.16 Regardless of any other ventilation in the MER, the “floor level” fan shall be capable of exhausting the calculated refrigerant purge as discussed in paragraph 12.12.

Refrigerant Monitoring

12.17 Permanently mounted, continuously operating area-monitoring systems shall be provided for the refrigeration MER. Monitoring systems insure occupant safety by detecting a build-up of refrigerant in the MER. Monitoring systems shall consist of refrigerant vapor detectors or oxygen depletion sensors (or both as appropriate to the type(s) of refrigerant used) and remote monitoring panels.

12.18 Mechanical rooms being upgraded in accordance with ASHRAE-15 for all air conditioning retrofit or replacement projects are required to install refrigerant sensors when changes are made to the mechanical room. These sensors should be capable of detecting refrigerant loss. The sensor should be positioned in areas where vapor from a refrigerant leak would most likely concentrate, thus providing personnel with a means to avoid catastrophic refrigerant loss. Sensors should be calibrated and tested so that the allowable exposure limit for the refrigerant will not be exceeded. It is recommended that the set point for the actuation of emergency ventilation be no greater than one half (1/2) of the Threshold Limit Value for the refrigerant with the lowest TLV. The TLV is the concentration of refrigerant vapor in air for a normal 8-hour workday and 40-hour work week to which occupants may be repeatedly exposed without adverse effect. Specific TLV's are available from the American Conference of Governmental and Industrial Hygienists or from the manufacturer.

12.19 If the refrigerant vapor detector is actuated, an alarm shall sound and the mechanical ventilation shall be activated. Also, all air handling units within the MER shall be deactivated.

12.20 The vapor detector(s) and/or oxygen depletion sensor(s) shall be located where a leakage is likely to concentrate. There will be cases where a single sensor or detector is sufficient; however, large rooms, multiple-level rooms, and pits are examples of cases where multiple sensors or detectors are required.

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12.21 Mount detectors and sensors close to the perimeter of a chiller, between two chillers, and between the refrigerating system and entry door. A refrigeration system shall not be more than 50 feet from a sensor. See Figures Figure 11 and Figure 12 for suggested layouts.

12.22 The recommended height for the sensor shall be a maximum of 18 inches above the floor, as refrigerants, which are heavier than air, tend to drop to the floor and fill the MER from the bottom.

12.23 The monitoring panels required shall be stable over a range of temperatures, humidifies and barometric pressures to which it is exposed, and shall require little maintenance. It shall have alarm limits that correspond to the refrigerant being monitored and have the outputs required to signal alarm conditions and start auxiliary ventilation equipment.

12.24 To prevent personnel from entering a contaminated equipment space, the monitor shall be located outside, but close to, the MER.

12.25 Periodic tests of the sensor(s) or detector(s), alarm(s) and mechanical ventilating system shall be performed in accordance with manufacturers' recommendations and/or local jurisdictional authority.

12.26 Refer to ASHRAE 15 - 1994 for all other detecting or ventilation requirements

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13. References

13.1 Information contained in this section is based on AT&T 760-310-100 — Building Envelope and AT&T 760-550-212 — Refrigeration Systems and the following documents:

- GL-77-10-025 — Equipment Cooling Systems for No. 4 ESS, AT&T, October 7, 1977.
- IL 81-04-389 — Revisions to the No. 5 ESS Building Design Guide, AT&T, April 28, 1981.
- RL 81-03-260 — No. 5 ESS Building Design Guide, AT&T, March 18, 1981 (EL 7189).
- American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE), 1993, Fundamentals Handbook.
- American Society of Heating, Refrigerating, and Air-Conditioning Engineers Standard 62, 1989, “Ventilation for Acceptable Indoor Air Quality.”
- American Society of Heating, Refrigerating and Air-Conditioning Engineers Standard 34, 1992, “Number Designation and Safety Classification of Refrigerants.”
- American Society of Heating, Refrigerating and Air-Conditioning Engineers Standard 15- 1994, “Safety Code for Mechanical Refrigeration.”
- Trane Applications Engineering Manual, “Refrigeration System Equipment Room Design,” The Trane Company, David Guckelberger and Brenda Bradley, August 1992.

Table 3. Selected Refrigerants [a] and Amount Limits [c]

Refrigerant	Name	Chemical Formula	Quantity of Refrigerant Allowable per Occupied Space	
			lb per 1000 ft.^{3} [a]	Vol. %
Group A1				
R-11	Trichlorofluoromethane	CCl_{3F}	1.6	0.4
R-12	Dichlorodifluoromethane	CCl_{2F2}	12	4.0
R-13	Chlorotrifluoromethane	$CClF_3$	31	12
R-13B1	Bromotrifluoromethane	$CBrF_3$	22	5.7
R-14	Tetrafluoromethane (Carbon tetrafluoride)	CF_4	25	11
R-22	Chlorodifluoromethane	$CHClF_2$	9.4	4.2
R-113	Trichlorotrifluoroethane	$CC_{l2FCClF2}$	1.9	0.4
R-114	Dichlorotetrafluoroethane	$CClF_{2CClF2}$	9.4	2.1
R-115	Chloropentafluoroethane	CCl_{F2CF3}	38	9.4
R-134a[d]	1,1,1,2-Tetrafluoroethane	CH_{2FCF3}	16	6.0

Table 3. Selected Refrigerants [a] and Amount Limits [c] (Continued)

Refrigerant	Name	Chemical Formula	Quantity of Refrigerant Allowable per Occupied Space	
			lb per 1000 ft.^{3} a	Vol. %
Group A1 (continued)				
R-C318	Octafluorocyclobutane	C_{4F8}	50	9.7
R-400	R-12 and R-114	$CCl_{2F2/C2C2F4}$	b	b
R-500	R-12/152a (73.8/26.2)	$CCl_{2F2/CH3CHF2}$	16	4.7
R-502	R-22/115 (48.8/51.2)	$CHClF_{2/CClF2CF3}$	19	6.5
R-503	R-23/13 (40.1/59.9)	$CHF_{3/CClF3}$	25	11
R-744	Carbon Dioxide	CO_2	5.7	5.0
Group A2				
R-142b	1-Chloro-1,1, Difluoroethane	CH_{3CClF2}	3.7	1.4
R-152a	1,1-Difluoroethane	CH_{3CHF2}	1.2	0.7
Group A3				
R-170	Ethane	C_{2H6}	0.5	0.64
R-290	Propane	C_{3H8}	0.5	0.44
R-600	Butane	C_{4H10}	0.5	0.34
R-600a	2-Methyl propane (Isobutane)	$CH(CH_{3)3}$	0.5	0.34
R-1150	Ethene (Ethylene)	C_{2H4}	0.4	0.52
R-1270	Propene (Propylene)	C_{3H6}	0.4	0.34
Group B1				
R-123[d]	2,2-Dichloro-1,1,1-Trifluoroethane	$CHCl_2CF_3$	0.004	0.001
R-764	Sulfur Dioxide	SO_2	0.016	0.01
Group B2				
R-40	Chloromethane (Methyl Chloride)	CH_{3Cl}	1.3	1.0
R-611	Methyl Formate	$HCOOCH_3$	0.78	0.5
R-717	Ammonia	NH_3	0.022	0.05

Footnotes:

a. The classifications shown are a partial list, for the convenience of the user, from ASHRAE Standard 34, which governs in the event of a difference. Because classifications are subject to revision as new data on refrigerants become available, the latest classification by Standard 34 shall be used.

b. The quantity of the component shall comply with the limits set in this table for the pure compound, and the total volume% of all components shall not exceed 12 volume% (see Appendix A, ASHRAE Standard 15).

c. The basis of the table amounts is given as follows, where ILDH is the "Immediately Dangerous to Life and Health" concentration, LFL is the Lower Flammability Limit and the TLV is the Threshold Limit Value.
Group A1 - 80% of the cardiac sensitization level for R-11, R-12, R-13B1, R-22, R-113, R-114, R-134a, R-500, and R-502. 100% of the ILDH for R-744. Others are limited by oxygen levels where oxygen deprivation begins to occur.
Group A2, A3 - Approximately 20% of the LFL.
Group B1 - 100% of IDLH for R-764, and 100% of the measure consistent with the TLV for R-123.
Group B2, B3 - 100% of IDLH or 20% of LFL, whichever is lower.

d. Toxicity classification is based on recommended exposure limits provided by chemical suppliers. This rating is provisional and will be reviewed when toxicological testing is completed.

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14. Figures

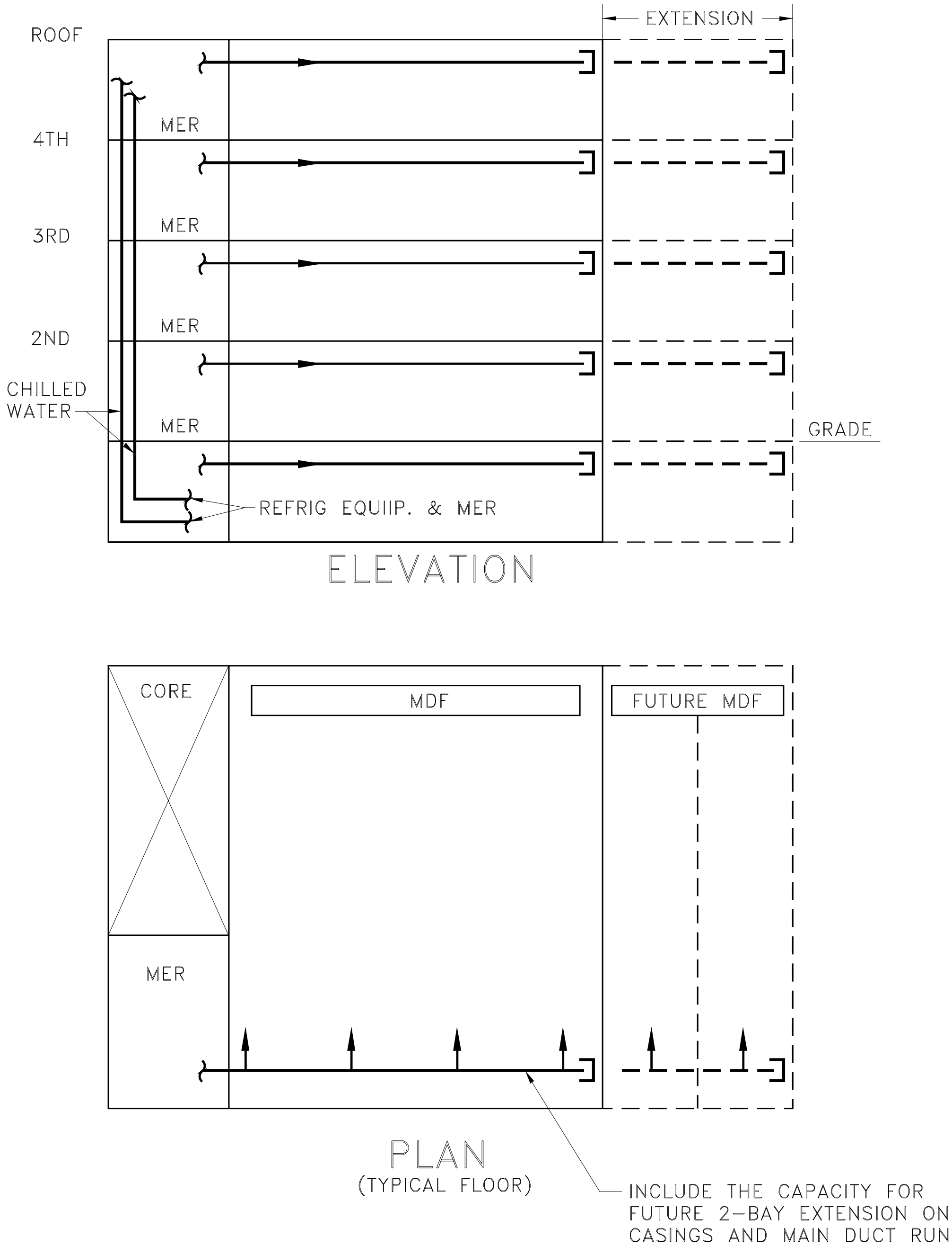


Figure 1. Preferred Location for MER in CO Equipment Building (2-Bay Extension) (Sheet 1 of 2)

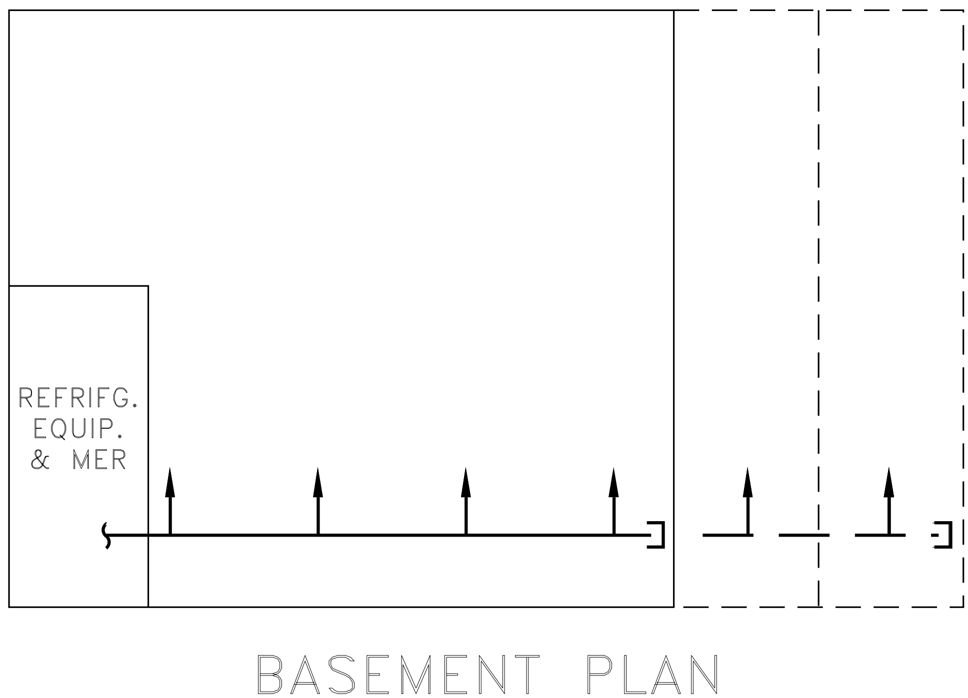
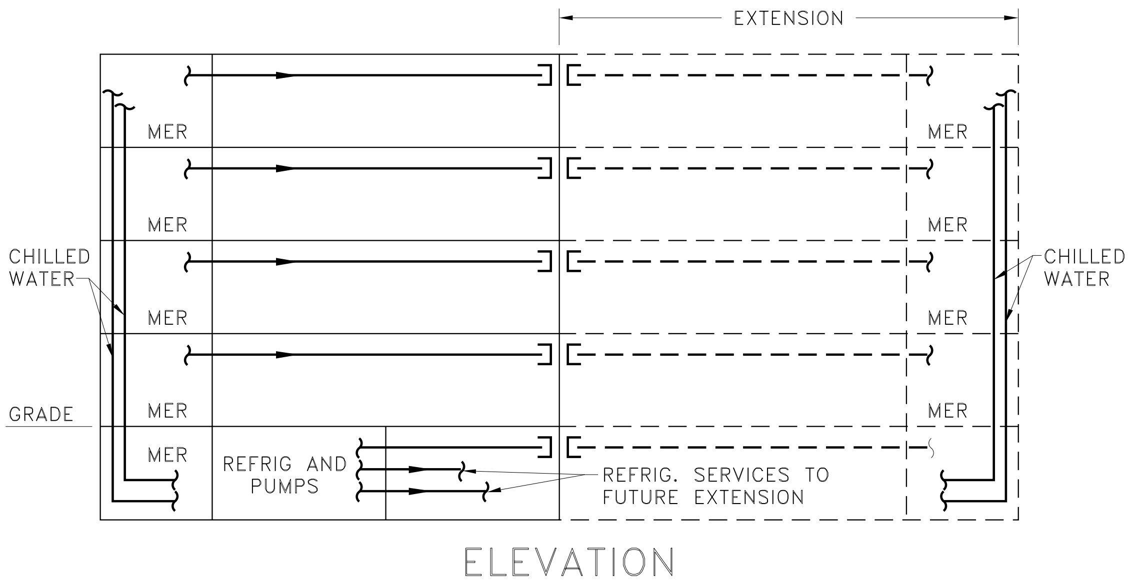


Figure 2. Preferred Location for MER in CO Equipment Building (2-Bay Extension) (Sheet 2 of 2)



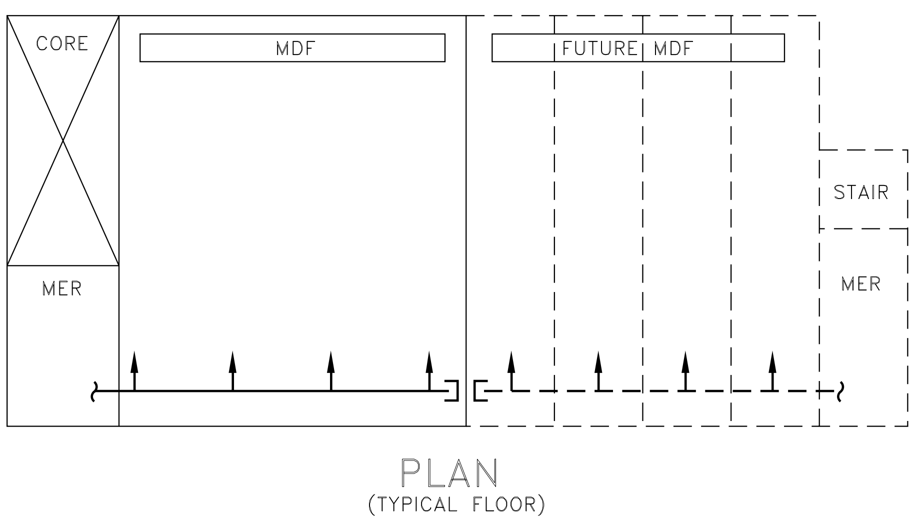


Figure 3. Preferred Location for MER in CO Equipment Building (4-Bay Extension) (Sheet 1 of 2)

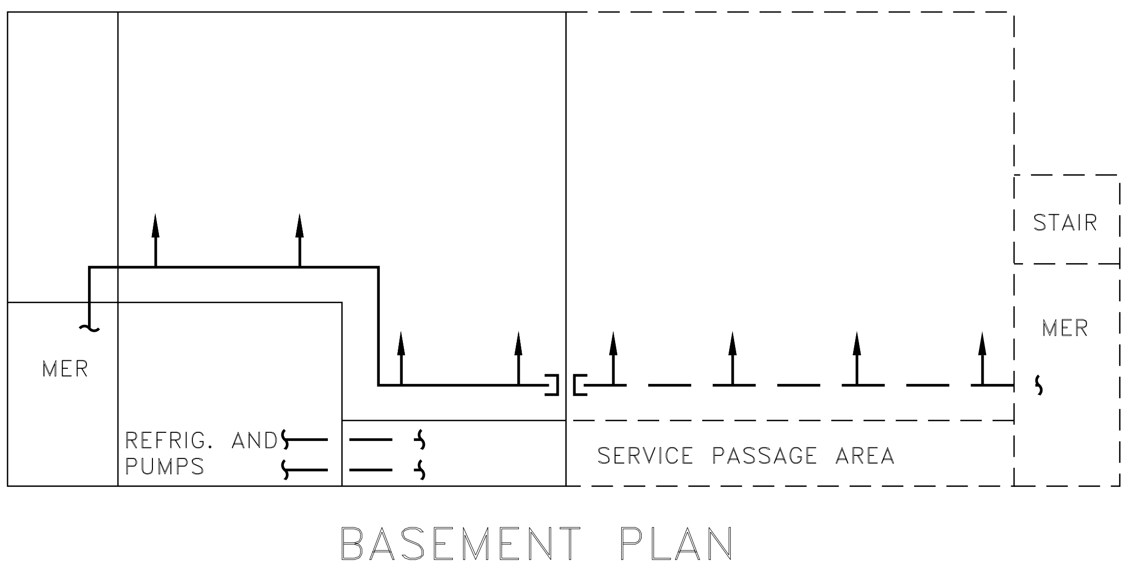


Figure 4. Preferred Location for MER in CO Equipment Building (4-Bay Extension) (Sheet 2 of 2)

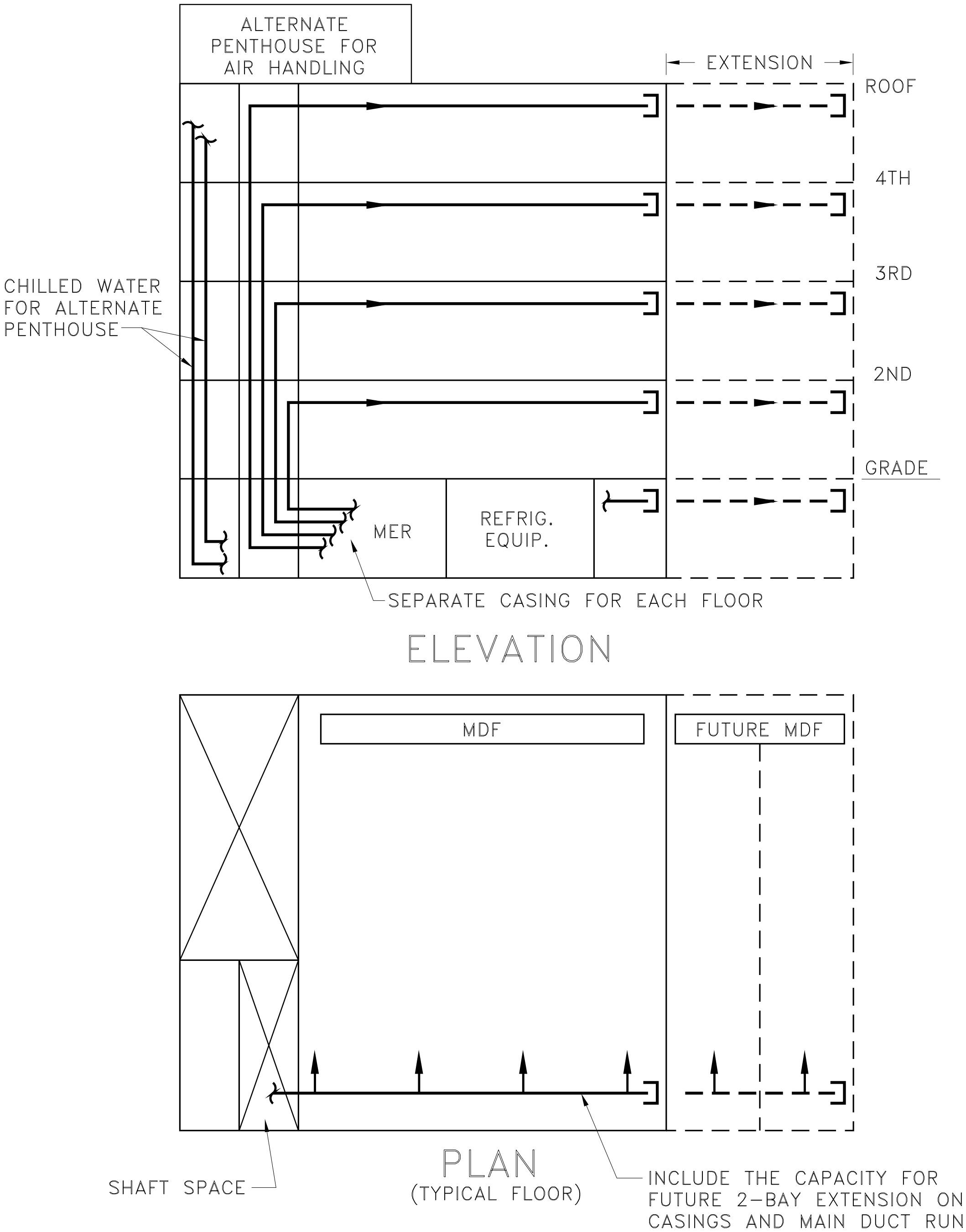
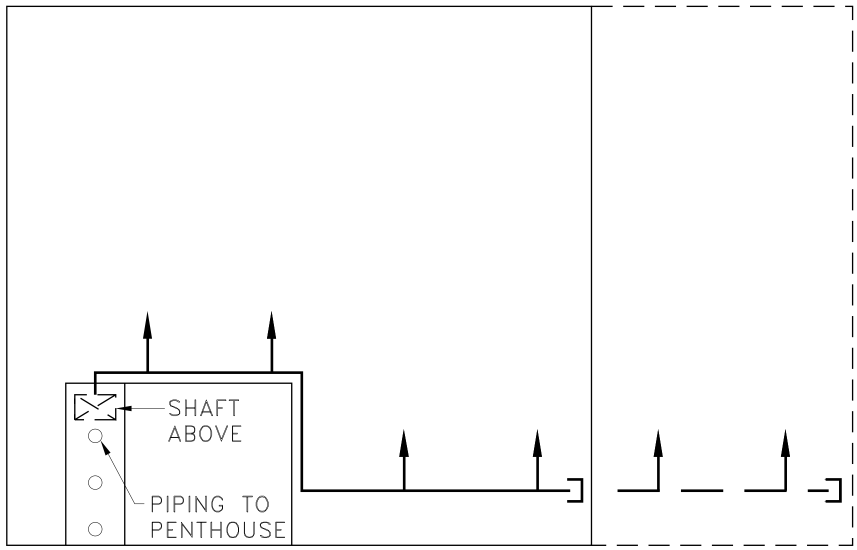
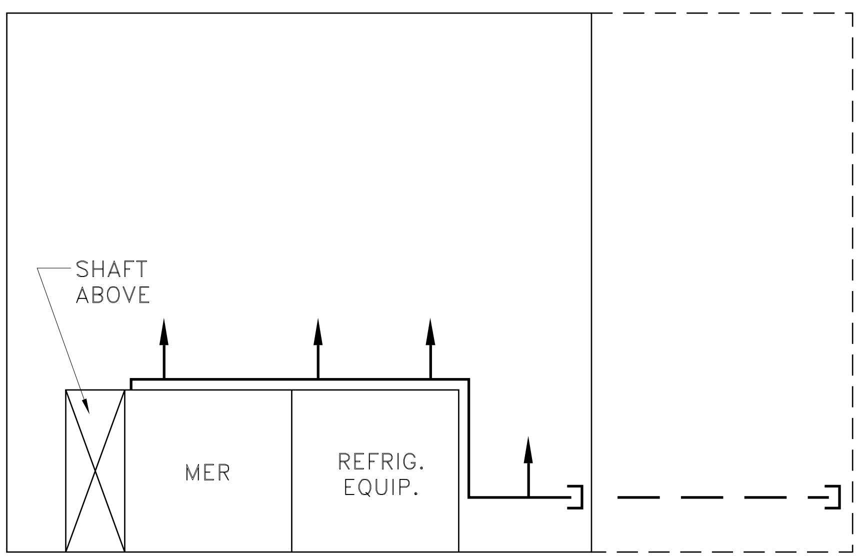


Figure 5. Acceptable Location for MER in CO Equipment Building (2-Bay Extension) (Sheet 1 of 2)



BASEMENT PLAN

(ALTERNATE—WHEN PENTHOUSE IS ON ROOF, DUCT WORK FEEDS DOWN.)



BASEMENT PLAN

Figure 6. Acceptable Location for MER in CO Equipment Building (2-Bay Extension) (Sheet 2 of 2)

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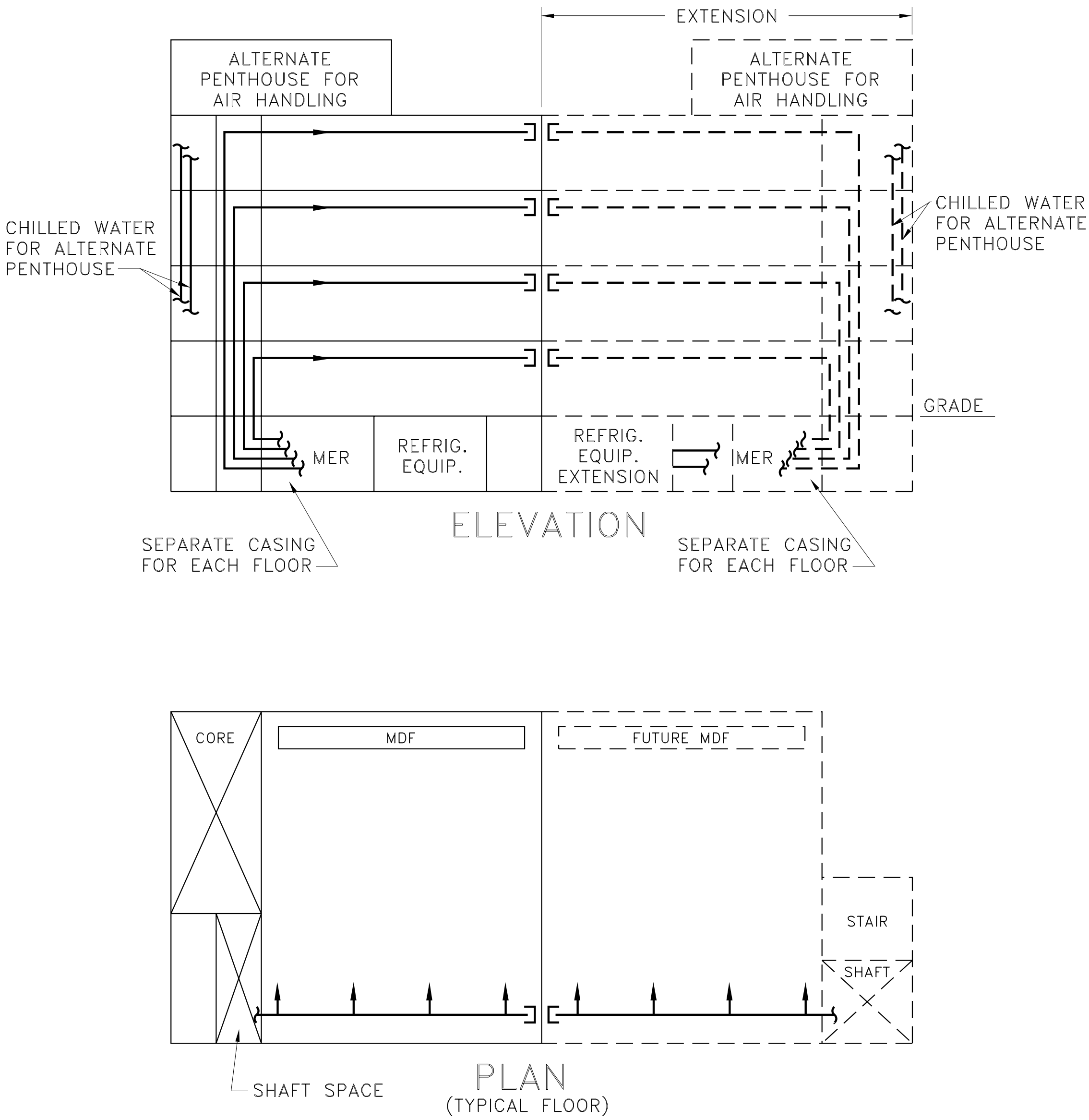
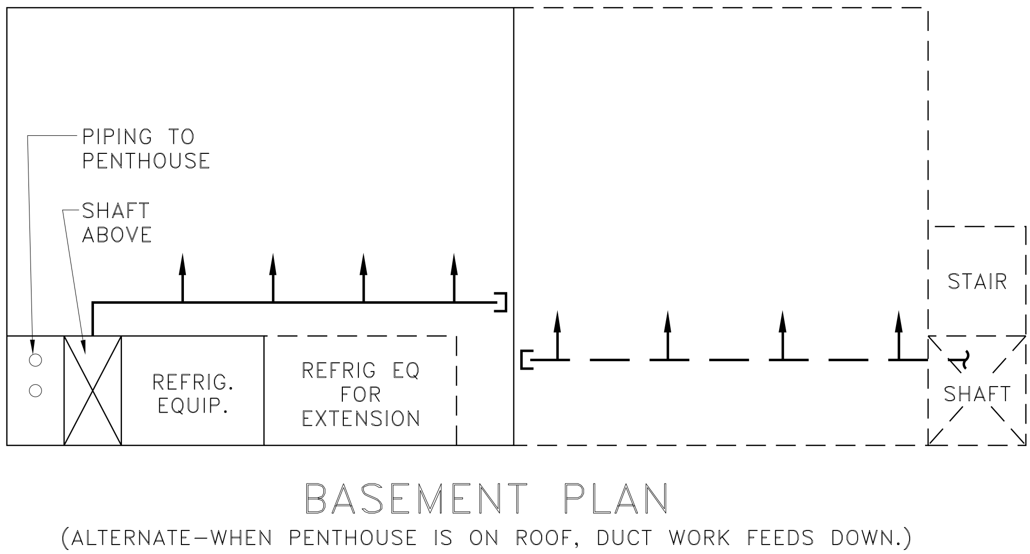


Figure 7. Acceptable Location for MER in CO Equipment Building (4-Bay Extension) (Sheet 1 of 2)



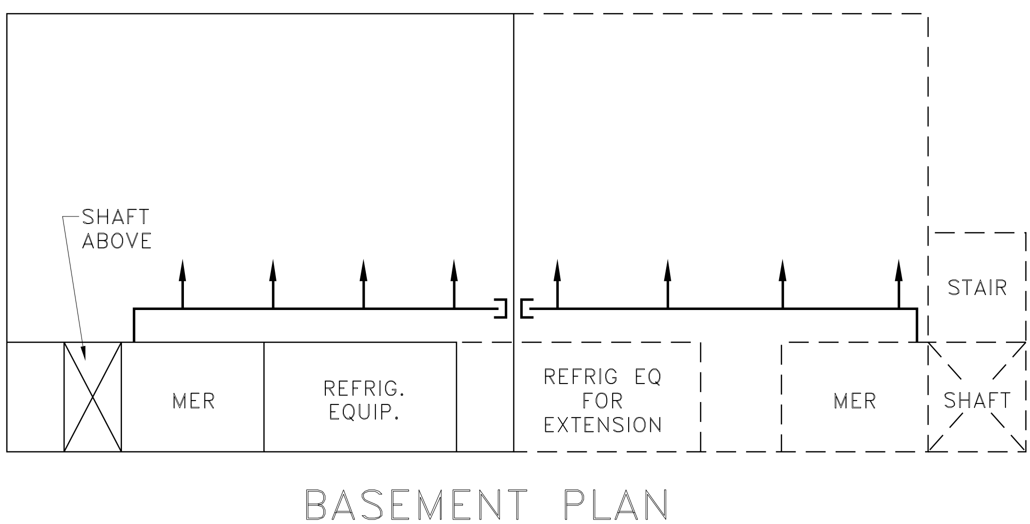
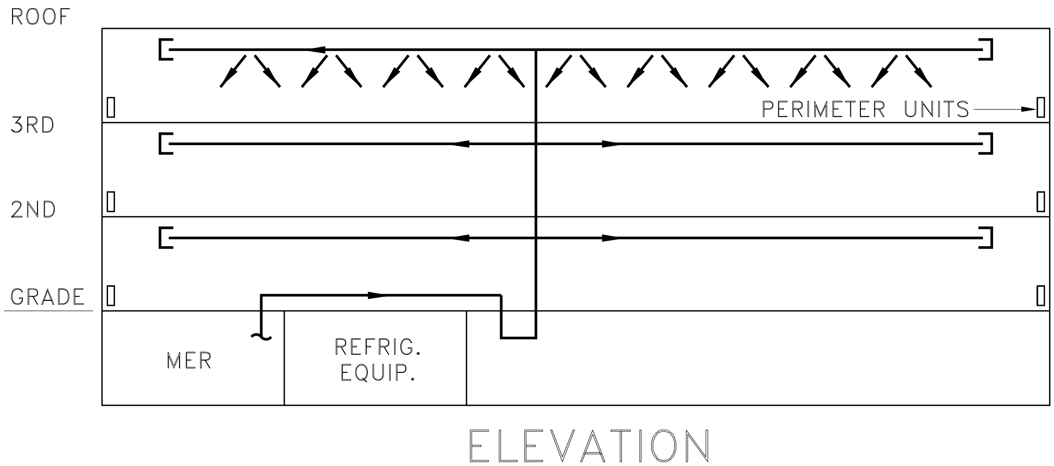


Figure 8. Acceptable Location for MER in CO Equipment Building (4-Bay Extension) (Sheet 2 of 2)



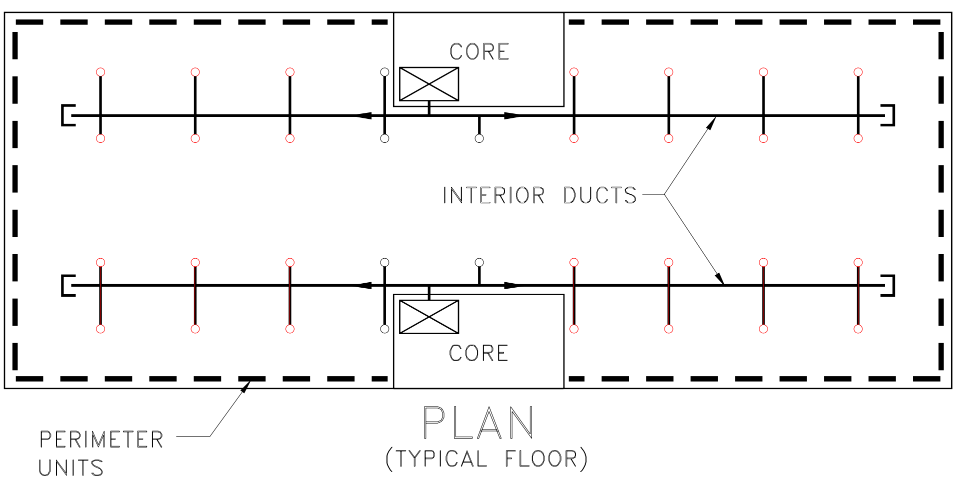
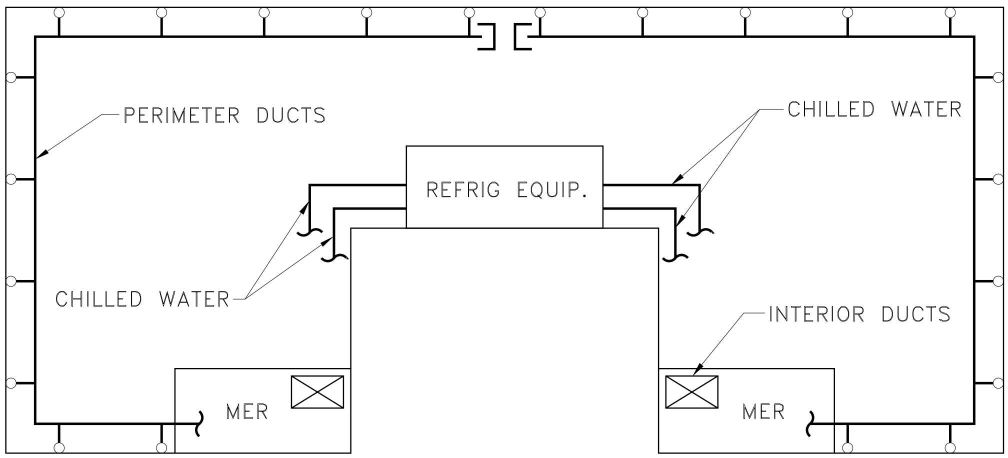
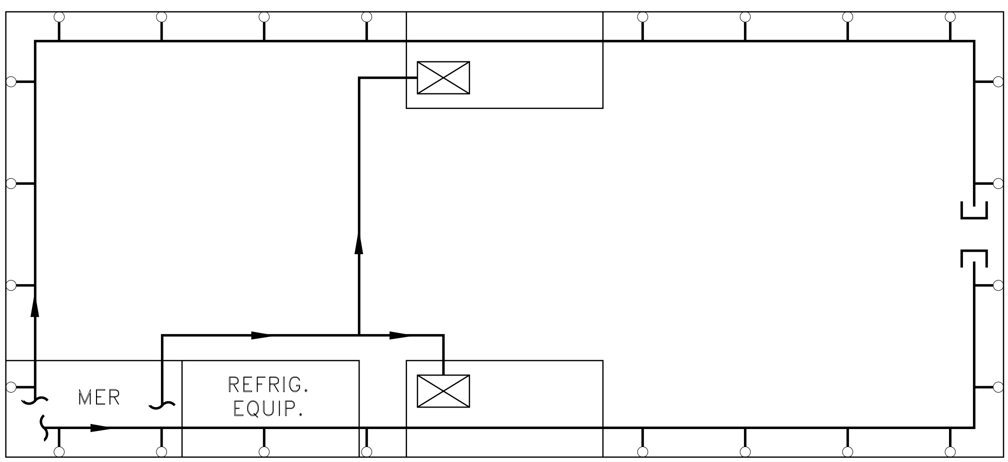


Figure 9. Suburban Office Building (Sheet 1 of 2)



BASEMENT PLAN
(ALTERNATE BUILDING CONFIGURATION)



BASEMENT PLAN

Figure 10. Suburban Office Building (Sheet 2 of 2)

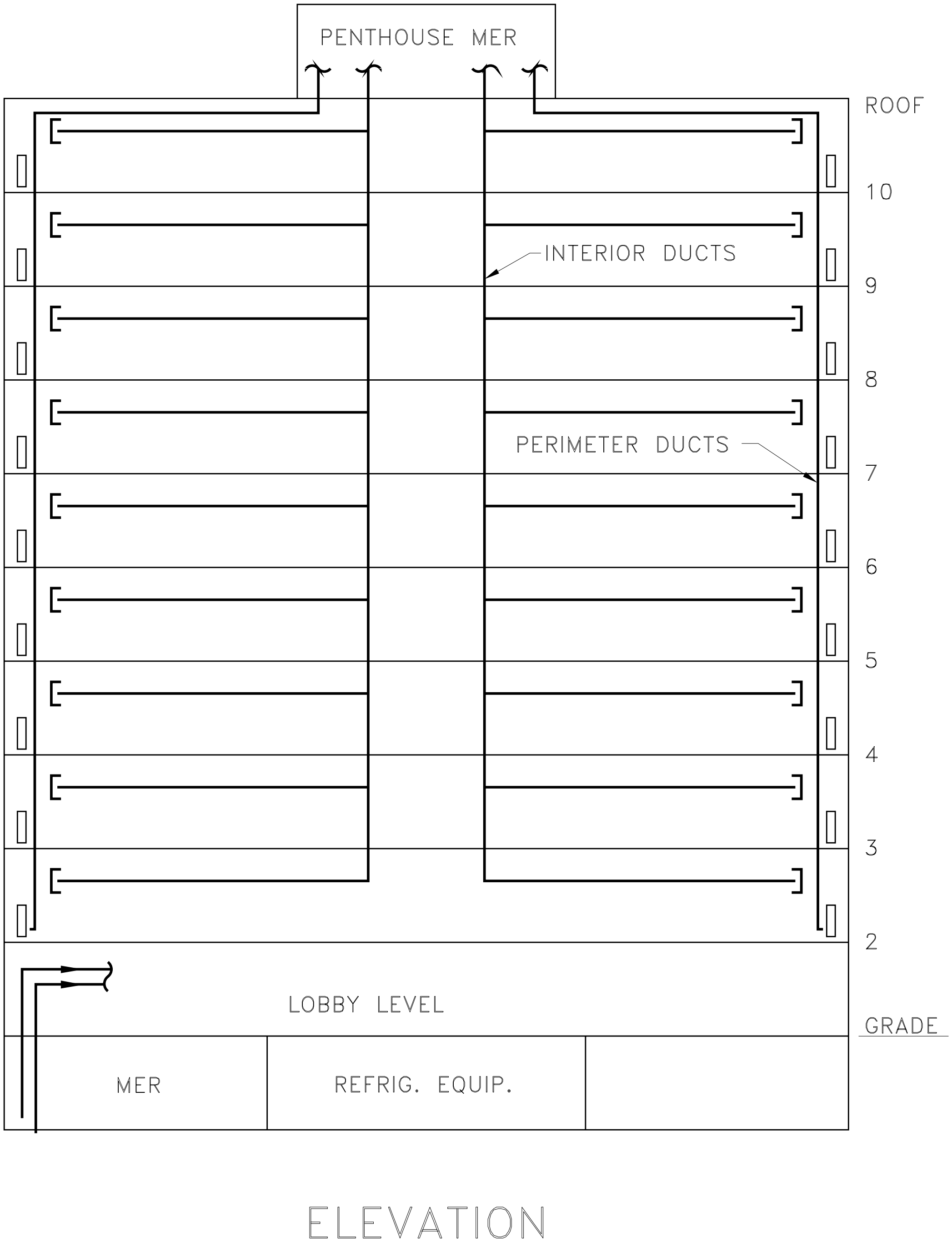
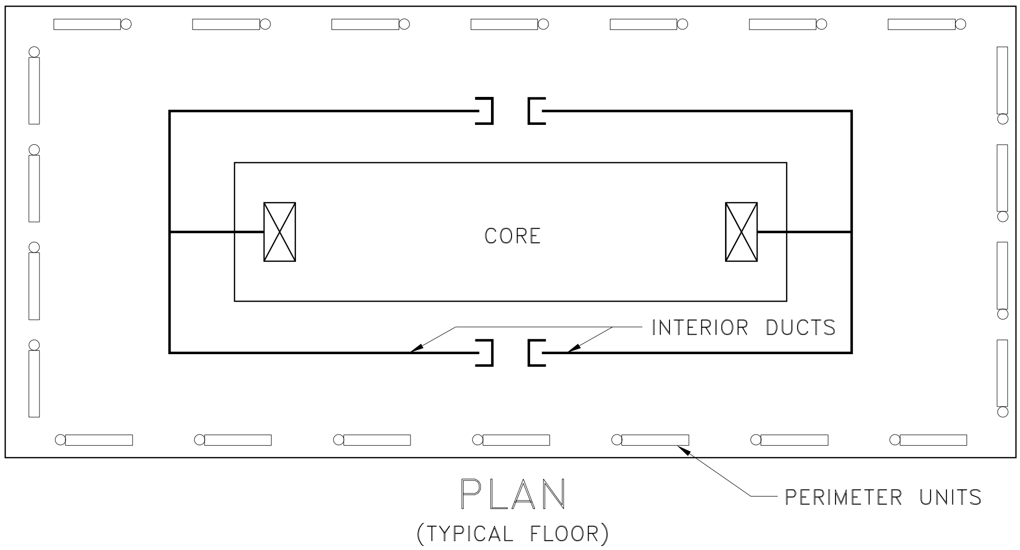


Figure 11. High-Rise Office Building (Over Ten Floors) (Sheet 1 of 2)



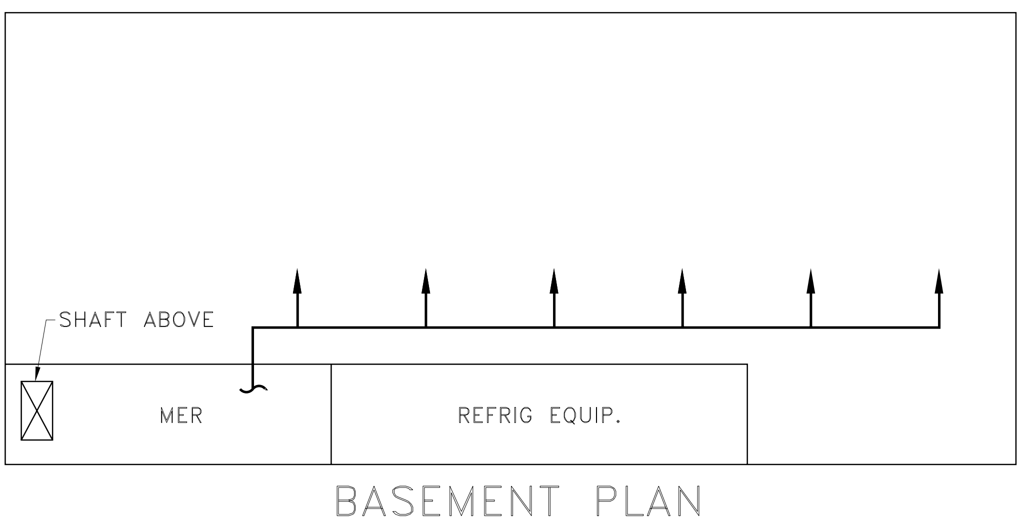


Figure 12. High-Rise Office Building (Over Ten Floors) (Sheet 2 of 2)

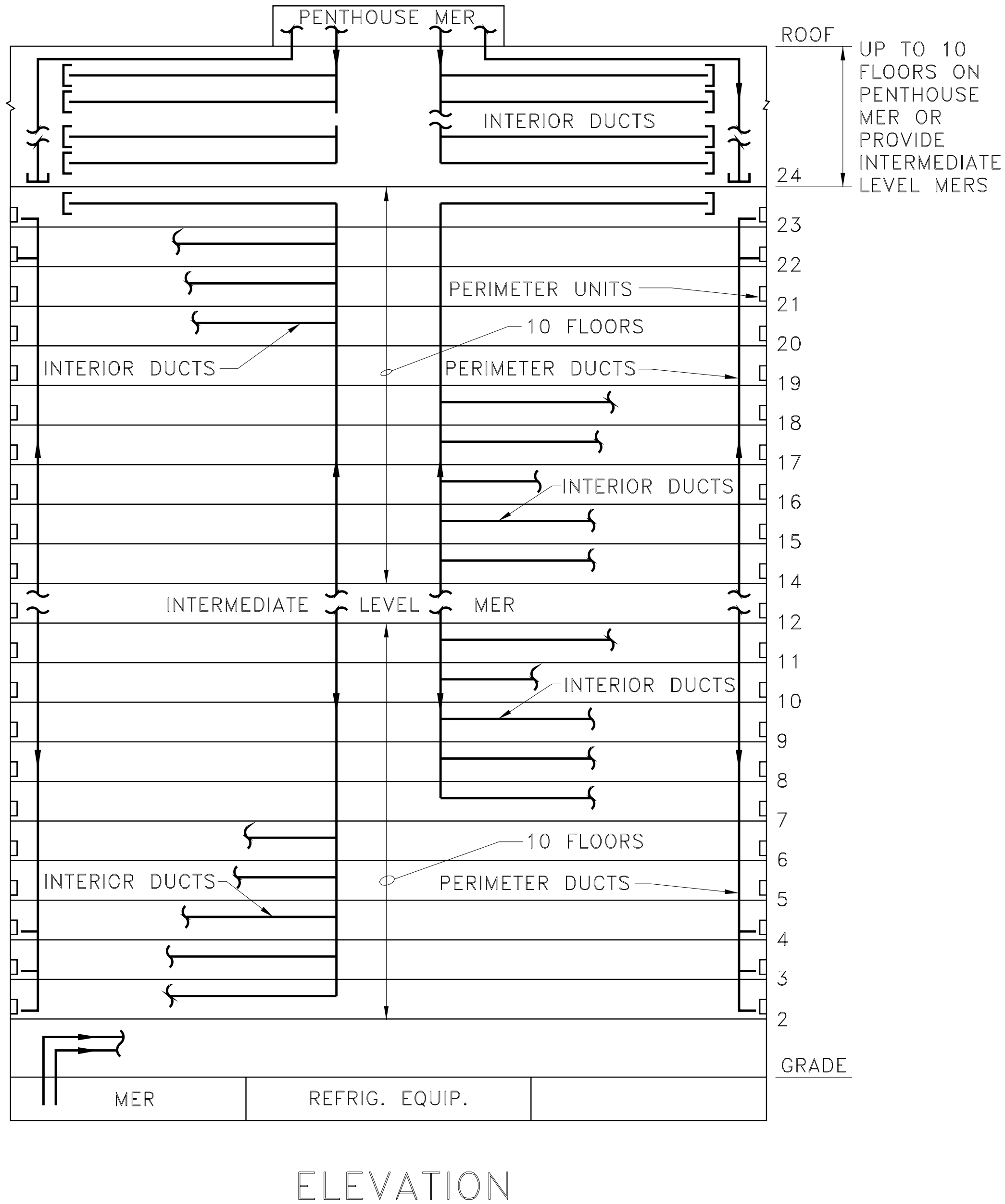


Figure 13. High-Rise Office Building (Over Ten Floors) (Sheet 1 of 2)

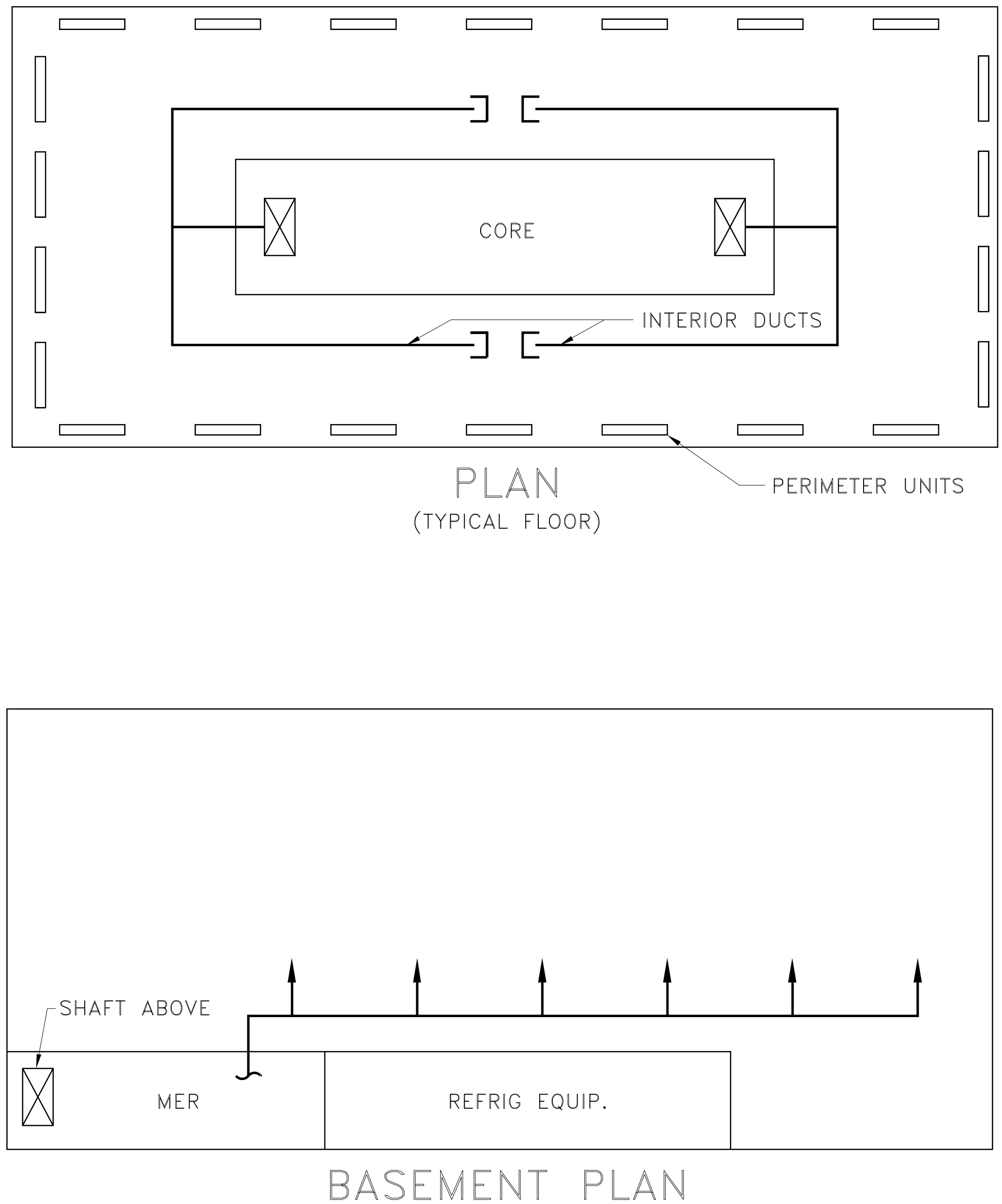


Figure 14. High-Rise Office Building (Over Ten Floors) (Sheet 2 of 2)

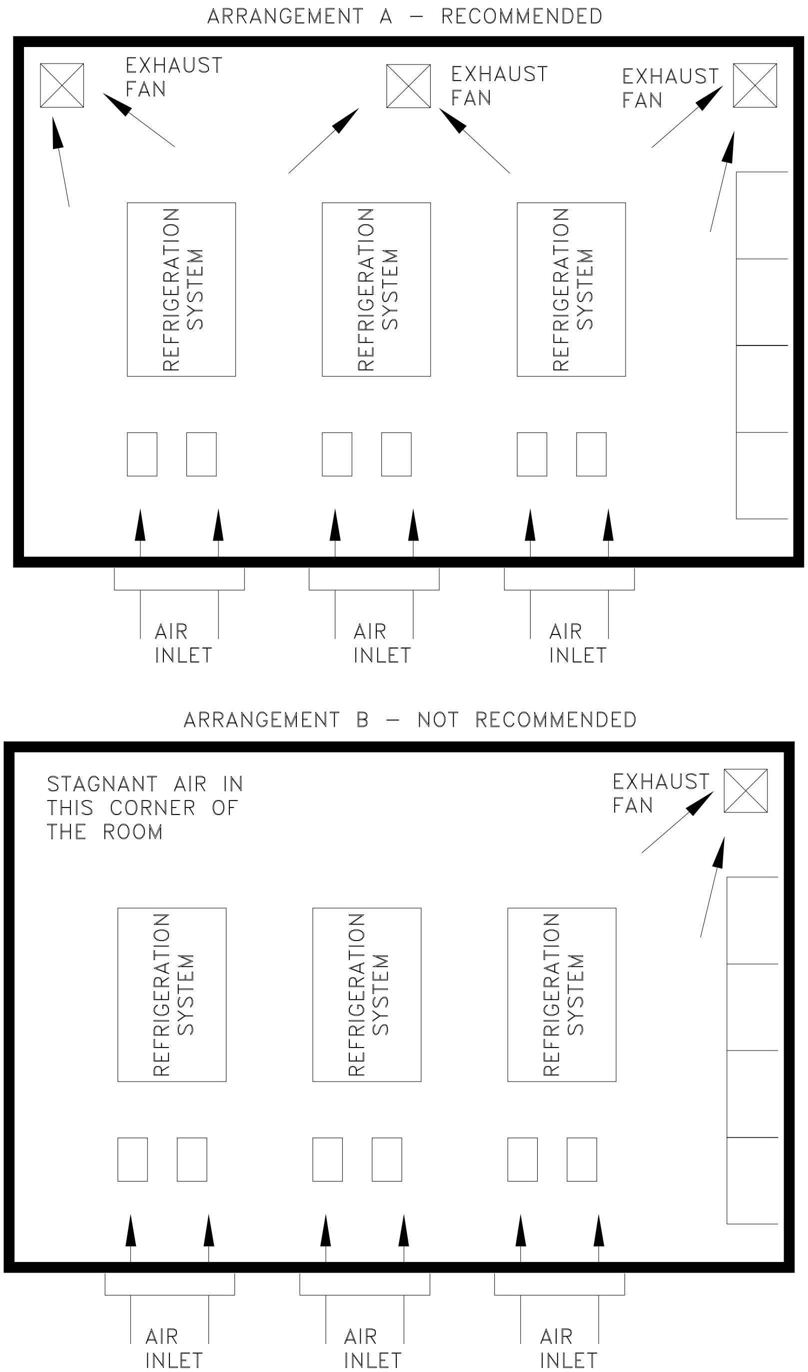


Figure 15. Mechanical Equipment Room Layout

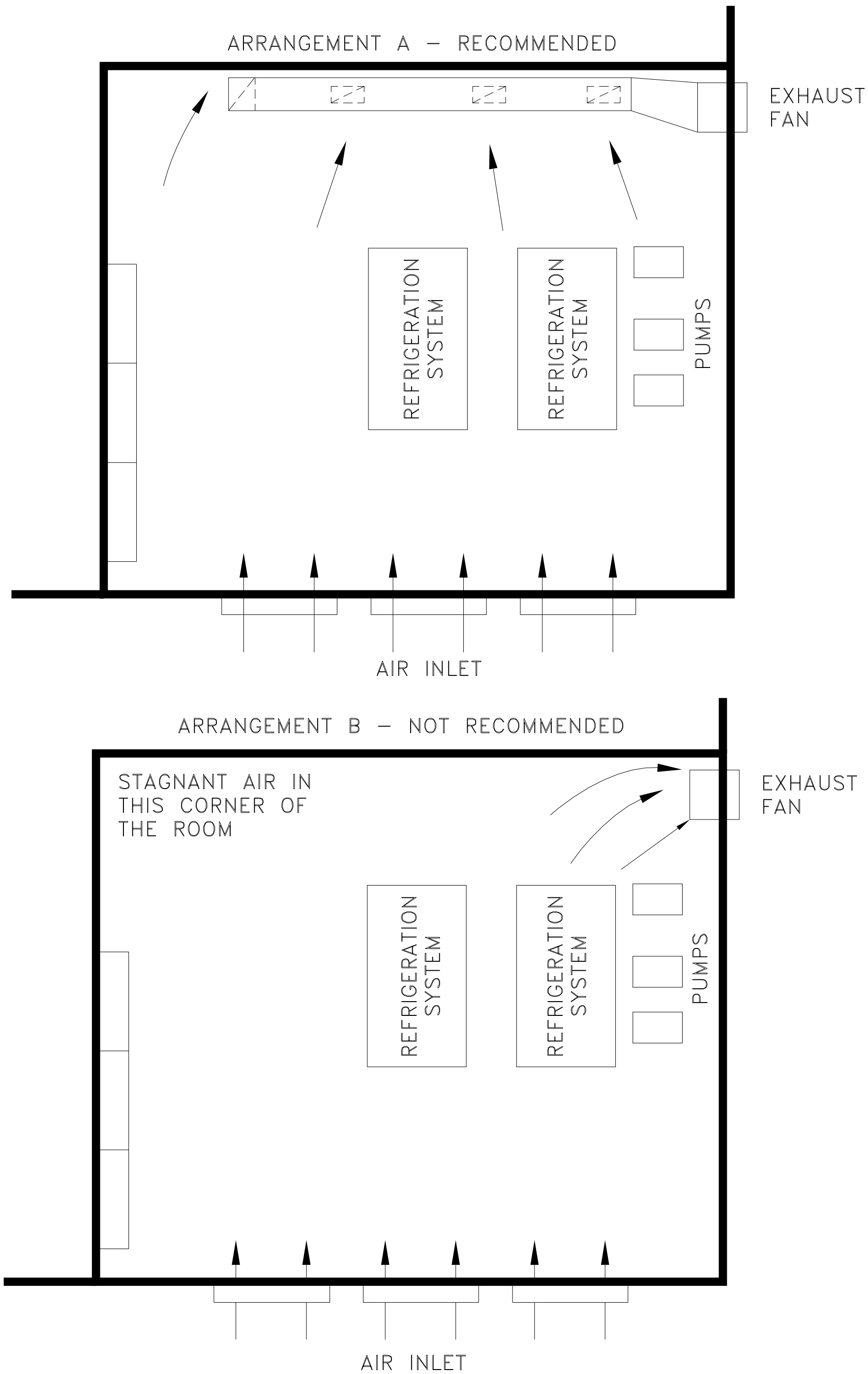


Figure 16. Mechanical Equipment Room Layout

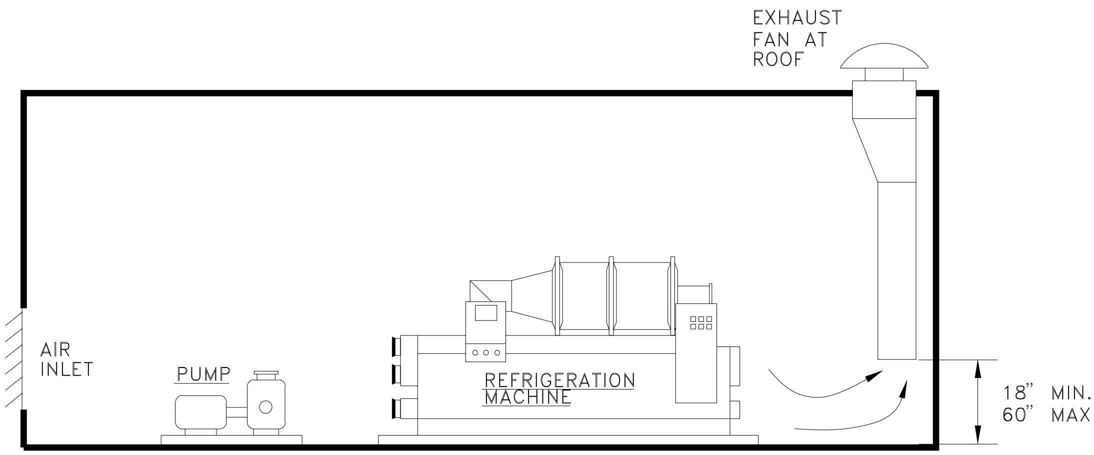


Figure 17. Exhaust Fan Location

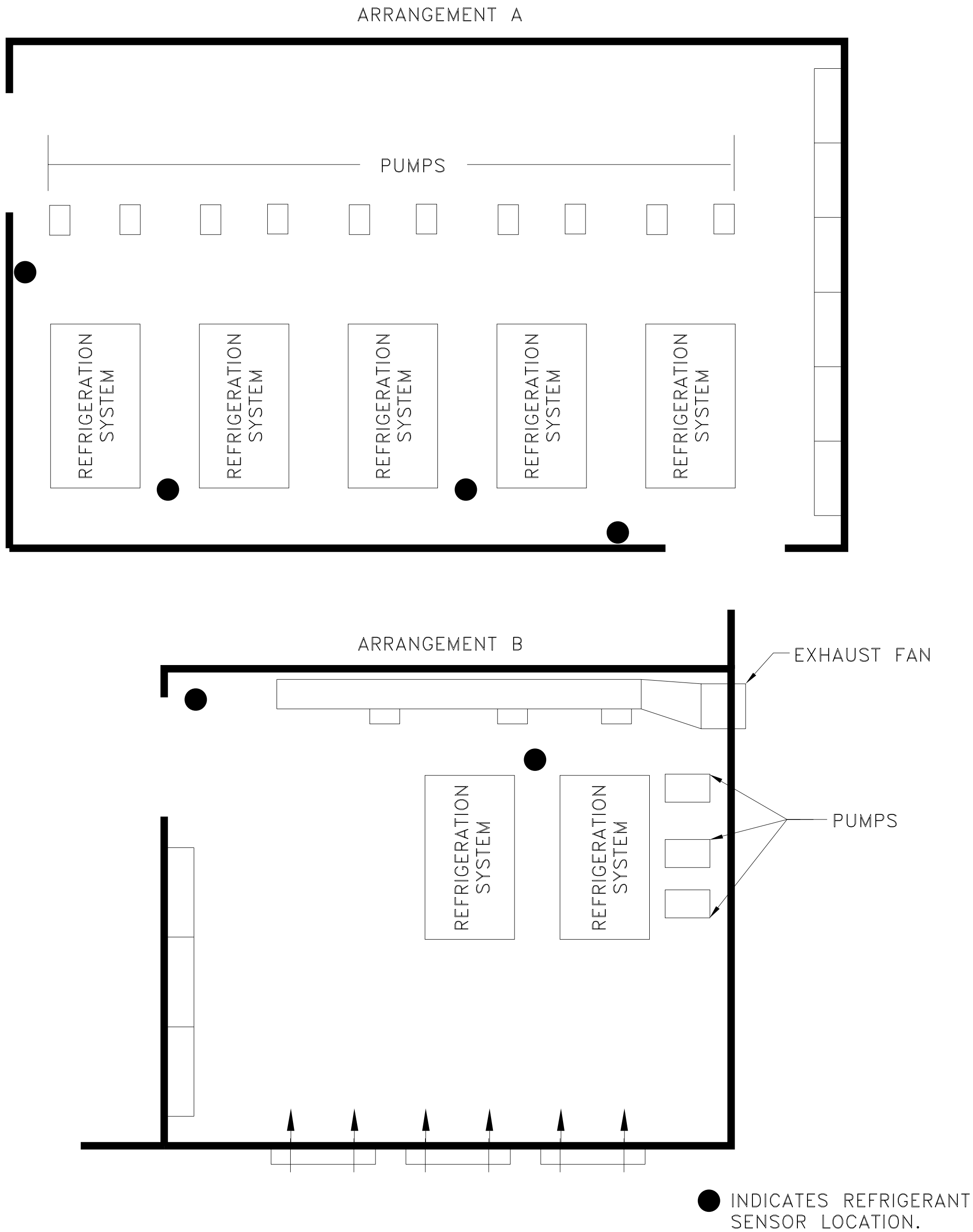


Figure 18. Refrigerant Vapor Detector/Oxygen Depletion Sensor Location

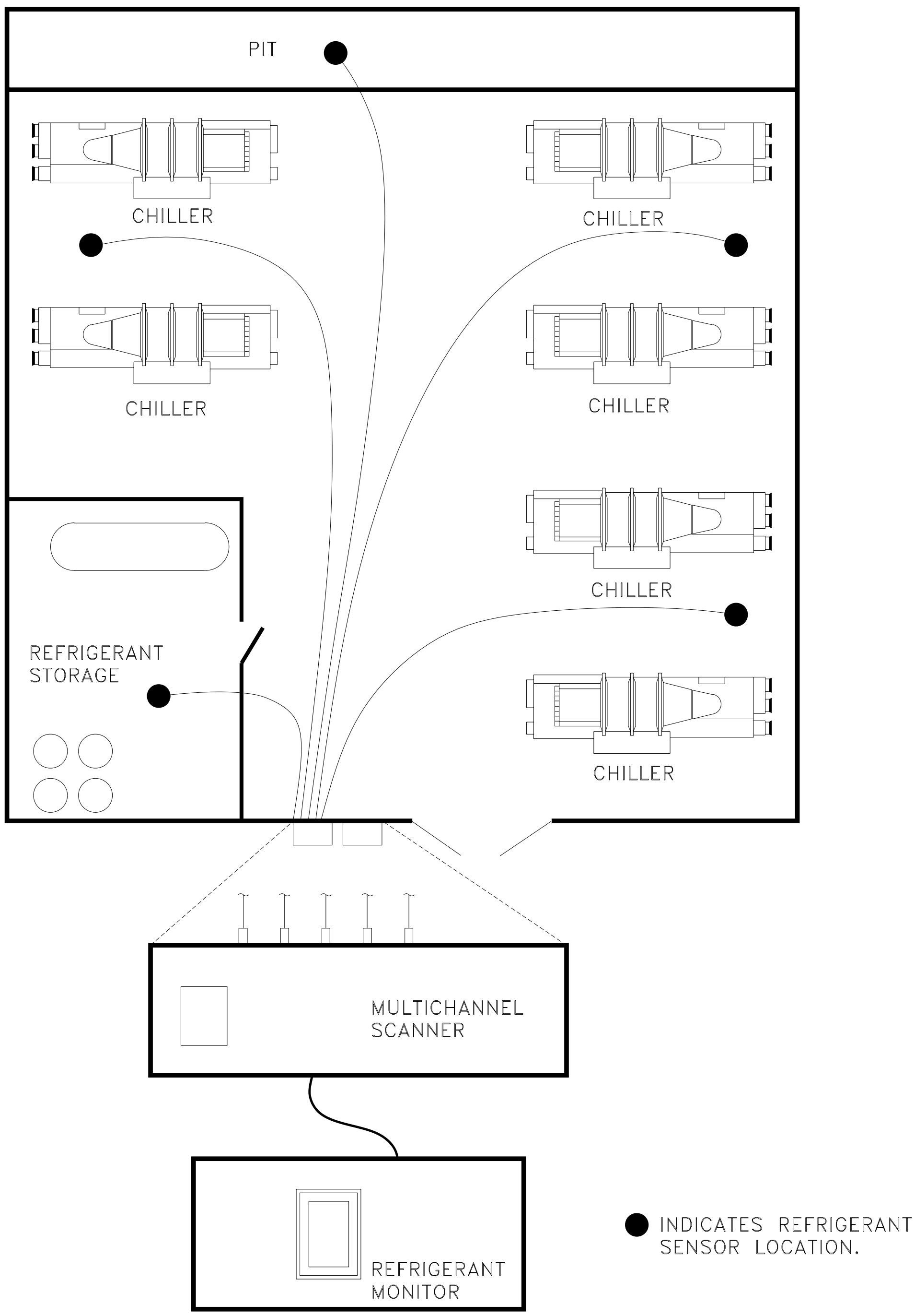


Figure 19. Refrigerant Vapor Detector/Oxygen Depletion Sensor Location

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