Chapter – 10

People/Occupancy Rules of Thumb

(၁) Offices, Commercial

(က)	General	80–150 Sq.Ft./Person
(ခ)	Private	1, 2, or 3 People
(ဂ)	Private	100–150 Sq.Ft./Person
(ဃ)	Conference, Meeting Rooms	20–50 Sq.Ft./Person

(၂) Banks, Court Houses, Municipal Buildings, Town Halls
50–150 Sq.Ft./Person

(၃) Police Stations, Fire Stations, Post Offices
100–500 Sq.Ft./Person

(၄) Precision Manufacturing
100–300 Sq.Ft./Person

(၅) Computer Rooms
80–150 Sq.Ft./Person

(၆) Restaurants
15–50 Sq.Ft./Person

(၇) Kitchens
50–150 Sq.Ft./Person

(၈) Cocktail Lounges, Bars, Taverns, Clubhouses, Nightclubs
15–50 Sq.Ft./Person

(၉) Hospital Patient Rooms, Nursing Home Patient Rooms

80–150 Sq.Ft./Person

(၁၀) Hospital General Areas
50–150 Sq.Ft./Person

(၁၁) Medical/Dental Centers, Clinics, and Offices
50–150 Sq.Ft./Person

(၁၂) Residential
200–600 Sq.Ft./Person

(၁၃) Apartments (Eff., 1 Room, 2 Room)
100–400 Sq.Ft./Person

(၁၄) Motel and Hotel Public Spaces
100–200 Sq.Ft./Person

(၁၅) Motel and Hotel Guest Rooms, Dormitories
100–200 Sq.Ft./Person

(၁၆) School Classrooms
100–200 Sq.Ft./Person

(၁၇) Dining Halls, Lunch Rooms, Cafeterias, Luncheonettes
10–50 Sq.Ft./Person

(၁၈) Libraries, Museums
30–100 Sq.Ft./Person

(၁၉) Retail, Department Stores
15–75 Sq.Ft./Person

(၂၀) Drug, Shoe, Dress, Jewelry, Beauty, Barber, and Other Shops
15–50 Sq.Ft./Person

(၂၁) Supermarkets
50–100 Sq.Ft./Person

(၂၂) Malls, Shopping Centers
50–100 Sq.Ft./Person

(၂၃) Jails
50–300 Sq.Ft./Person

(၂၄) Auditoriums, Theaters
5–20 Sq.Ft./Person

(၂၅) Churches
5–20 Sq.Ft./Person

(၂၆) Bowling Alleys

2–6 People/Lane

Note: People/Occupancy requirements should be determined from architect or client whenever possible.

Lighting Rules of Thumb

(၁) Offices, Commercial

(က)	General	1.5–3.0 Watts/Sq.Ft.
(ခ)	Private	2.0–5.0 Watts/Sq.Ft.
(ဂ)	Conference, Meeting Rooms	2.0–6.0 Watts/Sq.Ft.

(၂) Banks, Court Houses, Municipal Buildings, Town Halls

2.0–5.0 Watts/Sq.Ft.

(၃) Police Stations, Fire Stations, Post Offices

2.0–3.0 Watts/Sq.Ft.

(၄) Precision Manufacturing

3.0–10.0 Watts/Sq.Ft.

(၅) Computer Rooms

1.5–5.0 Watts/Sq.Ft.

(၆) Restaurants

1.5–3.0 Watts/Sq.Ft.

(၇) Kitchens

1.5–2.5 Watts/Sq.Ft.

(၈) Cocktail Lounges, Bars, Taverns, Clubhouses, Nightclubs

1.5–2.0 Watts/Sq.Ft.

(၉) Hospital Patient Rooms, Nursing Home Patient Rooms

1.0–2.0 Watts/Sq.Ft.

(၁၀) Hospital General Areas

1.5–2.5 Watts/Sq.Ft.

(၁၁) Medical/Dental Centers, Clinics, and Offices

1.5–2.5 Watts/Sq.Ft.

(၁၂) Residential

1.0–4.0 Watts/Sq.Ft.

(၁၃) Apartments (Eff., 1 Room, 2 Room)

1.0–4.0 Watts/Sq.Ft.

(၁၄) Motel and Hotel Public Spaces

1.0–3.0 Watts/Sq.Ft.

(၁၅) Motel and Hotel Guest Rooms, Dormitories
1.0–3.0 Watts/Sq.Ft.

(၁၆) School Classrooms
2.0–6.0 Watts/Sq.Ft.

(၁၇) Dining Halls, Lunch Rooms, Cafeterias, Luncheonettes
1.5–2.5 Watts/Sq.Ft.

(၁၈) Libraries, Museums
1.0–3.0 Watts/Sq.Ft.

(၁၉) Retail, Department Stores
2.0–6.0 Watts/Sq.Ft.

(၂၀) Drug, Shoe, Dress, Jewelry, Beauty, Barber, and Other Shops
1.0–3.0 Watts/Sq.Ft.

(၂၁) Supermarkets
1.0–3.0 Watts/Sq.Ft.

(၂၂) Malls, Shopping Centers
1.0–2.5 Watts/Sq.Ft.

(၂၃) Jails
1.0–2.5 Watts/Sq.Ft.

(၂၄) Auditoriums, Theaters
1.0–3.0 Watts/Sq.Ft. (3)

(၂၅) Churches
1.0–3.0 Watts/Sq.Ft.

(၂၆) Bowling Alleys
1.0–2.5 Watts/Sq.Ft.

Notes:

1. The lighting values for most energy conscious construction will be the lower values.
2. Actual lighting layouts should be used for calculating lighting loads whenever available.
3. Does not include theatrical lighting.

28.01 General

A. Provide all materials and equipment and perform all labor required to install complete and operable mechanical systems as indicated on the drawings, as speci-fied and as required by code.

B. Contract document drawings for mechanical work (HVAC, plumbing, and fire protection) are diagrammatic and are intended to convey scope and general arrangement only.

C. Install all mechanical equipment and appurtenances in accordance with manu-facturers' recommendations, contract documents, and applicable codes and regula-tions.

D. Provide vibration isolation for all mechanical equipment to prevent transmis-sion of vibration to building structure.

E. Provide vibration isolators for all piping supports connected to and within 50 feet of isolated equipment (except at base elbow supports and anchor points) throughout mechanical equipment rooms. Do the same for supports of steam mains within 50 feet of boiler or pressure reducing valves.

F. Provide vibration isolators for all piping supports of steam mains within 50 feet of boilers and pressure reducing valves.

G. The location of existing underground utilities is shown in an approximate way only. The contractor shall determine the exact location of all existing utilities before commencing work. The contractor shall pay for and repair all damages caused by failure to exactly locate and preserve any and all underground utilities unless other-wise indicated.

H. Coordinate construction of all mechanical work with architectural, structural, civil, electrical work, etc., shown on other contract document drawings.

I. Maintain a minimum of 6'-8" clearance to underside of pipes, ducts, conduits, suspended equipment, etc., throughout access routes in mechanical rooms.

J. All tests shall be completed before any mechanical equipment or piping insula-tion is applied.

K. Locate all temperature, pressure, and flow measuring devices in accessible locations with straight section of pipe or duct up- and downstream as recommended by the manufacturer for good accuracy.

L. Testing, adjusting, and balancing agency shall be a member of the Associated Air Balance Council (AABC) or the National Environmental Balancing Bureau (NEBB). Testing, adjusting, and balancing shall be performed in accordance with the AABC Standards.

M. Where two or more items of the same type of equipment are required, the prod-uct of one manufacturer shall be used.

N. Reinforcement, detailing, and placement of concrete shall conform to ASTM 315 and ACI 318. Concrete shall conform to ASTM C94. Concrete work shall conform to ACI 318, part entitled "Construction Requirements." Compressive strength in 28 days shall be 3,000 psi. Total air content of

exterior concrete shall be between 5 and 7 per-cent by volume. Slump shall be between 3 and 4 inches. Concrete shall be cured for 7 days after placement.

O. Coordinate all equipment connections with manufacturers' certified drawings. Coordinate and provide all duct and piping transitions required for final equipment connections to furnished equipment. Field verify and coordinate all duct and piping dimensions before fabrication.

P. All control wire and conduit shall comply with the National Electric Code and Division 16 of the specification.

Q. Concrete housekeeping pads to suit mechanical equipment shall be sized and located by the mechanical contractor. Minimum concrete pad thickness shall be 6 inches. Pad shall extend beyond the equipment a minimum of 6 inches on each side. Concrete housekeeping pads shall be provided by the general contractor. It shall be the responsibility of the mechanical contractor to coordinate size and location of concrete housekeeping pads with general contractor.

R. All mechanical room doors shall be a minimum of 4'-0" wide.

S. Where beams are indicated to be penetrated with ductwork or piping, coordi-nate ductwork and piping layout with beam opening size and opening locations. Coordination shall be done prior to fabrication of ductwork, cutting of piping, or fab-rication of beams.

T. When mechanical work (HVAC, plumbing, sheet metal, fire protection, etc.) is sub-contracted, it shall be the mechanical contractor's responsibility to coordinate subcon-tractors and the associated contracts. When discrepancies arise pertaining to which contractor provides a particular item of the mechanical contract or which contractor provides final connections for a particular item of the mechanical contract, it shall be brought to the attention of the mechanical contractor, whose decision shall be final.

U. The locations of all items shown on the drawings or called for in the specifica-tions that are not definitely fixed by dimensions are approximate only. The exact locations necessary to secure the best conditions and results must be determined by the project site conditions and shall have the approval of the engineer before being installed. Do not scale drawings.

V. All miscellaneous steel required to ensure proper installation and as shown in details for piping, ductwork, and equipment (unless otherwise noted) shall be fur-nished and installed by the mechanical contractor.

W. Provide access panels for installation in walls and ceilings, where required, to ser-vice dampers, valves, smoke detectors, and other concealed mechanical equipment. Access panels shall be turned over to general contractor for installation.

X. All equipment, piping, ductwork, etc., shall be supported as detailed, specified, and required to provide a vibration free installation.

Y. All ductwork, piping and equipment supported from structural steel shall be coordinated with general contractor. All attachments to steel bar joists, trusses, or joist girders shall be at panel points. Provide beam clamps meeting mss standards. Welding to structural members shall not be permitted. The use of C-clamps shall not be permitted.

Z. Mechanical equipment, ductwork, and piping shall not be supported from metal deck.

AA. All roof mounted equipment curbs for equipment provided by the mechanical contractor shall be furnished by the mechanical contractor and installed by the gen-eral contractor.

BB. Locations and sizes of all floor, wall, and roof openings shall be coordinated with all other trades involved.

CC. All openings in fire walls due to ductwork, piping, conduit, etc., shall be fire stopped with a product similar to 3M or approved equal.

DD. All air conditioning condensate drain lines from each air handling unit and rooftop unit shall be piped full size of the unit drain outlet, with "P" trap, and piped to nearest drain. See details shown on the drawings or the contract specifications for depth of air conditioning condensate trap.

EE. Refer to typical details for ductwork, piping, and equipment installation.

28.2 Piping

A. Provide all materials and equipment and perform all labor required to install complete and operable piping systems as indicated on the drawings, as specified and as required by code.

B. Elevations as shown on the drawings are to the centerline of all pressure piping and to the invert of all gravity piping.

C. Maintain a minimum of 3'6" of ground cover over all underground HVAC piping

(edit depth of ground cover to suit frost line depth and project requirements).

D. Unless otherwise noted, all chilled water and heating water piping shall be 3/4 inch size (edit system type or pipe size to suit project requirements).

E. Provide an air vent at the high point of each drop in the heating water, chilled water, and other closed water piping systems (edit system types to suit project requirements). All piping shall grade to low points. Provide hose end drain valves at the bottom of all risers and low points.

F. Unless otherwise noted, all piping is overhead, tight to underside of structure or slab, with space for insulation if required.

G. Install piping so that all valves, strainers, unions, traps, flanges, and other appurtenances requiring access are accessible.

H. All valves shall be installed so that valve remains in service when equipment or piping on equipment side of valve is removed.

I. All balancing valves and butterfly valves shall be provided with position indica-tors and maximum adjustable stops (memory stops).

J. Provide chainwheel operators for all valves in equipment rooms mounted greater than 7′-0″ above floor level; Chain shall extend to 7′-0″ above floor level.

K. All valves (except control valves) and strainers shall be full size of pipe before reducing size to make connections to equipment and controls.

L. Unions and/or flanges shall be installed at each piece of equipment, in bypasses, and in long piping runs (100 feet or more) to permit disassembly for alter-ation and repairs.

M. Pitch steam piping downward in the direction of flow 1/4 inch in 10 feet (1 inch in 40 feet) minimum. Pitch all steam return lines downward in the direction of conden-
sate flow 1/2 inch per 10 feet (1 inch in 20 feet) minimum. Where length of branch lines are less than 8 feet, pitch branch lines toward mains 1/2 inch per foot minimum.

N. Pitch up all steam and condensate runouts to risers and equipment 1/2 inch per foot. Where this pitch cannot be obtained, runouts over 8 feet in length shall be one size larger than noted.

O. Tap all branch lines from top of steam mains (45 degrees preferred, 90 degrees acceptable).

P. Provide an end of main drip at each rise in the steam main. Provide condensate drips at the bottom of all steam risers, downfed runouts to equipment, radiators, etc., at end of mains and low points, and ahead of all pressure regulators, control valves, isolation valves, and expansion joints.

Q. On straight steam piping runs with no natural drainage points, install drip legs at intervals not exceeding 200 feet where pipe is pitched downward in the direction of steam flow and a maximum of 100 feet where the pipe is pitched up so that con-densate flow is opposite of steam flow.

R. Steam traps shall be minimum 3/4" size.

S. Install all piping without forcing or springing.

T. All piping shall clear doors and windows.

U. All valves shall be adjusted for smooth and easy operation.

V. All piping work shall be coordinated with all trades involved. Offsets in piping around obstructions shall be provided at no additional cost to the owner.

W. Provide flexible connections in all piping systems connected to pumps, chillers, cooling towers, and other equipment which require vibration isolation except water coils. Flexible connections shall be provided as close to the equipment as possible or as indicated on the drawings.

X. Slope refrigerant piping one percent in the direction of oil return. Liquid lines may be installed level.

Y. Install horizontal refrigerant hot gas discharge piping With 1/2" per 10 feet down-ward slope away from the compressor.

Z. Install horizontal refrigerant suction lines with 1/2" per 10 feet downward slope to the compressor, with no long traps or dead ends which may cause oil to separate from the suction gas and return to the compressor in damaging slugs.

AA. Provide line size liquid indicators in main liquid line leaving condenser or receiver. Install moisture-liquid indicators in liquid lines between filter dryers and thermostatic expansion valves and in liquid line to receiver.

BB. Provide line size strainer upstream of each automatic valve. Provide shutoff valve on each side of strainer.

CC. Provide permanent filter dryers in low temperature systems and systems using hermetic compressors.

DD. Provide replaceable cartridge filter dryers with three valve bypass assembly for solenoid valves, adjacent to receivers.

EE. Provide refrigerant charging valve connections in liquid line between receiver shutoff valve and expansion valve.

28.03 Plumbing

A. Provide all materials and equipment and perform all labor required to install com-plete and operable plumbing systems as indicated on the drawings, as specified and as required by code.

B. Run all soil waste and vent piping with 2% minimum grade unless otherwise noted (edit slope to suit project requirements). Horizontal vent piping shall be graded to drip back to the soil or waste pipe by gravity.

C. Elevations as shown on the drawings are to the centerline of all pressure piping and to the invert of all gravity piping.

D. Adjust sewer inverts to keep tops of pipe in line where pipe size changes.

E. Maintain a minimum of 3'6" of ground cover over all underground water mains and a minimum of 3'0" of ground cover over all underground sewers and drains (edit depth of ground cover to suit frost line depth and project requirements).

F. Provide shutoff valves in all domestic water piping system branches in which branch piping serves two or more fixtures.

G. Unless otherwise noted, all domestic cold and hot water piping shall be 1/2 inch size (edit system type or pipe size to suit project requirements).

H. Unless otherwise noted, all piping is overhead, tight to underside of slab, with space for insulation if required.

I. Install piping so that all valves, strainers, unions, traps, flanges, and other appur-tenances requiring access are accessible.

J. Where domestic cold and hot water piping drops into a pipe chase, the size shown for the pipe drops shall be used to the last fixture.

K. Install all piping without forcing or springing.

L. All piping shall clear doors and windows.

M. All piping shall grade to low points. Provide hose end drain valves at the bottom of all risers and low points.

N. Unions and/or flanges shall be installed at each piece of equipment, in bypasses, and in long piping runs (100 feet or more) to permit disassembly for alteration and repairs.

O. All valves shall be adjusted for smooth and easy operation.

P. All valves (except control valves) and strainers shall be full size of pipe before reducing size to make connections to equipment and controls.

Q. Provide chainwheel operators for all valves in equipment rooms mounted greater than 7′-0″ above floor level; Chain shall extend to 7′-0″ above floor level.

R. Provide all plumbing fixtures and equipment with accessible stops.

S. Unless otherwise noted, drains shall be installed at the low point of roofs, areaways, floors, etc.

T. Provide cleanouts in sanitary and storm drainage systems at ends of runs, at changes in direction, near the base of stacks, every 50 feet in horizontal runs and elsewhere as indicated (edit horizontal cleanout spacing to suit code and project requirements).

U. All cleanouts shall be full size of pipe for pipe sizes 6 inches and smaller and shall be 6 inches for pipe sizes larger than 6 inches.

V. All balancing valves and butterfly valves shall be provided with position indicators and maximum adjustable stops (memory stops).

W. All valves shall be installed so that valve remains in service when equipment or piping on equipment side of valve is removed.

X. All piping work shall be coordinated with all trades involved. Offsets in piping around obstructions shall be provided at no additional cost to the owner.

Y. Provide flexible connections in all piping systems connected to pumps and other equipment which require vibration isolation. Flexible connections shall be provided as close to the equipment as possible or as indicated on the drawings.

28.04 HVAC/Sheet Metal

A. Provide all materials and equipment and perform all labor required to install com-plete and operable HVAC systems as indicated on the drawings, as specified and as required by code.

B. Certain items such as rises and drops in ductwork, access doors, volume dampers, etc., are indicated on the contract document drawings for clarity for a spe-cific location requirement and shall not be interpreted as the extent of the require-ments for these items.

C. In corridors where ceiling speakers and air diffusers are indicated between the same light fixtures, install both devices at the quarter points between the same fixture.

D. Unless otherwise shown, locate all room thermostats and humidistats 4′-0″ (cen-terline) above finished floor. Notify the engineer of any rooms where the above loca-tion cannot be maintained or where there is a question on location.

E. All ductwork shall clear doors and windows.

F. All ductwork dimensions, as shown on the drawings, are internal clear dimen-sions and duct size shall be increased to compensate for duct lining thickness.

G. Provide all 90 degree square elbows with double radius turning vanes unless otherwise indicated. Elbows in dishwasher, kitchen, and laundry exhaust shall be
unvaned smooth radius construction with a radius equal to 11/2 times the width of the duct. Provide access doors upstream of all elbows with turning vanes.

H. Coordinate diffuser, register, and grille locations with architectural reflected ceil-ing plans, lighting, and other ceiling items and make minor duct modifications to suit.

I. Field erected and factory assembled air handling unit coils shall be arranged for removal from the upstream side without dismantling supports. Provide galvanized structural steel supports for all coils (except lowest coil) in banks over two coils high to permit independent removal of any coil.

J. All air handling units shall operate without moisture carryover.

K. Locate all mechanical equipment (single duct, dual duct, variable volume, con-stant volume and fan powered boxes, fan coil units, cabinet heaters, unit heaters, unit ventilators, coils, steam humidifiers, etc.) for unobstructed access to unit access panels, controls and valving.

L. Finned tube radiation enclosures shall be wall to wall unless otherwise indicated.

M. Provide flexible connections in all ductwork systems (supply, return, and exhaust) connected to air handling units, fans, and other equipment which require vibration isolation. Flexible connections shall be provided at the point of connection to the equipment unless otherwise indicated.

N. Unless otherwise noted, all ductwork is overhead, tight to the underside of the structure, with space for insulation if required.

O. Runs of flexible duct shall not exceed 5 feet (edit maximum length of flexible duct to suit project; 5 feet maximum recommended length, 8 feet maximum length).

P. All ductwork shall be coordinated with all trades involved. Offsets in ducts, including divided ducts and transitions around obstructions, shall be provided at no additional cost to the owner.

Q. Provide access doors in ductwork to provide access for all smoke detectors, fire dampers, smoke dampers, volume dampers, humidifiers, coils, and other items located in the ductwork which require service and/or inspection.

R. Provide access doors in ductwork for operation, adjustment, and maintenance of all fans, valves, and mechanical equipment.

S. All ducts shall be grounded across flexible connections with flexible copper grounding straps. Grounding straps shall be bolted or soldered to both the equip-ment and the duct.

T. Smoke detectors shall be furnished and wired by the electrical contractor. The mechanical contractor shall be responsible for mounting the smoke detector in duct-work as shown on the drawings and in accordance with manufacturer’s printed instructions.

U. Terminate gas vents for unit heaters, water heaters, high pressure parts washer, high pressure cleaner, and other gas appliances a minimum of 3′0″ above roof with rain cap (edit appliances and height above roof to meet code and to suit project requirements).

V. See specifications for ductwork gauges, bracing, hangers, and other requirements.

W. Exterior louvers are indicated for information only. Detailed descriptions are pro-vided in the architectural specifications.

X. Exterior louvers are indicated for information only. Louver sizes, locations, and details shall be coordinated with general contractor.

Y. Exterior louvers are indicated for information only. Louver sizes, locations, mounting, and details shall be coordinated with other trades involved.

28.05 Fire Protection

A. Provide all materials and equipment and perform all labor required to install com-plete and operable fire protection systems as indicated on the drawings, as specified and complying with the standards of the National Fire Protection Association, Indus-trial Risk Insurers, Factory Mutual, and all state and local regulations.

B. The entire building sprinkler system shall be hydraulically designed unless other-wise noted on the drawings. Head spacing in general and water quantity shall be based on Light Hazard Occupancy (edit occupancy classification to suit project requriements; see NFPA 13—Light Hazard Occupancy, Ordinary Hazard Group I Occu-pancy, Ordinary Hazard Group II Occupancy, Extra Hazard Group I Occupancy, Extra Hazard Group II Occupancy).

C. The entire building sprinkler system shall be pipe schedule designed unless otherwise noted on the drawings. Head spacing in general and water quantity shall be based on Light Hazard Occupancy (edit occupancy classification to suit project requirements. See NFPA 13—Light Hazard Occupancy, Ordinary Hazard Group I Occu-pancy, Ordinary Hazard Group II Occupancy, Extra Hazard Group I Occupancy, Extra Hazard Group II Occupancy).

D. Provide an automatic wet pipe sprinkler system throughout the entire building, complete in all respects and ready for operation including all test and drain lines, pressure gauges, hangers and supports, signs, and other standard appurtenances. Wiring shall be provided under the electrical division.

E. Provide an automatic dry pipe sprinkler system throughout the entire building, complete in all respects and ready for operation including all test and drain lines, pressure gauges, dry pipe valves, air compressors, hangers and supports, signs, and other standard appurtenances. Wiring shall be provided under the electrical division.

F. See architectural drawings for exact location of fire extinguisher cabinets, fire hose cabinets, and Siamese connections.

G. All shutoff valves in sprinkler, standpipe, and combined systems shall be approved indicating type.

H. Coordinate sprinkler head locations with the architectural reflected ceiling plans, lighting, and other ceiling items and make minor modifications to suit.

I. Sprinklers installed in ceilings of finished areas shall be symmetrical in relation to ceiling system components and centered in the ceiling tile.