JUDGE DOYLE SQUARE
PUBLIC PARKING FACILITY

FOR

THE CITY OF MADISON, WISCONSIN

SCHEMATIC DESIGN
PROJECT DESCRIPTION

MARCH 22, 2017

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1 Comprehensive Development

The Judge Doyle Square development is located in the Central Area of Madison Wisconsin between East Doty and East Wilson Streets and consists of two blocks – Block 88 and Block 105 – on the east and west sides of South Pinckney Street. Block 88 is shared with the existing Madison Municipal Building, a four story limestone building of classical revival style that is listed on the National Register and has City of Madison Landmark status.

The development of Block 88 is programmed for an apartment building of approximately 155 units on ten floors with associated resident parking above grade, and a 600 car public parking facility in 5 levels below grade. The below grade facility will be built, owned and operated by the City of Madison, and the above grade residential development will be privately constructed.

Block 105 envisions a second apartment building of approximately 210 units and a hotel of approximately 250 rooms. Parking for this parcel will be in two levels underground, serving the hotel and residential with approximately 250 spaces.

This project description addresses only the Block 88 improvements and the public right of way improvements associated. More specifically, the parking structure element is the salient subject of the building structure development.

2 Site Improvements

a) Description of site and relationship to MMB

A new property line has been established on the Certified Survey Map twenty-five feet east of the main east façade of the MMB building. The MMB proposed new addition will extend to this property line in the center of the site in the north-south direction. The JDS project will be held approximately four feet east of the property line to allow for retention system installation between the property line and the below-grade foundations. To avoid undermining the new addition, a secant pile or other special retention system may be required in a limited area. Alternatively, the City may elect to provide deep foundations for the addition.

The building will extend to the property lines on the north and south, allowing for a 10 ft sidewalk on the north, and a 12 ft sidewalk on the south. These walks will be concrete to match those on Pinckney Street as described below. Curbs along Doty and Wilson Streets are expected to be City of Madison standard concrete. Curbs will be formed or cut at access driveways to allow for an opening 6 feet wider than the width of the driveway (3 feet on each side). Curbs will be formed at sidewalk/street intersections to meet City of Madison standards (ADA compliant). Curbs along Pinckney Street are not fully designed, but will likely be 30 inches wide and may be shaped like driveway entrance curbs on each side of the street to match the length of the island in the center of the street. This will provide accommodating access for bicycles to the Bicycle Center, and hotel patrons with wheeled luggage. Light poles along Doty and Wilson Streets will be salvaged and relocated or replaced. Light poles along Pinckney Street will be

new. Light pole locations and tree plantings within any sidewalk areas will be located to meet City of Madison requirements.

The above-grade Pinckney Street face of the building will be held back from the east property line approximately six feet at the grade through level two, creating a generous connection to the Pinckney Street "piazza".

The nature of the below grade facility limits its above grade functional and aesthetic exposure to its vehicle and pedestrian access portals which will require sensitive aesthetic and graphic incorporation into the above grade development and the surrounding environment, while providing visibility for unfamiliar people looking for parking.

b) Circulation and Access

Entrances to the public parking will be located both at Doty and Wilson Streets adjacent to the west property line. The operational and identification aspects of these entries are discussed in section 2, below. Pedestrian entries and exits to the garage will be located at these entries as well.

The loading dock serving the apartment and retail components of the project will be located on the Wilson Street side of the building.

The entrance to the apartment building which also will serve as the primary address for the entire building when completed will be located north of the building center at Pinckney Street. The Bike Center entry will be located at the northeast corner, and another retail space will enter at the southeast corner.

c) Pinckney Street Fountain and ROW Development

Pinckney Street will be renovated to serve as not only a two lane street connecting Doty and Wilson Streets, but also a paved and landscaped public "piazza" with a central water feature. In addition to eleven foot lanes in each direction, six-foot bicycle lanes will also be provided in both directions. Layby zones will be provided for taxi and drop-offs at the apartment and retail entries. The fountain will incorporate sculptures designed by McKenzie Thorpe that celebrate bicycling.

The sidewalks will vary from approximately 11 feet to 20 feet wide of scored concrete. Within the sidewalks, trees will be planted in pits with raised curbs.

Landscape and exterior lighting will be incorporated into the design in accordance with City of Madison standards.

d) Hardscapes and Landscapes Maintenance

It is anticipated that the maintenance of the Pinckney Street hardscape and landscape, as some non-standard design and materials and the fountain will require further discussion and agreement between the public and private entities, however the specifics of this at the schematic level cannot be defined well enough to address at this stage.

e) Accessibility

Accessibility will be provided for all pedestrians into, out of, and throughout the site.

Tactile warnings will occur at the edges of walks at flush pavings. All intersection corners will be constructed with Type 2A curb ramps and curb ramps will be used at all vehicular curb cuts.

Sidewalk slopes will not exceed 5% in the direction of travel and 2% cross slope.

Entries and floor levels of the ground floor will vary to meet the sidewalk elevations.

f) Fire Protection and Access

The new building will have fire department access on the north, south and east elevations. Existing fire hydrants are located at each of the site northeast and southeast intersections. These will be maintained as well located to serve the siamese connections located on the three street facing elevations of the building. All roadways and building structure beneath the streets will be designed for fire truck loading.

g) Utilities

As the parking structure for Block 88 will extend beneath Pinckney to past the middle of the right-of-way, significant utility work and reconstruction will be necessary in this street. These utilities include storm sewer, water main, sanitary sewer, and city owned electric (street lighting) and city owned fiber optic (traffic signals). There is also an existing telephone line (owner unknown) per the ALTA survey that would require relocation. Madison Gas & Electric (MG&E) has a live 2-inch gas line in Pinckney near the Wilson Street intersection that may require relocation. There is also a retired 6-inch gas main that has been abandoned in-place. MG &E has no electrical in Pinckney. There are no other known utilities in Pinckney Street. Charter has fiber communications facilities on the east side of Wilson Street. There are also many other utilities located in Doty Street and Wilson Street. MG&E can service the building from either Wilson or Doty Streets. Gas service from Wilson is preferred. MG&E prefers to service the project with electrical from the intersection of Doty & Pinckney.

h) Madison Planned Infrastructure Improvements

There are planned improvements, but solid dates have not been set. The planned improvements include repaving Wilson and Doty Streets, and upgrading the water mains looped around the isthmus. Sanitary and storm sewer are reviewed and considered for replacement when street reconstruction occurs.

3 Parking Design

The challenge of the below grade portion of the parking facility is to create a facility that is functionally and operationally excellent with an environment that is organizationally clear, sustainable, and user friendly with communication technology throughout.

a) Public Parking

The public parking garage is a City of Madison facility managed by the Parking Utility Department. It extends down to elevation +849.5 at Level U4 below the Wilson Street elevation of +900. The structure will be concrete pitched to drains with typical floor to floor heights varying from 9'-6" to 11'-6", it maintains a minimum 8'-2" clear structure height at all floors. Due to the 9-foot elevation difference between Doty and Wilson Streets, there is an additional partial level, U0, on the north half of the garage. Also at this level is a "mezzanine" at the south side to accommodate incoming utilities and utility distributions.

In addition to approximately 527 public parking spaces on four and one half levels, the garage houses spaces for 38 City vehicles on the second lower level, U2, twenty motorcycle spaces at the first lower partial level, U0, and thirty bicycle spaces at Level 2.

b) Typical Floors

Floors of the garage levels will be concrete with a urethane/epoxy waterproof traffic coating and painted striping. All ceilings, walls, and columns will be white stained or painted concrete.

Two lobbies will be provided on each floor at the north and south ends of the floor. Walls will be concrete masonry, painted with large areas of tempered glazing in powder coated aluminum framing and glazed self-closing painted hollow metal door. Floors will be ceramic tile and ceilings will be exposed construction, painted. Lobbies to be smoke protected per IBC requirements.

Each lobby will be serviced by two 4000 pound elevators which are stretcher capable per IBC code and have electronic graphic display wall panels. See elevator system description below.

Stairs will be cast-in-place or precast concrete with phosphorescent luminous abrasive nosing inserts and stainless steel wall mounted hand and center hand/guard rails. Stair doors will be painted hollow metal fire doors with 100 square inch rated glass panels. The north stair will be accessed through a one hour rated vestibule that on completion of the tower above and addition of the fire access elevators to this core, will serve as the fire access vestibule.

Garage ventilation will be provided through shafts in the four corners of the floor plate. Fan rooms will be located on level U0 and beneath level 1.

c) Customer Service Office

A central customer service office is located near the entrance at Wilson Street. The office is approximately 900 square feet, with room for a video monitor wall, two work stations, lockers, bathrooms and a kitchenette. The kitchenette will contain a refrigerator, microwave oven, kitchen style sink, counters and cabinets, and employee break table. There will be a transaction window with security glass & transaction tray. The office will be climate controlled as per ASHRAE standards.

Office floors will be vinyl tile. Ceilings will be suspended acoustical tile and slabs above and below will be insulated with mineral fiber insulation as per IECC requirements. Walls will be painted drywall interior and painted drywall over CMU at the perimeter, insulated.

d) Maintenance Workshop

A maintenance workshop will be located at the second lower level with the City fleet parking for Parking Utility maintenance staff. This will contain a work bench, slop sink and storage cabinets. Floors will be sealed hardened concrete. Ceilings will be exposed construction, painted. Walls will be painted drywall furring over CMU. Walls and slabs above and below will be insulated.

e) Parking Access and Revenue Control System (PARCS)

A parking access and revenue control system (PARCS) will be provided in the parking structure. We have assumed the following PARCS will be used at each of the entrance and exit locations:

<u>Level 1 Plan (Wilson Street):</u>

Entrance Lane Equipment:

- One parking gate
- Three detector loops
- One counter system
- One AVI card reader
- One entrance station (ticket dispenser)
- One lot full sign
- One intercom

Reversible Lane Equipment:

- Two parking gates
- Six detector loops

- Two counter systems
- Two AVI card readers
- One entrance station (ticket dispenser)
- One pay-in-lane machine (cash, credit, validations)
- One lot full sign
- Two intercoms

Exit Lane Equipment:

- One parking gate
- Three detector loops
- One counter system
- One AVI card reader
- One pay-in-lane machine (cash, credit, validations)
- One intercom

Wilson Street Elevator Lobby:

- Two pay-on-foot machines (cash, credit)
- One pay-on-foot machine (credit card only)

Level 2 Plan (Doty Street)

Top of Reversible Ramp:

- One parking gate
- Two detector loops

Bottom of Reversible Ramp

Reversible Lane Equipment:

- Two parking gates
- Six detector loops
- Two counter systems
- Two AVI card readers
- One entrance station (ticket dispenser)
- One pay-in-lane machine (cash, credit, validations)
- Two intercoms

Doty Street Elevator Lobby:

- Two pay-on-foot machines (cash, credit)
- One pay-on-foot machine (credit card only)

Level U2 Plan (City of Madison Parking)

Entrance Lane Equipment:

- One parking gate
- Three detector system
- One counter system
- One AVI card reader
- One intercom

Exit Lane Equipment:

- One parking gate
- Three detector loops
- One counter system
- One AVI card reader
- One intercom

f) City Vehicle Facilities

Sweeper Room to be provided 21′ wide x 16′8″ deep and 10′ wide x 8′-2″ high overhead door and a side door. Walls will be CMU with insulation and painted water resistant drywall sheathing on furring. Slabs will be insulated above and below. Floor will be concrete with traffic topping with floor drain.

g) Bicycle and Motorcycle Parking

Access and egress for motorcycles will be provided from Wilson Street. Twenty motorcycle spaces will be located at level U0. Provision for metered motorcycle parking shall be provided.
Bicycle access is provided from Doty Street at Level 2. There will be thirty temporary type bicycle spaces.

h) Parking Count Monitoring and Parking Guidance System

(i) The parking count monitoring system will utilize counters in the entrance and exit lanes that allow the Facility Management System (FMS) to track vehicles as they enter and exit the facility. In turn, a count panel on the FMS is updated with the number of available parking spaces. The system is used to control the "lot full" signs, which is located at the entrances to the facility. Similar counters will be installed at various points throughout the facility to allow parkers to observe the number of spaces available on a particular level or within a particular area. Parking space availability signage will be located at both the Wilson Street and Doty Street entrances to inform the customers of the number of available spaces.

i) Other

(i) Parking spaces are 9 ft by 18 ft at a 90-degree parking angle. Aisles are 24 ft wide with a 26 ft wide end aisle.
(ii) Clear overhead height will be 8′2″ clear at a minimum through any areas for accessible van parking and for City vehicle parking.
(iii) The slope on speed ramp will be 12 percent, with shallower slopes at the transitions at the end of the ramps.
(iv) Ten car and two van parking spaces will be signed and marked for use by vehicles with valid disabled plates or hangtags displayed.

(v) The 38 city fleet vehicles and eighteen additional spaces will have electric provisions, with capability to add more in the future. These provisions are rough-in only to facilitate future installation of charging stations.
(vi) Lighting will be dimmable LED.
(vii) Security cameras will be provided throughout facility, including all stairwells, elevator lobbies, elevator cabs and general parking areas as evaluated.
(viii) Repeaters to be installed for below-grade cell and city radio service to maintain service on all levels.
(ix) Parking bays will have keyed 1.5" water hose connections at every level.
(x) Keyed ¾" hose bibs and drains near stairwells shall be provided.
(xi) Stairwells should have electrical outlets with locks every second level. Electrical circuits shall allow these electrical outlets to be turned off separately from other electrical equipment and lighting.
(xii) Parking Utility fiber optic cable service to Government East garage shall be maintained through the duration of the project.
(xiii) A small wood bumper, 18" w x 12" h, or similar surface, will be provided at the end of each space to provide an area for staff to post No Parking signs to take spaces out of service.

j) Infrastructure and Utilities

Incoming utilities servicing both the City parking facility and the private development above are currently anticipated to enter primarily off Wilson Street at the first lower level. A mezzanine structure is planned to accommodate the M&G power vault, incoming water and fire pump, switch gear for the parking facility, and gas entrance.

k) Exterior Enclosure and Waterproofing Design

(i) There will likely be a combination of positive side and blindside waterproofing required due to conditions on site, overall constructability and the availability of access to and/or use of the public right-of-way.
(ii) The design solution will be a hybrid, that employs the use of sheet membrane and fluid applied membrane systems. System selection will be impacted by the overall waterproofing requirements, access to the construction for installation (for instance, there will be locations that are too confined for high-VOC applications), long-term performance expectations and ease of maintenance.
(iii) The waterproofing systems design will be continuous and comprehensive from sub-slab to grade.
(iv) System selections will be based on best practices; preference will be given to manufacturer's systems that are all inclusive to avoid overlapping systems.
(v) The design will include multiple redundancies, particularly at vulnerable details such as terminations, penetrations and transitions including all flexible and rigid flashings as well as construction and control joints.

(vi) Final design will be impacted by the depth of the excavation and unforeseeable conditions encountered on site.
(vii) All critical details will be flood tested prior to the installation of any overburden.

l) Wayfinding and Signage

Since there are reversible lanes on both Wilson Street and Doty Street, external signage and graphics will be provided to direct parkers to which entrance lanes are open and which are closed and used by exiting traffic only. Space availability signage will be located near the entrance lanes to let parkers know the number of available parking spaces.

Internal signage and graphics will be provided to direct parkers to spaces and to the elevators/stairs. Way-finding and floor designations will be provided to help users find their ultimate destination and recall their parking location.

m) Durability

Careful consideration should be given to the durability of the parking structure. The following elements will be included in the design to improve the durability of the structure:

- Provide positive drainage to prevent ponding of water. 1.5% slope for drainage with a minimum of 1%.

- Provide generous concrete cover. Top cover as recommended by ACI 362. IR-97 should be a minimum of 1.5" if a corrosion inhibitor or epoxy-coated rebar is used. The clear cover at the bottom of the slab should be a minimum of 1" as recommended by ACI 362. IR-97.
- Use a water cement ratio of 0.40 as recommended by ACI 362. IR-97.
- Provide air entrainment in the concrete of 7% ± 1 ½% to reduce effect of freeze-thaw cycles.
- Provide corrosion inhibiting admixture in the concrete.
- Provide epoxy coated rebar in the top and bottom reinforcement in the slabs.
- Provide 7-day moist curing of the concrete.
- Provide vehicular traffic membrane on all supported slabs in the parking structure.
- Provide annual maintenance of the structure.

n) Sustainability

In their commitment to sustainability, the City of Madison will develop the parking facility to meet a Parksmart Certification of Bronze level. Following is the Parksmart Certification "scorecard" with the targeted levels of achievement.

Elements of Parksmart Certification

Technology and Structure Design	Max Points	Points achievable
Idle Reduction Payment Systems	4	4
Fire Suppression Systems	2	2
No/Low VOC Coatings, Paints, Sealants	2	2
Tire Inflation Stations	2	0
EV Charging Stations	6	0
HVAC Systems - Occupied Spaces	6	5
Ventilation Systems - Parking Decks	6	4
Lighting Controls	8	7
Energy-efficient Lighting System	8	8
Stormwater Management	6	0
Rainwater Harvesting	4	0
Greywater Reuse	2	0
Indoor Water-efficiency	2	2
Water-efficient Landscaping	2	0
Roofing Systems	6	0
Renewable Energy Generation	12	0
Design for Durability	6	6
Energy Resiliency - Storage	4	0
Total Technology & Structure Design Points	**88**	**40**
Management	**Max Points**	**Points achievable**
Parking Pricing	6	6
Shared Parking	6	0
TMO/TMA	4	0
Recycling Program	4	3
Sustainable Purchasing Program	2	2
Proactive Operational Maintenance	6	6
Cleaning Procedures - Occupied Spaces	2	0
Cleaning Procedures - Parking Decks	6	3
Building Systems Commissioning	8	6
Construction Waste Management	6	4
Regional Materials	6	6
Regional Labor	4	1
Reused/Repurposed/Recycled Materials	6	6
Third Party Sustainability Certification	12	0
Credentialed Management	4	0
Life-cycle Assessment	8	8
Total Management Points	**90**	**51**

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Programs	Max Points	Points achievable
Placemaking	6	1
Access to Mass Transit	4	0
Wayfinding Systems - External	4	1
Wayfinding Systems - Internal	4	2
Traffic Flow Plan	4	4
Carshare Program	6	0
Rideshare Program	6	2
Low-emitting and Fuel-efficient Vehicles	4	2
Alternative Fuel Vehicles	6	0
Alternative Fuel Fleet Vehicles	4	2
Bicycle Parking	6	4
Bicycle Sharing/Rental	6	4
Marketing/Educational Program	4	0
Total Programs Points	**64**	**20**
Innovation	**Max Points**	**Points achievable**
Innovative Approach	6	0
Total Innovation Points	**6**	**0**
Total Parksmart Points	**248**	**111**
Parksmart Award Levels / Existing Facilities		
Certification level	Points	
Parksmart Pioneer	90+	
Required minimums in Management, Programs and Technology & Structure Design categories: 15 in each category		
Parksmart Award Levels / New Construction		
Certification level	Points	
Parksmart Bronze	110 - 134	111
Parksmart Silver	135 - 159	
Parksmart Gold	160+	

4 Structural Description

a) Foundations

The foundations will consist of reinforced concrete spread footings approximately 5 stories below grade. Due to the dense granular soils at this depth, a very high maximum allowable bearing pressure of 30ksf has been proposed by the geotechnical engineer, CGC, in their 2010 reports, and will thus allow for reasonably sized footings, approximately 11'x11'. A concrete slab-on-grade above a permanent under-slab drainage system will form the lowest level of the parking garage structure. The perimeter reinforced concrete foundation walls will resist the horizontal pressures from the subgrade soils and water.

A temporary earth retention system will be required to facilitate construction of the underground parking levels. ERS is envisioned to consist of a conventional system utilizing soil nail tiebacks with a reinforced shotcrete wall.

b) Parking Structure

Floor framing to consist of reinforced concrete slabs, beams, and columns. The garage layout consists of 3 rows of parking, with the east row ramping between levels. Typical column spacing is 30'-0". Slabs will be 8" thick with 6" thick drop panels, for a total structure thickness of 14". Slabs are pitched top and bottom to drains.

Entry and exit ramps utilize the west bay of parking and will generally be supported by the same slab and column layout. Where ramps divide the main bay, additional beams will be utilized.

The east bay of the parking garage extends below Pinckney Street. The roof level of this area will support the subgrade, paving, and live loads of Pinckney Street. A 2'-0" thick structural slab will be used to support the heavy loading.

c) Above Grade Structure

A reinforced concrete apartment tower and parking / retail podium will be placed above the underground parking structure by a future development. The podium structure will continue the lower level structural framing systems and column layout upward. The columns, walls, and elevators will also extend vertically from the garage levels into the apartment tower levels to the greatest extent possible. Due to the curved outline of the apartment floor plan, some of the tower columns will need to transfer above the parking floors. This will be accomplished with reinforced concrete transfer beams. Post-tensioned reinforcement could be utilized to reduce the required depth of transfers. Transfer columns will be placed along the E-W grids of the garage columns such that columns only need to transfer in one plan direction. The typical residential tower floor system is envisioned to be 8" post-tensioned concrete slabs. To provide flexibility of column locations within the residential floor plans, a post-tensioned transfer slab is

envisioned above the residential parking structure. This slab is envisioned to be 3 feet thick depending upon final column locations.

Construction sequencing may dictate that the level 1 slab which would act as the roof over the parking garage would need to be designed to support heavy loading for trucks and material storage or shoring support of the floors above.

d) Materials

See attached Structural Design Criteria.

e) Code

See attached Structural Design Criteria.

5 Mechanical

The following summarizes the mechanical systems anticipated to serve the public parking facility. Please refer to the Engineering Basis of Design for additional detail, systems criteria and for descriptions of systems anticipated to serve the private development portion of the building.

a) HVAC

(i) Garage occupied spaces (offices) will be heated, cooled and ventilated with a packaged single zone system. Direct expansion cooling, and either gas heat or heat pump heat connected to the main building condenser water loop. A packaged ventilation heat recovery ventilator will provide ventilation air to the occupied garage support spaces.
(ii) Ductwork will be constructed in accordance with SMACNA Standards for appropriate pressure class. Ductwork will be sealed to meet SMACNA Seal Class A as a minimum and to limit ductwork leakage not exceeding 1% of the design flow rate for high pressure ductwork and 2% for low pressure ductwork.

b) Parking Ventilation

(i) Air intake will be accomplished by drawing air in through openings on the Wilson Street side, with supply fans delivering pressurized air down two corner supply shafts to each level. Air will be distributed throughout the parking structure with ductwork or impulse transfer fans and be exhausted in each corner of each level on the Doty Street side. Impulse transfer fans or ducting will be used to provide air movement across each parking level. Approximately 200,000 cfm will be exhausted, split evenly at each corner. A vertical chase in each corner will exhaust the air to the exterior with grating at top of chase.
(ii) Supply and Exhaust fans will be mixed flow or vane axial type. Fans will be direct drive. Each fan will be furnished with backdraft damper. Fans will be controlled based on carbon monoxide and nitrogen dioxide sensor.

c) Generator Ventilation & Exhaust Systems

(i) Emergency generator exhaust system will consist of generator exhaust piping from the outlet of the generator engine exhaust muffler and extend either above the roof or through the west wall. Exhaust system will be designed per manufacturer's recommendations or within maximum backpressure of 27" WG.

(ii) Emergency generator ventilation system will provide air for engine makeup combustion and radiator cooling.

d) Pressurization of the Fire Access Stair

(i) Each stairwell requiring pressurization will be provided with a stairwell pressurization system. System will consist of one stair pressurization fan in each stairwell that will be controlled via the Fire/Life Safety System. Supply fan will deliver untempered 100% outside air at multiple locations in each stair enclosure.

e) Elevator Machine Rooms

(i) Elevator machine rooms will be provided with single fan coil unit, return/relief fans for economization as required, associated control dampers and ductwork to maintain required space temperatures depending on the room size and HVAC load.
(ii) Fan coil unit to include supply fan driven by electronically commutated motor, filters, and direct expansion cooling coil.

f) Stairwell Heating and Cooling

(i) Each stairwell in the residential tower having external glazing/exposure and access to the exterior for egress will be provided with cabinet unit heaters to provide heating to the space. If heat gain of the stairwell may cause temperatures in excess of 85°F, heating and cooling fan coil units will be utilized to provide heating and cooling to the space. Stairwells that only serve the public parking garage will not be heated.
(ii) Fan coil unit to include supply fan driven by electronically commutated motor, filters, and direct expansion cooling coil.

g) Technology Space Cooling

(i) Intermediate Distribution Framework (IDF) Rooms that require cooling will be provided with self-contained fan-coil units to maintain required space temperature and humidity
(ii) Fan coil unit to include supply fan driven by electronically commutated motor, filters, and direct expansion cooling coil.

6 Plumbing

The following summarizes the plumbing systems anticipated to serve the public parking facility. Please refer to the Engineering Basis of Design for additional detail, systems criteria and for descriptions of systems anticipated to serve the private development portion of the building.

a) Storm and Clearwater Drainage

A storm drainage system will be provided to convey rainwater from flat roofs and canopies to the existing site storm sewers.

(i) Secondary roof drainage will be accomplished by using a dedicated piped overflow drainage system separate from the primary storm drainage system which will discharge onto grade.
(ii) Clearwater waste from air handling units and other devices and equipment that discharge clearwater will be conveyed by gravity flow through a separate piping system and will connect to the building storm drain.
(iii) Storm and clearwater drainage systems which cannot discharge to the storm sewer by gravity flow will be drained by gravity to a sump with duplex pumps and will be pumped into the building storm drainage system. Sump pumps will be connected to the emergency (standby) power system to permit operation during a loss of normal power.

b) Sub-soil Drainage

Sub-soil drainage will convey groundwater from exterior, below-grade walls and lowest level floor slab to a sump. The effluent will be piped into the building storm drainage system. Design criteria for the subsoil drainage system will be defined by the Geotechnical Report.

c) Sanitary Waste and Vent

A sanitary waste and vent system will be provided for all plumbing fixtures and other devices that produce sanitary waste.

(i) Plumbing fixtures will be drained by gravity through conventional soil, waste and vent stacks, building drains and building sewers to the existing site sewer. All fixtures will have traps and will be vented through the roof. Vent terminals will be located away from air intakes, exhausts, doors, openable windows and parapet walls at distances required by the plumbing code.
(ii) Sanitary wastes which cannot discharge to the sewer by gravity flow will be drained by gravity to duplex sewage ejectors and will be pumped into the sanitary drainage system. Sewage ejectors will be connected to the emergency (standby) power system to permit operation during a loss of normal power
(iii) Sanitary waste drainage systems which are located in unconditioned spaces will be insulated and heat traced to prevent freezing. The exception to this will be the sanitary system that picks up the drains in the underground parking structure. This system will not be trapped or heat traced and will utilize garage catch basins at the base of each stack.

d) Domestic Water

A combined domestic water and fire service will be provided, connected to City of Madison water utility.

(i) Two service laterals (currently estimated at 8" each) will extend from the existing 16" water main below East Wilson Street. A butterfly valve will be installed in the existing water main, between the service laterals, to provide redundant paths of flow into the building.

(ii) Domestic water will be provided to all toilet room fixtures, sinks, hose bibs, and any other devices that require a domestic water supply.

(iii) Hot water at 120°F will be provided to all domestic fixtures and devices that require hot water. Hot water will be generated/stored using forced draft, natural gas condensing hot water heaters.

(iv) Domestic water systems that are routing through unconditioned spaces and service needs to be maintained year-round will be heat traced to prevent freezing.

e) Natural Gas

Natural gas will be piped to equipment as required to meet building needs. Gas pressure will be determined based on equipment requirements.

7 Fire Protection

The following summarizes the fire protection systems anticipated to serve the public parking facility. Please refer to the Engineering Basis of Design for additional detail, systems criteria and for descriptions of systems anticipated to serve the private development portion of the building.

a) A fire protection system will be installed to protect the new facility. The system will be fed from a minimum of 2 water mains either located in different streets, or from the same main provided that the main is valved such that an interruption can be isolated without interruption through at least 1 of the connections. The water mains will be connected to an electric motor-driven fire pump, which is used to supply the Class 1 automatic wet standpipe system. A combined standpipe will be used to supply wet pipe sprinkler systems throughout the facility. Where subject to temperatures below 40°F, a dry pipe sprinkler system will be used to protect the facility. Refer to Engineering Basis of Design document for additional detail including; design criteria, systems description, material and distribution.

8 Electrical

The following summarizes the electrical systems anticipated to serve the public parking facility. Please refer to the Engineering Basis of Design for additional detail,

systems criteria and for descriptions of systems anticipated to serve the private development portion of the building.

a) Normal Power Electrical Service
The facility will be fed from an electrical service from the serving utility company, MG&E. Dual 13.8 kV primary service feeder will be provided to an owner owned, MG&E controlled, vault located below grade along the East Wilson Street side of the building. The vault shall be adjacent to an outside wall to accept MG&E service. Vault construction and space planning shall comply with MG&E required standards. It is anticipated that the vault will be a network design which will contain (2) oil-filled transformers with switching components to serve the City of Madison parking structure and (2) oil-filled transformers with switching components to serve the private development above.
(i) The utility will provide a 480V secondary service from the networked vault to connect to the City of Madison service entrance switchboard located in the main electrical room of the City of Madison parking structure.
(ii) The utility will provide a second 480V secondary service from the networked vault to connect to the private development service entrance switchboard located in the main electrical room of the private development structure.
(iii) A third 480V secondary service, sized to accommodate locked rotor in-rush, will also come from the vault to feed the normal side of an electric driven fire pump ATS serving the fire protection system.
(iv) A fourth 208V secondary service from the networked vault to connect to the private development service entrance switchboard located in the main electrical room of the private development
(v) Except in the electrical room, fire pump room and outside the building, fire pump feeder shall be 2-hour rated.

b) Emergency/Standby Power System

Emergency power source for the facility will consist of an Emergency Power Supply (EPS) coupled to an Emergency Power Supply System (EPSS).

(i) The EPS will include a single natural gas operated engine generator to serve the City of Madison parking structure optional standby systems.
(ii) The EPS will also include a single diesel operated engine generator to serve the development emergency and legally required standby systems (Articles 700 and 701).
(iii) The emergency power system will be a Level 1 system per NFPA 110.
(iv) The emergency/standby power will be distributed to multiple automatic transfer switches segregated by system. Segregated systems are as described below:

System	Associated Loads
Emergency Systems	Egress Lighting

System	Associated Loads
NEC Article 700	Exit Signs
	Fire Alarm Detection and Annunciation Systems
	Elevator Cab Lighting
	Fire Pump / Jockey Pump
	Generator Set Accessories
Legally Required Standby Systems NEC Article 701	One Elevator per Elevator Bank
	Public Safety Communication System
	Ventilation systems where essential to maintain life, fire detection and alarm systems
	Mechanical smoke control equipment associated with the atrium exhaust and stair pressurization
	Building automation systems associated with control of required ventilation systems
	Sewage ejectors
	Sump pumps
Optional Standby Systems NEC Article 702	Access Control System
	Telecommunication System
	Building Automation System (BAS) and Accessories
	Select Mechanical Equipment
	Compressed air systems.
	Uninterruptable Power Systems
	Water Booster Pumps

c) Normal Power Distribution

The normal distribution system shall include all electrical distribution equipment from the serving utility service point to the branch distribution outlet device, not including those systems and devices as described in the following subsections.

(i) Secondary City of Madison parking structure service will be distributed to the switchboard unit via feeder conduit. The raceway will originate at the transformer and route into the City of Madison main electrical room, where it will feed directly into the top/bottom of the main circuit breaker sections.

(ii) Distribution to the distribution panelboards will consist of conduit and wire. Each distribution panelboard will be fed directly from the service entrance switchboard; feed-through distribution panelboards will not be used. This approach allows electrical isolation of each distribution panelboard without affecting loads served from other loads.

(iii) 480Y/277V distribution will be accomplished with conduit risers. Typical at each level: the riser will deliver power to a normal power lighting panelboard and a 480:208Y/120V distribution transformer.

(iv) Each 208Y/120V secondary distribution transformer will deliver power to a Distribution Panel. The Distribution Panel will deliver power to the branch circuit panelboards.

d) Emergency / Standby Power Distribution

(i) As required by Code, the feeders and branch circuit wiring to emergency loads (lighting, fire alarm, telecommunications, etc.) will be in dedicated raceway. Individual feeders will originate at the emergency distribution panel and will rise through the building to serve the emergency lighting panels. The emergency branch circuit panelboards will be served from the emergency lighting panels via the distribution transformer.
(ii) Individual standby equipment feeders will originate at the standby equipment switchboard and will rise through the building to serve the standby equipment distribution transformers. The transformers will serve 208Y/120V distribution panels which will in turn serve the individual standby equipment branch circuit panelboards.
(iii) Individual standby motor feeders will originate at the standby motor switchboard and will rise through the building to serve standby Distribution panelboards located in the exhaust fan rooms. Feeders to standby Distribution panelboards in basement areas will be routed through the ceiling spaces of the respective levels.

e) Grounding System

A complete low-impedance grounding electrode system will be provided for this facility.

(i) The grounding electrode system will include the main water service line, structural steel, Ufer ground, and ground ring around the perimeter of the building. The equipment grounding system will extend from the building service entrance equipment to the branch circuit. All grounding system connections will be made using irreversible compression connections.
(ii) Bonding jumpers will be provided as required across pipe connections to water meters, dielectric couplings in a metallic cold water system, and across expansion/deflection couplings in conduit and piping systems.
(iii) All feeders and branch circuits will be provided with an equipment ground conductor. Under no circumstances will the raceway system be used as an equipment grounding conductor.

f) Lighting

A complete lighting system for all indoor and outdoor illumination will be provided. The indoor lighting system will consist primarily of energy-efficient LED lighting fixtures. The outdoor lighting system will consist of LED fixtures.

(i) At a minimum, the lighting, including illuminance levels, shall meet standard design practices recommended by the Illuminating Engineering Society of North America (IESNA) as outlined in their recommended practice *Lighting for Parking Facilities*.

(ii) Horizontal illumination levels shall be measured at the floor and 30″ above floor level. Point-by-point photometric computer analyses will be conducted to verify proposed lighting layouts meet illumination criteria.

Normal Use Illuminance Criteria (fc)				
Garage Parking Vehicular Entries	Average Horizontal	Minimum Horizontal	Uniformity Horizontal Max/Min	Minimum Vertical[3]
Night	5-10	2.0	10:1	0.5
Parking/Ramps	3-5	1.0	10:1	0.5
Elevator Lobby	15-20	5.0		
Stairs	10-20	5.0		

g) Fire Alarm System

The fire alarm system will be a stand-alone, fully addressable system comprised of smoke detectors, heat detectors, duct detectors, manual pull stations, and audio/visual signaling devices.

(i) A main fire alarm control panel will be located at the fire command center.
(ii) A fire alarm annunciator panel will be mounted at the main building entrance.
(iii) Audio/visual devices will be installed in all areas of the building in accordance with the NFPA and the ADA Guidelines.
(iv) Smoke detectors shall be installed as required by the National Fire Protection Association, the Uniform Building Code, and the Uniform Fire Code. Smoke detectors will be installed in, but not limited to, the following locations: air handling units, elevator lobbies, elevator machine rooms, and electrical equipment rooms.
(v) Heat detectors will be installed in areas that are not feasible for smoke detectors.
(vi) Manual Pull Stations will be installed adjacent to all exit doors and in each elevator lobby.
(vii) The fire alarm system will be linked with the city central system.
(viii) The fire alarm system will be able to communicate with the existing fire alarm control.

9 Above Grade Development

a. Residential Program

Above grade, the project program consists of retail at levels 1 and 2, two levels of parking at floors 3 and 4 for the apartments, apartments at floors 5 through 13. Amenities for the apartments is also located on the fifth floor.

The typical residential floors have three two bedroom units, ten one bedroom units, and three studios. The total number of units is 155.

b. Exterior Enclosure

The exterior enclosure shall form a high quality, water tight, airtight and structurally sound system. Overall energy performance to minimally meet the requirements of the International Energy Conservation Code 2015.

The typical floor exterior wall will consist of unitized structurally glazed “hybrid” window wall panels, designed to span slab to slab, but integrally cover the slab edge with a glazed insulated spandrel section. Mullion framing will be a custom color aluminum with a two-coat fluoropolymer finish. The glass will be 1 1/16” thick insulating units with clear, low ‘E’ coating with 5/16” tinted outer lite, ½”

air space and ¼" inner lite with low E coating on the third surface. Spandrel glass to be matching insulating units with ceramic frit on the 4th surface. Operable awning type windows will be incorporated in the wall for natural ventilation.

At the apartment garage levels, the vision glass will be utilized with a silkscreen pattern to allow light in, but obscure the view of the cars from outside.

Performance requirements:
Air infiltration: not to exceed 0.06 cfm/sf at 6.24 psf per ASTM E283.
Water infiltration: no uncontrolled water entry at 12.0 psf per ASTM E331.
Thermal: CRF min 60 for framing per ASTM C236.
Structural: Max deflection 1/175 member span at full loading.
Wind load pressure: 40 lb/sf, 60 lb/sf at corner conditions.
Thermal movements: Accommodate a range of 120 degrees F ambient, 180 degrees F material surfaces.
Provide project testing for assemblies which have not been previously tested by manufacturer to specified criteria.

"Podium" cladding.
To relate the JDS Block 88 to the MMB, a limestone rainscreen system is proposed to wrap the north, west and south elevations at levels 1 and 2.

Storefronts
"Storefronts" will be aluminum curtainwall framing in fluorocarbon finish and glazing similar to the typical levels. Glass will be insulated vision and spandrels units to match typical levels. Provide safety glazing as required by applicable codes.

Entrance doors will be medium stile aluminum with insulating tempered glass. The residential lobby entry will be a glass revolving door.

Roof Screening

The two elevator overruns will be clad with spandrel glass. Mechanical equipment – fans and cooling towers will be screened from view with a decorative metal clad steel structure.
Roof

The roofing system for low-slope roof membrane areas will employ two-ply modified bitumen roof membrane systems over rigid polyisocyanurate insulation and a HD polyisocyanurate cover board membrane substrate. Structural slopes will be employed wherever possible with tapered insulation in all other areas. Overall "R" values will average 35 - 40.

The green roof at the upper roof level roof will be planter "tray" systems.

c. Cores

Two apartment building cores are located at the north and south quarter points of the tower plan. The northernmost core will contain the passenger elevators, an exit stair, and a lobby at each floor. This core also serves as the fire access core. At lobby level will be located the fire command center, an office and mail room.

The southernmost core is the service core which contains the service elevator, trash chute and exit stair. At the ground floor this core has a trash and recycling room and direct access to the loading dock.

Both cores contain make-up air distribution and closets for electrical distribution.

d. Amenities

Both indoor and outdoor amenity areas are to be located at the fifth floor level. The indoor amenities are approximately 3000 square feet and will contain a fitness room and a club room with kitchen area for hosting events with food. The club room will open onto the outdoor roof deck with gas grilles and outdoor seating.

e. Typical Apartment Units

Apartments will have engineered hardwood floors throughout except bedrooms, which will receive carpet and bathrooms, which receive ceramic or stone tile. Walls will be drywall, painted and ceilings will be drywall in bathrooms and painted veneer plaster elsewhere. Cabinetry will be flush overlay and countertops will be granite with tile backsplash. Window covering to be manual roll-down shades.

f. Retail
All retail spaces will be unfinished “shell” spaces for completion by tenant with rough-in power.

10 Appendices

Structural Design Criteria
MEP/FP Basis of Design
Vertical Transportation Report
Code Analysis

Judge Doyle Square Parking Garage

Structural Design Criteria

22 March 2017

Project Name: Judge Doyle Square Parking Garage

H+P Project Number: 1605877

Owner: Beitler Real Estate / City of Madison

Architect: Lothan Van Hook Destefano Architecture LLC

Geotechnical Engineer: CGC, Inc

MEP Engineer: Affiliated Engineers, Inc.

Parking Consultant: Walker Parking Consultants

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1.0 General Project Description

1.1 Site Location

The site is located on the west side of Pinckney Street between E. Doty Street and E. Wilson Street in Madison Wisconsin.

1.2 Proposed Construction

A reinforced concrete structure will extend 5 stories below grade and partially below Pinckney Street. A future development above the parking garage structure will extend 14 stories above grade, also of reinforced concrete.

2.0 Structural Description

Foundations

The foundations will consist of reinforced concrete spread footings approximately 5 stories below grade. Due to the dense granular soils at this depth, a very high maximum allowable bearing pressure of 30ksf has been proposed by the geotechnical engineer, CGC, in their 2010 reports, and will thus allow for reasonably sized footings, approximately 11'x11'. A concrete slab-on-grade above a permanent under-slab drainage system will form the lowest level of the parking garage structure. The perimeter reinforced concrete foundation walls will resist the horizontal pressures from the subgrade soils and water.

A temporary earth retention system will be required to facilitate construction of the underground parking levels. ERS is envisioned to consist of a conventional system utilizing soil nail tiebacks with a reinforced shotcrete wall.

Parking Structure

Floor framing to consist of reinforced concrete slabs, beams, and columns. The garage layout consists of 3 rows of parking, with the east row ramping between levels. Typical column spacing is 30'-0". Slabs will be 8" thick with 6" thick drop panels, for a total structure thickness of 14". Slabs are pitched top and bottom to drains.

Entry and exit ramps utilize the west bay of parking and will generally be supported by the same slab and column layout. Where ramps divide the main bay, additional beams will be utilized.

The east bay of the parking garage extends below Pinckney Street. The roof level of this area will support the subgrade, paving, and live loads of Pinckney Street. A 2'-0" thick structural slab will be used to support the heavy loading.

Above Grade Structure

A reinforced concrete apartment tower and parking / retail podium will be placed above the underground parking structure by a future development. The podium structure will continue the lower level structural framing systems and column layout upward. The columns, walls, and elevators will also extend vertically from the garage levels into the apartment tower levels to the greatest extent possible. Due to the curved outline of the apartment floor plan, some of the tower columns will need to transfer above the parking floors. This will be accomplished with reinforced concrete transfer beams. Post-

tensioned reinforcement could be utilized to reduce the required depth of transfers. Transfer columns will be placed along the E-W grids of the garage columns such that columns only need to transfer in one plan direction. The typical residential tower floor system is envisioned to be 8" post-tensioned concrete slabs. To provide flexibility of column locations within the residential floor plans, a post-tensioned transfer slab is envisioned above the residential parking structure. This slab is envisioned to be 3 feet thick depending upon final column locations.

Construction sequencing may dictate that the level 1 slab which would act as the roof over the parking garage would need to be designed to support heavy loading for trucks and material storage or shoring support of the floors above.

3.0 Structural Design Criteria

3.1 Design Standards and Codes

Building Codes:

- Wisconsin State Code, Latest Edition
- International Building Code, 2015
- ASCE 7-10

Structural Concrete Design:

- American Concrete Institute, Building Code Requirements for Structural Concrete ACI 318-11

Structural Steel Design:

- American Institute of Steel Construction, Specification for Structural Steel Buildings – Load and Resistance Factor Design Specification for Structural Buildings AISC 13th Edition, 2005

Welding:

- American Welding Society, Structural Welding Code - Steel (AWS D1.1-92)

Reinforced Masonry Design:

- American Concrete Institute, Building Code Requirements for Masonry Structures (ACI 530-92 / ASCE 5-92 / TMS 402-92) [Also refer to 2005 edition]

Seismic Design:

- International Building Code, 2015

3.2 Structural Materials

3.2.1 Concrete

Normal weight Reinforced Concrete (145 pcf) with 28-day min. compressive strengths as follows:

• Spread Footings	10000 psi
• Grade beams, Mats	6000 psi
• Foundation Walls	6000 psi
• Columns	8000 -10000 psi
• Core Walls and Link Beams	6000 psi
• Floor Slabs and beams	6000 psi

3.2.2 Reinforcement

- ASTM A615, Grade 60, reinforcing bars
- Epoxy coat reinforcing bars to ASTM A775 at all garage areas, and any exposed area
- ASTM A185, welded wire reinforcing
- Epoxy coat welded wire reinforcing to ASTM A884 at all garage areas, any exposed area
- ASTM A706, weldable reinforcing bars

3.2.3 Steel

- Wide Flanges, WT's: ASTM A992 (Fy = 50 KSI)
- Channels, Angles: ASTM A36 (Fy = 36 KSI)
- Misc. Plates: ASTM A36, unless noted otherwise
- Column Base Plates: ASTM A36 (Fy = 36 KSI)
- Continuity Plates: ASTM A992 (Fy = 50 KSI)
- Rectangular Tubes (HSS): ASTM A500, Grade C (Fy = 50 KSI)
- Round Tubes (HSS): ASTM A500, Grade C (Fy = 50 KSI)
- Round Pipes: ASTM A53, Type S, Grade B (Fy = 35 KSI)
- Anchor Bolts: ASTM F1554 Grade 36, unless noted otherwise.

3.2.4 Shear Studs/Connectors

- 0.75" diameter headed shear studs per ASTM A108 (lengths vary with slab thickness)

3.2.5 Welding

- AWS E70XX electrodes for shop welding
- AWS E7018 electrodes for field welding

3.2.6 Bolts, Nuts, and Washers

- ASTM A325; ASTM A490 where noted.
- 3/4" diameter minimum.

3.2.7 Structural Steel Fireproofing

- Spray-on or board cementitious fireproofing to meet code requirements.
- See Architectural drawings and specifications for additional requirements.

3.2.8 Masonry

- Normal weight CMU with f'm = 2,500psi, type S mortar.

3.3 Design Loads

3.3.1 General

- Occupancy/Risk Category II

3.3.2 Floor Loads

SDL = Superimposed Dead Load (in addition to self-weight of the structure)

LL = Live Load

Live Load Reductions taken in accordance with the International Building Code.

- Demising walls and partitions shall be of lightweight steel studs and drywall, except where indicated on the Architectural (Structural) Drawings.
- Weight of masonry partitions shall be in addition to the loads listed below where:
  8 inch CMU = 55 PSF (wall surface area)
- Glass Exterior Façade = 15 PSF (wall surface area)

	Occupancy	SDL (PSF)	LL (PSF)
1	Slab-On-Grade	---	250
2	Parking MEP Allowance – 5psf	5	50
3	Stair	---	100
4	Public / Retail Floor Finish – 5psf Partitions – 10psf MEP Allowance – 5psf	20	125
5	Mechanical MEP Allowance – 5psf Misc – 15psf	20	50 + equip. wt
6	Residential Floor Finish – 5psf Partitions – 10psf MEP Allowance – 5psf	20	40
7	Storage Floor Finish – 5psf MEP Allowance – 5psf	10	125
8	Loading Dock MEP Allowance – 5psf Misc – 50psf	55	250
9	Pinckney Street 9” Asphalt paving – 110psf 1’-0” concrete road base (150pcf) – 150psf 6’-0” soil – 720psf Geofoam (3pcf) – 15psf 4” concrete protection slab(150pcf) – 50psf Waterproofing– 5psf MEP Allowance – 5psf	1055	1000
12	Green Roof – Non Accessible 12” Omni Ecosystem –60psf MEP Allowance – 5psf Ceiling – 5psf	65	25 + DRIFT
13	Terrace Roof 2” paver – 25psf Waterproofing/Pedestals – 5psf MEP Allowance – 10psf Ceiling – 5psf	45	100

3.3.3 Wind Loads

IBC code minimum wind design loads shall be based on the following:

- Basic wind speed, V: 115 mph
- Building category: II
- Wind exposure category (typical): C
- Internal pressure coefficient, GCPI: 0.18

3.3.4 Seismic Loads

IBC code minimum seismic design loads shall be based on the following:

- Seismic importance factor, I_e: 1.0
- Seismic use group: II
- Mapped spectral response accelerations:
  - S_s: 0.084 g

S_I: 0.046 g
- Site class: C
- Spectral response coefficients: 0.01
- Seismic Design Category: A
- Basic Seismic-Force-Resisting System(s): Reinforced Concrete Shear Walls
- Seismic response coefficient: 0.01
- Design Base Shear: 980 KIPS
- Analysis procedure used: Equivalent Lateral Frame Method

3.3.5 Snow Loads

Code minimum snow loads based on the following:
- Ground snow load, Pg: 30 psf
- Flat-roof snow load, Pf: 21 psf
- Snow exposure factor, Ce: 0.9
- Snow load importance factor, Is: 1.0
- Thermal factor, Ct: 1.1

3.3.6 Ice Loads

- Per IBC 1614

3.3.7 Rain Loads

- Per IBC 1611

3.3.8 Temperature Effects

- Per Section 2.3.5 of ASCE 7

3.4 Strength Design

3.4.1 Load Cases

- D = Dead load
- E = Combined effect of horizontal and vertical earthquake induced forces
- F = Load due to fluid pressures
- H = Load due to lateral earth pressures, ground water pressure or pressure of bulk materials
- L = Live load, except roof live load, including any permitted live load reduction
- L_r = Roof live load including any permitted live load reduction
- R = Rain load
- S = Snow load
- T = Self-straining force arising from contraction or expansion resulting from temperature change, shrinkage, moisture change, creep in component materials, movement due to differential settlement or combinations thereof
- W = Load due to wind pressure

3.4.2 Load Combinations

- 1.4(D + F)
- 1.2(D + F + T) + 1.6(L + H) + 0.5(Lr or S or R)
- 1.2(D + F) + 1.6(Lr or S or R) +1.6H +(f1L or 0.5W)
- 1.2(D + F) + 1.0W + f1L + 1.6H + 0.5(Lr or S or R)
- 1.2(D + F) + 1.0E + f1L + 1.6H + f2S
- 0.9D + 1.0W + 1.6H

- 0.9(D + F) + 1.0E + 1.6H
  Where:
- f1=1.0 for Assembly areas with LL>100 and Parking Garages; 0.5 for other live loads
- f2=0.7 for non-shedding roofs; 0.2 for other roofs

3.5 Serviceability Design

3.5.1 Load Combinations

- D + F
- D + H + F + L + T
- D + H + F +(Lr or S or R)
- D + H + F + 0.75(L + T) + 0.75(Lr or S or R)
- D + H + F +(0.6W or 0.7E)
- D + H + F + 0.75(0.6W) + 0.75L + 0.75(Lr or S or R)
- D + H + F + 0.75(0.7E) + 0.75L + 0.75(Lr or S or R)
- 0.6D + 0.6W + H
- 0.6(D + F) + 0.7E + H

3.5.2 Floor Framing Deflections

- Deflections limited per IBC Table 1604.3

CONSTRUCTION	*L*	*S* or *W*[f]	*D* + *L*[d, g]
Roof members:[e]			
Supporting plaster or stucco ceiling	//360	//360	//240
Supporting nonplaster ceiling	//240	//240	//180
Not supporting ceiling	//180	//180	//120
Floor members	//360	—	//240
Exterior walls:			
With plaster or stucco finishes	—	//360	—
With other brittle finishes	—	//240	—
With flexible finishes	—	//120	—
Interior partitions:[b]			
With plaster or stucco finishes	//360	—	—
With other brittle finishes	//240	—	—
With flexible finishes	//120	—	—
Farm buildings	—	—	//180
Greenhouses	—	—	//120

3.5.3 Lateral Deflections

- For service level wind pressures, the overall drift of the building would be limited to H/400.
- For service level wind pressures, the inter-story drift would be limited to H/400.

3.6 Other Criteria

3.6.1 Corrosion Protection of concrete reinforcement

Minimum Requirements:

- All reinforcement to be epoxy coated
- All concrete to contain corrosion inhibitor admixture
- A slabs shall be sloped to drain at 1.5% to avoid ponding
- Waterproof traffic coating membrane shall be applied to top of all slabs
- Rebar cover per structural drawings
- Air entrainment in concrete of 7% ± 1½%
- Moist curing of concrete
- Provide annual maintenance of the structure.

Optional Durability enhancements:

- Waterproofing of the slab concrete could be achieved with a concrete admixture such as Xypex, to provide a very durable structure.

3.6.2 Fire Resistance

ACI 216.1-97

Table 2.1, utilizing Siliceous or Carbonate aggregate
Table 2.3, restrained concrete

CITY OF MADISON – JUDGE DOYLE SQUARE BLOCK 88 PARKING FACILITY

MEP BASIS OF DESIGN

PREPARED BY AFFILIATED ENGINEERS, INC.

MARCH 22, 2017

CITY OF MADISON – JUDGE DOYLE SQUARE
BLOCK 88 PARKING FACILITY

MEP BASIS OF DESIGN

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INTRODUCTION

Intent of Basis of Design

Definition of the Mechanical, Electrical, Piping, and Fire Protection systems early in the project is a fundamental element of project development. AEI accomplishes this through the development of a MEP Systems Basis of Design (BOD) document that establishes the base design criteria and systems descriptions for the project. The BOD is the engineering equivalent to the architectural program, and is developed during the Schematic Design phase. It is intended to be a "living" document and, therefore, will be updated at various stages of design to track and reflect changes in design decisions and project direction.

The BOD not only ensures technical goals are met. It establishes a framework from which scheduled milestones can be set, provides a basis for early estimation and budget control, sets direction for engineering space planning, guides the design team throughout the design process, and ultimately provides a basis for systems commissioning.

The process that AEI will utilize for the Judge Doyle Square City of Madison Parking Facility project will employ the following activities:

A. Development of design criteria based on established project goals such as budget, quality of systems, anticipated useful life, reliability, flexibility and future considerations.

B. Development of alternative system configurations that define common and innovative solutions.

C. Review and assessment of alternative system configurations taking into account the operation's staff resources and impacts on building efficiency.

D. Selection of systems that are consistent with project goals and project budget.

E. Documentation of the results in a published BOD.

Organization of Basis of Design

Technical information of the BOD is organized to address pertinent design criteria typically followed by the anticipated systems to be utilized.

END OF SECTION

MECHANICAL SYSTEMS

BASE DESIGN CRITERIA

Outdoor Design Conditions

		Dry Bulb Temperature (°F)	Wet Bulb Temperature (°F)
Summer	System Design[1]	89.6	74.2
	Coil Design[2]	85.9	76.8
	Dehumidification[3]	82.9	76.2
	Tower Design[4]	-	77.0
Winter	System Design[5]	-7.0	-

(1) Based on 0.4% Cooling DB/MCWB for MADISON/DANE County, WI as published in 2013 ASHRAE Fundamentals.

(2) Based on 0.4% Enthalpy MCDB/Enthalpy for MADISON/DANE County, WI as published in 2013 ASHRAE Fundamentals.

(3) Based on 0.4% Dehumidification MCDB/DP for MADISON/DANE County, WI as published in 2013 ASHRAE Fundamentals.

(4) Based on 0.4% Evaporation MCDB/WB for MADISON/DANE County, WI as published in 2013 ASHRAE Fundamentals.

(5) Based on 99.6% Heating DB for MADISON/DANE County, WI as published in 2013 ASHRAE Fundamentals.

System Design Conditions

System	Design Temperature [1] (°F)	Differential Temperature [1] (°F)
Condenser Water	85 reset to 70	14
Heating Hot Water	130	30
Preheat Hot Water	120	30
Perimeter Hot Water	130	20

(1) Refers to circulated fluid temperature unless otherwise indicated.

Terminal Device Design Conditions

System	Design Temperature [1] (°F)	Differential Temperature [1] (°F)
Preheat Coils	130	30
Reheat Coils	130	30
Perimeter/Misc. Heating	130	20
Humidifiers	240 (10 psig saturated)	N/A
Dedicated Outdoor Air Unit	62 to 65 (tempered air)	N/A
Zone Terminal Supply Air	55 reset to 65	N/A

(1) Refers to circulated fluid temperature unless otherwise indicated.

Indoor Design Conditions, Ventilation Rates and Pressure Relationships

Room	Temperature (°F) [2]		Humidity (%RH) [3]		Minimum Ventilation [4]	
	Min.	Max.	Min.	Max.	cfm/person	cfm/sf
Office, and Administrative Support Areas	**68**	**75**	**25**	**60**	5	0.06
Residential (Studio, 1Bedroom, and 2 Bedroom)	**68**	**75**	**25**	**60**	5	0.06
Residential Dryer (Studio, 1Bedroom, and 2 Bedroom)	**60**	**85**	**25**	**60**	-	**200**
Residential Kitchen (Studio, 1Bedroom, and 2 Bedroom)	**68**	**75**	**25**	**60**	**100/50 cfm variable/continuous**	
Residential Bathroom (Studio, 1Bedroom, and 2 Bedroom)	**68**	**75**	**25**	**60**	**50/25 cfm variable/continuous**	
Amenity	**68**	**75**	**25**	**60**	TBD	TBD
Retail	**68**	**75**	**25**	**60**	7.5	0.12

Room	Temperature (°F) (2)		Humidity (%RH) (3)		Minimum Ventilation (4)	
	Min.	Max.	Min.	Max.	cfm/person	cfm/sf
Janitor Closets	**65**	**80**	NR		75 cfm or 1 cfm/sf (whichever is greater)	
Toilet rooms	**65**	**80**	NR		75 cfm/unit	
Corridor	**65**	**80**	NR		-	0.06
Telecommunication Rooms	72 (year round)		Mechanical humidification not planned		NR	
Mechanical and Electrical Rooms	60 - 85°F Maximum		Mechanical humidification not planned		NR	
Elevator Machine Room	75 (year round)		Mechanical humidification not planned		NR	
Private Parking Garage	-	-	NR		0.05 cfm/ sq ft to 0.75 cfm/sq ft (Wisconsin Administrative Code COMM 64.0404.)	
Public Parking Garage	-	-	NR		0.05 cfm/ sq ft to 0.75 cfm/sq ft (Wisconsin Administrative Code COMM 64.0404.)	
Unoccupied Spaces	65	95	Mechanical humidification not planned		NR	

(1) Minimum – Winter Heating

Maximum – Summer Cooling.

NR – No requirement

N/A – Not applicable.

(2) Systems will be designed to meet the indicated temperature with a ± 2°F accuracy unless otherwise noted.

(3) Systems will be designed to meet the indicated relative humidity with a ± 5% accuracy unless otherwise noted.

(4) Based on Table 6-1 of ASHRAE 62.1 Standard 2013.

Assumed Heating and Cooling Loads

Internal Load Density					
Space	Lighting Density (W/sf) [(1)]	Equipment Density (W/sf) [(1)]	Occupant		
			Occupants per 1000sf [(2)]	Sensible BTUH [(3)]	Latent BTUH [(3)]
Offices, Conference, and Administrative Support Areas	1.0	1.0	5	250	200
Residential (Studio, 1Bedroom, and 2 Bedroom)	0.6	0.5	2 people for studio or 1-bed residence, +1 person per additional bedroom	250	200
Telecommunication Rooms	1.7	To be determined by actual equipment load	-	-	-
Mechanical and Electrical Rooms	0.95	0.2	-	-	-
Elevator Machine Room	-	To be determined by actual equipment load	-	-	-
Amenity	**TBD**	**TBD**	**TBD**	**TBD**	**TBD**
Retail	1.68	0.5	40	250	200
Corridor	0.7	-	-	-	-
Storage Rooms [<50 SF] [>50SF]	[1.2] [0.6]	-	-	-	-

(1) Actual load will be used where higher than the listed value.

(2) Occupant density in each space will be based on code adopted ASHRAE Standard 62.1-2013 or the actual occupant density listed in the facility program.

(3) The occupancy heat rejection will be based on ASHRAE Handbook of Fundamentals 2013.

Infiltration

The building heat loss calculations will include an infiltration load for building perimeter spaces.

Type	Airflow
Exterior Wall with Windows	0.11 cfm per square foot of wall
Exterior Walls without Windows	0.06 cfm per square foot of wall
Main Exterior Doors	200 cfm per door
Loading Dock Doors	5 cfm per square foot of door opening area

Building Envelope

Performance criteria for building envelope construction materials will be in accordance with the **data provided by Architect**.

	U-factor (BTUH/°F-ft^2)	Shading Co-efficient
Wall, Opaque Above Grade, Exposed soffits	0.05 (1)	-
Wall, Below Grade	0.03 (1)	-
Average Fixed Glazing with Mullion	0.35 (2)	0.34
Roofs	0.03 (1)	-
Skylights	0.35 (1)	0.30
Doors, Opaque	0.20	-
Curtain Wall (2)	0.17	0.34

(1) Based on **[XX% better than]** ASHRAE 90.1-2013, Climatic Zone #6a

(2) Based on ASHRAE RP-1365 showing 3-dimensional heat transfer effects of curtain wall assembly

Systems Diversity

In conjunction with the variable flow systems serving the building, an HVAC equipment sizing diversity will be applied to the design supply air quantities for sizing the primary heating, and cooling system equipment. Diversity factors will be based on expected use factors and maximum building population.

System	Type	Diversity Factor
Terminal Systems (zone heat pumps)	-	100%
Air Handling System	Occupant	85%
	Lighting	90%
	Equipment	85%
Condenser Water		
Preheat Water		
Perimeter Heat Water		

(1) Occupancy Density = **[XXX]** people

HVAC AND PROCESS PIPING SYSTEMS DESCRIPTIONS

This section includes general descriptions for HVAC and process piping systems. Refer to Pipe Distribution Criteria for more detail.

Humidification System

System Description

Refer to the Humidification System Flow Diagram on Sheet No. **[XXX]**.

Equipment and Components

Condenser Water System

System Description

Condenser water system with boilers for heat generation and cooling towers for heat rejection will serve zone heat pump units.

Condenser water system will be variable volume system utilizing a modulating 2-way control valve at each zone heat pump device. Distribution pumps will each be provided with VFD.

A differential pressure transmitter between the supply and return mains will be utilized to vary the speed of the pumps, via variable frequency drives, to maintain a constant pressure differential between the piping mains.

Equipment and Components

Hot water boilers will be condensing type with sealed combustion with natural gas burner. Heat rejection from the Condenser water system will be from the Cooling Towers.

Distribution pumps will be base mounted end suction centrifugal type with VFDs. Boiler pumps will be in-line type.

The condenser water system will also include the following components:

- Chemical pot feeder
- Air separator
- Bladder type expansion tank
- Make-up water assembly
- Zone heat pumps
- Appropriate valving and piping specialties

Preheat Water System

System Description

Preheat water system will serve preheating coils in the air handling units and will consist of hot water boilers, distribution pumps, distribution piping system and preheat coils in the air handling units.

Preheat water system will be variable volume system utilizing a modulating 2-way control valve at each preheat coil. Distribution pumps will be provided with variable frequency drives (VFD).

A differential pressure transmitter between the preheat water supply and return mains will be utilized to vary the speed of the pumps, via variable frequency drives, to maintain a constant pressure differential between the piping mains.

Each preheat coil will be served by a coil pump circuit which will maintain constant flow through the preheat coil. A modulating 2-way control valve will be provided at each preheat coil pump circuit to maintain the required water temperature in the pumped coil circuit.

The system will be filled with a treated propylene glycol/water solution with approximately 30% propylene glycol by volume to prevent freezing.

Refer to the Preheat Water System Flow Diagram on Sheet No. **[XXX]**.

Equipment and Components:

Hot water boiler will be condensing type with sealed combustion type with natural gas type burner.

Distribution pumps will be end suction centrifugal type with VFDs.

Coil pumps will be in-line type.

Preheat water system will also include the following components:

- 10% sidestream water filter
- Chemical pot feeder

- Air separator
- Bladder type expansion tank
- Make-up water assembly
- Air handling unit preheat coils
- Appropriate valving and piping specialties
- Glycol fill assembly

Sub-circuits will be selected for linear control characteristics of the terminal device and control valve combination. All major control valves will be sized by engineering calculations for linear control.

Perimeter Heating and Reheat Water System

System Description

Perimeter heating system will serve terminal heating devices, such as unit heaters, convectors, cabinet unit heaters, **[radiant ceiling panels] [fin tube radiation] [radiant slabs]**, etc. The reheat system will **[service reheat coils].**

Above system is two separate hot water distribution pumping systems, one for perimeter heating and one for reheat, with common heat exchangers. Edit above as required.

Perimeter heating and reheat water system will consist of hot water boilers, two perimeter heating distribution pumps, two reheat coil distribution pumps, two distribution piping systems.

Perimeter heating water will be distributed at supply temperature of 130°F.

Reheat coil water will be distributed at supply temperature of 130°F.

Perimeter heating and Reheat water system will be variable volume system utilizing a modulating 2-way control valve at each terminal device except selected devices such as unit heaters will cycle unit fans on and off with constant flow. Distribution pumps will each be provided with VFD.

A differential pressure transmitter between the hot water supply and return mains will be utilized to vary the speed of the pumps, via variable frequency drives, to maintain a constant pressure differential between the piping mains.

Refer to the Perimeter Heating and Reheat Water System Flow Diagram on Sheet No. **[XXX]**.

Equipment and Components

Hot water boiler(s) will be condensing type with sealed combustion type with natural gas burner(s).

Distribution pumps will be end suction centrifugal type with VFDs.

The perimeter heating and reheat water system will also include the following components:

- 10% sidestream water filter
- Chemical pot feeder
- Air separator

- Bladder type expansion tank
- Make-up water assembly
- Reheat coils
- Convectors
- Fin tube radiation
- Unit heaters
- Cabinet unit heaters
- Radiant ceiling panels
- Appropriate valving and piping specialties

Subcircuits will be selected for linear control characteristics of the terminal device and control valve combination.

Terminal devices will be sized for water temperature drop of approximately 20°F.

Cooling Tower System

System Description

Cooling tower will be multiple cells and will provide 100% of the design load.

The towers will be located on the building roof.

Equipment and Components

Tower will be induced draft cross-flow.

A base mounted end suction type pump will be provided for each chiller.

Chemical treatment system.

Electrical basin heater and electrical heating cable will be used for cooling tower early and late season operation.

Chemical Treatment Systems

System Description

Equipment and Components

Pipe Distribution Criteria

Piping Distribution Criteria			
System	**Material**	**Size Criteria**	**Pipe and Fitting Insulation**
Fuel System (Above ground)	Standard weight carbon steel piping with threaded fittings for pipes 2″ and smaller.	Maximum pressure drop of 5 ft. per 100 ft. of pipe	None
Humidification	[Hard pipe or flexible pipe depending on the distance between the units]. Piping will be carbon steel with threaded fittings for piping 2″ and smaller and with welded fittings for piping 2-1/2″ and larger.	For steam pressure equal to or less than 15 psig will be sized for a maximum pressure drop of 3/4 psi/100 feet of pipe and a maximum velocity of 6000 fpm.	Rigid glass fiber insulation with appropriate insulation jacket
Building Condenser Water	Type L copper piping with soldered fittings for pipes 2" and smaller and ST carbon steel piping with welded fittings for pipes 2-1/2" and larger. Grooved end steel piping and fittings are optional for connection to equipment only in lieu of welded fittings. Unions will not be provided at terminal heating devices in copper piping.	Maximum pressure drop of 4 ft of water/100 ft of pipe for piping 6″ or smaller. 10 fps maximum velocity for piping 8" and larger.	Rigid glass fiber insulation with appropriate insulation jacket
Preheat Water	Type L copper piping with soldered fittings for pipes 2" and smaller and ST carbon steel piping with welded fittings for pipes 2-1/2" and larger. Grooved end steel piping and fittings are optional for connection to equipment only in lieu of welded fittings.	Maximum pressure drop of 4 ft of water/100 ft of pipe for piping 6″ or smaller. 10 fps maximum velocity for piping 8" and larger.	Rigid glass fiber insulation with appropriate insulation jacket

Piping Distribution Criteria			
System	**Material**	**Size Criteria**	**Pipe and Fitting Insulation**
Perimeter Heat Water	Type L copper piping with soldered fittings for pipes 2" and smaller and ST carbon steel piping with welded fittings for pipes 2-1/2" and larger. Grooved end steel piping and fittings are optional for connection to equipment only in lieu of welded fittings. Unions will not be provided at terminal heating devices in copper piping.	Maximum pressure drop of 4 ft of water/100 ft of pipe for piping 6" or smaller. 10 fps maximum velocity for piping 8" and larger.	Rigid glass fiber insulation with appropriate insulation jacket
Cooling Tower Condenser Water	Type L copper piping with soldered fittings for pipes 2" and smaller and ST carbon steel piping with welded fittings for pipes 2-1/2" and larger. Grooved end steel piping and fittings are optional in mechanical rooms in lieu of welded fittings.	Maximum pressure drop of 4 ft of water/100 ft of pipe for piping 6" or smaller. 10 fps maximum velocity for piping 8" and larger.	None

HVAC AIR SYSTEMS DESCRIPTIONS

This section includes general descriptions for HVAC air systems. Refer to Duct Distribution Criteria for more detail.

Air Handling Systems

System Description

Factory packaged dedicated outside air units will serve the residential spaces, corridors and amenity area. The system will be a single duct variable volume system with an enthalpy wheel, heating, cooling and humidification control. Tempered ventilation air will be delivered to each zone and mixed with supply air from the zone conditioning devices. Exhaust air will pass through a total energy recovery wheel to provide reheat for the dedicated outside air units. The ventilation air handling system will operate 24 hours per day, seven days per week.

Heat pumps within the units connected to the main building condenser water loop will provide mechanical heating and cooling for the space conditioning. Air will be supplied to all appropriate spaces with a portion of this air either relieved to outside via the DOAS relief fan or exhausted by the exhaust systems.

Equipment and Components

Dedicated outside air units will include the following equipment and components:

- Outside Air Intake Damper
- Total Energy Recover Wheel
- Preheating Coils
- DX Cooling Coils
- Multi-fan Array Supply Fan
- 1:1 Fan to VFD Ratio
- Duct Mounted Sound Attenuator
- MERV 8 2" Prefilters
- MERV 14 Cartridge Final Filters
- Electronic Air Flow Measuring Stations
- Multi-fan Array Return Fan
- Isolation Smoke Dampers
- Relief Air Damper

Supply fans will be plenum type with airfoil blades. Fan speed and air volume will be modulated through variable frequency drives (VFDs) controlled by supply duct static pressure controller.

Return fans will be plenum type with air foil blades. Fan speed and air volume will be modulated through VFDs controlled by return fan discharge static pressure controller.

Design Criteria

Air Handling Unit Maximum allowable nominal face velocities at Maximum airflow	
Air Intake Louvers	400 fpm through free area of louver
Intake Hoods	400 fpm through free area of louver
Relief Hoods	400 fpm through free area of louver
Hot Water Heating Coils	650 fpm
Energy Recovery Wheel	400 fpm
Pre-filters	400 fpm
Final-filters	400 fpm
Sound Attenuating Devices	Located in AHU: 500 fpm Located in ductwork: Maximum 1,200 fpm or maximum 0.25" w.g.

Air Terminal Devices

Individual residential spaces will be served by one common water source heat pump with ducted supply air. Each residential space will have a single thermostat controller.

Amenity, commercial and retail spaces will be served by water source heat pumps with ducted supply air. Individual spaces, with up to three spaces having a common exterior exposure or a common interior space, and common occupancy, will be served by one heat pump. A single heat pump will be provided where individual space temperature control is required.

Garage occupied spaces (offices) will be heated, cooled and ventilated with a packaged single zone system. Direct expansion cooling, and either gas heat or heat pump heat connected to the main building condenser water loop. A packaged ventilation heat recovery ventilator will provide ventilation air to the occupied garage support spaces.

General Exhaust Systems

System Description

General/Sanitary

General exhaust will be ducted to the energy recovery device coupled with the main building DOAS units. The system will service toilet rooms, janitor's closets, locker rooms, service sink closets, soiled workroom/utility rooms, etc. System will consist of multiple exhaust fans that will be controlled via occupied/unoccupied control. System will consist of exhaust fans connected to a common exhaust fan inlet plenum and will be located on the roof.

Dryer

Dryer exhaust will be exhausted separate from the general exhaust system with direct vertical shafts to the roof level. System will consist of variable flow, constant pressure exhaust fans connected to a common exhaust fan inlet plenum and will be located on the roof. The dyer exhaust will use a sensible energy recovery device coupled with the main building DOAS units.

Kitchen

Kitchen exhaust hoods. **[Ducted hoods] [recirculating hoods**]. **TBD**

Equipment and Components

Exhaust Components	Dryer	General/Sanitary	Kitchen
DWDI centrifugal fan(s)	X	X	X

Exhaust Components	Dryer	General/Sanitary	Kitchen
Roof mounted upblast centrifugal fan			
Inline exhaust fans			
Automatic damper		X	

Life Safety Air Handling Systems

System Description

Stairwell Pressurization System

Each stairwell requiring pressurization will be provided with a stairwell pressurization system. System will consist of one stair pressurization fan in each stairwell that will be controlled via the Fire/Life Safety System. Supply fan will deliver untempered 100% outside air at multiple locations in each stair enclosure.

Supply fan will have a variable frequency drive and barometric relief damper/hood at the top of the stair to maintain stairwell pressure as doors open and close.

Ductwork will be galvanized steel sheet per SMACNA standards for 2" WG pressure class.

[Code COMM 62.0513] [IBC 909].

Fan will provide a minimum pressurization of 0.15" WG and maximum 0.35" WG in the stair shaft with all stairway doors closed.

Enclosed Parking Garage Ventilation System

Below Ground System Description

Air intake will be accomplished by drawing air in through area well openings on the North West side, with supply fans delivering pressurized air down two corner supply shafts to each level. Air will be distributed throughout the parking structure with ductwork or impulse transfer fans and be exhausted at roof level and on the Wilson Street side. Impulse transfer fans or ducting will be used to provide air movement across each parking level. 200,000 cfm will be exhausted, split evenly at each corner. A vertical chase in each corner will exhaust the air to exterior louvers.

Above Ground Private System Description

Air intake will be accomplished by drawing air in through supply louvers on South Pinkney Street. Air will be drawn across the parking structure with impulse transfer fans and two ducted exhaust fan systems. The fans will located on the 3rd floor parking level will exhaust a total of 60,000 CFM through two louvers to the exterior of the North West side.

Equipment and Components

Supply and Exhaust fans will be mixed flow or vane axial type. Fans will be direct drive. Each fan will be furnished with backdraft damper. Fans will be controlled based on carbon monoxide and nitrogen dioxide sensor.

Design Criteria

Design will be per Wisconsin Administrative Code COMM 64.0404.

Parking Level Exhaust Calculations

- Total parking area is 240,000 sq ft.
- At 0.75 cfm/sq ft exhaust rate per Wisconsin Code, the total exhaust rate for all levels is 200,000 cfm,
- At 0.05 cfm/ sq ft exhaust rate per Wisconsin Code minimum the total exhaust rate for all levels is 15,000 cfm

Generator Exhaust System

System Description

System will consist of generator exhaust piping from the outlet of the generator engine exhaust muffler and extend above the roof or horizontally from the West façade, at a suitable location clear of air intakes.

Design Criteria

Exhaust system will be designed per manufacturer's recommendations or within maximum backpressure of 27" WG.

Generator Ventilation System

System Description

Emergency Generator ventilation system will provide air for engine makeup combustion and radiator cooling.

Equipment and Components

The ventilation system will consist of the following components:

Outside air hood

Outside air intake dampers

Outside air sound attenuators

Exhaust air acoustic louvers

Exhaust air dampers

Discharge air sound attenuators

Supply Fan

Exhaust Fan

Preheat coil

Run around loop

Design Criteria

Air Handling Unit Maximum allowable nominal face velocities or pressure drop	
Air Intake Louvers	350 fpm through free area of louver
Exhaust Louvers	400 fpm through free area of louver
Outside air sound attenuating device (SAD)	400 fpm
Exhaust air sound attenuating device (SAD)	400 fpm

Ductwork Systems

Ductwork will be constructed in accordance with SMACNA Standards for appropriate pressure class. Ductwork will be sealed to meet SMACNA Seal Class A as a minimum and to limit ductwork leakage not exceeding 1% of the design flow rate for high pressure ductwork and 2% for low pressure ductwork.

Duct System Distribution Criteria based on diversified CFM where applicable.

Supply and Return/Exhaust System with Air Terminals

Description	Construction	Design Criteria	Insulation
Shaft	Galvanized Steel +6" Pressure class	(1)	Fiberglass insulation
Air Handling Unit to Air terminal (AT) Device	Galvanized Steel +2"Pressure class	(1)	Fiberglass insulation
Zone Terminal Device to Supply Diffuser	Galvanized Steel +2" Pressure class Ductwork will be lined for 5 ft downstream of air terminal devices	(2)	Fiberglass insulation
Return/Exhaust Ductwork Sizing	Galvanized Steel (-2)" Pressure class	(2)	None
Return/Exhaust Grille to AT	Galvanized Steel (-2)" Pressure class	(2)	None

Description	Construction	Design Criteria	Insulation
Return/Exhaust Air Terminal (AT) Device to fan	Galvanized Steel (-2)" Pressure class	(1)	None

(1) Maximum pressure drop of 0.15"/100 ft when ⩽10,000 cfm

Maximum velocity of 2,000 fpm when > 10,000 cfm

Maximum velocity of 2,500 fpm when > 10,000 cfm in mechanical room, risers in shafts, and where space constraints dictate quantity of fans dependent on size of unit. Utilize economies of scale to select the appropriate number of fans for each individual unit.

(2) Maximum pressure drop of 0.1"/100 ft when ⩽8,000 cfm

Maximum velocity of 1,600 fpm when > 8,000 cfm

Supply and Return/Exhaust System without Air Terminals

System	Construction	Design Criteria	Insulation
Return/Exhaust Ductwork Sizing	Galvanized Steel ±2" Pressure class	(2)	None

(1) Maximum pressure drop of 0.1"/100 ft when ⩽8,000 cfm

Maximum velocity of 1,600 fpm when > 8,000 cfm

Generator Exhaust

Piping system will utilize welded carbon steel piping with stainless steel bellows type expansion joints.

Piping and muffler will be insulated with 4" hydrous calcium silicate and aluminum jacket.

Generator exhaust system will extend from the outlet of the generator engine exhaust muffler to a minimum of 10 feet above the roof **[grade]**.

Estimated diameter of exhaust piping is **[XXX]** inches.

Generator Ventilation

Duct sizing criteria of outside air ductwork, radiator exhaust air ductwork, outside air dampers, radiator exhaust air dampers, outside air SAD and radiator exhaust air SAD will be sized not to exceed 0.5" WG static pressure.

2" pressure class galvanized steel ductwork will be utilized for all ductwork. Outside air ductwork will be externally insulated with fiberglass insulation.

Sound attenuation will be specified in accordance with recommendations by Owner's acoustic consultant.

Miscellaneous Systems

Elevator Machine Rooms

Elevator machine rooms will be provided with single fan coil unit, return/relief fans for economization

as required, associated control dampers and ductwork to maintain required space temperatures depending on the room size and HVAC load.

Fan coil unit to include supply fan driven by electronically commutated motor, filters, and direct expansion cooling coil.

Stairwell Heating and Cooling

In accordance with guidance from the City of Madison , no heating or cooling will be provided to the garage stairwells.

Technology Space Cooling

Intermediate Distribution Framework (IDF) Rooms that require cooling will be provided with self-contained fan-coil units to maintain required space temperature and humidity

Fan coil unit to include supply fan driven by electronically commutated motor, filters, and direct expansion cooling coil.

Snowmelt System

Radiant heating will be provided to the parking garage entrance ramps to prevent snow and ice from forming on concrete and access paths to the facility.

END OF SECTION

ELECTRICAL SYSTEMS

BASE DESIGN CRITERIA

Design Voltages

Type	Voltage
Building Service	13.8kV, 3 phase, 3 wire + ground
Motors; ½ HP and larger	480V, 3 phase, 3 wire
Motors; less than ½ HP	120 or 208 Volts, 1 phase, 2 wire + ground
Lighting	277 Volts, 1 phase, 2 wire + ground
Specific Equipment	480 Volts, 3 phase, 3 wire + ground
Receptacles	120V, 1 phase, 2 wire + ground

Equipment Sizing Criteria

Branch Circuit Sizing Criteria

Type	Load
Lighting	Actual Installed VA
Receptacles	180 VA per outlet (duplex or single)
Multiple Outlet Assemblies	180 VA per 2'
Special Outlets	Actual Installed VA of Equipment Served
Motors	125% of Motor VA
Special Equipment	Actual Installed VA

Diversity Factor

Diversity factors will be used in establishing power service, feeder and equipment capacities. The diversity factor represents the ratio of the sum of the individual non-coincident maximum demands of various subdivisions of the system to the maximum demand of the complete system and will be established using historical data from similar buildings in conjunction with industry standards.

Long Continuous Load/Demand Factors Criteria

Type	LCL Factor
Lighting (Continuous Loads)	125% of installed VA
General Receptacles	100% of first 10 kVA installed plus 50% of remainder
Motors	125% of VA of largest motor plus 100% of VA of all other motors

Type	LCL Factor
Fixed Equipment	100% of total installed VA

SYSTEMS DESCRIPTIONS

Electrical Service

System Description

The facility will be fed from and electrical service from the serving utility company, MG&E. Dual 13.8 kV primary service feeder will be provided to an owner owned, MG&E controlled, vault located below grade along the East Wilson Street side of the building. The vault shall be adjacent to an outside wall to accept MG&E service. Vault construction and space planning shall comply with MG&E required standards. It is anticipated that the vault will be a network design which will contain (2) oil-filled transformers with switching components to serve the City of Madison parking structure and (2) oil-filled transformers with switching components to serve the private development above.

The utility will provide a 480V secondary service from the networked vault to connect to the City of Madison service entrance switchboard located in the main electrical room of the City of Madison parking structure.

The utility will provide a second 480V secondary service from the networked vault to connect to the private developer service entrance switchboard located in the main electrical room of the private development parking structure.

The utility will provide a third 480V secondary service, sized to accommodate locked rotor in-rush, will also come from the vault to feed the normal side of an electric driven fire pump ATS serving the fire protection system. Except in the electrical room, fire pump room and outside the building, fire pump feeder shall be 2-hour rated.

The utility will provide a fourth 208V secondary service from the networked vault to connect to the private developer service entrance switchboard located in the main electrical room of the private development parking structure.

Design Criteria

The primary system service capacity will be designed to serve the calculated connected load of the facility plus an additional 25% for anticipated future loads.

Surge protection shall be provided at the main switchboard.

Switchboard distribution circuit breakers shall be fixed mounted circuit breakers with power metering and power quality monitoring and reporting capability.

Emergency/Standby Power System

System Description

Emergency power source for the facility will consist of an Emergency Power Supply (EPS) coupled to an Emergency Power Supply System (EPSS).

The EPS will include a single natural gas operated engine generator to serve the City of Madison parking structure optional standby systems (NEC Article 702).

The EPS will also include a single diesel operated engine generator to serve the development emergency and legally required standby systems (NEC Article 700 and 701).

The emergency power system will be a Level 1 system per NFPA 110.

The 480Y/277V, Emergency/Standby generator serving the City of Madison parking structure will be diesel engine driven. A belly tank installed below the generator enclosure will have adequate capacity to operate the generator at full load for at least 8 hours.

The emergency/standby power generator will be located in a dedicated room interior to the City of Madison parking ramp.

The emergency/standby power will be distributed to multiple automatic transfer switches segregated by system. Segregated systems are as described below:

System	Associated Loads
Emergency Systems NEC Article 700	Egress Lighting
	Exit Signs
	Fire Alarm Detection and Annunciation Systems
	Elevator Cab Lighting
	Fire Pump / Jockey Pump
	Generator Set Accessories
Legally Required Standby Systems NEC Article 701	One Elevator per Elevator Bank
	Public Safety Communication System
	Ventilation systems where essential to maintain life, fire detection and alarm systems
	Mechanical smoke control equipment associated with the atrium exhaust and stair pressurization
	Building automation systems associated with control of required ventilation systems
	Sewage ejectors
	Sump pumps
Optional Standby Systems NEC Article 702	Access Control System
	Telecommunication System
	Building Automation System (BAS) and Accessories
	Select Mechanical Equipment
	Compressed air systems.
	Select Chillers and Chilled Water Pumps
	Uninterruptable Power Systems

System	Associated Loads
	Water Booster Pumps
	Gate Arms and Ticketing Kiosks

Design Criteria

The capacity of the generator will be sufficient to serve the facility, with future capacity.

Electrical Distribution

System Description

Normal Power Distribution

The normal distribution system shall include all electrical distribution equipment from the serving utility service point to the branch distribution outlet device, not including those systems and devices as described in the following subsections.

City of Madison parking structure:

Secondary City of Madison parking structure service will be distributed to the switchboard unit via feeder conduit. The raceway will originate at the utility transformer and route into the City of Madison main electrical room, where it will feed directly into the top/bottom of the main circuit breaker sections. This feeder shall be concrete encased from the point exiting the utility vault until it enters the main switchboard.

Distribution to the distribution panelboards will consist of conduit and wire. Each distribution panelboard will be fed directly from the service entrance switchboard; feed-through distribution panelboards will not be used. This approach allows electrical isolation of each distribution panelboard without affecting loads served from other loads.

480Y/277V distribution will be accomplished with conduit risers. Typical at each level: the riser will deliver power to a normal power lighting panelboard and a 480:208Y/120V distribution transformer.

Each 208Y/120V secondary distribution transformer will deliver power to a Distribution Panel. The Distribution Panel will deliver power to the branch circuit panelboards.

Private Development:

Secondary Private Development service will be distributed to the switchboard unit via feeder conduit. The raceway will originate at the utility transformer and route into the Private Development main electrical room, where it will feed directly into the top/bottom of the main circuit breaker sections. This feeder shall be concrete encased from the point exiting the utility vault until it enters the main switchboard.

Distribution to the distribution panelboards will consist of conduit and wire. Each distribution panelboard will be fed directly from the service entrance switchboard; feed-through distribution panelboards will not be used. This approach allows electrical isolation of each distribution panelboard without affecting loads served from other loads.

480Y/277V distribution will be accomplished with conduit risers. Typical at each level: the riser will deliver power to a normal power lighting panelboard and a 480:208Y/120V distribution transformer.

Each 208Y/120V secondary distribution transformer will deliver power to a Distribution Panel. The Distribution Panel will deliver power to the branch circuit panelboards.

Emergency/Standby Power Distribution

As required by Code, the feeders and branch circuit wiring to emergency loads (lighting, fire alarm, telecommunications, etc.) will be in dedicated raceway. Individual feeders will originate at the emergency distribution panel and will rise through the building to serve the emergency lighting panels. The emergency branch circuit panelboards will be served from the emergency lighting panels via the distribution transformer.

Individual standby equipment feeders will originate at the standby equipment switchboard and will rise through the building to serve the standby equipment distribution transformers. The transformers will serve 208Y/120V distribution panels which will in turn serve the individual standby equipment branch circuit panelboards.

Individual standby motor feeders will originate at the standby motor switchboard and will rise through the building to serve standby Distribution panelboards located in the exhaust fan rooms. Feeders to standby Distribution panelboards in basement areas will be routed through the ceiling spaces of the respective levels.

Design Criteria

Building service and distribution equipment sizes will be based on estimated demand plus known or anticipated future loads.

Power distribution equipment will be sized to support 25% spare capacity (amperes) to accommodate functional changes over the life of the building.

Power distribution equipment will be sized to include 25% spare circuit breakers.

Power factor correction will be considered in the design of the power distribution system to bring the calculated power factor to 90% or better.

Provisions will be provided in the electrical distribution system to allow power factor correction equipment to be installed in the future should a low power factor develop after building occupancy.

Equipment and Components

Equipment	Description of Components
Metal Enclosed Low Voltage Switchgear	UL 891 construction Copper Bus Metal enclosed single-ended section(s) of front only accessible switchgear. Fixed mounted insulated case Circuit Breakers LSIG solid state trip units with Arc Flash Over-ride on main and feeder breakers.
Switchboards	UL 891 construction Front access NEMA 1 enclosure Copper Bus

Equipment	Description of Components
	Main Circuit Breaker Group mounted bolt-on feeder circuit breakers Electronic trip circuit breakers with field-adjustable and field-changeable trip units will be used for all circuit breakers 150 amps and greater and for smaller sizes if special circumstances exist. Circuit breakers 800 amps and greater will be UL listed for applications at 100% of their continuous ampere rating in their intended enclosure
Distribution Panelboards	UL 891 listed, Front access NEMA 1 enclosure switchboards Copper Bus Main Circuit Breaker Group-mount circuit breakers Electronic trip circuit breakers with field-adjustable and field-changeable trip units will be used for all circuit breakers 150 amps and greater and for smaller sizes if special circumstances exist.
Branch Panelboards	UL 67 listed 42 Pole, NEMA 1 enclosure, recessed and/or surface mounted Copper Bus Main Circuit Breaker Molded case with non-adjustable trip units to be used for all circuit breakers 150 amps and smaller All circuit breakers will be bolt-on style Panelboard covers will be hinged trim with door-in-door construction.
Apartment Panelboards	UL 67 listed 30 Pole, NEMA 1 enclosure, recessed mounted Copper Bus Main Circuit Breaker Molded case with non-adjustable trip units to be used for all circuit breakers All circuit breakers will be bolt-on style Panelboard covers will be hinged trim with door-in-door construction.
Distribution Transformers	480 Delta to 208Y/120 VAC, Wye, three-phase, four-wire; 3-coil, 2-winding type; 115°C rise above 40°C ambient Copper Winding K1 rated Neutral conductors for K-4 and higher units to be increased in size from the transformer to the first distribution panel and will be able to support 150% of the normal phase current.

Equipment	Description of Components
	Transformers will incorporate vibration isolation pads in their construction located between the core/coil assembly and the transformer case
Automatic Transfer Switches	Four pole Copper Bus 65kAIC rating Isolated Neutral Open Transition Transfer Controls: Solid State microprocessor Isolation Bypass: Maintenance Switch Bypass 3 cycle for use with molded case breakers short circuit rating

Grounding System

System Description

A complete low-impedance grounding electrode system will be provided for this facility. The grounding electrode system will include the main water service line, structural steel, Ufer ground, and ground ring around the perimeter of the building. The equipment grounding system will extend from the building service entrance equipment to the branch circuit. All grounding system connections will be made using irreversible compression connections.

Bonding jumpers will be provided as required across pipe connections to water meters, dielectric couplings in a metallic cold water system, and across expansion/deflection couplings in conduit and piping systems.

All feeders and branch circuits will be provided with an equipment ground conductor. Under no circumstances will the raceway system be used as an equipment grounding conductor.

Design Criteria

The grounding electrode system will be designed in accordance with NEC article 250.

System resistance to ground will be 5.0 ohms or less.

All conductors will be installed in steel conduit unless installed below grade or in concrete.

Equipment and Components

The reference ground for the equipment grounding system will be established from a structural ground grid as follows:

A No. 4/0 AWG bare copper ground wire will be installed at 30" below grade around the entire perimeter of the building. 3/4" x 10 ft driven copper ground rods (test wells) will be installed and connected to this ground loop at not-greater-than 200' intervals with a No. 4/0 AWG bare copper conductor. Steel columns in exterior walls will also be connected to this ground loop with 4/0 AWG bare copper at intervals not to exceed 60'. Interior steel columns will be connected to the exterior ground loop on each side of the building at intervals not to exceed 200' with a No. 4/0 AWG bare copper conductor.

A “Ufer” ground will be provided in the footing of the building consisting of 50’ of 500 kcmil wire located 3” from the bottom of the footing.

Wall-mounted copper ground bus will be located in the main electrical room, floor electrical rooms, and voice/data rooms. The main electrical room ground bus will be connected to exterior ground loop and “Ufer” ground.

Distribution

A separate, insulated 4/0 AWG ground wire will be provided from the main electrical room ground bus to each floor's electrical room ground buses, underground incoming water service line ahead of meter, and underground gas line at the building entrance.

The main service entrance neutral will be bonded to the system ground bar within the switchboard by a removable bus bar link.

A code-sized, unbroken bond leader will be connecting the electrical room ground bar to the XO terminal of the local transformers.

A No. 4/0 AWG, bare copper, grounding electrode conductor will be extended to all voice/data rooms, so that those systems can be properly bonded.

A separate ground wire will be provided for all circuits.

Lightning Protection System

System Description

A lightning protection system will be provided to protect structure and associated appurtenances as recommended in the Lightning Risk Assessment which will consist of a system of conductance designed to safely divert the energy of a lightning strike to the earth while minimizing damage to the facility.

Design Criteria

System will comply with NFPA 780 - Standard for the Installation of Lightning Protection Systems. The installer will be certified with the Lightning Protection Institute and the installing Contractor will provide a UL Master Label for the completed system.

Equipment and Components

Materials will be rated Class I for structure heights of 75’ or less. Class II for structure heights above 75’.

Air terminals will be solid copper with a tapered point, 10” minimum height, and have a mounting base suitable for the location.

Conductors will be bare-stranded copper, except aluminum will be used where installation is in contact with aluminum surfaces.

Ground rods will be copper-clad steel, 3/4” diameter by 10’ long, with a bronze mechanical-type conductor clamp.

Distribution

The system layout and design will encompass all exterior surfaces of the facilities under a complete zone of protection as defined by NFPA 780. Air terminal spacing will not exceed 20 ft, except spacing up to 50' is allowed for non-perimeter areas of flat roofs. Locations will comply with NFPA 780 and will generally follow the building roof ridges and/or perimeters.

One (1) down conductor will be provided for every 250 ft of building perimeter, with a minimum of two (2) conductors. Conductors will be configured to provide a two-way path to earth. Metal bodies will be bonded to the conductor system in accordance with NFPA 780.

A ground rod will be connected to each down conductor. The electric power service grounding system will be bonded to the Lightning Protection System.

Lighting Systems

System Description

A complete lighting system for all indoor and outdoor illumination will be provided. The indoor lighting system will consist primarily of energy-efficient LED lighting fixtures. The outdoor lighting system will consist of LED fixtures.

In general, indoor lighting controls will consist of low-voltage switches controlled by low-voltage lighting control system, room occupancy sensors, line voltage switches, centralized time clock and sentry switches. Outdoor lighting controls will utilize photocells and time switches with line voltage manual override switches.

Emergency/night lighting will be provided by unswitched branch circuits. These unswitched branch circuits will be fed from an emergency lighting panel. Exit signs and emergency egress lighting will be provided throughout the facility to illuminate egress corridors, stairwells, lobbies, etc. Exit and egress lighting circuits will originate from emergency system branch panels. Base design intent is that egress lighting circuits will be constant "on" with dimming control.

Illuminance Levels Design Criteria

Space	Average Maintained Footcandles
Corridor	15-20
Lobby	15-25
Toilets	15-20
Storage	10-30
Task	40
Open Parking	1-2
Covered Parking	1-2
Exterior Lighting	1-2

Equipment and Components

Space	Fixture Type
Common Area	Premium quality architectural LED lighting
Circulation	1' x 4',LED troffer with acrylic lens or wall-mounted LED sconces
Building Support	4', surface- or pendant-mounted, open industrial LED fixture; LED industrial fixture
Open Parking	LED parking lot fixture
Closed Parking	LED surface mounted fixture
Cold Rooms	Rated for intended applications
Wash Rooms and Wet Areas	UL Listed for a wet location

EXIT signs will be State Fire Marshal approved LED type, located in all paths of egress.

Lamps and Ballasts

LED lamps to be LM-79 and LM-80 tested, have two step MacAdam ellipse tolerance, and have a minimum CRI of 80 to be supplied with applicable drivers or power supplies.

Lighting Control

Photocells and occupancy sensors will be utilized in select spaces to minimize energy consumption. Occupancy sensors will be passive infrared or a combination infrared/ultrasonic type.

Dimmers will be provided as required. All corridor lighting, except life-safety branch lighting, will be controlled by a time clock.

A programmable, low-voltage control system will be provided. It will consist of low-voltage switching and relays and will control all lighting excluding mechanical, and janitorial spaces. The system will be software based and will provide flexible control of automatic and manual on/off, recording, and reporting functions.

Distribution

In general, LED lighting will be 277V and lighting control wiring will be low voltage.

All lighting circuit wiring will be in conduit and routed concealed within walls, partitions, or ceiling spaces. Surface-mounted conduit will be minimized and used only in non-finished spaces.

The ampacity of lighting circuits will be sized for 25% future growth plus 125% continuous loading factor per the National Electric Code.

Fire Alarm System

System Description

The fire alarm system will be a stand-alone, fully addressable system comprised of smoke detectors, heat detectors, duct detectors, manual pull stations, and audio/visual signaling devices.

Design Criteria

The fire alarm system will comply with requirements of NFPA 72 for a protected premises signaling system except as modified and supplemented by this document.

A main fire alarm control panel will be located at the fire command center.

A fire alarm annunciator panel will be mounted at the main building entrance.

Audio/visual devices will be installed in all areas of the building in accordance with the NFPA and the ADA Guidelines.

Smoke detectors shall be installed as required by the National Fire Protection Association, the Uniform Building Code, and the Uniform Fire Code. Smoke detectors will be installed in, but not limited to, the following locations: air handling units, elevator lobbies, elevator machine rooms, and electrical equipment rooms.

Heat detectors will be installed in areas that are not feasible for smoke detectors.

Manual Pull Stations will be installed adjacent to all exit doors and in each elevator lobby.

The fire alarm system will be linked with the city central system.

The fire alarm system will be able to communicate with the existing fire alarm control.

Equipment and Material

The fire alarm system will be an electronically multiplexed voice communication system.

Remote transponder panels will be used to provide supervised amplifiers and signal circuits for audio/visual devices and magnetic door holders.

The system will utilize individual, addressable photoelectric smoke detectors; heat detectors; addressable manual pull stations; and addressable monitor and control modules. The system will monitor all sprinkler supervisory and water flow switches and will interface with elevators, HVAC smoke control, and smoke fire dampers.

Distribution

All initiating and signaling devices will operate at 24VDC and will be installed in accordance with manufacturer's specifications.

All wiring will be installed in conduit. Minimum conduit size will be 3/4".

ELECTRICAL SYSTEM STANDARDS

Feeder and Branch Circuits

Secondary distribution and branch circuit system design will be based on a maximum of 5% voltage drop from the service transformer to the utilization equipment

Neutral conductors derived from harmonic mitigating transformers will be capable of carrying 100% of normal phase current from transformer to first distribution panelboard. Neutral conductors from distribution panelboard to downstream panelboard or device will not be increased in size

Feeder and branch circuit sizes will be based on the load supplied and adjusted for voltage drop.

Feeder and branch circuit ampacity will not be smaller than the upstream overcurrent device or downstream equipment bus.

Circuit Voltage Length	Wire Size
480Y/277 volt circuits over 150′ in length	Increase wire size one size for each 150′ of length
208Y/120 volt circuits over 60′ in length	Increase wire size one size for each 60′ of length

Receptacles

Receptacles in general support rooms and similar locations, (depending upon room layout) will be provided with a minimum of (4) outlets total or (1) outlet on each wall.

Common areas will be provided with at least (1) duplex receptacle per wall. Typically, receptacles to be spaced on 12′ centers.

Building Support (Equipment rooms, storage rooms) will be provided with (1) duplex receptacle per wall or (1) per every 150 square feet, whichever is greater

Duplex receptacles in lounges, lobbies, etc., shall be circuited with an average of (6) duplex receptacle's per 20A, single pole circuit.

Equipment such as commercial refrigerators or freezers shall be connected to dedicated circuits.

Ground fault protection will be provided for outlets within 6′ of a sink edge and other wet locations. Electrical outlets will be individually ground fault interrupted (GFCI) protected (not at the circuit breaker or first outlet on the circuit)

One duplex outlet will be provided in corridors on 50′ centers for cleaning equipment with an average of (6) duplex receptacle's per 20A, single pole circuit**.**

Overcurrent Protective Device Coordination

Overcurrent protective devices supporting Emergency NEC Article 700 (typically exit and egress lighting), Legally Required NEC Article 701) and NEC Article 695 (fire pump) systems will be selectively coordinated from source of supply (normal and emergency) through final device. Selectivity will be through the entire instantaneous region including ground fault.

Overcurrent protective devices supporting normal power systems and NEC 702 systems will be selectively coordinated with supply side overcurrent protection to the greatest extent possible given the material capabilities of breaker types selected with the exception of the instantaneous region devices in keeping with industry practice.

Overcurrent protective device will be selectively coordinated with supply side overcurrent protective devices as follows:

System	Seconds
Emergency System (NEC 700)	0.01
Legally Required System (NEC 701)	0.01
Optional Standby System (NEC 702)	0.10
Fire Pump	0.01

System	Seconds
Elevators	0.01
Normal Power System	0.10

Arc Flash

The electrical distribution system will be configured to allow equipment to be worked on energized using reasonable PPE (category 3 or less). Arc flash calculations for Arc Flash Incident Energy (AFIE) levels and flash protection boundary distances will be by the contractor based on the actual equipment supplied using an independent Registered Profession Engineer in the State of Wisconsin using SKM System Analysis tools.

Fault Current Ratings

Equipment will have ratings not less than the calculated symmetrical short circuit value at each point in the distribution system.

Equipment will be fully rated for the calculated available short circuit. Series ratings will not be allowed.

Short Circuit Ratings	
208Y/120V	**480Y/277V**
10 kAIC where fed via 75kVA and smaller transformers	14 kAIC where fed via 300 kVA and smaller transformers
22 KAIC where fed via 112.5 kVA transformer	30 kAIC where fed via 500 kVA transformer
22 KAIC where fed via 150 kVA transformer	35 kAIC where fed via 750 kVA transformer
42 KAIC where fed via 225 kVA transformer	42 kAIC where fed via 1000 kVA transformer
42 KAIC where fed via 300 kVA transformer	65 kAIC where fed via 1500 kVA transformer
65 KAIC where fed via 500 kVA transformer	100 kAIC where fed via 2000 kVA transformer
-	100 kAIC where fed via 2500 kVA transformer

Conduit and Raceway

Conduit Types and Application	
Conduit Type	**Application**
Electrical Metallic Tubing (EMT)	Low voltage feeders and branch circuit wiring where installed above 6'-6" AFF, when exposed in unfinished spaces.
Galvanized Rigid Steel (GRS)	Low voltage feeders and branch circuit wiring where exposed below 6'-6" AFF. Exterior locations, Under slab, Areas subject to physical abuse
Schedule 40 PVC	Concrete encased ductbanks and direct buried under slab

Conduit will be run concealed, unless installed in mechanical, electrical, telecom, interstitial areas and other similar unfinished spaces.

Minimum conduit size for power circuits will be 3/4".

Conduits will be independently supported.

All conduit stub-ups from below floor or in floor (where specifically allowed) will be galvanized rigid steel.

Surface mounted conduits below 6'-6" will be rigid galvanized steel with threaded fittings and boxes will be cast steel.

EMT fittings will be steel body.

EMT fittings used on conduit sizes 2-1/2" and smaller shall be compression type.

EMT fittings used on conduits larger than 2-1/2" may be set screw or compression type.

Conduits may be installed below floor slabs on grade.

Conduits and boxes will be installed a minimum of 1' and a maximum of 3' above ceilings. Installation outside of this zone will not be allowed. Special permission may be obtained to run ceiling conduits outside of this zone providing that pull and junction boxes are unobstructed and accessible from floor using a standard 8 foot ladder. Also, light fixtures, smoke detectors, junction and pull boxes and other equipment that is installed on or directly above the ceiling will be serviced and maintained without damage to ceiling tiles and other building elements.

Raceways for 2-hour rated systems shall be installed in either: UL listed assemblies for 2 hour fire rated applications or in 2-hour rated enclosures.

For lighting conduit homeruns, a j-box will be located above light fixture in an accessible location to allow for future expansion.

No home run will terminate in a wall mounted device box. A separate J-box will be provided above device box above ceiling in an accessible location.

Wire and Cable

Cable Types		
Voltage Class	**Insulation**	**Notes**
600 V	THWN-2 or XHHW-2	Conductors #10 and smaller will be solid copper. Conductors larger than #10 will be stranded copper

All feeder conductors to be 98% conductivity copper.

All branch wiring conductors will be 98% conductivity copper.

Minimum wire size #12 AWG, for all areas.

Multi-wire branch circuits will be provided with dedicated neutral conductors for each phase, common neutral circuits will not be permitted.

Feeder conductors will be terminated using compression lugs. Mechanical lugs will not be used for feeders. Branch circuit conductors will typically be terminated using mechanical lugs.

Conductor insulation color code will be as follows:

Conductor Color Code	
208Y/120V	**480Y/277V**
Phase A – Black	Phase A – Brown
Phase B – Red	Phase B – Orange
Phase C – Blue	Phase C – Yellow
Neutral – White	Neutral – Gray
Ground – Green	Ground – Green

Wiring Devices

Wiring devices will be specification grade, complete with all accessories

Isolated ground receptacles will be used only when necessary. If used, isolated grounds will be in addition to equipment ground. Panelboard will have an isolated ground bus that will be connected back to applicable derived system or service.

Receptacle and Switch Color Code	
Normal Power	Selected by Architect
Emergency Power	Red

Receptacles, switches, etc., will have faceplates with labeling indicating system panel and circuit identification.

Motors and Motor Control

Stand-alone motor disconnects (separate from starter or VFD) will be fused and will be installed at each motor.

Motors smaller than 60 HP that are not provided with a variable frequency drive (VFD) will be provided with an across the line combination magnetic motor starter. Motors 60 HP and larger that are not provided with a variable frequency drive (VFD) will be provided with reduced voltage motor starter. Refer to other sections of the narrative for VFD requirements.

Combination motor starters will use circuit breakers or motor circuit protectors in lieu of fuses to reduce the possibility of single phasing. For mechanical and HVAC equipment that are not provided with a VFD, individual combination motor starters will be located within sight of the motor.

Selected motors will have variable frequency drives (VFDs) as described in other sections of this narrative.

VFD drive specifications will require that the VFDs for the project be provided such that the Special Category harmonic limits recommended in IEEE 519-1992 be maintained. The supplier of the drive will be required to perform harmonic analysis as defined in IEEE 519-1992 and employ as a minimum 6 pulse VFD with equivalent 5% impedance by employing a combination of line reactors and/or DC bus choke to achieve the equivalent impedance. [

Grounding and Bonding

A separate, insulated equipment grounding conductor, sized per the National Electrical Code, will be provided within each raceway and cable tray, with each end terminated on a suitable lug, bus, enclosure, or bushing.

A grounding riser with ground box will be located in each electrical closet.

Surge Protection

Surge Protective Devices (SPD) will be used as design dictates. A single SPD device will be installed on the load side of each main service disconnects, the generator switchboard and at the first distribution panel on the load side to each automatic transfer switch. Second-tier SPD devices at branch panelboards and other locations will be incorporated as required but is not anticipated at this time.

EMF and Harmonics

Electrical vaults and major electrical equipment rooms containing transformers larger than 300 kVA to not be located adjacent to occupied workstations.

The power service will be required to meet the requirements IEEE Standard 519 to insure proper service. Harmonic distortion will be limited to 5% maximum at the point of common coupling. The point of common coupling is being defined as the secondary side of upstream utility transformer.

Electrical Rooms

Electrical equipment rooms will be positioned to facilitate unobstructed initial installation of large equipment, and unobstructed removal and replacement of defective equipment.

Adequate space will be provided for maintenance of electrical equipment and equipment removal.

Pipes and other equipment foreign to the electrical equipment will not be located in, enter, or pass through such spaces or rooms.

Panelboards will be grouped, surface-mounted, in dedicated ventilated rooms. Electrical rooms will be stacked vertical whenever practicable.

Penthouses and mechanical rooms will be utilized for electrical equipment and panelboard placement where applicable for optimization of space.

Panelboards serving lighting and appliance circuits will be located on the same level as the circuits they serve and will be served from source of supply with a dedicated feeder.

Feed through, sub-fed and double section panelboards will not be used unless required to comply with selective coordination requirements

Prohibited Materials and Construction Practices

The entire Emergency/Standby power distribution system will consist of conduit and wire. Busway will not be used in any portion of this system

Use of wood strips and wood screws to support lighting fixtures.

Extra-flexible non-labeled conduit

Conduit installation in concrete slabs

Conduit less than 3/4" diameter will not be used except for switch legs, fixture whips and door controls

Use of wire ties to support conduit

Suspension systems for conduits, fixtures, etc. connected to other utility equipment is prohibited. Any suspension system with multiple levels must be hung from trapeze suspension systems

Use of Incompatible Materials: Aluminum fittings and boxes will not be used with steel conduit. All materials in a raceway system will be compatible

Direct burial electrical cable

Power Distribution Acceptance Testing

An independent testing firm will be employed to assure all electrical equipment, both contractor and Owner supplied, is operational and within industry and manufacturer's tolerances and is installed in accordance with design specifications.

Testing firm will be a corporately and financially independent testing organization that can function as an unbiased testing authority, professionally independent of the manufacturer, supplier, and installers of equipment or system evaluated by the testing firm. The testing firm's on-site technical person will be currently certified by the International Electrical Testing Association in electrical power distribution system testing. Items to be tested and inspected are as follows:

Acceptance Tests	
600V Conductors and Cables	Medium Voltage Surge Arresters
Medium Voltage Conductors and Cables	Automatic Transfer Switches
Electrical Metering	Motor Control and Motor Control Centers
Engine Generators	Metal Enclosed Busway
Dry Type Transformers (Small)	Ground Fault Protection Systems
Dry Type Transformers (Large)	Grounding Systems
Low-Voltage Switchgear	Protective Relays
Switchboards	Instrument Transformers
Medium Voltage Metal Enclosed Air Switches	Thermographic Survey
Medium-Voltage Vacuum Circuit Breakers	Power Distribution Units
Low-Voltage Power Circuit Breakers	Lighting and Appliance Panelboards
Low-Voltage Insulated-Case/Molded-Case Circuit Breakers	Static and Flywheel Uninterruptable Power Supply Systems
Low-Voltage Disconnect Switches	Distribution Panelboards
Enclosed Circuit Breakers	Surge Protective Devices
Lightning Protection System	

END OF SECTION

PIPING SYSTEMS

SYSTEM DESCRIPTIONS

Storm and Clearwater Drainage

System Description

A storm drainage system will be provided to convey rainwater from flat roofs to site storm sewers.

Secondary roof drainage will be accomplished by using a dedicated piped overflow drainage system separate from the primary storm drainage system which will discharge through the building wall onto grade. Clearwater waste from air handling units, coolers, and other devices and equipment that discharge clearwater will be conveyed by gravity flow through a separate piping system and will connect to the building storm drain.

Storm drainage systems which cannot discharge to the storm sewer by gravity flow will be drained by gravity to a sump with pump(s) and will be pumped into the building storm drainage system.

Design Criteria

The primary storm drainage system will be sized based on the tributary area. The area in square feet shall be divided by the following applicable divisors:
a. For roofs the divisor is 26 square feet/gpm.

The secondary storm drainage system will be sized based on the same design criteria as the primary system.

The sizing for all clearwater discharge from equipment system will be based on the maximum flow rate of the equipment.

Equipment and Material

Storm and clearwater drainage systems which cannot discharge to the storm sewer by gravity flow will be drained by gravity to a sump with pump(s) and will be pumped into the building storm drainage system.

Refer to Appendix-System Equipment Reliability, Generator Power, and Capacity Matrix for pump redundancy.

Sump pumps will be connected to the emergency (standby) power system to permit operation during a loss of normal power.

Distribution

Storm and Clearwater Waste Systems Materials		
System	**Below Ground**	**Above Ground**
Storm and Clearwater Waste and Vent	• Service-weight hub-and-spigot cast iron pipe with neoprene push-on compression gaskets • Schedule 40 PVC with DWV pattern solvent cement socket fitting joints	• Hubless cast-iron pipe with heavyweight no-hub couplings with stainless steel clamps
Pressurized Storm and Clearwater Waste and Vent	• Schedule 40 PVC with solvent cement socket fitting joints • Copper water tube, Type K, soldered joints and fittings	• Schedule 40 PVC with solvent cement socket fitting joints • Copper water tube, Type L, soldered joints and fittings • Schedule 40 galvanized steel with threaded joints and fittings

Roof and overflow drain bodies and above ground storm, secondary roof drainage and clearwater waste piping will be insulated. All clearwater waste piping which collects clearwater condensate from air handing equipment will be insulated to prevent condensation on the piping.

Sub-soil Drainage

System Description

If a sub-soil drainage system is required by the Geotechnical Report, it will convey groundwater from exterior footing, interior footing and/or underslab to a sump. The effluent will be pumped into the building storm drainage system.

Design Criteria

Design criteria for the subsoil drainage system will be defined by the Geotechnical Report.

Equipment and Material

Subsoil drainage systems which cannot discharge to the storm sewer by gravity flow will be drained by gravity to sump pump(s) and will be pumped into the building storm drainage system. Each sump pump will be sized for 100% of the estimated design flow.

Refer to Appendix-System Equipment Reliability, Generator Power, and Capacity Matrix for pump redundancy.

Sump pumps will be connected to the emergency (standby) power system to permit operation during a loss of normal power.

Distribution

Subsoil drainage piping, will be:

- Heavy duty corrugated polyethylene perforated piping with mechanical couplings

Piping will be sized in accordance with the Geotechnical Report recommendations and code requirements.

Waste and Vent Systems

System Description

A sanitary waste and vent system will be provided for all plumbing fixtures and other devices that produce sanitary waste. Plumbing fixtures will be drained by gravity through conventional soil, waste and vent stacks, building drains and building sewers to the street sewer.

All fixtures will have traps and will be vented through the roof. Vent terminals will be located away from air intakes, exhausts, doors, openable windows and parapet walls at distances required by the plumbing code.

Sanitary waste drainage systems which cannot discharge to the sanitary sewer by gravity flow will be drained by gravity to a sump with pump(s) and will be pumped into the building sanitary drainage system.

Sanitary waste drainage systems which are located in unconditioned spaces will be insulated and heat traced to prevent freezing. The exception to this will be the sanitary system that picks up the drains in the underground parking structure. This system will not be trapped or heat traced.

Design Criteria

The waste and vent piping will be sized in accordance with code requirements.

Equipment and Material

Floor drains, floor sinks and indirect waste receptors will be provided with trap seal inserts when subject to loss of their trap seals due to evaporation caused by infrequent use.

Sewage ejectors will be connected to the emergency (standby) power system to permit operation during a loss of normal power.

Distribution

Waste System Materials		
System	**Below Ground**	**Above Ground**
Gravity Sanitary Waste and Vent	• Service-weight hub-and-spigot cast iron pipe with neoprene push-on compression gaskets • Schedule 40 PVC with DWV pattern solvent cement socket fitting joints	• Hubless cast-iron pipe with heavyweight no-hub couplings with stainless steel clamps • Type DWV copper tube with soldered joints and [wrought copper][cast bronze]drainage pattern fittings
Pressurized Sanitary Waste	• Schedule 40 PVC with solvent cement socket fitting joints • Copper water tube, Type K, soldered joints and fittings	• Schedule 40 PVC with solvent cement socket fitting joints • Copper water tube, Type L, soldered joints and fittings • Schedule 40 galvanized steel with threaded joints and fittings

Waste piping will be pitched according to code to maintain a minimum velocity of 2 fps when flowing half full.

Vents and the venting systems will be designed and installed so that the water seal of a trap will be subject to a maximum pneumatic pressure differential equal to 1" water column. This will be accomplished by sizing and locating the vents in accordance with the venting tables contained in the plumbing code.

A sand/solids interceptor will be installed on the sanitary system that collects drains in the parking garage before discharging to the sewage ejector pumps. The owner will maintain this interceptor by trailer style vacuum pump. No special piping or pumps will be necessary to remotely suction this basin out.

The underground parking structure sanitary system will employ a stack and garage catch basin strategy. Drains on the different levels in this structure will drain to stacks. At the base of each stack, a garage catch basin will be provided. This will eliminate the need for traps, vents and heat trace on the drains.

Elevator Sump Pumps

System Description

An elevator sump shall be required in the base of each elevator pit. Unless noted otherwise sump pit shall be formed into the elevator hoist-way base. Sump pump discharge will be with an air gap to a receptor and into the building sanitary drainage system.

Design Criteria

Sump pump will be sized in accordance with code requirements. Provide a pump sufficient to discharge 30 gpm per elevator hoist-way.

Equipment and Material

Sump pump shall be submersible type. Sump pumps will be connected to the emergency (standby) power system to permit operation during a loss of normal power.

Distribution

Piping shall be the same material and joint type as sanitary drainage system(s).

Domestic Water

System Description

Domestic water will be provided to all toilet room fixtures, electric water coolers/drinking fountains, sinks, emergency shower/eyewash units, and any other devices that require a domestic water supply.

Hot water will be provided to all fixtures and devices that require hot water. Temperature of hot water depends on use. See design criteria below.

Emergency showers and eyewashes that are required in mechanical spaces will be supplied with tepid water per the ANSI Z358.1 definition of tepid water.

Non-potable water system will provide make-up water to irrigation, water features and mechanical (HVAC) systems such as heating hot water, chilled water, and cooling towers. A reduced pressure backflow preventer will protect the domestic water supply.

Domestic water systems that are routing through unconditioned spaces will be heat traced to prevent freezing.

Design Criteria

Each building support and amenities water heater will be sized for 66% of the design hot water load at an outlet temperature of 120°F. Each apartment unit water heater will be sized for 100% of the design hot water load at an outlet temperature of 110°F

Backflow preventers will be sized for 100% of the design flow.

Equipment and Material

Water meters will be provided on the building service entrance. Each retail tenant space will have separate domestic water meters, as well as one (1) central meter for the apartments above and one (1) meter for the below ground parking structure. Each water meter will be sized for the building's maximum design flow rate.

A water pressure booster pump system will be provided. The booster pump system will be configured such the system is capable of 100% of the total design flow with the loss of the largest pump.

Domestic hot water for building support and amenities will be produced by a gas-fired, storage-type water heaters. Domestic hot water for apartment units will be produced by Individual electric type domestic water heaters located inside each apartment unit. Domestic hot water for the parking offices and maintenance areas will be provided by small electric storage type water heaters. Domestic hot water for retail spaces will be produced by equipment provided by the individual retail tenant build-out.

Remote fixtures will be provided with hot water by electric instantaneous water heaters.

Booster water heaters will be provided as part of equipment, dishwashers, laundries, etc., which have water temperature requirements above the normal distribution temperature stated above.

The hot water system (minus retail spaces, individual apartment units, parking office and maintenance spaces) temperature will be maintained by recirculating the hot water through a continuous loop with an in-line circulating pump.

Refer to Appendix-System Equipment Reliability, Generator Power, and Capacity Matrix for water heater and pump redundancy.

Water softener(s) will be installed ahead of the building support and amenities water heater(s).

Water hammer arrestors will be provided at all quick closing solenoid valves and at other potential water hammer sources.

Tepid water to emergency fixtures will be provided by a point of use thermostatic mixing valve with cold water bypass device at each fixture.

Distribution

Water System Materials		
Size	**Below Ground**	**Above Ground**
2-1/2" and smaller: Copper	• Copper water tube, Type K, soldered joints and wrought copper fittings	• Type L copper tube with soldered joints and wrought copper fittings
Underground (3" and larger): Ductile Iron	• Ductile iron, Class 52, AWWA C151, cement mortar lined with restrained mechanical joints and ductile iron fittings	• Not applicable
Copper (3" and larger)	• Not applicable	• Type L copper tube with brazed joints with wrought copper fittings or grooved joints with copper alloy fittings with rolled groove couplings
Stainless Steel (3" and larger)- option to copper	• Not applicable	• 304L, schedule 10, stainless steel with welded or roll grooved joints and welded or grooved fittings with grooved couplings

Piping 2-1/2" and larger and located in mechanical equipment rooms may be rolled groove mechanical joints.

The hot water system will be insulated in accordance with Code. The cold water system will be insulated to prevent condensation from forming. Isolation valves will be provided at all riser connections, branch piping run-outs to fixture groups, and at devices requiring maintenance.

The piping will be sized to limit the velocity in any section of the system to a maximum of 8 fps for cold water system and 4 fps for hot water and hot water circulating systems.

Natural Gas

System Description

Natural gas is anticipated to be piped to equipment (ex: boilers, water heaters, generators) as required to meet building needs. Gas pressure will be determined based on equipment requirements. Natural gas will be extended to the building from the gas company's natural gas main in the street. It is anticipated that the gas meter(s) will be located interior on one of the lower levels of the building.

Design Criteria

All design and installation will be in accordance with the applicable codes**.**

Natural gas will be supplied at a pressure of 7" water column. The piping will be sized to limit the pressure drop across the system to 0.5" water column. Where more robust gas loads are anticipated (i.e. boilers, generators, etc.), natural gas may be supplied at a pressure of 2-10 psig. In this case, piping will be sized to limit the pressure drop across the system to 10% of the supply pressure.

Equipment and Material

Natural gas meter and building pressure regulating valves will be provided by and in accordance with gas utility company requirements. Each retail tenant space will have separate gas meters as required.

Point of use pressure regulators will be self-operated spring-loaded constant pressure valves with internal relief capability.

Distribution

Natural gas piping 2-1/2" and smaller will be Schedule 40 black steel pipe with malleable iron threaded fittings. Natural gas piping 3" and larger will be Schedule 40 black steel pipe with welded fittings.

Natural gas valves 2-1/2" and smaller will be two-piece ball valves with bronze bodies and stainless steel balls. Valves 3" and larger will be plug valves with cast iron bodies.

END OF BOD

FIRE PROTECTION SYSTEMS

EXECUTIVE SUMMARY

A fire protection system will be installed to protect the new facility. The system will be fed from a minimum of 2 water mains located in different streets, or from the same main provided that the main is valved such that an interruption can be isolated without interruption through at least 1 of the connections. The water mains are connected to an electric motor-driven fire pump, which is used to supply the Class 1 automatic wet standpipe system. A combined standpipe will be used to supply wet pipe sprinkler systems throughout the facility. Where subject to temperatures below 40°F, a dry pipe sprinkler system will be used to protect the facility.

SYSTEM DESCRIPTIONS

Fire Service

System Description

Two underground fire lines will supply the fire pump and sprinkler systems in the building. The underground lines will be supplied by connections to water mains in different streets. Each connection and the supply piping between the connection and the fire pump will be sized to supply the flow and pressure required for the pump to operate. Two connections to the same main will be permitted provided the main is valved such that an interruption can be isolated so that the water supply will continue without interruption through at least one of the connections.

Design Criteria

The design of the underground fire lines shall comply with NFPA 24.

Current water supply flow test data will be obtained from the City Water Department in order to determine the capacity of the water mains.

Equipment and Material

Piping for all underground lines will be cement lined ductile iron or, where approved by the Owner and local Authority Having Jurisdiction, Polyvinyl Chloride (PVC).

Fire Pump

System Description

The building standpipe and sprinkler systems will be served by a UL Listed centrifugal fire pump. The fire pump will be installed in a dedicated fire pump room.

Design Criteria

The fire pump will be sized in accordance with NFPA 13, NFPA 14, and NFPA 20. Current water supply flow test data will be obtained from the City Water Department in order to determine the required pressure rating of the fire pump.

Equipment and Material

The fire pump will be a horizontal split case centrifugal fire pump. The jockey pump will be a centrifugal type pump and is intended to be utilized for pressure maintenance in the fire protection piping system.

The fire pump controller will include all features required in NFPA 20 with a reduced voltage solid state type starter.

Distribution

The fire pump installation will include a fire pump test header, fire department connection, and fire pump bypass line. Piping and valves will be configured in accordance with NFPA 20.

Fire Pump Test Header (FPTH) – A fire pump test header will be provided for the fire pump. The test header will consist of 2-1/2" outlets with caps and chains.

- An automatic ball drip valve will be installed between the control valve for the test header and the header itself to allow any water to drain out of the piping.
- The FPTH location will be coordinated with the local Fire Department, Project Architect, and Civil Engineer to ensure that adequate drainage is provided in the area to prevent any water damage from occurring.
- The test header will be installed on the exterior wall of the building.

Fire Department Connection (FDC) - Each fire department connection will consist of 2-1/2" inlets with drop clappers, snoots, caps and chains.

- A check valve will prevent flow from the fire protection system to the FDC.
- An automatic ball drip valve will be installed between the check valve and the FDC to allow any minor leakage past the check valve to drain out of the system.
- The FDC location will be coordinated with the local Fire Department and Project Architect.
- Typically, the design will require a fire hydrant within 100 feet of the FDC.
- The FDC will be installed on the exterior wall of the building.

Standpipe System

System Description

When required, the building will be protected by a hydraulically designed, Class I Standpipe System without hoses or hose cabinets.

Design Criteria

The design of the standpipe system will comply with NFPA 14.

For automatic standpipe systems in a fully sprinklered building, the standpipe system will be designed and hydraulically calculated to provide a flow of 250 gpm at 100 psig residual pressure at the highest fire department valve located on the most remote standpipe. An additional flow of 250 gpm will be added at the next highest valve on that standpipe. Finally, 250 gpm flows will be added at the two next remote standpipes, bringing the total to 1,000 gpm.

Equipment and Material

The standpipe system piping will be black steel. Piping will either be Schedule 10 with welded fittings or roll groove couplings or Schedule 40 with welded fittings or roll groove couplings.

Distribution

Standpipe risers within a standpipe system shall be interconnected.

A 2-1/2" fire department valve will be provided on the stair's intermediate landing between each floor level.

Additional fire department valves will be provided on the roof and at other locations as required by Code or the local authority.

All rooftop or exterior fire department valves will be protected from freezing with shutoff valves located inside the thermal envelope of the building.

Wet Pipe Sprinkler System

System Description

The building will be protected throughout with hydraulically calculated sprinkler systems, which except for special protection needs, will be wet pipe systems. All areas of the building will be protected per NFPA 13, including electrical rooms (i.e. switchgear rooms, transformer rooms, generator rooms, electrical closets, and similar rooms), loading docks, stair towers, exterior canopies, and mechanical rooms.

Design Criteria

The sprinkler system for the building will be designed and installed in accordance with NFPA 13.

All systems will be hydraulically calculated with a computer calculation program using the Hazen-Williams method.

If there are no special Client standards or Client insurance carrier recommendations, the following sprinkler design densities shall apply:

Sprinkler Design Densities			
Hazard-Areas Designated as	**Density-Minimum Sprinkler Flow**	**Remote Area**	**Hose Stream Allowance**
Light Hazard	0.10 gpm per sq. ft.	1500 sq. ft.	100 gpm
Ordinary Hazard Group 1	0.15 gpm per sq. ft.	1500 sq. ft.	250 gpm
Ordinary Hazard Group 2, where stockpiles of combustibles do not exceed 12 ft.	0.20 gpm per sq. ft.	1500 sq. ft.	250 gpm
Extra Hazard Group 1, where the quantity and combustibility of contents is very high and the probability of rapidly developing fires with high rates of heat release are expected	0.30 gpm per sq. ft.	2500 sq. ft.	500 gpm

The system demand will be based upon the most remote 1500 sq. ft. for ceilings that are pitched less than or equal to a 2 in 12 slope. Ceilings exceeding this pitch will require that the 1500 sq. ft. remote area size is increased by 30%.

The pipe sizing for the systems will be as required to satisfy the hydraulic demand.

Equipment and Material

Piping 2" and smaller in size will be Schedule 40 black steel with welded fittings, threaded joints, or roll groove couplings.

Piping larger than 2" will be Schedule 10 black steel with welded fittings or roll groove couplings or Schedule 40 black steel with welded fittings, threaded joints, or roll groove couplings.

All sprinklers in Light Hazard areas will be quick-response type.

The type of sprinkler installed in a particular area will be selected by the Engineer and the Project Architect. Generally, concealed sprinklers will be installed in areas having suspended ceilings. Pendent or upright sprinklers will be installed in areas without ceilings. Sidewall sprinklers will be provided only when other types cannot be utilized.

Areas subject to temperatures below 40°F will be protected by dry sprinklers when possible. If dry sprinklers cannot be provided, then a dry pipe sprinkler system will be installed. Glycol antifreeze system will not be an option to dry sprinklers or dry pipe system.

Distribution

The sprinkler system will be provided throughout the building in accordance with NFPA 13 and, when required by the Owner, with insurance carrier recommendations.

Dry Pipe Sprinkler System

System Description

Areas of the building subject to temperatures below 40°F will be protected by a dry pipe sprinkler system.

Design Criteria

The dry pipe sprinkler system will be designed and installed in accordance with NFPA 13.

All systems will be hydraulically calculated with a computer calculation program using the Hazen-Williams method.

If there are no special client standards or client insurance carrier recommendations, the following sprinkler design densities shall apply:

Sprinkler Design Densities			
Hazard-Areas Designated as	**Density-Minimum Sprinkler Flow**	**Remote Area**	**Hose Stream Allowance**
Light Hazard	0.10 gpm per sq. ft.	1950 sq. ft.	100 gpm
Ordinary Hazard Group 1	0.15 gpm per sq. ft.	1950 sq. ft.	250 gpm
Ordinary Hazard Group 2, where stockpiles of combustibles do not exceed 12 ft.	0.20 gpm per sq. ft.	1950 sq. ft.	250 gpm

The system demand will be based upon the most remote 1950 sq. ft. for ceilings that are pitched less than or equal to a 2 in 12 slope. Ceilings exceeding this pitch will require that the 1950 sq. ft. remote area size is increased by 30%.

The pipe sizing for the systems will be as required to satisfy the hydraulic demand.

Equipment and Material

Piping 2" and smaller will be Schedule 40 galvanized steel with threaded joints.

Piping larger than 2" will be Schedule 10 galvanized steel with welded fittings or roll groove couplings or Schedule 40 galvanized with welded fittings, threaded joints, or roll groove couplings.

All sprinklers in Light Hazard areas will be quick-response type.

Depending upon the actual installation method, sprinklers on dry pipe systems will be either: upright type; dry pendent type; or pendent and sidewall type sprinklers installed on return bends, where the sprinklers, return bend, and branch line piping are in an area maintained at or above 40°F.

A UL Listed dry pipe valve with trim will be provided.

Distribution

The sprinkler system will be provided throughout the building in accordance with NFPA 13 and, when required by the Owner, with insurance carrier recommendations.

END OF BOD

BUILDING PERFORMANCE

Project Goals and Objectives

The goals of this project are to set performance targets for occupant experience and resilience and resource utilization as a foundation for the basis of the design.

Occupant Experience

Occupant experience covers thermal quality, air quality, visual quality (glare), acoustics, vibration, security, and connectivity. The following sections will define each of these categories and provide minimum performance thresholds.

Thermal Comfort

Thermal comfort is the primary purpose of the mechanical systems within the residential areas and amenity space. Occupant comfort is defined as compliance with ASHRAE 55 2010.

Operative temperature, humidity, air speed, local thermal discomfort and temperature variations with time are considered in the system design. The following thermal comfort criteria are used as the basis for system design:

Thermal Comfort Criteria						
Space	Metabolic Rate	Clothing Insulation	Air Temperature	Radiant Temperature	Air Speed (1)	Humidity
	(met)	(clo)	(°F)	(°F)	(fpm)	(%RH)
Office	1.0	0.8	To be calc'd.	To be calc'd.	To be calc'd.	60% max
Bedroom	0.7	0.5	To be calc'd.	To be calc'd.	To be calc'd.	60% max
Livingroom	1.0	0.8	To be calc'd.	To be calc'd.	To be calc'd.	60% max

Notes:

(1) Air speed at work surface

Air Quality

Indoor air quality is achieved through multiple means including but not limited to: supplying outside air through forced air or natural ventilation, filtering air, pressurization control, and isolating contamination, and exhausting contaminated air.

The project shall comply with ASHRAE Standard 62.1-2013 requirements to ensure occupant health and safety.

Visual Quality

Visual quality may be enhanced by ensuring the right level of light and contrast is provided to the space. Poor visual quality may impact worker productivity or patient recovery times due to low light, excess light and glare and/or contrast. The design will ensure proper management of glare and contrast as well as achieving user defined light levels meeting IESNA-XXX requirements.

Acoustics

Acoustic requirements will be defined by standard design practice per ASHRAE for mechanical systems and interior finishes.

Energy Performance Goals

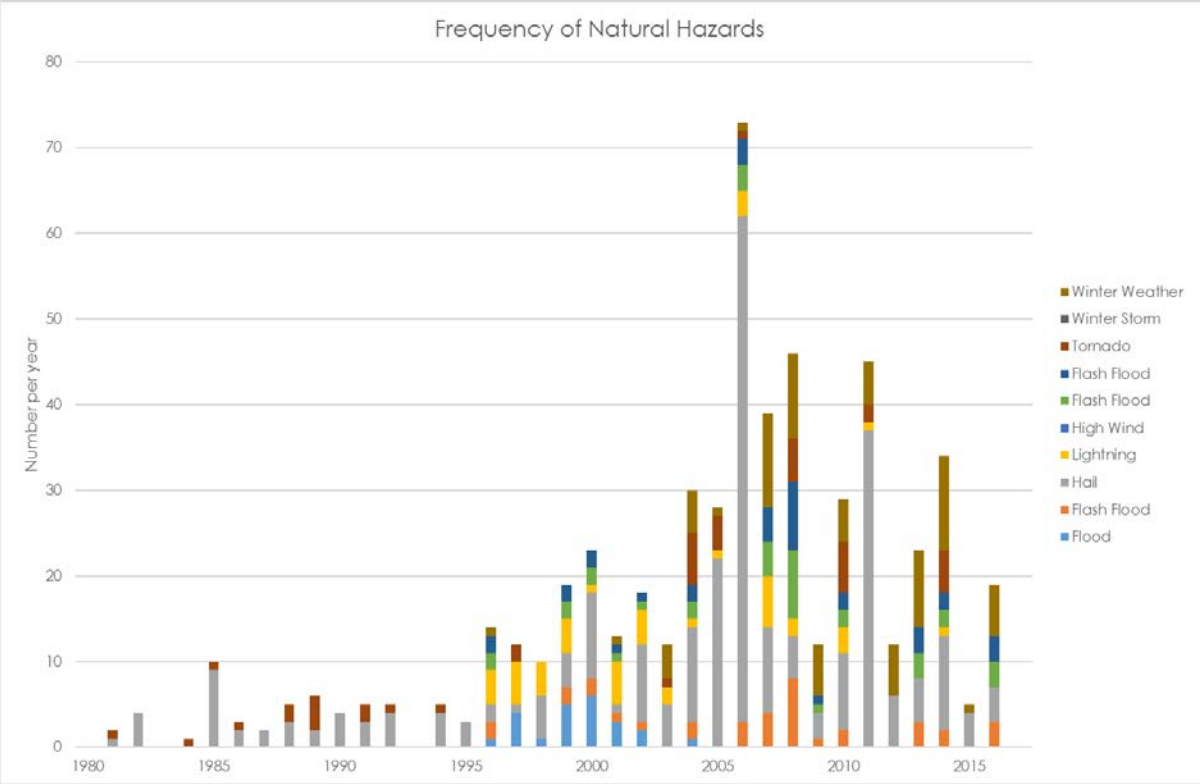
The building is designed to comply with Wisconsin Energy Code. The project will be designed to consume 30% less energy when compared to an ASHRAE 90.1 2013 baseline.

Water Performance Goals

The project will be designed to consume 30% less potable water than the water use design team defined baseline calculated (not including irrigation). The baseline shall meet the requirements of the Energy Policy Act (EPAct) of 1992 and subsequent ruling by the Department of Energy, requirements of the EPAct of 2005 and current Plumbing Code Requirements.

Resilience Design Goals

The project will be designed to address the high risks associated with man-made events and natural hazards as is reasonable to the project site, the building function and the owner's articulation of tolerable risk associated with these hazards. The project will be designed to address climate change vulnerabilities .including long-term impact of a changing climate on building performance. This project's high risks are winter storms, hail, flooding, tornadoes and high winds.



Design Standard and Certification Programs

The project will be designed to meet ParkSmart certification requirements for the parking garage.

Climate Data	
ASHRAE Climate Zone	6A
Design Cooling Temperatures	89.8°F/74.4°F
Design Dehumidification Temperatures	74.0°F/83.5°F
Design Heating Temperature	-15°F
2013 ASHRAE Fundamentals HDD-55 / CDD-65	7197 / 608
Latitude / Longitude	43.13 / 89.35

Resilience Guideline for Climate Change

USGBC LEED

Climate Change (general – identify relevant federal, state, regional and local studies and plans. As is appropriate, validate and/or make current the information in those documents that should influence the project design.

Drought - determine whether the project is in U.S. locations that have experienced Moderate, Severe, or Extreme drought conditions for more than 25% of the time in the past 10 years.

Earthquake – determine if project is within FEMA[1] Earthquake zones SDC C (yellow), D (orange), or E (red).

The site is located in the lowest SDC zone, seismic category A.

Flood – determine if project is within the 500-year FEMA National Flood Insurance Program flood zone.

The site is located is within Zone X, an area determined to outside of the 500-year flood zone. Dane County however is susceptible to flooding, experiencing heavy periods of intense rain fall. As such site placement and form with respect to surface run off should be a consideration.

Tornado and high wind – determine if project is within a Zone II, III or Zone IV high wind region or above average tornado activity.

The site is deemed high risk, with 6-10 recorded tornadoes per 100 sqm and Zone 3 wind speeds of 200 mph.

Tsunami - determine if project is within a tsunami inundation zone.

No threat to the site.

Water inundation – as is appropriate to the site, determine if project is identified by NOAA Long Range River Flood Risk of having a greater than 50% river flood risk or identify risk according to NOAA sea level rise analysis.

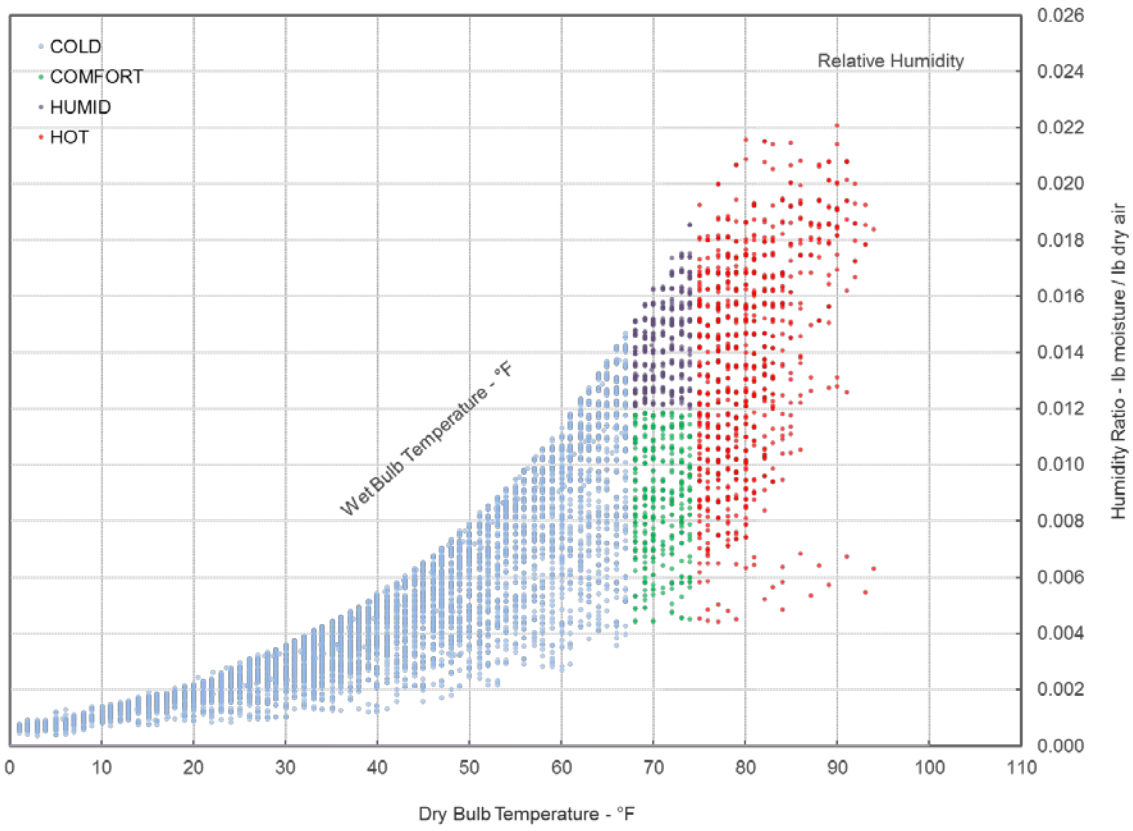
No threat to the site.

Wildfire – determine if project is located in a county that is designated by red or black on FEMA map[1].

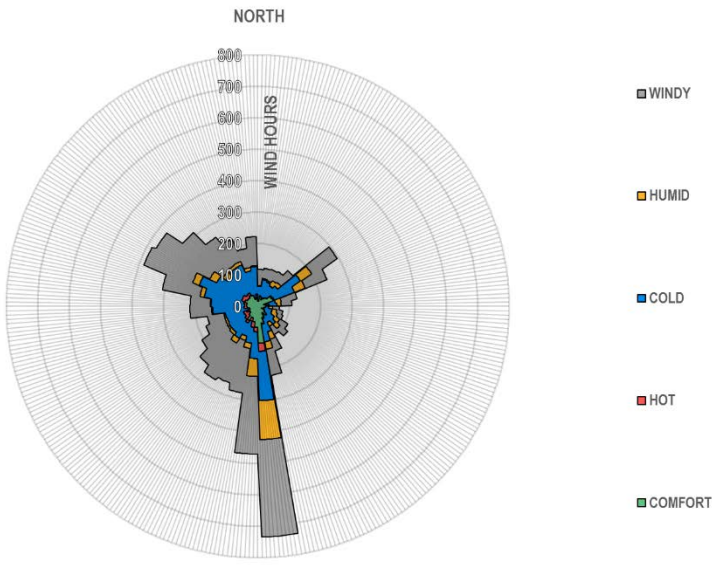
No threat to the site.

Resilience Goals			
Peak Rain Fall (2-year, 10-year, 100-year)	0.120 in/hr for 24 hrs	0.174 in/hr for 24 hrs	0.283 in/hr for 24 hrs
Resilience Concerns	Tornado, Wind, Long Term Rising Temperature, Flood,		
Expected Building Life	100 Years		

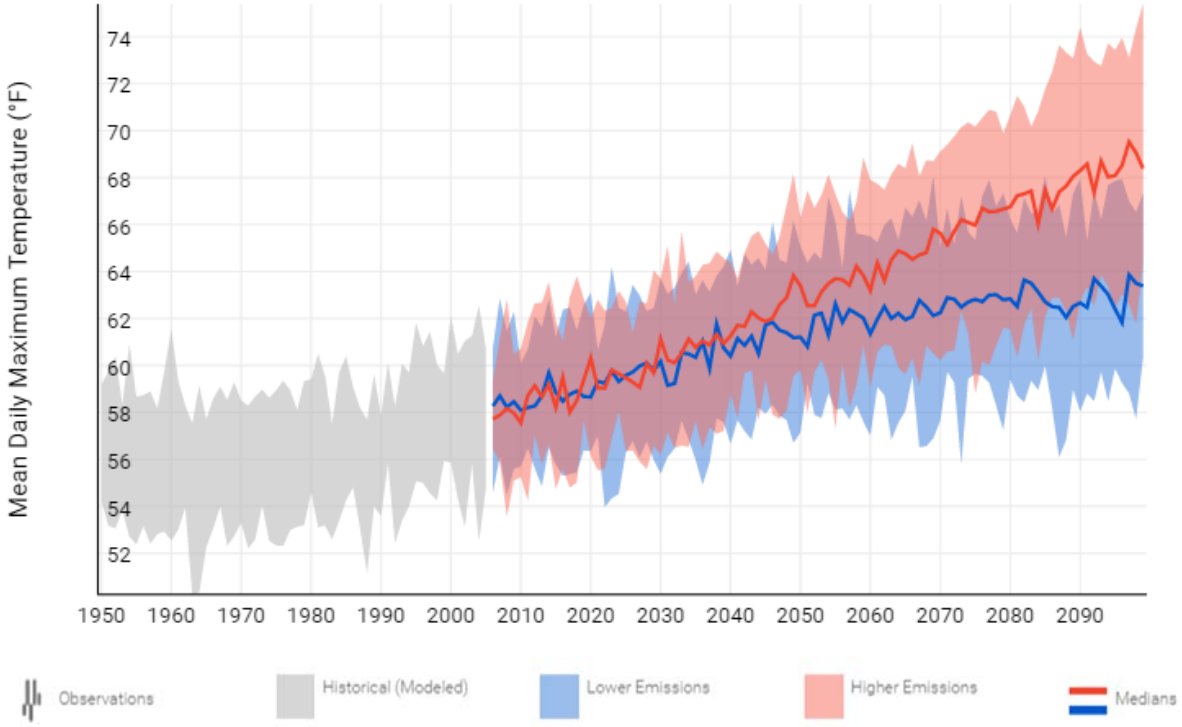
Project Psychrometric Chart using 726410TYA weather file, which is located 5 miles North East from the project site.



The annual wind rose(s) assists in defining locations for air intakes and exhaust, cooling towers, boiler stacks, generator stacks and for exploration of natural ventilation options.



Future climate modeling for high and low carbon emission scenarios both show a predicted rise in peak ambient condtions over the lifespan of the building.



HHAngus

VERTICAL TRANSPORTATION

REPORT FOR

JUDGE DOYLE SQUARE

BLOCK 88

MADISON, WISCONSIN

Prepared by: H. H. Angus
Date: December 14, 2016

SUMMARY

1. Two passenger elevators are recommended for the apartment building serving levels 1 to 14 with a capacity of 4,000 pounds and a speed of 350 feet per minute (fpm). They will provide an excellent level of service with an average waiting time of 36.6 seconds and a maximum handling capacity of 65.2% of the apartment population.

2. If the apartment passenger elevators are the designated fire service access elevators, then they also must serve floors U5 to U0 in the event of an emergency.

3. Two passenger elevators are recommended for the west parking garage serving levels U5 to U0, 1 and 2 with a capacity of 4,000 pounds and a speed of 350 fpm. They will provide a good level of service with a waiting interval of 43.9 seconds and a maximum handling capacity of 16.0% of the west parking garage population.

4. Two passenger elevators are recommended for the east parking garage serving levels U5 to U1 and 1 with a capacity of 4,000 pounds and a speed of 350 fpm. They will provide an excellent level of service with a waiting interval of 33.2 seconds and a maximum handling capacity of 26.9% of the east parking garage population.

5. One service elevator is recommended for the entire building serving levels 1 to 14 with a capacity of 4,500 pounds and a speed of 350 FPM. A counterweight safety will be required on this elevator so space underneath the hoistway can be used.

6. Service elevator will have clear inside cab dimensions of 5’-8” wide by 7’-11” deep by 10’-0” high. Door dimensions will be 4’-0” wide by 7’-0” high.

7. Since the building will be constructed in phases all elevators are designed to accommodate an ambulatory stretcher in the open and horizontal position.

BUILDING DESCRIPTION

1. Judge Doyle Square, Block 88, is a mixed-use building consisting of an underground public parking garage, retail space and a 14-story rental apartment building located in Madison, Wisconsin. The building will be constructed in two phases – first the underground parking garage and then the 14 story apartment building.

2. Level U5 will accommodate 56 public parking spaces.

3. Level U4 will accommodate 134 public parking spaces.

4. Level U3 will accommodate 133 public parking spaces.

5. Level U2 will accommodate 133 public parking spaces.

6. Level U1 will accommodate 126 public parking spaces.

7. Level U0 will accommodate 56 public parking spaces.

8. Level 1 (Wilson Street) will accommodate the apartment lobby, leasing and management offices, loading dock, bicycle center and retail space.

9. Level 2 (Doty Street) will accommodate retail space, bicycle storage and back of house space for the apartment.

10. Level 3 will accommodate 83 parking spaces reserved for the apartment residents.

11. Level 4 will accommodate 67 parking spaces reserved for the apartment residents.

12. Level 5 will accommodate indoor and outdoor amenity spaces for the apartment residents and 8 one bedroom units and 3 two bedroom units.

13. Levels 6 through 14 will each accommodate 3 studio units, 10 one bedroom units and 3 two bedroom units.

14. Floor heights are as follows.

Floors	Height
U5 to U4	10’-6”
U4 to U3	10’-6”
U3 to U2	10’-6”
U2 to U1	10’-6”

U1 to U0	10’-6”
U0 to 1	9’-0”
1 to 2	9’-0”
2 to 3	12’-0”
3 to 4	9’-6”
4 to 5	9’-4”
5 to 6	9’-3”
6 to 7	9’-4”
Typical	9’-4”
13 to 14	9’-4”

15. Current plans show two west parking garage elevators serving levels U5 to U0, 1 and 2, two east parking garage elevators serving levels U5 to U1 and 1, two apartment passenger elevators serving floors U5 to U0, 1 to 14 and one service elevator serving levels 1 to 14.

DESIGN CRITERIA

1. Population of apartment building is based on the following densities.

Unit Type	No. of Persons/Unit
Studios	1.1
One Bedroom Units	1.3
Two Bedroom Units	2.5

2. Population of public parking garage is based on 1.5 persons per parking space.

3. Door open and door close times are based on 4'-0" wide center opening doors or 2.0 seconds to open and 3.0 seconds to close.

4. Flight times or the elapsed time in seconds from car start to car stop between adjacent floors are based on microprocessor based controllers or 5.0 seconds.

5. Maximum number of persons that can be carried on an elevator is based on the capacity or 17 persons for a 4,000-pound capacity elevator.

6. West parking garage elevators must accommodate at least 60% of the parking garage population and the east parking elevators must at accommodate at least 40% of the parking garage population.

7. The two major components considered when evaluating the performance of an elevator system are waiting interval and maximum handling capacity. The waiting interval is a measure of an elevator system's qualitative performance and represents the elapsed time in seconds between successive elevator departures from the main lobby during a five-minute period of two-way traffic. If the waiting interval is too long, then there will be long waits for an elevator. The maximum handling capacity is a measure of an elevator system's quantitative performance and represents the number of people (expressed as a percentage of the building population) that the elevator system can carry during a five-minute period of two-way traffic. If the maximum handling capacity is less than the demand, there will be overcrowded elevators and elevator lobbies.

8. Recommended levels of passenger elevator service for an apartment building are as follows.

Maximum Handling Capacity	Waiting Interval Seconds	Rating
More than 10%	Less than 40	Excellent
8% to 10%	40 to 50	Good
6% to 8%	50 to 60	Satisfactory
Less than 6%	More than 60	Poor

9. Recommended levels of passenger elevator service for a public parking garage are as follows.

Maximum Handling Capacity	Waiting Interval Seconds	Rating
More than 14%	Less than 40	Excellent
12% to 14%	40 to 50	Good
10% to 12%	50 to 60	Satisfactory
Less than 10%	More than 60	Poor

TRAFFIC ANALYSIS

Based on the building description and design criteria the level of elevator service has been analyzed for each group of passenger elevators so they can be compared to the recommended standards. The results are as follows.

Apartment Passenger Elevators

No. of Elevators	Floors Served	Capacity Lbs.	Speed FPM	Waiting Interval Seconds	Maximum Handling Capacity
1	1 to 14	4,000	350	86.9	32.6%
2	1 to 14	4,000	350	36.6	65.2%

One passenger elevator with a capacity of 4,000 pounds and a speed of 350 feet per minute will provide a very poor level of service with a waiting interval of 86.9 seconds and a maximum handling capacity of 32.6% of the apartment building population. Two passenger elevators with a capacity of 4,000 pounds and speed of 350 fpm will provide an excellent level of service with a waiting interval of 36.6 seconds and a maximum handling capacity of 65.2%. Since there is a dedicated service elevator for the apartment, none of the passenger elevators have to be removed from group operation for deliveries, move-ins, move-outs, etc.

West Parking Garage Elevators

No. of Elevators	Floors Served	Capacity Lbs.	Speed FPM	Waiting Interval Seconds	Maximum Handling Capacity
2	U5 to U0, 1 and 2	4,000	350	43.9	16.0%

Two west parking garage elevators with a capacity of 4,000 pounds and a speed of 350 fpm will provide a good level of service with a waiting interval of 43.9 seconds and a maximum handling capacity of 16.0% of the west parking garage population.

East Parking Garage Elevators

No. of Elevators	Floors Served	Capacity Lbs.	Speed FPM	Waiting Interval Seconds	Maximum Handling Capacity
2	U5 to U1 and 1	4,000	350	33.2	26.9%

Two east parking garage elevators with a capacity of 4,000 pounds and a speed of 350 fpm will provide an excellent level of service with a waiting interval of 33.2 seconds and a maximum handling capacity of 26.9% of the east parking garage population.

MATERIAL HANDLING

In any mixed used building, there is a demand for material handling. These activities include garbage, move-ins, move-outs, deliveries, mechanical and electrical repairs, capital improvements, etc.

A dedicated service elevator is recommended in a mixed used building especially for a rental apartment building where move-ins and move-outs are frequent and can exceed 15% of the apartment units in any given month. This elevator must be designed for move-ins and move-outs and also for emergency purposes including the ability to accommodate an ambulatory stretcher. Consequently, a minimum capacity of 4,500 pounds and a speed of 350 fpm is recommended.

The building code requires that in any building more than 3 floors in height be provided with an elevator that can accommodate an ambulatory stretcher in the open and horizontal position. Since the building will be built in phases, all elevators will have a capacity of at least 4,000 pounds so that they can accommodate an ambulatory stretcher in the open and horizontal position.

ELEVATOR DIMENSIONS

1. Elevators are based on machine roomless type elevators with each machine located at top of respective hoistway.

2. Hoistway dimensions of each apartment passenger elevator and each parking garage passenger elevator are 9’-4” wide by 7’-10” deep. There will be a 4-inch wide divider beam between each elevator. These dimensions are based on front loading elevators.

3. Clear overhead of each apartment passenger elevator and each parking garage passenger elevator is 15’-9” based on an overall cab height of 8’-0”.

4. Pit depth of each apartment passenger elevator and each parking garage passenger elevator is 5’-6”.

5. Controller room dimensions for each group of apartment passenger elevators and parking garage passenger elevators are 10’-0” wide by 6’-0” deep and 8’-0” high. Each controller room must be located no more than 100’-0” remote top of respective hoistways.

6. Hoistway dimensions of service elevator are 8’-9” wide by 9’-11” deep. These dimensions are based on a front-loading elevator.

7. Clear overhead of service elevator is 18’-4” based on overall cab height of 10’-0”.

8. Pit depth of service elevator is 9’-0” (walk-in pit at level U0).

9. Controller room dimensions of service elevator are 6’-0” wide by 6’-0” deep by 8’-0” high and not more than 100’-0” remote from top of hoistway.

JUDGE DOYLE SQUARE
PUBLIC PARKING FACILITY
Madison, Wisconsin
Building Code Analysis

~~15~~November 1, 2016

1. Applicable Codes

A. Madison Code of Ordinances:
Chapter 6: Fire Department and Fire Regulations
Chapter 18: Plumbing Code
Chapter 19: Electrical Code
Chapter 28: Zoning Code
Chapter 29: Building Code (dwellings)
Chapter 34: Fire Prevention Code
Adopting: The International Fire Code – Current, as modified by this chapter

B Wisconsin Administrative Code
Chs. SPS 361-366 Commercial Building Code
Adopting: The International Building Code – 2009 as modified by SPS 362
The International Energy Conservation Code – 2009 w/ SPS 363
The International Mechanical Code – 2009 w/ SPS 364
The International Fuel Gas Code – 2009 w/ SPS 365
In anticipation of adoption of the 2015 IBC, this analysis reflects 2015 codes.
Chs. SPS 380-387 Plumbing Code
Chs. SPS 314 Fire Prevention
Adopting: NFPA 1– 2012 as modified by SPS 314 (Excludes design reqm's)
Chs. SPS 316 Electrical Code
Adopting: NFPA 70– 2011 NEC as modified by SPS 316

B. Accessibility Code:
Americans with Disabilities Act Accessibility Guidelines (ADAAG)

2. Use and Occupancy Classification

2.1 Use Groups and Occupancy Classifications

Storage: Low Hazard – Group S-2 IBC 311.3

2.2 Accessory Occupancies IBC 508.2
Accessory occupancies are subsidiary to the main occupancy of the building or portion thereof. Aggregate accessory occupancies shall not occupy more than 10% of the area of the story in which they are located and shall not exceed the tabular values in Table 503 for allowable height and area without allowed increases for such accessory occupancies.

~~*Not applicable to xxxxxxxxx; larger than 750 SF.~~

2.3 Mixed Occupancies / ~~Nonseparated~~Nonseparated Occupancies IBC 508.3

2.3.1 Parking garages shall be separated from other occupancies IBC 406.4.6

2.4 Mixed Occupancies / Separated Occupancies IBC 508.4

2.4.1 Code requirements shall apply to each fire area of the building based on the individual occupancy classification of that portion of the building. IBC 508.4.1

2.4.2 In each story, the building area shall be such that the sum of the ratios of the actual floor area of each occupancy divided by the allowable area for each occupancy shall not exceed one. IBC 508.4.2

2.4.3 Individual occupancies shall be separated from adjacent occupancies in accordance with Table 508.3.3. IBC 508.4.4

2.4.4. Separations shall be fire barriers (Section 707) or horizontal assemblies (Section 712), or both, so as to completely separate adjacent occupancies. IBC 508.4.4.1

3. Special Detailed Requirements

This section is applicable as the parking garage structure is part of the proposed high-rise structure above.

3.1 High-Rise Buildings IBC 403

3.1.1 Type of construction may be reduced when each floor has sprinkler control valves equipped with supervisory initiating devices and water flow initiating devices.

For buildings less than 420', Type IA can reduced to Type IB, except columns supporting floors cannot be reduced.

Type IB may be reduced to IIA

Shafts other than stair and elevators may be reduced to 1 hour if sprinklers are installed at alternate floors.

3.1.2 Automatic sprinklers are required per 903.3.1.1 and secondary water supply per 903.3.5.2. Water supply to the fire pump shall be via two mains located in different streets. IBC 403.3

3.1.3 The following emergency systems are to be provided: IBC 403.4

Smoke detection per 907.2.13.1
Fire alarm system per 907.2.13
Standpipe system per 905.3
Emergency voice/ alarm communication system per 907.5.2.2
Emergency responder radio coverage per IFC 510
Fire command center
Smoke removal windows max 50' intervals, min 40 sf/50'
May be mechanical per 403.4.6.2
Standby Power for:
Fire command center power and lighting

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Ventilation and fire detection for smokeproof enclosures
Elevators
Manual start and transfer switches to be provided in the FCC.
Emergency power for:
Exit lighting
Elevator car lighting
Emergency voice/alarm communication system
Automatic fire detection systems
Fire alarm system
Fire pump

3.1.4 Means of egress IBC 403.5

Egress stairs must be min 30' separation or ¼ the diagonal of the floor they serve, measured in a straight line between points of the stair enclosure.

Stairway doors may be locked from the stairway side with automatic fail-safe unlocking. If locked provide 2 way communication every 5th floor.

Stairs serving floors more than 75 ft above lowest fire dept. access must be pressurized with vestibules per 1023.11 and 909.20

Note: markings within exit enclosures – see 1024.2

Elevators may be used for occupant evacuation per 3008.

3.2 Underground Buildings IBC 405
Parking garages with automatic sprinkler systems per 405.3 are excepted from the provisions of this section. IBC 405.1

3.2.1 The highest level of exit discharge and all levels below must be protected with an automatic sprinkler system per 903.3.1.1. IBC 405.3

3.3 Motor Vehicle Related Occupancies IBC 406

3.3.1 Height: Clear height shall be min 7'. Van accessible parking shall conform to ICC A117.1. IBC 406.4.1

3.3.3 Vehicle barriers not less than 2'-9" high shall be at ends of all drive lanes and parking spaces with more than 1' change in elevation. Loading per 1607.8.3. IBC 406.2.4

3.3.4 Ramps: shall not be considered exits unless pedestrian facilities are provided. Vehicle ramps used for pedestrian circulation may not exceed a slope of 1:15. IBC 406.2.5

3.3.5 Floors: Shall be concrete or similar material IBC 406.2.6

3.3.6 Heating equipment shall be installed per the Int'l Mech code (change to IBC 406.2.8) SPS 362.0406

3.4 Enclosed Parking Garages IBC 406.6

3.4.1 Height and area: Shall be per table 503 IBC 406.4.1

3.4.2 Mechanical ventilation shall be provided per the Int'l Mech Code IBC 406.4.2

4. General Building Heights and Areas

4.1 Definitions IBC 502.1

4.1.1 Basement – basement is a story that is not a story above grade plane.

4.1.2 A story having it's finished floor level entirely above grade plane, or when the level above is more than 6' above grade plane or more than 12' above grade at any point.

4.1.2 Building Area – area within exterior and fire walls exclusive of vent shafts and courts. Areas without surrounding walls shall be included in building area if covered by roof or floor above.

4.1.3 Building Height – Vertical distance from grade plane to average height of the highest roof surface.

4.1.4 Grade Plane – a reference plane representing the average of finished ground level adjoining the building at exterior walls. Where it slopes away from the walls, the lowest point within the area between the building and a point six feet from the building, or property line if it is closer.

4.2 General Height and Area Limitations IBC 503

4.2.1 Allowable Height and Building Areas IBC 504, 506

Use Group	Construction Type	Allowable Stories / with Approved Automatic Sprinkler System 903.3.1.1	Allowable Height in Feet / with Approved Automatic Sprinkler System 903.3.1.1	Allowable Area per Floor / with Approved Automatic Sprinkler System 903.3.1.1
S-2	I-A	UL	UL	unlimited / UL
	I-B*	12*	180*	237,000*
R-2	I-A	UL	UL	UL
	I-B*	12	180	UL
~~*The Level 1 assembly spaces of 4,888 SF total is less than the allowed 9,500 SF. Thus: Okay.*~~				
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4.2.3 Building Area IBC 506

Frontage increase – Where a building has more than 25 percent of its perimeter on a public way or open space having a minimum width of 20 feet, the increase in allowable area is calculated as per 506.3. IBC 506.3

Note: As this increase is granted for ease of fire department access to the exterior of the building, the logic of this provision is dubious for an underground structure and for this project, allowable area is unlimited as a type 1A below grade.

4.2.4 Mixed Use and Occupancy IBC 508

Each portion of the building must conform to the requirements of 508.2 (Accessory occupancies), 3 (Non-separated occupancies) and/or 4 (Separated occupancies). (As the parking levels below grade are separated per 510.2 and are Type 1A construction, and the residential levels above are Type 1B unlimited area, either separated or non-separated occupancies can be used, and therefor the approach will be to do separated occupancies because the exception in 508.3.3 will require this separation above grade anyway.)

4.2.5 Special Provisions IBC 510.2

A horizontal building separation per this provision can be effected to separate the structure into two buildings for height and area limitations. This requires: 3 hr separation, Type 1A construction for the building below, two hour shafts through the horizontal assembly. In this case, this will permit the levels above grade to be of Type IIA construction.

5. Types of Construction – Chapter 6 IBC

5.1 Fire-Resistance Rating Requirements (hours) IBC Tables 601, 602

Building Element	Type I-A	Type I-B	Type II-A
Structural frame: columns, girders, trusses	3	2	1[1]
Bearing Walls			
Exterior	3	2	1
Interior	3	2	1
Nonbearing exterior walls and partitions 10-30 ft separation[2]	1	1	1
Nonbearing exterior walls and partitions over 30’	0	0	0
Nonbearing walls and partitions	0	0	0
Floor construction – and secondary members	2	2	1
Roof construction – and secondary members	1 1/2	1	1

1 In reducing to IIA from IB per section 403, columns may not be reduced
2 For separations less than 10 ft, see table 602

See section 603 for combustible materials permitted in type I and II construction.

6. Fire-Resistance Rated Construction

6.1 Fire resistance ratings and fire tests – See section 703. Note per 703.7 fire walls, barriers , partitions and smoke partitions to be marked. For firewalls, see also SPS 362.0706. IBC 703

6.3 Exterior Wall Fire-resistance Ratings IBC 705.5
As required by tables 601, 602.
Rating of exterior walls with a fire separation distance of greater than 10 feet shall be rated for exposure to fire from the inside; with 10 feet or less, rated for exposure from both sides.

6.4 Exterior Wall Allowable Area of Openings IBC705.8/705.8.1
See table 705.8. Opening protectives not required with window sprinklers.

Maximum Area of Exterior Wall Openings (% of area of exterior wall per floor)								
Classification of Opening	Fire Separation Distance (feet)							
	0-3 f	>3-5	>5-10	>10-15 d	>15-20 d	>20-25 d	>25-30 d	>30
Unprotected	Not Permitted	Not Permitted	10% i	15% i	25% i	45% i	70% i	No Limit
Unprotected with AASS	Not Permitted	15%	25%	45%	75%	No Limit	No Limit	No Limit
Protected	Not Permitted	15%	25%	45%	75%	No Limit	No Limit	No Limit

- Buildings whose exterior bearing wall, exterior nonbearing wall and exterior structural frame are not required to be fire-resistance rated by Table 601 or 602 shall be permitted to have unlimited unprotected openings.

6.5 Exterior Wall Vertical Separation of Openings IBC 705.8.5
Openings in exterior walls in adjacent stories shall be separated vertically per this section. Not applicable to buildings with an automatic fire suppression system.

~~* Exception x is applicable.~~

6.6 Exterior Wall Vertical Exposure IBC 705.8.6
For buildings on same lot, opening protectives having a fire-protection rating of not less than ¾ hour shall be provided in every opening that is less than 15 feet vertically above the roof of an adjoining building or adjacent structure that is within a horizontal fire separation distance of 15 feet of the wall in which the opening is located.

Exception: Openings protectives are not required where the roof construction has a fire-resistance rating of not less than 1 hour for a minimum distance of 10 feet from the adjoining building, and the entire length and span of the supporting elements for the fire-resistance-rated roof assembly has a fire-resistance rating of not less than 1 hour.

6.7 Exterior Wall Parapets IBC 705.11

Parapets shall be provided on exterior walls except where:
1. wall is not required to be fire-resistance rated due to fire-separation distance.
2. building has an area of not more than 1,000 square feet on any floor.
3. walls terminate at roofs of not less than 2-hour fire-resistance-rated construction or where roof, including the deck and supporting construction, is constructed entirely of noncombustible materials.
4. one-hour fire-resistance-rated exterior walls that terminate at the underside of the roof sheathing, deck or slab provided: see IBC for 4 requirements.
5. For Groups R-2 and R-3 – see IBC.
6. the wall is permitted to have at least 25 percent of the exterior wall areas containing unprotected openings based on fire separation distance.

6.8 Parapet Construction IBC 705.11.1

Parapets shall have same fire-resistance rating as supporting wall, and on any side adjacent to a roof surface, shall have noncombustible faces for the uppermost 18 inches, including counterflashing and coping materials. Height shall be not less then 30 inches above point where roof surface and wall intersect. Where roof slopes toward a parapet at greater than two units vertical in 12 units horizontal, the parapet shall extend to same height as any portion of the roof within a fire separation distance where protection of wall openings is required, but in no case shall the height be less than 30 inches.

6.11 Fire Barriers IBC 707

See this section for rating requirements for shafts, exit enclosures, exit passageways, horizontal exits, incidental and separated occupancies, and fire areas. Supporting construction shall be of a rating no less than the fire barrier supported.

Fire Barrier Fire-resistance Rating				
IBC	Element	Reference	Rating (Hours)	
707.3.1	Shaft Enclosures	713.4	2 hours connecting 4 or more stories	
			1 hour connecting less than 4 stories	
707.3.2	Exit Enclosures	1023.1	2 hours connecting 4 or more stories	
			1 hour connecting less than 4 stories	
707.3.3	Exit Passageways	1024.3	1 hour but not less than a connecting exit enclosure	
707.3.5	Horizontal Exits	1026.2	2 hours	
707.3.6	Incidental Use Areas	509	See Below	
707.3.8	Separation of Mixed	508.4	AASS	

	Occupancies		S2 to M	1		
			S2 to R	1		
707.3.9	Single-occupancy Fire Areas	707.3.9	M, R, S2	2		

Fire-Resistance Rating for Non-Structural Elements (sprinklered)

Public corridors (Use S)	0	IBC 1020.1
Standby or emergency generator room	2 hours	IBC 403.4.8.1
Rooms containing fire pumps	2 hours	NFPA
Trash rooms and chutes	2 hours (>4 stories)	IBC 713.13.4

6.12 Exterior Walls as Fire Barrier IBC 707.4
Exterior walls part of a rated shaft or exit enclosure shall comply with 705 and rated enclosure requirement shall not apply.

6.13 Fire Barrier Continuity IBC 706.5 / SPS362.0707
Constructed from top of foundation or horizontal assembly to and securely attached to underside of floor, roof slab or deck above, continuous through concealed spaces such as suspended ceilings. Supporting structure shall be protected to same rating as fire barrier supported, except for 1-hour rated incidental use area separations as required by 508.2 in buildings of Type II-B and IIIB construction.

6.14 Fire Barrier Fireblocking IBC 707.5.1
Hollow vertical spaces within a fire barrier shall be fireblocked in accordance with 718.2 at every floor level.

6.15 Fire Barrier Openings IBC 707.6
Openings in a fire wall shall be protected per 716, and shall be limited to a maximum aggregate width of 25 percent of the length of the wall and a maximum of 156 sf. Openings in exit enclosures and exit passageways shall also comply with 1019, 1023.4 and 1024.5, respectively.

Exceptions:
1. Fire doors serving an exit enclosure.
2. Openings shall not be limited to 156 square feet or an aggregate width of 25 percent of the length of the wall where the opening protective assembly has been tested in accordance with ASTM E119 and has a minimum fire-resistance rating not less than the rating of the wall.
3. Fire windows permitted in atrium separation walls shall not be limited to a maximum aggregate width of 25 percent of the length of the wall.

6.16 Fire Barrier Penetrations: comply with 714. IBC 707.7

6.17 Fire Barrier Prohibited Penetrations IBC 707.7.1
Penetrations into an exit enclosure or an exit passageway shall be allowed only when permitted by 1019, 1023.5 or 1024.6, respectively.

6.18 Fire Barrier Joints: Comply with 715. IBC 707.8

6.19 Fire Barrier Ducts and Transfer Openings: Comply with 717. IBC 707.10

6.20 Shaft Enclosures IBC 713.2
Vertical shaft enclosures required to protect openings or penetrations through floor/ceiling or roof/ceiling assemblies shall be constructed as fire barriers in accordance with 707, or horizontal assemblies in accordance with 711, or both.

6.21 Shaft Enclosure Fire-resistance Rating IBC 713.4
2 hours connecting 4 or more stories; 1 hour connecting less than 4 stories
Number of stories connected shall include basements but not mezzanines.
Rating shall not be less than the floor assembly penetrated, but need not exceed 2 hours.

6.22 Shaft Enclosure Continuity IBC 713.5
Fire barrier shaft enclosures shall have continuity in accordance with 707.
Horizontal assembly shaft enclosures shall have continuity in accordance with 711.

6.23 Shaft Enclosure Openings IBC 713.7
Openings in a shaft enclosure shall be protected per 716 as required for fire barriers. Doors shall be self- or automatic closing by smoke detection in accordance with 716.5.9.3.

6.24 Shaft Enclosure Prohibited Openings IBC 713.7.1
Openings other than those necessary for the purpose of the shaft shall not be permitted.

6.25 Shaft Enclosure Penetrations: comply with 714 as for fire barriers. IBC 713.8

6.26 Shaft Enclosure Enclosure at the Bottom IBC 713.11
Shafts that do not extend to the bottom of the building shall:
1. Be enclosed at the lowest level with construction of the same fire-resistance rating as the lowest floor through which the shaft passes, but not less than the rating required for the shaft enclosure.
2. Terminate in a room having a use related to the purpose of the shaft. The room shall be separated from the remainder of the building by a fire barrier having a fire-resistance rating and opening protectives at least equal to the protection required for the shaft enclosure, or
3. Be protected by approved fire dampers at the lowest floor level within the shaft enclosure.

Exceptions to 713.11:
1. The fire-resistance-rated room separation is not required, provided there are no openings in or penetrations of the shaft enclosure to the interior of the building except at the bottom. The bottom of the shaft shall be closed off around the

penetrating items with materials permitted by 718.3.1 for draftstopping, or the room shall be protected by an AASS.
2. The fire-resistance-rated room separation and the protection at the bottom of the shaft are not required, provided there are no combustibles in the shaft and there are no openings or other penetrations through the shaft enclosure to the interior of the building.

6.27 Shaft Enclosure at the Top IBC 713.12
Shafts that do not extend to the underside of the roof sheathing, deck or slab of the building shall be enclosed at the top with construction of the same fire-resistance rating as the topmost floor through which the shaft passes, but not less than the rating required for the shaft enclosure.

6.28 Waste and linen chutes shafts shall not be used for any other purpose, shall be accessed from access rooms and not corridors. Doors shall be self-closing. Access rooms to be 1 hr w/ ¾ hr door. Waste discharge room rating and openings to match shaft rating. IBC 713.13

6.28 Elevator Shaft Enclosures per 713 and Chapter 30.) IBC 713.14

6.29 Elevator Lobby IBC 3006
An enclosed elevator lobby or other hoistway protection shall be provided at each floor per 3006.3.

6.30 Smoke Barrier Fire-resistance Rating IBC 709.3
A one hour fire-resistance rating is required.

6.31 Smoke Partitions Fire-resistance Rating IBC 710.3
Unless required elsewhere, a fire-resistance rating is not required.

6.32 Smoke Partition Continuity IBC 710.4
Constructed from top of floor to underside of floor, roof sheathing, deck or slab above, or to the underside of the ceiling above where the ceiling membrane is constructed to limit the transfer of smoke.

6.33 Smoke Partition Openings IBC 710.5
Windows shall be sealed to resist the free passage of smoke or be automatic self-closing upon detection of smoke.

6.34 Horizontal Assemblies Fire-resistance Rating IBC 711.2
Fire-resistance rating of floor and roof assemblies shall not be less than that required by the building type of construction; where separating mixed occupancies, not less than that required by 508.4.

6.35 Horizontal Assemblies Continuity IBC 711.2.2
Assemblies shall be continuous without openings, penetrations or joints except as permitted by this section and section 712.

6.36 Ceiling panels with insufficient weight to resist uplift of 1 psf require approved devices to prevent uplift. IBC 711.2.5

6.37	Vertical Openings – see section 712 Two story openings permitted per 712.1.9 Vertical openings in parking garages permitted per 712.1.10	IBC 712
6.38	Shaft Enclosures – see section 713	IBC 713
6.39	Penetrations – see section 714	IBC 714
6.40	Fire-Resistant Joint Systems: See IBC section 715	IBC 715
6.41	Opening Protectives	IBC 716
6.42	Fire resistance rated glazing- permitted per their listing	!BC 716.2
6.43	Alternate means for determining protection ratings – see 715.3	IBC 716.4
6.44	Fire door and shutter assemblies.	IBC 716.5

Table 716.5

See full table for glazing, sidelight and transom requirements

Fire Door and Fire Shutter Fire Protection Ratings		
Type of Assembly	Required Assembly Rating	Minimum Fire Door and Fire Shutter Assembly Rating (hours)
Fire Walls and Fire Barriers > 1Hour Rating	4 3 2 1 ½1/2	3 3 1 ½ 1-½/2 1 1/2
Enclosures for shafts, exit stairs and ramps	2	1 1//2
Fire Barriers of 1 Hour Rating; Shaft, Exit Enclosure and Exit Passageway Wall	1	1
Other Fire Barriers	1	¾3/4
Fire Partitions: Corridor Walls	1 0.51/2	1/3 1/3
Other Fire Partitions	1 0.51/2	¾ 3/4 1/3
Exterior Walls	3 2 1	1 ½ 1-½/2 ¾1 1/2 3/4
Smoke Barriers	1	1/3

6.45 Fire doors in corridors and smoke barriers must be tested per NFPA 252 or UL 10C. IBC 715.4.3
Fire door assemblies shall also meet smoke and draft control per UL 1784.
Doors in exit enclosures and passageways shall meet temperature rise requirements of not more than 450 deg @ 30 min.

6.46 Fire-Protection-Rated Glazing IBC 715.5

Fire Window Assembly Fire Protection Ratings		
Fire Walls	All	Not Permitted except as specified in 716.2

Fire Barriers	>1 1	Not Permitted except as specified in 716.2
Smoke Barriers	1	~~¾~~3/4
Fire Partitions	1 1/2	~~¾~~¾ 1/3
Exterior Walls	>1	1 ~~½~~1/2
Exterior Walls	1	~~¾~~3/4
Party Wall	All	Not Permitted except as specified in 715.2

6.47	Glazing material	IBC 716.5.8
6.48	Ducts and Air Transfer Openings, Dampers	IBC 717
6.49	Concealed Spaces	IBC 718
6.50	Thermal and Sound Insulating Materials	IBC 720
6.51	Prescriptive Fire Resistance	IBC 721
6.52	Calculated Fire Resistance	IBC 722

7. Interior Finishes – Chapter 8

7.1 Wall and Ceiling Finishes - ASTM E84 Classifications IBC 803.1

Classification*	Flame Spread Index	Smoke-Developed Index
Class A	0 to 25	0-450
Class B	26 to 75	0-450
Class C	76 to 200	0-450

* Interior wall or ceiling finish materials, other than textiles, may be alternately classified in accordance with NFPA 286 and shall comply with IBC 803.2.1. Textiles may be tested per NFPA 265. See section 803 for foam plastics, timber, vinyl wall coverings and other provisions. IBC 803

7.2 Interior Wall and Ceiling Finish Material Requirements IBC 803.5
ASTM E84 Classifications where Sprinklered in accordance with 903.3.1.1, except that materials, other than textiles, tested in accordance with NFPA 286 and complying with IBC 803.2.1 are permitted where ASTM E84 Class A classification is required.

Group	Exit enclosures and exit passageways (a)	Corridors	Rooms and enclosed spaces
S (sprinklered)	C	C	C

7.3 Suspended acoustical ceiling systems shall be installed in accordance with ASTM C635 and C636, and where part of a fire-resistance rated assembly, they shall be installed in same manner used in the assembly tested and shall comply with IBC Chapter 7. IBC 808

7.4 Interior floor finish and floor covering materials shall comply with Section 804 except those of traditional type, such as wood, vinyl, linoleum or terrazzo, and resilient floor covering materials that are not comprised of fibers. IBC 804.1

7.5 Interior Floor Finish determined by NFPA 253 IBC 804.4

Classification	Critical Radiant Flux
Class I	0.45 watts per square centimeter or greater
Class II	0.22 watts per square centimeter or greater

7.6 Interior Floor Finish Requirements by Occupancy IBC 804.4
Sprinklered in accordance with 903.3.1.1 IBC 804.4.1

Group	Exit enclosures and exit passageways	Corridors	Rooms or Spaces not separated from corridors by full-height partitions from floor to ceiling
A, B, U	DOC FF-1 “pill test” Compliant	DOC FF-1 “pill test” Compliant	DOC FF-1 “pill test” Compliant

8. Fire Protection Systems – Chapter 9

8.1 Group S-2 – An automatic sprinkler system shall be provided throughout enclosed parking garages of over 12,000 square feet or when beneath other occupancies. Also required when there are stories without exterior openings. IBC 903.2.10.11

8.2 Sprinklers shall be installed throughout in accordance with NFPA 13. Exempt areas per SPS 362 are any rooms or spaces where Sprinklers are considered undesirable because of the nature of the contents, where approved by the department. IBC 903.3.1.1

8.3 Supervision and Alarms – All valves, tanks, pumps, water levels, air pressures, waterflow switches shall be monitored by a fire alarm control unit, shall be monitored by an approved supervisory station. Exterior alarms shall be provided. IBC 903.4

8.4 Standpipe System – Shall be provided in new buildings and structures. Fire hose threads shall be approved and shall be compatible with fire department hose threads. Location of fire department hose connections shall be approved. Standpipe systems may be combined with an automatic fire suppression system. A Class III standpipe system is required when the IBC 905.1

lowest story is more than 30 ft below fire department access. Class I are permitted in fully sprinklered buildings.

8.5 Location of Class I Standpipe Hose Connections IBC 905.4

1. In every required stairway, a hose connection shall be provided for each floor level. Connections shall be located at an intermediate floor level landing between floors, unless otherwise approved by the fire code official.
2. On each side of the wall adjacent to the exit opening of a horizontal exit. Except: Where floor areas adjacent to a horizontal exit are reachable from exit stairway hose connections by a 30-foot hose stream from a 100 feet hose, a hose connection shall not be required at the horizontal exit.
3. Where the most remote portion of a floor or story is more than 200 feet from a hose connection, the fire code official is authorized to require additional hose connections be provided in approved locations.

8.6 Interconnection Class III – Where more than one standpipe is provided, the standpipes shall be interconnected per NFPA 14. IBC 905.6

8.7 Cabinets – containing standpipes, fire hoses, fire extinguishers or fire department valves shall not be blocked from use or obscured from view. IBC 905.7

8.8 Cabinet Equipment Identification – Cabinets shall be identified in an approved manner by a permanently attached sign with letters not less than 2 inches high in a color that contrasts with the background color, indicating the equipment contained therein. IBC 905.7.1

Except:

1. Doors not large enough to accommodate a written sign shall be marked with a permanently attached pictogram of the equipment contained therein.
2. Doors that have either an approved visual identification clear glass panel or a complete glass door panel are not required to be marked.

8.9 Dry Standpipes – shall not be installed except where subject to freezing and in accordance with NFPA 14. IBC 905.8

8.10 Portable Fire Extinguishers – provide as required by International Fire Code – max area per extinguisher = 11,250 sf, max distance = 75'. IBC 906.3

8.11 Fire Alarm and Detection Systems IBC 907.2

An approved manual, automatic, or manual and automatic fire alarm system installed in accordance with this Code and NFPA 72 shall be provided in new buildings in accordance with Section 907 unless required otherwise in the Code. Where automatic sprinkler protection installed in accordance with 903.3.1.1 is provided and connected to the building alarm system, automatic heat detection required by this section shall not be required. The automatic fire detectors shall be smoke detectors.

Single and multiple station smoke alarms shall be wired and equipped with battery backup or emergency power. If with integral strobes, shall be connected to emergency power.

8.12 Deep underground buildings – A manual fire alarm system shall IBC 907.2.19

be installed in underground buildings if more than 60' from lowest level of exit discharge.

8.13 Manual Fire Alarm Boxes – located within 5 ft of exits. IBC 907.2
Mount 42 – 48 inches above floor level.

8.~~25~~ 14 Smoke Detectors – shall be connected to the building's IBC 907.3
fire alarm control panel when a fire alarm system is required by 907.2.

8.15 Occupant Notification shall be activated by annunciation IBC 907.9.5
at the fire alarm panel when activated by fire detectors, sprinkler waterflow devices, manual fire alarm boxes, or sprinklers.

8.16 Audible Alarms – shall be provided. IBC 907.5.2.1

8.17 ~~Visible Alarms – in employee work areas, audible alarm system IBC 907.9.1.2~~

8.~~33~~32 Fire Department Connections Location IBC 912.2
With respect to hydrants, driveways, buildings, and landscaping, fire department connections shall be so located that fire apparatus and hose connected to supply the system will not obstruct access to the building for other fire apparatus. The location of fire department connections shall be approved.

8.~~34~~33 Visible Location – Fire department connections shall be located IBC 912.2.1
on the street side of buildings, fully visible and recognizable from the street or nearest point of fire department vehicle access or as otherwise approved by the fire code official.

8.~~35~~34 Fire Department Connection Access – Immediate access IBC 912.3
shall be maintained at all times and without obstruction for a minimum of 3 feet.

8.~~36~~35 Fire Department Connection Signs – A metal sign with raised IBC 912.4
letters at least 1 inch in size shall be mounted on all fire department connections serving automatic sprinklers, standpipes or fire pump connections. Such signs shall read: AUTOMATIC SPRINKLERS, STANDPIPES or TEST CONNECTION, or a combination thereof as applicable.

Means of Egress – Chapter 10

9. General Means of Egress – Section 1003

9.1 Ceiling Height – 7 feet 6 inches (90 inches) min except where IBC 1003.2
otherwise noted such as:
.1 allowable projections – See IBC 1003.3.
.2 door height – See IBC 1008.1.1.
.3 80 inches minimum at stairs measured vertically above a IBC 1009.2
line connecting the nosings, for full width of stair and landing.
.4 Parking garages – min 7 ft per 406.4.1

9.2 Protruding Objects – 80 inches min headroom for any walking IBC 1003.3.1
surface, and for not more than 50 percent of ceiling area of a means of egress.

Except: door closers and stops not less than 78 inches
Barrier: provide where vertical clearance is less than 80 inches high; leading edge of barrier maximum 27 inches above the floor.

9.3 Free-standing objects – See IBC 1003.3.2. IBC 1003.3.2

9.4 Horizontal projections (structural elements, fixtures or furnishings) – maximum 4 inches between heights of 27 and 80 inches above walking surface. IBC 1003.3.3

Except: stair and ramp handrails may project 4.5 inches.

9.5 Clear width – protruding objects shall not reduce the minimum clear width of accessible routes required by Section 1104. IBC 1003.3.4

9.6 Floor Surface – of means of egress slip resistant and securely ~~Attached~~attached. IBC 1003.4

9.7 Elevation change – less than 12 inches in means of egress use sloped surface; slope > 1 in 20 use ramp in accordance with Section 1010 if difference 6 inches or less, use handrails or floor finish material that contrasts with adjacent floor. IBC 1003.5

Except: where not required for accessibility, a stair with a single riser or two risers and a minimum 13 inch tread in accordance with Section ~~1009~~1009.3, and at least one handrail in accordance with Section ~~1012~~1012 within 30 inches of the centerline of the normal path of egress travel on the stair.

9.8 Means of egress continuity – path of egress travel along a means of egress shall not be interrupted by any building element other than a means of egress component. Obstructions shall not be placed in the required width of a means of egress except where projections are permitted. Capacity of a means of egress system shall not be diminished along the path of egress travel. IBC 1003.6

9.9 Elevator – shall not be used as a component of a required means of egress unless used an accessible means of egress in accordance with Section 1007.4. IBC 1003.7

10. Occupant Load – Section 1004

10.1 Floor Area, Gross, is the floor area within the inside perimeter of the exterior walls, exclusive of vent shafts and courts, without deduction for corridors, stairways, closets, the thickness of interior walls, columns or other features. The floor area, or portion thereof, not provided with surrounding exterior walls shall be the usable area under the horizontal projection of the roof or floor above. The gross floor area shall not included shafts with no openings or interior courts. IBC 1002

10.2 Floor Area, Net, is actual occupied area not including unoccupied IBC 1002

accessory areas such as corridors, stairways, toilet rooms, mechanical rooms and closets.

10.3 Design occupant load – Occupant load in a primary space shall include occupant load of primary space plus number of occupants egressing through it from any accessory area. IBC 1004.1

10.4 Occupant Load of Areas without Fixed Seating – the number of occupants computed at the rate of an occupant per unit of area as prescribed in Table 1004.1.1. For areas without fixed seating, not less than number determined by dividing the floor area under consideration by the occupant per unit of area factor in Table 1004.1.1. If not listed, the building official shall establish a use based on a listed use that most nearly resembles the intended use. IBC 1004.1.1

Maximum Floor Area Allowances per Occupant IBC 1004.1.1

Function of Space	Area (SF) per Occupant
Accessory storage areas, mechanical equipment room	300 gross
Parking garages	200 gross

10.5 Exiting from Multiple Levels - Where exits serve more than one floor, the occupant load of each floor considered individually shall be used in computing the exit capacity at that floor, provided that the exit capacity shall not decrease in the direction of egress travel. IBC 1004.4

10.6 Egress Convergence – Where means of egress from floors above and below converge at an intermediate level, capacity at and beyond point of convergence shall not be less than the sum of the two floors. IBC 1004.5

10.7 Yards and courts – Must have egress as per interior spaces and egress of the building through them must be cumulative. SPS 362.1004

10.~~11~~8 Multiple Occupancies – Means of egress requirements shall apply to each portion of building shall be based on occupancy of that space. Shared portions of means of egress shall meet most stringent requirements. IBC 1004.9

11. Egress Sizing – Section 1005

11.1 Egress Width per Occupant IBC 1005.1

Minimum required egress width	
Stairways	0.3 (inches per occupant)
Other egress components	0.2 (inches per occupant)

Multiple means of egress shall be sized such that loss of any one means of egress shall not reduce the available capacity to less than 50 percent of the required capacity. The maximum capacity required from any story shall be maintained to the means of egress termination.

11.2 Door Encroachment – Doors opening into path of egress travel IBC 1005.2

shall not reduce the required width to less than one-half during the course of the swing. When fully open, the door shall not project more than 7 inches into the required width. IBC 1008.1.5

12. Number of Exits and Exit Access Doorways – Section 1006

12.1 Egress from spaces IBC 1006.1
Two means of egress are to be provided where the occupancy exceeds the maximum number per table 1006.2.1. Three or more exits shall be provided for occupancies over 500 to 1000. Four are required for over 1000.

12.2 See section 1006 for specific occupancy requirements.

13. Exit and Exit Access Doorways Configuration– Section 1007

13.1 Two exits shall be separated by a distance no greater than ½ the diagonal dimension of the room or floor, 1/3 the diagonal dimension for sprinklered buildings.

13.2 The separation distance shall be measured to any point on the doorway or the closest riser in an exit access stair.

13.3 For three or more exits no less than two shall be separated as per the above.,

12. Means of Egress Illumination – Section 1008

12.1 Illumination Required IBC 1006.1
The means of egress, and exit discharge, shall be illuminated at all times the building space served by the means of egress is occupied.

12.2 Illumination Level – not less than 1 foot candle at the walking surface IBC 1006.2

12.3 Illumination Emergency Power – normally provide by building's electrical supply. In case of power failure, an emergency electrical system shall automatically illuminate: IBC 1006.3

1. Aisles and unenclosed egress stairs in rooms requiring two or more means of egress.
2. Corridors, exit enclosures and exit passageways in buildings requiring two or more exits.
3. Exterior egress components at other than the level of exit discharge is accomplished for buildings requiring two or more exits.
4. Interior exit discharge elements, as permitted by Section 1024.1, in buildings requiring two or more exits.
5. Exterior landings, as required by Section 1008.1.5, for exit discharge doorways in buildings required to have two or more exits.

13. Accessible Means of Egress – Section 1009

13.1 Accessible spaces shall be served by not less than one accessible means of egress, and where more than one means IBC 1009.1

of egress is required from an accessible space, each accessible portion of the space shall be served by not less than two accessible means of egress.

2. One accessible means of egress is required from an accessible mezzanine level in accordance with 1009.3, 1009.4 or 1009.5.

13.2 Required accessible means of egress shall be continuous to a public way and shall consist of one or more of the following: IBC 1009.2

- accessible routes	1104
- stairways within vertical exit enclosures	1009.3 and 1023
- exterior exit stairways	1009.3 and 1027
- elevators	1009.4
- platform lifts	1009.5
- horizontal exits	1026
- ramps	1012
- areas of refuge	1009.6

Exceptions:
1. Where exit discharge is not accessible, provide an IBC 1007.8 exterior area for assisted rescue.
2. Where exit stairway is open to the exterior, the accessible means of egress shall include either a Section 1007.6 area of refuge or a 1007.8 exterior area for assisted rescue.

13.3 Elevators required – In buildings where a required accessible floor is four or more stories above or below a level of exit discharge, at least one required accessible means of egress shall be a Section 1009.4 elevator. IBC 1009.2.1

13.4 Elevators – if used as an accessible means of egress, follow: emergency operation and signaling device requirements of ASME A17.1 Section 2.27; standby power requirements of IBC 2702 and 3003. IBC 1009.4

13.7 Signage – At exits and elevators serving a required accessible space but not providing an approved accessible means of egress, signage shall be installed indicating the location of accessible means of egress. IBC 1009.10

13.8 Exterior area for assisted rescue – must be open to the outside air and meet the requirements of Section 1009.7.1 - 4. IBC 1009.7

13.8.3 Two way communication shall be provided at the elevator landings on each accessible floor above or below the level of exit discharge; requirements and directions per 1009.8.1 and 1009.8.2. IBC 1009.8

14. Doors Gates and Turnstiles– Section 1010

14.1 Means of egress doors shall be readily distinguishable from the adjacent construction and finishes, such that the doors are easily recognizable as doors. IBC 1010.1

14.2 Size of doors - Minimum width sufficient for occupant load served and provide a clear opening of a single leaf door, or of one leaf in a pair, IBC 1010.1.1

	32 inches with the door open 90 degrees, measured between the face of the door and the opposite stop. Maximum width – 48 inches per leaf. Minimum height – 80 inches. 32" not required for toilet stall doors	SPS 362.1008
14.3	Projections into required clear width – below 34 inches above the floor are prohibited; maximum 4 inches permitted between 34 and 80 inches above the floor, i.e. hardware.	IBC 1010.1.1.1
14.4	Door swing – egress doors shall be side-hinged swinging. Except: Power-operated doors - See IBC 1010.1.3.2.	IBC 1010.1.2
14.5	Door swing direction - swing in the direction of egress travel where serving an occupant load of 50 or more.	IBC 1010.1.2
14.6	Operating force – interior swing door shall not exceed 5-pound latch-side force. For others, latch shall release with 15-pound latch-side force, door set in motion with 30-pound latch-side force, and swing to full-open position with 15-pound latch-side force.	IBC 1010.1.3
14.7	Revolving doors – per 1010.1.4.1 May be used as egress for no more than 50 person capacity.	IBC 1010.1.4
14.8	Power-operated doors – in event of loss of power, door must be manually operable with forces listed at 1010.1.3 except door set in motion with maximum 50-pound latch side force. Full-power-operated doors shall comply with BHMA A156.10. Power-assisted and low-energy doors shall comply with BHMA A156.19.	IBC 1010.1.4.2
14.9	Floor elevation – provide level and clear floor area adjacent to all doors. Floor elevation to be the same elevation on each side of door, and level, except 0.25 in 12 (2%) slope permitted at exterior Except – variations due to differences in finish materials, but no more than 0.5 inch	IBC 1010.1.5
14.9	Landings at doors – width not less than door width. Doors in fully open position shall not project more than 7 inches into the required width, and when open in any position shall not reduce the required width to less than one-half during the course of the swing.	IBC 1010.1.6
14.10	Thresholds – ½ inch maximum with level changes greater than ¼ inch beveled not greater than 1 unit vertical to 2 horizontal (50% slope).	IBC 1010.1.7
14.11	Door arrangement – minimum 48 inches between doors in series plus the width of any door swinging into the space. Doors shall swing in same direction, or away from the space. Where maneuvering space is provided, meet IBC 1101.2 so wheelchairs will not block the doors.	IBC 1010.1.8 SPS 362.1008

14.12 Door operations – readily openable from the egress side without the use of a key or special knowledge or effort — IBC 1010.1.9

14.13 Hardware height – hardware used to unlock, unlatch, and put door in motion shall be mounted between 34 and 48 inches above finished floor, with maximum projection of 4 inches. Locks for security not used for normal operation are permitted at any height. — IBC 1010.1.9.2

14.14 Bolt locks – manually operated flush bolts or surface bolts are not permitted except on inactive leaf of a pair serving storage or equipment room. — IBC 1010.1.9.4

14.15 Unlatching of any door or leaf shall not require more than one operation. — IBC 1010.1.9.5

14.17 Stairway doors shall be openable from both sides without the use of a key or special knowledge or effort, except the discharge doors shall be openable from the egress side and shall only be locked from the opposite side. — IBC 1010.1.9.11

14.18 Electrical rooms with equipment rated 1,200 amperes or more and over 6 feet wide contain overcurrent devices, switching devices or control devices with exit access doors must be equipped with panic hardware and doors must swing in the direction of egress. — IBC 1010.1.10

15. Stairways – Section 1011

15.1 Width – determined in accordance with 1005.1 except individual stair minimum 44 inches.
Except: if serving less than 50 occupants, then 36 inches minimum. — IBC 1011.2

15.2 Head Room 80 inches minimum at stairs measured vertically above a line connecting the nosings down to the landings, for full width of stair and landing. — IBC 1011.3

15.3 Treads and Risers — IBC 1011.5.2

.1	Maximum riser heights	7 inches nosing-to-nosing
	Minimum riser heights	4 inches
.2	Minimum tread depth	11-inches nosing-to-nosing

15.4 Dimensional Uniformity – greatest deviation between largest and smallest risers or treads in a flight shall be 0.375 inches.
See IBC for requirements of exterior stairs meeting a sloping grade. — IBC 1011.5.4

15.5 Profile – Nosing curvature maximum 9/16 inch; beveling of nosing maximum 9/16 inch. Risers shall be solid, vertical or sloped not more than 30 degrees from the vertical. Nosing projection maximum 1.25 inches over tread next below; all nosing shall be uniform including at landing or floor. — IBC 1011.5.5

Except: Solid risers not required for stairs not required as accessible enclosed exit stair. However, riser opening shall not allow sphere of 4 inches diameter to pass.

15.6 Landings – are required at top and bottoms of stairs IBC 1011.6
- .1 Width of landing (perpendicular to gap between flights) equals width of stair minimum
- .2 Length of landing in direction of exit travel equals width of stair minimum, or need not exceed 48 inches if stair is straight run
- .3 Doors in fully open position shall not project more than 7 inches into the required landing width, and when open in any position shall not reduce the required landing width to less than one-half during the course of the swing.

15.7 Construction – stairs shall be built of materials consistent with building construction type, except that wood handrails are permitted. IBC 1011.7

15.8 Walking surface – maximum slope 1 unit vertical in 48 horizontal (2-percent) in any direction with a solid, securely attached surface, openings in treads and landings permitted provided a sphere of 1-1/8 inches diameter cannot pass. IBC 1011.7.1

15.9 Outdoor – Outdoor stairways and outdoor approaches to stairways shall be designed so that water will not accumulate on walking surfaces. IBC 1011.7.2

15.10 Vertical rise between landings – maximum 12 feet IBC 1011.8

15.11 Handrails IBC 1011.11
- .1 Stairways shall have handrails at both sides of all stairs complying with Section 1014, and Section 2407 if made of glass.
- .2 Top of Handrail — 34 inches to 38 inches above nosings or ramp
- .3 Reach Distance — All portions of stairway width required for egress capacity within 30 inches of a handrail
- .4 Handrail Size (circular) — 1-1/4 to 2 inches outside diameter or provide equivalent graspability (if not circular see Code for requirements)
- .5 Continuity — handrail gripping surface continuous.
- .6 Handrail Extensions: — must return to the wall
  - Top Riser — 12-inches
  - Bottom Riser — slope one tread length beyond bottom riser
- .7 Clear Space at Handrails — 1-1/2 inches free of any sharp or abrasive elements
- .8 Stairway projections — 4-1/2 inches at or below handrail height not limited above required headroom clearance

15.12 Guards complying with 1015 required along stairs and landings IBC 1011.13

16. Ramps – Section 1012

16.1 Section 1010 applies to means of egress ramps except: IBC 1012.1
1. Curb ramps shall comply with ICC A117.1.
2. Vehicle ramps in parking garages for pedestrian exit access shall not be required to comply with Sections 10120.3 through 1012.10 when they are not an

accessible route serving accessible parking spaces, other required accessible elements or part of an accessible means of egress.

16.2 Slope – Ramps used as part of a means of egress shall have a running slope not steeper than one unit vertical in 12 units horizontal (8-percent slope). The slope of other pedestrian ramps shall not be steeper than one unit vertical in eight units horizontal (12.5 percent slope). IBC 1012.2

16.3 Cross Slope – The slope measured perpendicular to the direction of travel of a ramp shall not be steeper than one unit vertical in 48 units horizontal (2 percent slope). IBC 1012.3

16.4 Vertical Rise – for any ramp run shall be 30 inches maximum. IBC 1012.4

16.5 Minimum Dimensions – of means of egress ramp
Width – not less than required for corridors by Section 1020.2. IBC 1012.5.1
Clear width of a ramp and the clear width between handrails, if provided, shall be 36 inches minimum.
Headroom – in all parts shall not be less than 80 inches. IBC 1012.5.2
Restrictions – shall not reduce in width in the direction of egress travel. Projections into the required ramp and landing width are prohibited. Doors opening onto a landing shall not reduce the clear width to less than 42 inches. IBC 1012.5.3

16.6 Landings – Ramps shall have landings at the bottom and top of each ramp, points of turning, entrance, exits and at doors. IBC 1012.6

16.6.1 Slope – not steeper than one unit vertical in 48 units horizontal, (2 percent) in any direction. Changes in level are not permitted. IBC 1012.6.1

16.6.2 Width – at least as wide as the widest ramp run adjoining the landing. IBC 1012.6.2

16.6.3 Length – Landing length shall be 60 inches minimum. IBC 1012.6.3
Except: where the ramp is not part of an accessible route, the length of the landing shall not be required to be more than 48 inches in the direction of travel.

16.6.4 Changes in Direction – Where changes in direction of travel occur at landings provided between ramp runs, the landing shall be 60 inches by 60 inches minimum. IBC 1012.6.4

16.6.5 Doorways – located adjacent to a ramp landing, maneuvering clearances required by ICC A117.1 are permitted to overlap the required landing area. IBC 1012.6.5

16.7 Ramp Construction – materials shall be consistent with those permitted for the type of construction of the building, except that wood handrails shall be permitted for all types of construction. Ramps used as an exit shall conform to applicable requirements of Sections 1020.1 through 1020.1.3 for exit enclosures. IBC 1012.7

16.7.1 Ramp Surface – shall be slip-resistant materials that are securely attached. IBC 1012.7.1

16.7.2 Outdoor – ramps and approaches shall be designed so water will not accumulate on walking surfaces. IBC 1012.7.2

16.8 Handrails – required on both sides for ramps with rise greater than 6 inches. IBC 1012.8

16.9 Edge Protection – required on each side of ramp runs and ramp landings. Except: IBC 1012.10
1. Not required for ramps not required to have handrails, provided they have flared sides that comply with ICC A117.1 curb ramp provisions.
2. Not required on sides of ramp landings serving an adjoining ramp run or stairway.
3. Not required on sides of ramp landings having a vertical dropoff of not more than 0.5 inch within 10 inches horizontal of the required landing area.

16.9.1 Curb, Rail, Wall or Barrier – shall be provided that prevents the passage of a 4-inch diameter sphere, where any portion of the sphere is within 4 inches of the floor or ground surface. IBC 1012.10.1

16.9.2 Extended Floor or Ground Surface – shall extend 12 inches minimum beyond the inside face of a handrail. IBC 1012.10.2

16.10 Guards – shall be provided where required by Section 1013 and and constructed in accordance with 1015. IBC 1012.9

17. Exit Signs – Section 1013

17.1 Exits and exit access doors shall be marked by an approved exit sign readily visible from any direction of egress travel. IBC 1013.1
Access to to exits shall be marked by readily visible exit signs where the exit or path of egress travel is not immediately visible. Exit sign placement shall be such that no point in a corridor is more than 100 feet, or the listed viewing distance for the sign, whichever is less, from the nearest visible exit sign.

Except:
1. Not required in rooms or areas that require only one exit or exit access.
2. Not required at main exterior exit doors or gates that are obviously and clearly identifiable as exits if approved by the building official.

17.2 Exit signs shall be internally or externally illuminated except Section 1011.3 tactile signs. IBC 1013.2

17.3 A visual and tactile sign, stating EXIT and complying with ICC A117.1shall be provided adjacent to each door to an egress stairway, an exit passageway and the exit discharge. IBC 1013.3

17.4 Internally illuminated exit signs shall be listed and labeled, and IBC 1013.4

installed in accordance with manufacturer's instructions and Chapter 27. Exit signs shall be illuminated at all times.

17.5 Externally illuminated exit signs shall comply with 1013.6.1 through 1013.6.3. IBC 1013.6

17.5.1 Graphics – Every exit sign and directional exit sign shall have plainly legible letters not less than 6 inches high with the principal strokes of the letters not less than 0.75 inch wide. "EXIT" shall have letters having a width not less than 2 inches wide, except "I", and the minimum spacing between letters shall not be less than 0.375 inch. If larger than minimum, widths, strokes and spacing shall be in proportion to height. IBC 1013.6.1

"EXIT" shall be in high contrast with background and shall be clearly discernible when the means of exit sign illumination is or is not energized. If a chevron directional indicator is provided, construction shall be such that the direction of the chevron cannot be readily changed. IBC 1013.6.1

17.5.2 Face of externally illuminated exit sign shall have an intensity of not less than 5 foot-candles. IBC 1013.6.2

17.5.4 Exit signs shall be illuminated at all times. To ensure not less than 90 minutes illumination in case of primary power loss, the sign illumination means shall be connected to an emergency power system provided from storage batteries, unit equipment or an on-site generator. The emergency power system installation shall be in accordance with Section 2702. IBC 1013.6.3
Except: Approved exit sign installation means that provide continuous illumination independent of external power sources for a duration of not less than 90 minutes, in case of primary power loss, are not required to be connected to an emergency electrical system.

18. Handrails – Section 1014

18.1 Handrails for stairways and ramps shall be adequate in strength and attachment in accordance with Section 1607.8. IBC 1014.1

18.2 Height – measured above tread nosing or ramp finish surface, not less than 34 inches and not more than 38 inches. IBC 1014.2

18.3 Graspability – A circular cross-section with outside diameter of at least 1.25 inches and not greater than 2 inches, or equivalent graspability. IBC 1014.3
If not circular, a perimeter dimension of at least 4 inches and not greater than 6.25 inches with a maximum cross-section dimension of 2.25 inches. Edges shall have a minimum radius of 0.01 inch.

18.4 Continuity – Handrail gripping surfaces shall be continuous, without interruption by newel posts or other obstructions. Except brackets or balusters attached to bottom of handrail that do not project horizontally beyond the sides of the handrail within 1.5 inches of the bottom of the handrail shall not be considered obstructions. For each 0.5 inch of additional handrail perimeter IBC 1014.4

dimension above 4 inches, the vertical clearance dimension of 1.5 inches shall be permitted to be reduced by 0.125 inch.

18.5 Extensions – Handrails shall return to a wall, guard or the walking surface or shall be continuous to the handrail of an adjacent stair flight or ramp run. At stairways where handrails are not continuous between flights, the handrails shall extend horizontally at least 12 inches beyond the top riser and continue to slope for the depth of one tread beyond the bottom riser. At ramps where handrails are not continuous between runs, the handrail shall extend horizontally above the landing 12 inches minimum beyond the top and bottom ramps. IBC 1014.6

18.6 Clearance – Clear space between a handrail and a wall or other surface shall be a minimum of 1.5 inches. A handrail and a wall or other surface adjacent to the handrail shall be free of any sharp or abrasive elements. IBC 1014.7

18.7 Projections – On ramps, clear width between handrails shall be 36 inches minimum. Projections into the required width of stairways and ramps at each handrail shall not exceed 4.5 inches at or below the handrail height. Projections into the requried width shall not be limited above the minimum headroom height required in Section 1009.2. IBC 1014.8

18.8 Intermediate Stairway Handrails – all portions of the stairway width required for egress capacity are within 30 inches of a handrail. On monumental stairs, handrails shall be located along the most direct path of egress travel. IBC 1014.9

19. Guards – Section 1015

19.1 Guards – of strength and attachment required by Section 1607.8, and Section 2407 if made of glass, located along open-sided walking surfaces, mezzanines, industrial equipment platforms, stairways, ramps, and landings located more than 30 inches above the floor or grade below, and similarly along glazed sides of stairs, ramps and landings where glazing does not meet strength and attachment requirements of Section 1607.8. IBC 1015.2

19.2 Height – 42 inches measured vertically above leading edge of tread, adjacent walking surface or seatboard. IBC 1015.2

19.3 Openings – 4-inches diameter sphere cannot pass through any opening up to height of 36 inches, and 4 3/8-inches from 36 inches to 42 inches. IBC 1015.4

Exceptions:
1. 6-inches diameter sphere cannot pass through triangular opening formed by riser, tread, and bottom rail of guard.
2. 21-inches diameter sphere cannot pass guard at elevated walkway used to access or used for MEP systems or equipment.

19.4 Mechanical Equipment – guards required where appliances, IBC 1015.6

equipment, fans, roof hatch openings or other components that require service are located within 10 feet of a roof edge or open side of a walking surface located more than 30 inches above floor, roof, or grade below. IBC 1015.7
21-inches diameter sphere cannot pass such guard. Guard shall extend 30 inches beyond each end of each item near the edge.

20. Exit Access – Section 1016

20.1 Egress shall not pass through intervening rooms or areas, except where such adjoining rooms or areas are accessory to area served, are not a high-hazard occupancy and provide a discernible path of egress travel to an exit. Egress shall not pass through storage rooms, kitchens or closets. Exit access shall not pass through a room that can be locked to prevent egress. Exception: In S occupancy if the intervening room or space is of the same or lesser occupancy group. IBC 1016.2

Exit access is permitted through an enclosed elevator lobby, but not less than one required exit shall be provided without exiting through an elevator lobby.

20.2 Common path of egress travel shall not exceed 100 feet; for Group S with automatic sprinkler system. IBC 1014.3

21. Exit Access Travel Distance – Section 1017

21.1 Exits shall be so located on each story such that the maximum length of the exit access travel, measured from the most remote point within a story to the entrance to an exit along the natural and unobstructed path of egress travel, shall not exceed the distances given in Table 1017.2. When sprinklered, in accordance with 903.3.1.1. IBC 1017.3

Maximum Travel Distances	
Use S-2	400 feet (sprinklered)

22. Exit Access Stairways and Ramps – Section 1019

22.1 Shall be enclosed per Section 713, except as listed in 1019.3 IBC 1019.3

23. Corridors – Section 1020

23.1 Rating – 0 hours rating required for sprinklered S occupancy IBC 1020.1

23.1 Width – as required by Section 1005.1 but not less than 44 inches IBC 1020.2

Except: 24 inches for access to and utilization of MEP systems and equipment; 36 inches with a required occupant capacity of less than 50;

23.2 Dead End – Where more than one exit or exit access doorway is required, the exit access shall be arranged such that there are no dead ends in corridors more than 50 feet in length (S Occupancy). IBC 1020.4

23.3 Air Movement – Corridors shall not serve as supply, return, Exhaust, relief or ventilation air ducts. IBC 1020.5

23.4 Ceiling Return Air Plenum – Permitted per IBC 1020.5.1

23.5 Continuity – Fire resistance rated corridors shall be continuous from point of entry to an exit, and shall not be interrupted by intervening rooms except foyers, lobbies, or reception rooms constructed as required for corridors. Other spaces may be open to corridors if: 1) Not a hazardous Use, 2) Not an incidental use (Table 508.2), 3) don't obstruct exiting. IBC 1020.6 SPS 362.1018

24. Exits – Section 1022

24.1 Once a given level of exit protection is achieved, such level of protection shall not be reduced until arrival at the exit discharge. IBC 1022.1

25. Interior Exit Stairways and Ramps– Section 1023

25.1 Interior exit enclosures shall not be used for any purpose other than a means of egress. Interior exit stairways and ramps shall be enclosed with fire barriers constructed in accordance with Section 707, or horizontal assemblies constructed in accordance with Section 711, or both. Shall discharge directly outside or through and exit passageway per 1023. Exceptions: see 1023.1 IBC 1023.1

25.2 Openings in exit enclosures other than unexposed exterior openings shall be limited to those necessary for exit access to the enclosure from normally occupied spaces and for egress from the enclosure. IBC 1023.4

25.3 Where interior exit enclosures are extended to the exterior by an exit passageway, the door assembly from the exit enclosure to the exit passageway shall be protected by a fire door conforming to Section 716.5. IBC 1022.2.1

25.4 Elevators shall not open into an exit enclosure. IBC 1023.4

25.5 Penetrations into and openings through an exit enclosure are prohibited except for required exit doors, equipment and ductwork necessary for independent pressurization, sprinkler piping, standpipes, electrical raceway for fire department communications and electrical raceway serving the exit enclosure and terminating at a steel box not exceeding 16 square inches. Such penetrations shall be protected in accordance with Section 715. IBC 1023.5

25.6 Ventilation – if required, see Code for requirements, location and enclosure of equipment and ducts. Exit enclosure ventilation systems shall be independent of other building ventilation systems. IBC 1023.6

25.7 Exterior walls of an exit enclosure shall comply with Section 705. Where non-rated walls or unprotected openings enclose the exterior IBC 1023.7

of the stairway, and the walls or openings are exposed by other parts of the building at an angle of less than 180 degrees, the building exterior walls within 10 feet horizontally of a non-rated wall or unprotected opening shall be constructed as required for a minimum 1-hour fire resistance rating with ¾-hour opening protectives. This construction shall extend vertically from the ground to a point 10 feet above the topmost landing of the stairway or to the roof line, whichever is lower.

25.8 Discharge Identification Barrier IBC 1023.8
Stairway in exit enclosure shall not continue below level of exit discharge unless an approved barrier is provided at the level of exit discharge. Provide directional exit signs in accordance with 1011.

25.9 A sign shall be provided at each floor landing in interior vertical exit enclosures connecting more than three stories designating: the floor level; the terminus of the top and bottom of the stair enclosure; the stair identification; the story of discharge; the direction to the exit discharge, and the availability of roof access from the stairway. The sign shall be located 5 feet above the floor landing in a position which is readily visible when doors are open and closed. See 1023.9.1 for details. IBC 1023.9

25.10 At stair landings where two or more doors lead to the floor Level, any door with direct access to an enclosed elevator lobby shall have a sign adjacent to the door stating “Elevator Lobby”. IBC 1023.10

25.11 Interior stairways must be smokeproof enclosures IBC 1023.11

26. Exit Passageways – Section 1024

26.1 Exit passageway shall not be used for any purpose other than as a means of egress. IBC 1024.1

26.2 Width – as required by Section 1005.1 but not less than 44 inches IBC 1024.2
Except: 36 inches with a required occupant capacity of less than 50.

26.3 Walls, floors, and ceiling not less than 1-hour fire-resistance IBC 1024.3

26.4 Shall terminate at an exit discharge or public way IBC 1024.4

26.5 Openings other than unexposed exterior openings shall be limited to those necessary for exit access to the exit passageway from normally occupied spaces and egress from the exit passageway. IBC 1024.5

26.6 Penetrations into and openings through an exit enclosure are prohibited except for required exit doors, equipment and ductwork necessary for independent pressurization, sprinkler piping, standpipes, electrical raceway for fire department communications and electrical raceway serving the exit passageway and terminating at a steel box not exceeding 16 square inches. Such penetrations shall be protected in accordance with Section 713. IBC 1024.6

27. Luminous Egress Path Markings – Section 1025

27.1 Not required in S or R-2 occupancies IBC 1025.1

28. Horizontal Exits – Section 1026

28.1 Horizontal exits shall not be the only exit from an area, nor more than half the exits. IBC 1026.1

28.2 Separation must be min 2 hours and the fire barrier must extend from exterior wall to exterior wall, completely dividing the floor. IBC 1026.2

28.3 Cross corridor doors must be automatic closed by smoke detector each side. IBC 1026.3

28.4 Capacity of each side shall be the occupancy of the side plus The exiting side at 3 sf /occup., and exits sized for both. IBC 1026.4

29. Exterior Exit Ramps and Stairways – Section 1027

29.1 Not permitted for high rise buildings IBC 1027.2

30. Exit Discharge – Section 1028

30.1 Exits shall discharge directly to the exterior of the building. The exit discharge shall be at grade or shall provide direct access to grade. The exit discharge shall not reenter a building. IBC 1028.1

Except:

.1 A maximum of 50 percent of the number and capacity of the exit enclosures is permitted to egress through areas on the level of discharge provided all of the following are met;

.1 Such exit enclosures egress to a free and unobstructed way to the exterior of the building, which way is readily visible and identifiable from the point of termination of the exit enclosure.

.2 The entire area of the level of discharge is separated from areas below by construction conforming to the fire-resistance rating for the exit enclosure.

.3 The egress path from the exit enclosure on the level of exit discharge is protected throughout by approved automatic system. All portions of the level of discharge with access to the egress path shall either be protected throughout by a sprinkler system, or separated from the egress path in accordance with the requirements for the enclosure of exits.

2. A maximum of 50 percent of the number and capacity of the exit enclosures is permitted to egress through a vestibule provided all of the following are met;

.1 The entire area of the vestibule is separated from areas below by construction conforming to the fire-resistance rating for the exit enclosure.

.2 The depth from the exterior of the building is not greater than 10 feet and the length is not greater than 30 feet.
.3 The area is separated from the remainder of the level of exit discharge by construction providing protection at least the equivalent of approved wired glass in steel frames.
.4 The area is used only for means of egress and exits directly to the outside.

30.2 Egress courts: See 1027.5 – if less than 10' wide must have 1 hr walls and protected openings. IBC 1028.4

30.3 Exit discharge shall provide a direct unobstructed access to a public way. IBC 1028.5

Accessibility – Chapter 11

31 Scoping Requirements

31.1 Sites, buildings, elements and spaces to be accessible except: IBC 1103.2
Employee work areas per 1103.2.3 and SPS 362.1103;
Raised areas for security, fire safety or life safety;
Limited access areas accessed by ladders, catwalks, etc;
Equipment spaces for maintenance.

32 Accessible Route

32.1 Accessible routes shall be provided from public transportation, parking, public streets, sidewalks, except if the only connection from the public way and the entrance is vehicular. IBC 1104.1

32.2 Accessible routes within the site shall connect all buildings, facilities and areas. IBC 1104.2

32.3 Accessible routes within a building shall connect all areas, except employee areas per 1104.3.1. IBC 1104.3

32.4 Accessible routes within a building shall connect all levels, except levels that do not contain elements per 1107 (dwelling and sleeping units) or 1108 (special occupancies). IBC 1104.4

34.5 Accessible routes shall coincide with general circulation IBC 1104.5

34.6 Security barriers shall not obstruct an accessible route IBC 1104.6

33 Accessible Entrances

33.1 Minimum of 60% of entrances shall be accessible, including: IBC 1105.1
Entrances from public parking,
Entrances from tunnels or walkways,
Restricted entrances,
Service entrances, if it is the only entrance to a building or tenant.

At least one entrance shall be provided to each tenant or dwelling unit in a facility.

34 Parking and Passenger Loading Facilities

34.1 Accessible parking shall be provided per table 1106.1 IBC 1106.1
For 501 to 1000 spaces, provide 2%.

34.2 Accessible parking shall located on the shortest accessible IBC 1107.6
Route to an accessible entrance. For parking facilities, the shortest accessible route to the pedestrian entry to the parking facility. If multiple entries, dispersed to those entries, except accessible van parking can be on one level.

35 Other Features and Facilities

35.1 Toilet rooms shall be accessible with at least one of each type IBC 1109.1
of each fixture to be accessible and at least 5% of lavatories.
Water closet compartments to be per ICC A117.1

35.2 Where drinking fountains are provided, they shall be hi-lo IBC 1109.5

35.3 Where elevators are provided, comply with 3001.3 IBC 1109.6

35.4 Signage shall be provided in the following locations: IBC 1110.1
1) Parking spaces required per 1106 for the general public SPS 362.1110
shall be identified with signage specified in s. Trans 200.07. except for parking for use only by employees.
2) Accessible passenger loading zones.
3) Accessible entrances where not all are accessible
4) Unisex toilet rooms
5) Exterior areas for assisted rescue per 1007.9

35.5 Directional signage or information about functional spaces or SPS 362.1110
Special accessibility provisions shall comply with ICC 117.1 and be provided in the following locations:
1) Inaccessible building entrances
2) Inaccessible public toilets
3) Elevators not serving an accessible route
4) Single sex toilet rooms directing to the nearest family toilet room
5) Exits not providing an accessible means of egress.

35.6 Signage shall also be provided at: IBC 1110.3
1) At each area of refuge, egress stairs, exit passageways, etc
2) At exterior areas for assisted rescue, provide signage per 1007.11
3) At two way communication, provide signage pe 1007.8.2
4) Within exit enclosures, provide signage per 1022.8

36. Interior Environment – Chapter 12

36.1 Ventilation – Buildings shall be provided with natural ventilation in IBC 1203.1

accordance with Section 1203.4 or mechanical ventilation in accordance with the International Mechanical Code.

36.3 Ventilation and exhaust systems for occupancies and operations involving flammable or combustible hazards or other contaminant sources shall be provided in accordance with the International Mechanical Code and International Fire Code. IBC 1203.5

36.4 Toilet rooms shall have a smooth, hard, non-absorbent floor surface and base of a minimum 6 inches high. IBC 1210.1

36.5 Toilet rooms shall have a smooth, hard, non-absorbent wall surface within 2 feet of urinals and water closets to a height of 4 feet above the floor, and except for structural elements, the materials used in such walls shall be of a type that is not adversely affected by moisture. Accessories, such as grab bars, towel bars, paper dispensers and soap dishes, provided on or within walls, shall be installed and sealed to protect structural elements from moisture. IBC 1210.2

37. Plumbing Fixture Requirements - Chapter 29

37.1 Minimum Number of Plumbing Fixtures IBC 2902.1
Not required for parking garages

37.2 Garage floor area wastewater. SPS 382.34
Garages for public buildings and facilities:
Where a drain will be installed to receive the wastewater from floor areas of public buildings and facilities on which vehicles can be driven, the wastewater shall discharge using one of the following methods:
In areas where vehicles will be driven or stored, the wastewater shall discharge through a floor drain equipped with a solid bottom sediment bucket, garage catch basin or oil interceptor.

38. Elevators - Chapter 30

38.1 Referenced Standards: Except as provided in chapter 30 or SPS 362, elevators shall comply with SPS 318. SPS 362.3001

38.2 Hoistway enclosures to comply with IBC 713.

38.3 Four or more cars serving all or the same portion of a building must be in at least two separate hoistways. Maximum of 4 cars per hoistway. IBC 3002.2

38.4 Except for elevators for egress per 1007.4 or 3008, signage must be provided at the call station to direct occupants to use stairs in case of fire. IBC 3002.3

38.5 At least one elevator serving all floors for buildings with levels 4 floors or more above or below grade must have an elevator of size to accommodate a stretcher. SPS 362.
Stretcher: 24 inches by 84 inches with not less than 5-inch

radius corners, in the horizontal, open position.
Except where all of a building's elevators are large enough for fire department emergency access, all elevator cars that are provided for fire department emergency access shall be identified by the international symbol for emergency medical services, star of life. The symbol may not be less than 3 inches high and shall be placed on both sides of the elevator hoistway door frame on all floor levels, approximately 60 inches above the floor.

38.6 Emergency doors shall be provided in blind hoistways.

38.7 Elevators shall not be in a common shaft with a stair.

39 Emergency Operations

39.1 Standby and emergency power to be per 3003.1.3. Hoistway venting to be on emergency power. IBC 3003.1

39.2 Elevators to be provided with fireman's recall per ASME IBC 3003.2

40 Machine rooms

40.1 Elevator machine rooms must be independently ventilated or air conditioned to prevent overheating of equipment. IBC 3005.2

40.2 Machine rooms serving pressurized hoistways must be pressurized on activation of a heat or smoke detector in the machine room or control room. IBC 3005.3

40.3 Machine rooms shall be rated per the hoistway requirements IBC 3005.4

41 Elevator Lobbies and Hoistway Opening Protection

41.1 Hoistway protection and enclosed elevator lobbies are required: IBC 3006.1
To comply with 3007.6 for fire service access elevators;
To comply with 3008.6 for occupant evacuation elevators

41.2 Hoistway opening protection is required per 3006.3 for elevators over 3 stories in high rise buildings if the elevator hoistway is over 75 ft. IBC 3006.2
Exception: not required at level of exit discharge for sprinklered bldgs.

41.3 Hoistway protection is to be one of the following: IBC 3006.3
1. A one hour lobby per 3006.3.1
2. For a fully sprinklered building, a smoke protected lobby
3. Additional doors protecting the hoistway openings per 3002.6
4. Hoistway pressurization per 909.2.1

42 Fire Service Access Elevator

42.1 Two are required by 403.6.1 for high-rise over 120 ft IBC 3007.1

42.2 An approved method shall be employed to prevent water from the sprinkler system from entering the hoistway. IBC 3007.3

42.3 Structural integrity of the hoistway construction shall meet the requirements of 403.2.3. Hoistway shall be lit to min 1 foot candle throughout it's height when emergency operation is active. IBC 3007.5

42.4 Fire service elevator shall open into a fire service access elevator lobby that: IBC 3007.6
Has direct access to an interior stairway;
Is enclosed with smoke barriers of min 1 hour rating (other than exit level);
Has 3/4 hr smoke rated doors per UL 1784;
Is min 150 sf, with no dimension less than 8 ft.
Has identified per 3006.6.5

Egress is permitted through the lobby per 1016.2.

42.5 Fire service access elevator shall be continuously monitored at the FCC.

42.6 See 3007.8 for electrical power requirements

42.7 A class I standpipe hose connection shall be provided in the exit stair having direct access from the fire service access lobby. The exit enclosure shall have access to the floor without passing through the fire service access lobby. IBC 3007.9

42.8 Note: See section 1009 for Elevators for accessible egress.

42. Special Construction - Chapter 31

Automatic Vehicular Gates

42.1 Shall comply with ASTM F 2200 and with UL 325.

END OF ANALYSIS