Transbay Transit Center
San Francisco, CA

MEP Basis of Design Report

Prepared for:

Pelli Clarke Pelli Architects
1056 Chapel Street
New Haven, CT 06510

Prepared by:

WSP
405 Howard Street, Suite 500
San Francisco, CA 94105

Mechanical Design Studio
1801 Oakland Blvd., Suite 110
Walnut Creek, CA 94596

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1.1. Codes and Standards

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- 2007 California Fire Code
- 2008 California Building Energy Efficiency Standards (Title 24)
- 2007 National Fire Protection Association (NFPA) 130
- American Society of Heating, Ventilation and Air Conditioning Engineers (ASHRAE)
- Sheet Metal and Air Conditioning Contractors Association (SMACNA)
- TJPA Owners Project Requirements (OPR) Report
- Transbay Transit Center Fire Life Safety Strategy Report

1.2. External Design Criteria

Location: San Francisco, California

Latitude: 37.6

Longitude: 122.4 West

Elevation: 6 feet

External Temperatures:

Season	Temperature	ASHRAE Value
Summer	85degF DB/62degF WB	0.4%
Winter	37degF DB	99.7%
Evaporation	65.1degF WB	

1.3. Indoor Design Criteria

The environmental design criteria for the various interior spaces within the Transbay Terminal have been determined based on the goal of achieving an optimal balance between comfort and energy efficiency.

The building has been separated into four distinct thermal zones:

- Naturally Ventilated (NV):

  The naturally ventilated spaces are areas that are considered transition spaces between indoors and outdoors. It is anticipated that commuters will pass through these transitory spaces to their transportation link or to an exit point in the building.

- Mechanically Ventilated (MV):

  The mechanically ventilated spaces include the Train Platforms and most mechanical, electrical and maintenance/storage rooms.

- Semi-Conditioned (SC):

  The main circulation and waiting areas on the Lower Concourse Level that connect the naturally ventilated Grand Hall to the mechanically ventilated Train Platform Level will be semi-conditioned to temper the air within the space and create a buffer without wasting energy through the loss of fully conditioned air to the unconditioned spaces above and below.

- Fully Conditioned (FC):

The comfort conditions within the future tenant spaces (office, transit operations and retail) will ultimately be determined by the tenants but we have provided guideline design criteria that will form the basis of the Tenant Standards and will be used for sizing of base building utilities to each space.

Space	Thermal Zone	Winter Conditions		Summer Conditions	
		Temp (±2°F)	RH (±5%RH)	Temp (±2°F)	RH (±5%RH)
Train Platform	MV	52	Uncontrolled	78 (Setpoint) 90 (Max)	Uncontrolled
Grand Hall	NV	52	Uncontrolled	78 (Setpoint) 90 (Max)	Uncontrolled
Lower Concourse Circulation	SC	55	Uncontrolled	78 (Setpoint) 90 (Max)	60
Lower Concourse Waiting Areas	SC	68	35	78	60
Bus Deck Waiting	NV	Uncontrolled	Uncontrolled	Uncontrolled	Uncontrolled
Public Lobbies and Circulation	FC	68	45	78	50
Retail	FC	68	45	75	50
Restaurants – Dining	FC	68	45	75	50
Restaurants – Kitchen	SC	68	45	80	60
Meeting Rooms	FC	68	45	75	50
Public Restrooms	SC	68	45	78	50
BOH Corridor	SC	68	45	78	50
Administration/BOH	FC	68	45	75	50
Electrical Substations	MV	50	Uncontrolled	85	Uncontrolled
Electrical Closets	MV	50	Uncontrolled	85	Uncontrolled
MDF Rooms	FC	75	35	75	50
IDF Closets	FC	70	35	70	50
Elevator Machine Rooms	FC	50	45	80	50
Fire Pump Room	MV	50	Uncontrolled	85	Uncontrolled
Mechanical Rooms	MV	50	Uncontrolled	85	Uncontrolled
CHSR/Caltrain Ops	FC	68	45	75	50
CHSR/Caltrain Support	FC	68	45	75	50
Locker/dressing rooms	FC	72	45	75	50
Intercity Bus	FC	68	45	75	50
FCC	FC	68	45	75	50
SOC	FC	68	45	75	50
Trash Compactor Room	FC	65	Uncontrolled	65	Uncontrolled
TSER Rooms	MV	50	Uncontrolled	85	Uncontrolled

1.4. Ventilation Design Criteria

Occupancy Category[1]	ASHRAE 62.1-2007[3]			Title 24 2008[3]	Design
	People Outdoor Air Rate (Rp)	Area Outdoor Air Rate (Ra)	Minimum Exhaust Rate	Cfm/ft²	Air Change Rate (ACH)
	Cfm/Person	Cfm/ft²	(CFM/ft²)		
Grand Hall	7.5	0.06	--	0.15	--
Lower Concourse Circulation	7.5	0.06	--	0.15	--
Lower Concourse Waiting Areas	7.5	0.06	--	0.15	--
Bus Deck Waiting	7.5	0.06	--	0.15	--
Public Lobbies	5	0.06	--	0.15	--
Retail	7.5	0.12	--	0.2	--
Retail – Circulation	7.5	0.06	--	0.15	--
Restaurants – Dining	7.5	0.18	--	0.15	--
Restaurants – Kitchen	--	0.06	0.7	0.15	20[2]
Meeting Rooms	5	0.06	--	0.15	--
Corridors	--	0.06	--	0.15	--
Administration/BOH	5	0.06	--	0.15	--
Public Restrooms	--	0.06	50/unit	--	10
CHSR/Caltrain Ops	7.5	0.06	--	0.15	--
CHSR/Caltrain Support	7.5	0.06	--	0.15	--
Locker/dressing rooms	20	0.06	0.25	0.15	--
Intercity Bus	7.5	0.06	--	0.15	--
FCC	7.5	0.06	--	0.15	--
SOC	7.5	0.06	--	0.15	--
Electrical Substations	--	--	--	--	2
Electrical Closets	--	--	--	--	2
Storage Rooms	--	0.12	--	--	--
MDF Rooms	5	0.06	--	--	--
IDF Closets	DNL	DNL	--	--	--
Elevator Machine Rooms	DNL	DNL	--	--	--
Fire Pump Room	DNL	DNL	1.5	--	2
Mechanical Rooms	DNL	DNL	--	--	2
Trash Compactor Room	--	--	1.0	--	6
TSER Rooms	--	--	--	--	2

Occupancy Category[1]	ASHRAE 62.1-2007[3]			Title 24 2008[3]	Design
	People Outdoor Air Rate (Rp)	Area Outdoor Air Rate (Ra)	Minimum Exhaust Rate	Cfm/ft²	Air Change Rate (ACH)
	Cfm/Person	Cfm/ft²	(CFM/ft²)		
Janitor Closet	--	--	1.0	0.15	--
Copy/printing rooms	--	0.06	0.5	0.15	--
Fuel Storage Rooms	--	--	1.0	--	--
Taxi Staging Area[5]	--	--	0.75	--	--
Taxi Waiting Area[6]	7.5	0.06			
Loading Dock	--	--	1.5	--	--

Footnotes:

1. If the occupancy category for a proposed space is not listed in ASHRAE 62.1-2007, then requirements for the listed occupancy category that is most similar in terms of occupant density, activities and building construction shall be used.
2. Kitchen exhaust allowance.
3. These ventilation rates are subject to reduction based upon Demand Controlled Ventilation (monitored indoor air quality).
4. DNL = data not listed
5. Taxi staging ventilation rates are subject to reduction based upon monitoring carbon monoxide (CO) levels.
6. Taxi waiting area exhausted as part of taxi staging area.

1.5. Internal Heat Gain Design Criteria

Space	Occupant Density			Lighting Gains (Watts/ft²)		Equipment Gains (Watts/ft²)
	#/1000 ft² (ASHRAE)	#/1000 ft² (Title 24)	#/1000 ft² (Design)	ASHRAE 90.1-2007	Design Goal	Design
Grand Hall1	DNL	25	25	0.6	0.6	0.25
Lower Concourse Circulation2	DNL	25	25	1.0	1.6	0.25
Lower Concourse Waiting Areas2	100	67	67	1.0	1.6	0.25
Bus Deck Waiting4	DNL	25	25	0.6	0.6	N/A
Public Lobbies	150	67	67	1.5	1.1	0
Retail3	15	33	15	1.7	1.6	0.25
Retail – Circulation	40	33	33	1.7	1.0	0
Restaurants – Dining	70	67	67	1.4	0.9	--
Restaurants – Kitchen	--	5	5	1.5	1.2	1.0
Meeting Rooms	65	67	65	1.3	1.0	0.75
Administration/BOH	5	10	10	1.1	0.9	1.0
Corridors	--	--	--	0.5	1.1	0
Public Restrooms	--	--	--	0.9	0.7	0
Electrical Substations	0	0	0	1.5	0.5	Note 5
CHSR/Caltrain Ops	5	10	10	1.1	0.9	1.0
CHSR/Caltrain Support	5	10	10	1.1	0.9	1.0
Locker/dressing rooms	10	20	20	0.6	0.6	0
Intercity Bus Waiting2	100	67	67	1.0	1.6	0.25
FCC	5	10	5	1.1	0.9	1.0
SCC	5	10	10	1.1	0.9	15
Electrical Closets	0	0	0	1.5	0.5	Note 5
MDF Rooms	4	0	0	1.5	0.5	150
IDF Closets	0	0	0	1.5	0.5	75
Elevator Machine Rooms	0	0	0	1.5	0.5	Note 5
Fire Pump Room	0	0	0	1.5	0.5	Note 5
Mechanical Rooms	0	3	3	1.5	0.5	Note 5
Taxi Staging Area	0	0	0	0.2	0.2	--
Taxi Waiting Area	100	0	100	0.3	0.25	--
Loading Dock	0	0	0	0.3	0.25	--

Footnotes:

1. Grand Hall lighting is based on Airport Concourse category (Table 9.6.1).
2. Lower Concourse circulation and seating areas is based on Transportation (Table 9.5.1).
3. Retail sales lighting design load based on Table 9.6.2 – 1,000Watts + Retail area x 1.0W/sf).
4. DNL = data not listed
5. Loads based on actual equipment loads in each room.

1.6. Ductwork Design Criteria

The following air velocities and pressure losses will be used as the basis of design for all ductwork distribution systems:

1.6.1. Low Pressure Ductwork – All ductwork downstream of terminal units and constant volume ductwork less than +/-2" pressure class and below.

CFM Range	Friction per 100 Feet (in. water)
0-100	0.04
101-200	0.05
201-400	0.06
401-700	0.07
701-1000	0.08
1001-1500	0.09
1501-2000	0.1
2001-8000	1800 Feet/minute

1.6.2. Medium Pressure Ductwork - All ductwork from fan outlet to terminal units and all ductwork operating at +/-3" pressure class or higher.

CFM Range	Friction per 100 Feet (in. water)
0-14,000	0.1
+14,000	1800 Feet/minute

1.6.3. Emergency Ventilation Systems – per NFPA 130 the emergency ventilation system ductwork for the train box levels will be sized at a maximum velocity of 2,100 feet per minute.

1.7. Piping Design Criteria

The following pipe sizing criteria and pressure losses will be used as the basis of design for all piping distribution systems:

Pipe Size (Inches)	Flow (GPM) Occupied Areas	Max Velocity (ft/sec)	Max Head Loss (ft/100ft)	Flow (GPM) Unoccupied Areas	Max Velocity (ft/sec)	Max Head Loss (ft/100ft)
¾”	2.6-3.5	5.0	5.0	2.6-3.5	5.0	5.0
1”	3.6-7.5	5.0	5.0	3.6-7.5	5.0	5.0
1-1/4”	7.6-13	5.0	5.0	7.6-13	5.0	5.0
1-1/2”	14-23	5.0	5.0	14-23	5.0	5.0
2”	24-50	5.0	5.0	24-50	4.8	5.0
2-1/2”	51-75	5.0	4.2	51-90	5.5	5.0
3”	76-115	5.0	3.5	91-140	6.0	5.0
4”	116-200	5.0	2.6	141-310	7.2	5.0
6”	201-450	5.0	1.5	311-900	9.5	5.0
8”	451-800	5.0	1.3	901-1900	12.0	5.0
10”	801-1225	5.0	0.9	1901-3000	12.0	4.0
12”	1226-1760	5.0	0.6	3001-4000	12.0	2.8
14”	1761-2150	5.0	0.6	4000-5000	12.0	2.5

1.8. Building Enclosure Design Criteria

The City of San Francisco is within California Climate Zone 3 and the building enclosure design is required to meet the provisions of the 2008 California Energy Efficiency Standards (Title 24). The project will be using the performance based compliance approach detailed under Title 24. The following table provides a summary of the minimum prescriptive envelope design criteria as a reference only – actual performance values may be different and will be documented as the design is detailed further into construction documents:

Building Element	U-Factor (Btu/h.°F.ft²)	Equivalent R-Value (Cavity + Continuous)	SHGC
Walls (Metal Framed)	0.082	R-11 + R-8	N/A
Walls (Mass High)	0.278	See CMU Wall	N/A
Walls (Mass Low)	0.65	See Concrete Wall	N/A
8-inch Grouted CMU (High Mass)	0.71	0 + R4	N/A
6-inch Solid Concrete (Low Mass)	0.82	None Required	N/A
Roofs	0.039	R-25	N/A
Floors/Soffits (Mass)	0.269	None Required	N/A
Floors/Soffits (Other)	0.071	0 + R12	N/A
Windows (North)[5]	0.77	N/A	0.61
Windows (Non-north)[5,6]	0.77	N/A	0.41
Skylights	1.11	N/A	0.40
Exterior Doors (Swinging)	0.7	N/A	N/A
Exterior Doors (Non-swinging)	1.45	N/A	N/A

Notes:

1. High mass walls are walls with heat capacity ≥ 15.0 Btu/°F.ft²
2. Low mass walls are walls with heat capacity 7.0 ≤ HC ≥ 15.0 Btu/°F.ft²
3. Mass floors are floors with heat capacity ≥ 7.0 Btu/°F.ft²
4. SHGC for windows is based on wall-window ratio (WWR)
5. Total window area cannot exceed 40% of gross wall area for envelope component compliance
6. West window area cannot exceed 40% of the west gross wall area for envelope component compliance.
7. When glazing is installed in doors and exceeds one-half of the entire door area it is treated as a window and must comply with the window requirements.

1.9. Title 24 Envelope Mandatory Measures

The mandatory measures for doors, windows, and skylights address the airtightness of the units and how their U-factor and SHGC are determined. Fenestration products must be labeled with a U-factor and SHGC, and the manufacturer or an independent certifying organization must certify that the product meets the air infiltration requirements of §116(a) shown in the table below.

Building Element	Type	Max Infiltration Rate
Windows - (cfm/ft²) of window area	All	0.3
Exterior Doors- (cfm/ft²) of door area	Sliding, swinging (single door)	0.3
	Sliding, swinging (single door)	1.0

1.10. Central Plant

The Transbay Transit Center will be heated and cooled by a condenser water/ground loop heat exchanger system serving water source heat pumps, water/water heat pumps and water cooled air conditioning units throughout the facility. The building condenser water/ground loop system will be maintained between upper and lower temperature limits by two (2) induced draft cooling towers separated from the main loop by plate and frame heat exchangers located at the Lower Concourse Level (west end). No boilers will be required to maintain the loop above the lower temperature limit during heating season.

The two cooling towers will be designed in Phase 1 to provide the full load capacity for the full build out to simplify the mechanical system and eliminate the need for cooling towers at the Intercity Bus Facility during Phase 2. The cooling towers will draw in air from the bike/vehicle ramp through air intake louvers and discharge saturated air into an architectural exhaust enclosure that will terminated a minimum of 14 feet above grade on the east side of Natoma Street within Parcel F. The exhaust shaft shall have a sloped protective grating to prevent foreign materials from being introduced into the building.

Condenser/ground loop water supply and return piping will run the full length of the building providing a source of heating and cooling for the HVAC equipment located throughout the building. Three (3) variable speed main system pumps (two operating, one standby) located in the west plant room will distribute the water. Valved and capped condenser water connections will be provided to facilitate the future retail fit out and Phase 2 installation.

In addition to space temperature control the building condenser water loop will also be used as a heat source for domestic hot water generation in the future restaurant tenant spaces. Within each restaurant tenant space, a water/water heat pump, connected to the water loop, will generate domestic hot water at a temperature of 110º-120ºF (adjustable). Specific details and criteria will be provided in the retail tenant design guidelines.

1.11. Ground Loop Heat Exchanger (Geothermal System)

The proposed heating and cooling system for the Transbay Transit Center replaces a conventional boiler/cooling-tower system with a modified (or hybrid) geothermal system that is supplemented by a cooling tower plant, ground loop heat exchanger and peak shaving thermal battery.

A ground loop or geothermal heat exchange system provides heating and cooling for a building by exchanging energy with the earth which remains at a relatively stable temperature regardless of the season. By slightly raising and lowering local ground temperatures over the course of the year, a ground loop heat exchange system can store thermal energy seasonally, reducing or eliminating the need for conventional conditioning systems powered by electricity and/or natural gas. The TTC ground loop heat exchange system lowers building energy consumption, reduces potable water usage and regulates the temperature of the building condenser water loop.

The ground loop heat exchange system consists of a network of horizontally laid 1-1/4” HDPE (high density polyethylene) loops located 24-inches below the mat foundation of the building. Multiple options were studied for this system but the preferred option from an economic and constructability perspective was the horizontal option below the mat foundation slab. The piping loops are segregated into 10 zones or sub-groups and have isolation valves located in the Lower Concourse ceiling to isolate each zone independently.

Multiple energy simulation runs were performed with 5’, 10’, 15’ and 20’ spacing of the horizontal geothermal piping below the foundation slab. The results of the simulation showed that as the length of geothermal piping increased the required size of the cooling tower reduced as did the annual water consumption. Of equal importance, it should be noted that as the length of geothermal piping reduces the minimum heat pump entering water temperature drops. The assumption was made that the geothermal ground loops interact with a 10’ depth of thermal store. This comprises of 6’ of concrete and 4’ of gravel and earth. Based on the results of the analysis it was determined that a minimum pipe spacing of 10 feet would be required to maintain entering heat pump temperatures above their minimum operating conditions.

The ideal application for a closed loop geothermal heat pump installation (with little or no moving ground water) is for an annual energy balance - the heat abstracted form the ground during the heating season is equal to the heat rejected during the cooling season. Significant imbalances between heating and cooling load will result in a gradual increase or decrease in ground temperature over successive years which will ultimately impair the efficiency of the installation. A detailed energy analysis of the facility has been carried out in order to gain an appreciation of the heating and cooling load profiles.

The results of the system analysis show that:

- The base building annual heating and cooling loads are very similar and offset each other (core and shell - excludes retail).
- Heating load is fairly consistent from day to day with a gradual seasonal swing.
- The cooling load is far more erratic with long periods of low load followed by short periods of very high demand.

The particular nature of the load profiles has implications for the design of the geothermal heat exchanger. The heat exchanger must be sized to cater for two distinctly different heat exchange phenomena. Firstly, the thermal storage capacity of the earth in contact with the exchanger needs to be sufficient to prevent significant seasonal shift in ground temperature (an outdoor temperature swing from 40°F in winter to 70▫F in summer is typical). Secondly, the exchanger needs to provide sufficient heat transfer area to limit the approach between the ground temperature and the leaving geothermal water temperature. Due to the erratic and intermittent nature of the cooling profile, the results of the simulation show that it is the latter requirement that is predominant in determining the required heat exchange area.

The graywater/storm water storage tanks and the geothermal system for the project are designed as one integrated thermal solution. In combination, the graywater system is well suited to provide additional thermal benefit to the geothermal performance: The geothermal system operates most effectively to serve base thermal loads that occur over long time periods. The gray water/storm water tanks are constantly being refilled and provide an additional source of heat rejection within the building. We believe this combination can be very effective in serving the types of thermal loads that may be seen on the Transbay Transit Center.

The combination of the ground loop heat exchange system, cooling towers and water storage tanks into one integrated thermal system has the following benefits to the project and community:

- Reduced space impacts associated with the removal of boilers.
- Lower maintenance and longer lifetime.
- The elimination of boilers and their associated natural gas use.
- Maintenance requirements are significantly reduced
- Significantly improved energy efficiency.
- Reduced cooling and heating energy costs (and corresponding reduction in greenhouse gas emissions).
- Reduced annual water consumption.

1.12. Grand Hall

The Grand Hall acts as a transitional space between indoors and outdoors and will be maintained within a relatively wide comfort control band. This will allow the space to be conditioned in the most sustainable manner possible, entirely passively using natural ventilation.

Natural ventilation intake vents will be located around the perimeter of the Grand Hall at Ground Level. Exhaust vents will be integrated into the perimeter of the skylight structure and “glass box” at the Roof Park Level. Natural stack effect generated by the temperature differential between indoors and outdoors and the height differential between the intake and exhaust air openings will drive air through the space.

The intake and exhaust vent openings will be equipped with motorized dampers that will be controlled via the BMCS system. The dampers will regulate the flow of air in response to the cooling requirements of the Grand Hall and to deliver the code minimum quantity of outside air to the space. Carbon monoxide (CO) sensors outside the building on First and Fremont Streets will monitor outdoor CO concentrations and if high levels are measured (for example during rush hour traffic) the operable ventilation openings will be closed by the BMCS. A carbon dioxide monitoring system will also be installed within the Grand Hall to monitor indoor air quality and adjust natural ventilation openings as required to maintain CO2 levels below the code maximum.

1.12.1. Grand Hall Environmental Design Criterion

1.12.1.1. Ventilation

The maximum allowable CO2 concentration is derived from California Title-24 Standard (CEC 400 – 2006), Section 121.4 – requirements for ventilation: “Ventilation controls shall maintain CO2 concentrations less than or equal to 600 ppm plus the outdoor air CO2 concentration in all rooms with CO2 sensors.”

Outdoor air CO2 concentration shall be determined by one of the following:

- CO2 concentration shall be assumed to be 400 ppm without any direct measurement; or

- CO_2 concentration shall be dynamically measured using a CO_2 sensor located outside.”

Using the guidelines for demand control ventilation requirements, unless there is an external CO_2 sensor, the maximum allowable CO_2 concentration within the space is established to be 1000 ppm.

1.12.1.2. Thermal Comfort

Given the transient nature of occupancy in the Grand Hall and its strong link with the exterior environment it was agreed by the Design Team that ASHRAE 55 would prescribe an unnecessarily tight comfort control band, the maintenance of which would require the use of mechanical heating and cooling. Informed by precedent studies of similar facilities, the following set of project specific comfort criteria were proposed and agreed upon early in the design process:

- Design comfort band between 52ºF in winter and 78.8ºF in summer.
- Permissible for internal temperature to stray outside of the design comfort band for short periods during the peak of summer, with an absolute maximum upper limit of 90ºF.
- The rationale behind this relatively wide comfort band is that the interior thermal conditions will vary seasonally, in sympathy with external conditions. The lower end of the comfort band of 52ºF will only occur on the coldest days of the year when commuters will be suitably dressed for cold weather.
- Similarly, the upper end of the comfort scale of 90ºF will only occur on the very hottest days of the year. It is our contention that moving from an exterior winter environment of say 40ºF, into the Grand Hall at 52ºF would be a perceived positively in terms of thermal comfort. The adoption of this seasonally varying set of comfort criteria makes viable the consideration of an entirely passively conditioned space that requires no supplemental heating, cooling or ventilation.

However, in response to the TJPA’s concern over thermal comfort within the space at extreme outdoor temperatures, a radiant heating and cooling system located within the floor construction was added to the Grand Hall. The radiant floor will be activated based on input from the BMCS in response to extreme weather conditions. It is not expected to be required for the majority of the year and will only be used as needed to conserve energy.

1.13. Bus Deck Level

The Bus Deck Level will be naturally ventilated and supplemented with a series of high volume low speed (HVLS) overhead ceiling fans to mix and dilute contaminants in the occupied waiting areas. This design eliminates the need for multiple large fans and long expensive runs of ductwork above the ceiling.

Figure: Example of HVLS Ceiling Fan

Steady state and transient computational fluid dynamics (CFD) models were used to simulate the emissions from the buses based on engine data provided by AC Transit for their 2010 bus fleet. The geometry of the Bus Deck Level and the surrounding openings created by the basket columns and awning structure were entered into the CFD models to analyze the impact of natural ventilation within the space. The initial results showed that during peak commute hours (and zero wind) the natural ventilation alone would not sufficiently reduce CO and NO2 levels to within the OSHA required maximum allowable concentrations.

Occupational Safety and Health Agency (OSHA) Standards Permissible Exposure Limits for Gaseous Pollutants		
Pollutant Type	TWA Limit (PPM) (8 hour time weighted average)	Ceiling Limit (PPM) (not to be exceeded at any time)
CO	50	200
NO	25	100 (approx.)
NO2	--	5

The CFD analysis was based on the following criteria:

- Diesel Bus Emissions – 5.0 g/bhp.hr CO and 0.2 g/bhp.hr NOx (California Exhaust Emissions Standards – 2007 & subsequent Heavy Duty Diesel Urban Bus Exhaust Emissions Standards)
- Bus Operations – The analysis modeled all 37 bus bays on the Bus Deck Level in operation per the actual operational schedule provided by the bus transit operators. The emissions used in the analysis are based on the following operation modes over a peak hour of operation from 4:45pm to 5:45pm:
  - 20% of buses at a given time are in full acceleration
  - 10% of buses at a given time are "cruising"
  - 70% of buses at a given time are idling (3 mins max. based on input from ARUP and TJPA)
- HVLS Ventilation Fans – the analysis uses eleven 14-foot diameter HVLS fans and twelve 8-foot diameter fans located over the main passenger waiting areas along the length of the bus deck. The total air volume is 1,284,300 cubic feet per minute (CFM).
- Exterior Conditions – analysis was performed during typical San Francisco design day but with a no wind condition to model the worst case condition where natural ventilation was at a minimum

The results of the CFD analyses showed that the gaseous pollutants are maintained well below their ceiling limit during the worst case peak hour of bus operations in a no wind condition.

The HVLS fans will be modulated to reduce energy and maintain passenger comfort through the use of a demand controlled system that uses carbon monoxide (CO) and nitrogen dioxide (NO2) sensors to monitor vehicle emissions and adjust the variable speed motors on the fans. The HVLS fans have low horsepower, high-efficiency direct drive motors with integral variable speed drives that will be used to modulate fan speed.

The HVLS fans will also have an input from the BMCS system to operate under conditions where the outside air temperature rises above a specific setpoint. This function will increase air movement on the bus deck and provide a thermal comfort benefit to the occupants of the bus deck.

The enclosed back of house service spaces located on the Bus Deck Level will be fully conditioned using water source heat pumps and ventilation air will be ducted to the space from the Roof Park Level. A mechanical exhaust system will be provided and discharged at the Roof Park Level within the stair/elevator core.

1.14. Retail

The retail spaces within the facility will be serviced on a 'core and shell' basis, with the basic utility supplies being installed as part of the Phase 1 works and the future 'fit-out' being provided by the individual retail tenants.

In their 'shell' state the retail spaces will be provided with the following infrastructure to each tenant demised area:

- Condenser water supply and return piping stub-outs valved and capped

- Outside air ventilation ductwork to louvers located on the Second Level
- General exhaust duct connection to louvers located on the Second Level
- Kitchen exhaust equipment and ductwork space provisions (Type A only)
- Kitchen exhaust pathway to exterior (Type A only)
- Vapor exhaust pathway to exterior (Type A only)

As part of the fit-out, each tenant will install water/air heat pumps units that will draw heat from, and reject heat into, the condenser water loop. The code required outside air for ventilation and kitchen exhaust hood make-up air will be drawn in through intake louvers in the façade on the Second Level. General exhaust air will be rejected to atmosphere via exhaust louvers located a minimum of ten feet (10'-0") from the intakes. Kitchen exhaust will be routed to exhaust louvers located above the stair cores at roof level.

The positions of the service shafts impose constraints on the location of certain types of retail space. For example retail outlets with cooking facilities (Type A) need to be located in close proximity to the utility riser shafts in order to facilitate the routing of the kitchen hood exhaust ductwork.

The core and shell ventilation design for the tenant spaces has provisions for a partial (50%) airside economizer mode in the Lower Concourse Level retail spaces and full (100%) airside economizer mode in all of the above grade retail spaces. The ventilation air for the Lower Concourse will be ducted to each tenant space and terminated with a single duct VAV terminal unit that can modulate the outside airflow from code minimum to 50% economizer mode. The ventilation air will be filtered with MERV 13 filters but unconditioned. Tenants will be required to size their HVAC equipment to handle the additional outside air heating and cooling loads.

1.15. TJPA Offices

The TJPA offices are no longer identified as being located within the Transbay Transit Center.

1.16. CalTrain/CHSRA Tenant Space

The future CalTrain/CHSRA designated spaces on the Lower Concourse and Train Platform Levels will be serviced on a 'core and shell' basis, with the basic utility supplies being installed as part of the Phase 1 works and the future 'fit-out' being provided by each tenant.

In its 'shell' state the spaces will be provided with the following infrastructure:

- Condenser water supply and return piping stub-outs valved and capped
- Outside air ventilation ductwork to louvers located on the Second Level
- Relief (spill) air ductwork to louvers located on the Second Level
- General exhaust duct connection (for Tenant restrooms)

1.17. Lower Concourse Level

The Phase 1 scope of work for the HVAC systems in the Lower Concourse is to build out all the MEP spaces (transformer vaults, switchgear, fan rooms, water storage tanks, pump rooms and MDF's, etc.) and leave the remainder of the level as an unconditioned shell space for future fit out in Phase 2 when the train station will become operational.

The unoccupied shell space will be provided with a minimum ventilation system to provide 0.06CFM/SF per Title 24. The system will comprise of inline centrifugal fans connected into the architectural air intake shafts ("snorkels") located directly above the fan rooms at Ground Level. The air intake shafts shall terminate a minimum of 25 feet above grade and have sloped intake grates to prevent foreign materials from entering into the building.

During Phase 2, the Lower Concourse Level passenger waiting areas will be mechanically conditioned in accordance with the 'Semi-conditioned' comfort criteria. The interim Phase 1 ventilation fans will be removed and the air intake shafts used to bring in ventilation air for the Lower Concourse public circulation and retail tenant HVAC systems. The excess (spill) air from the units will be used as make-up air for retail tenant exhaust and train platform exhaust.

The spaces will be heated and cooled via water/air heat pump air handling units. The units will be equipped with air-side economizer to harness the full free cooling potential of the San Francisco climate. Heating and cooling will be generated by water/air heat pumps that will exchange heat with the central condenser water loop. Conditioned air will be distributed within the ceiling void and delivered to the passenger waiting areas via ceiling diffusers.

The seated waiting areas within the Lower Concourse will be provided with radiant heating and cooling within the floor construction to ensure thermal comfort for passengers.

The taxi staging area in the Lower Concourse is now proposed to be relocated out of the building and replaced with a building service operations ramp and parking area. This area will be provided with a mechanical exhaust ventilation system designed for 1.5 CFM/sf. Make-up air will be pulled down the bike and taxi ramp off Howard Street. The exhaust fan will be modulated to reduce energy through the use of a demand controlled system that uses carbon monoxide (CO) sensors to monitor vehicle emissions and adjust the rate of mechanical ventilation supply as required. The exhaust air will be discharged into the vertical exhaust vent stack used for the cooling towers and terminated a minimum of 14 feet above adjoining grade.

1.18. Train Platform Level

The Phase 1 scope of work for the HVAC systems in the Train Platform Level is to build out all the MEP spaces (electrical rooms, mechanical rooms, and IMDF's, etc.) and leave the remainder of the level as an unconditioned shell space for future fit out in Phase 2 when the train station will become operational.

Similar to the Lower Concourse, the unoccupied shell space will be provided with a minimum ventilation system to provide 0.06CFM/SF per Title 24.

During Phase 2, the train platforms will be mechanically ventilated using the emergency ventilation overhead track exhaust (OTE) systems. The fans will be staged and modulated to maintain thermal comfort for passengers as they use the platforms to board or exit the trains within the station.

The train platform mechanical emergency ventilation system consists of two main fan plants located at the west and east ends of the Lower Concourse Level. Each plant will have four (4) variable speed vane axial reversible fans rated for high temperature service to extract smoke from the Lower Concourse or Train Platform Levels in the event of a fire. A heavy duty automatic damper will be used to isolate each fan when not in use. An integral sound attenuator will be installed on the intake and discharge of each fan to reduce sound levels to an acceptable level. An overhead steel I-beam and electric trolley will be used to remove the fan casing and motors for service and maintenance. Access doors will be provided with the intake and discharge plenums to allow maintenance personnel access throughout the fan plant.

Ductwork from each fan plant is extended down the length of both levels and divided into two main smoke zones – West Smoke Zone and East Smoke Zone. The fan plants discharge smoke from the trainbox at either of the building through large architectural exhaust shafts extending a minimum of ten feet above adjoining grade.

The emergency ventilation systems are not designed for simultaneous operation on both levels. Smoke control dampers within the ductwork will be configured by the fire alarm system with override control from the Train Operations Control Center to exhaust one level at a time in the event of a fire. The Lower Concourse Level smoke zones will be activated through the fire alarm system upon detection of water flow with a defined smoke zone. The BMCS will be used to control the fan plant during normal operating mode to maintain minimum ventilation rate and control space temperature for passenger comfort.

The train operator rooms on the platforms will be fully conditioned using water source heat pumps and provided with a source of ventilation air from outside.

Refer to ARUP's basis of design for the trainbox emergency ventilation system detailed design criteria and analysis.

1.19. Restrooms

The restrooms within the facility will be provide with mechanical exhaust ventilation in accordance with the indoor design criteria detailed at the beginning of this section. Each set of restrooms will be equipped with a dedicated exhaust fan and ductwork system connected to exhaust louvers located above the stair cores at Roof Park Level. In enclosed restroom facilities make-up air will be directly supplied to the space from the nearest air handling system. Where restrooms are provided with a maze-style doorless entry, make-up air will be drawn in from the adjacent public circulation spaces.

1.20. IDF and MDF Technology Rooms

The MDF equipment room will be provided with three (3) 25 Ton water cooled computer room air conditioning systems to maintain the indoor design space and humidity criteria. The cooling system design will provide N+1 redundancy such that one unit can be out of service for maintenance and the room will be maintained at setpoint with two units in operation. In addition, two of the AC units serving each MDF will be provided with backup air cooled condensers located in the Train Platform Level. Upon a loss of condenser water flow, the air cooled condensers will be used to maintain the AC units in operation to ensure the critical IT systems serving the facility have a source of cooling.

The UPS system serving the MDF's will also be provided with a dedicated air conditioning system to maintain batteries at a maximum temperature of 77 degF. The room will be provided with a dedicated exhaust fan system to meet the minimum requirement of 1 CFM/SF for battery storage rooms.

The IDF closets throughout the building will be provided with cooling from horizontal suspended water source heat pumps located outside of the room and ducted into the space with supply and return ductwork and grilles. In the event of a loss of water flow the heat pump systems have been configured to allow the heat pumps fans to operate in an exhaust mode configuration to provide minimal ventilation through the space. Upon loss of condenser water flow in the system, the BMCS will enable a sequence to close the supply FSD and opening a bypass control damper in the main supply duct.

The MDF, IDF and UPS AC/HP units will all be served from an emergency power source.

1.21. Security Operations Center (SOC)

The SOC will be fully conditioned with 100% outside air through a dedicated water cooled AC unit. Outside ventilation air will be ducted to the unit from the louvers located on the façade of the building at a minimum of 25 feet above adjoining grade. An air filtration system will be provided in the unit to meet all the requirements of the RVA design guidance criteria (DGC) for the project. The AC unit will be provided with N+1 variable speed drive supply fans and will be served from an emergency power source. More specific details on the unit components can be found in the project drawings and specifications.

Single duct terminal units with reheat coils will provide zone control within the SOC and provide flexibility for balancing and control of the various spaces within the suite. The SOC will be balanced to maintain a positive pressure with respect to the surrounding spaces (0.1 inches water gauge) as required in the RVA DGC.

A floor mounted water to water heat pump located in the SOC AC unit mechanical room will provide heating hot water at 130F for the terminal unit reheat coils. A small inline pump with circulate hot water to the coils. An air separator, expansion tank, pot feeder and make-up water connection will also be provided.

The restrooms, locker rooms, copy rooms and break rooms will be exhausted through a dedicated exhaust fan system. The exhaust fan will be provided with a VFD to permit balancing and also to allow for controls sequencing to reduce air change rates at night when the facility is closed.

The IT computer room and UPS Room within the SOC suite will be provided with floor mounted water cooled AC units (N+1 capacity) located in a dedicated mechanical room and ducted to/from the space. The units shall be mounted on 4-inch high concrete housekeeping pads.

1.22. Fire Command Center (FCC)

The FCC located on the Ground Level at First Street will be fully conditioned using a water source heat pump. Outside ventilation air will be ducted to the unit from the louvers located on the Second Level façade.

The space will be balanced to maintain a positive pressure with respect to the surrounding spaces. The heat pump unit will be served from an emergency power source.

1.23. Elevator Machine and Controller Rooms

The elevator machine and controller equipment rooms will be provided with cooling from independent horizontal suspended water-cooled heat pump systems located outside of the room and ducted into the space with supply and return ductwork and grilles. The units will be fed from an emergency power source.

1.24. Electrical Rooms

The main electrical switchgear equipment rooms located adjacent to the transformer vaults at the Lower Concourse Level will be provided with cooling from horizontal suspended water source heat pumps located outside of the room and ducted into the space with supply and return ductwork and grilles.

The electrical distribution closets throughout the building will be provided with cooling from inline centrifugal exhaust fans located outside of the room and ducted into the space with ductwork. The exhaust fans will draw air from the surrounding spaces using transfer ductwork and supply grilles in the wall.

Some electrical closets with high density loads may require cooling from horizontal suspended water source heat pumps located outside of the room and ducted into the space with supply and return ductwork and grilles.

1.25. Mechanical Rooms

Mechanical equipment rooms throughout the building will be ventilated using exhaust fans. All fan systems will be provided with automatic dampers for positive closure when not in operation.

1.26. Loading Docks

The main loading docks located on the Ground Level will be provided with mechanical exhaust ventilation systems. Make-up air will be transferred in through the loading dock shutters off Minna and Natoma Streets. The exhaust fan will be modulated to reduce energy through the use of a demand controlled system that uses carbon monoxide (CO) and nitrogen dioxide ($NO2$) sensors to monitor vehicle emissions and adjust the rate of mechanical ventilation supply as required.

1.27. Fuel Oil Storage Rooms

The fuel oil storage rooms will be continually exhausted at a minimum rate of 1 CFM/SF. Each room will be provided with a dedicated inline exhaust fan with explosion proof motor and ducted to the outside of the building. Make-up air will be provided from the nearest outside air ventilation system. Ductwork penetrations into the room will be protected with appropriately rated fire dampers to meet the fire rating for the room construction.

1.28. Generator Rooms

The generator rooms will be exhausted at a minimum rate of 1 CFM/SF. Each room will be provided with a dedicated inline exhaust fan with explosion proof motor and ducted to the outside of the building through the generator exhaust louvers in the building envelope. Make-up air will be drawn into the room through the louvers. The fan will be provided with an automatic control damper that will close the damper and shut down the fan upon start-up of the generator.

1.29. Elevator Hoistway Vents

Although not required by code in this type of facility (since it is fully sprinklered), elevator hoistway vents will be provided at the top of the hoistways at the Roof Park Level based on the recommendation of the elevator consultant to ventilate the shafts. Louvered style gravity ventilators sized to have a net free area the greater of, 3 square feet per elevator cab or 3-1/2% of the hoistway shaft area will be provided on prefabricated roof curbs at the high roofs. The ventilators will be hinged to allow access to smoke detectors at the top of the hoistway.

1.30. Stair Pressurization

Based on RFLE#7 (reference ARUP Fire Life Safety Report) all of the stairs serving the Roof Park Level (S301, 401 and 601 A/B) will be provided with pressurization systems to positively pressurize the stair enclosure to a minimum 0.15 inches water gauge pressure differential with respect to the adjacent spaces. Each pressurized stair will include a relief air opening with automatic damper (required for RVA) capable of relieving a minimum of 2,500 CFM. The fans will all be served from an emergency power source.

The stair pressurization fans will be included on the smoke control panel in the FCC and will be required to meet the operational requirements of CBC 909.16 “Firefighters Control Panel”. The stair pressurization fan characteristics and installation shall meet the provisions of CBC Section 909. The fans will start on any system fire alarm signal. Smoke detectors to activate the fans will be provided at the entrances to the stair enclosures only within enclosed conditioned spaces.

1.31. Gas Meter Room

The PG&E gas meter room will be mechanically ventilated with a dedicated exhaust fan using intake and exhaust louvers mounted in the exterior wall per the gas company’s installation requirements. A ventilation duct with sidewall grilles will be extended the length of the room to ensure adequate air movement throughout the room.

PG&E J-16 document dated November 2010 requires gas meter room ventilation rate requirements to meet one of the following:

- Continuous ventilation at a rate of either 1cfm/sqft or 6 air changes per hour (ACH)
- A combustible gas detection system interlocked with an automatic ventilation system that will provide outside air at a rate of either 1cfm/sqft or 6 air changes per hour (ACH) upon activation of the detection system. The gas detectors shall be set at 20% LEL (or 1% concentration of natural gas in air).

Mechanical ventilation fans shall be explosion proof and meet the requirements of the NFPA 70: National Electrical Code for Class 1, Division 1, Group D locations. Fans shall be continuously monitored in case of failure. Alarms for trouble and failure shall be installed in accordance with NFPA 72, National Fire Alarm Code.

2. PLUMBING

2.1. Codes and Standards

- 2007 San Francisco Building Code
- 2007 California Building Code
- 2007 California Plumbing Code
- 2007 California Fire Code
- 2008 California Building Energy Efficiency Standards (Title 24)
- 2007 National Fire Protection Association (NFPA) 130
- TJPA Owners Project Requirements (OPR) Report
- Transbay Transit Center Fire Life Safety Strategy Report

2.2. Domestic Cold Water

A new site water main will be provided to supply domestic water to the building and irrigation to the park.

- The building domestic water service connection to the street water main on Minna Street will be provided with a reduced pressure type backflow preventer and water meter located in a dedicated and protected entrance room on the Lower Concourse Level.
- The building fire protection service connection to the street water main on Minna Street will be provided with a double check detector assembly located in a dedicated and protected entrance room on the Lower Concourse Level. Space has been provided for a 40,000 gallon concrete fire water storage tank adjacent to the fire pump room.
- A separate connection to the street water main with meter and reduced pressure backflow preventer will be provided to serve the rooftop park and ground level irrigation systems. Dedicated irrigation water booster pumps will be required to deliver water to the roof park and ground level landscape areas.
- A separate connection to the building will also be provided for changeover to a future City recycled water ("purple pipe") system. The pipe will be extended into the building and valved and capped for future service. This future service will supplement the onsite building treated water systems. The irrigation water service and make-up water to the non-potable water tanks will be converted to recycled water when the service becomes available in the future.

A flow test has shown that a domestic water booster pump will be required to overcome limited site water pressure, piping friction and the static head of the building. This pump will be located in the Train Platform Level pump room. The residual pressure at the most remote cold water outlet shall be 35 psi. Domestic cold water will be furnished for lavatories, service sinks, drinking fountains, wall hydrants, hose bibs, irrigation and HVAC equipment.

Domestic water piping will be sized for a maximum velocity of 8 fps in shafts, mechanical equipment rooms and all transit areas where ambient sound levels will be relatively high. Piping in any sound sensitive normally occupied spaces such as offices or transit support spaces will be sized for approximately 4 fps. The domestic water system will be installed using Type "L" copper and wrought copper fittings with lead-free solder joints.

All plumbing fixtures will be low flow type to reduce water consumption and to alleviate demand on the municipal sewer systems. All fixtures with quick closing valves shall be provided with water hammer arrestors behind an access panel. Exterior hose bibbs will be provided around the perimeter of the building and on the roof for maintenance and window washing.

2.1. Domestic Hot Water

Domestic hot water for the various (base building) restrooms will be generated by electric water heaters (instantaneous and tank type). Small inline pumps will be provided to deliver hot water to plumbing fixtures.

It is also anticipated that the (future) retail facilities will generate their hot water (kitchens, food service, rest rooms, etc) using water/water heat pumps connected into the geothermal loop.

Hot water piping will be sized for a maximum velocity of 8 fps in shafts and mechanical equipment rooms and all transit areas where ambient sound levels will be relatively high. Piping in any sound sensitive normally occupied spaces such as offices or transit support spaces will be sized for approximately 4 fps. Hot water lines will be heat traced or provided with recirculation to maintain 110ºF water temperature at all plumbing systems. All hot water piping and storage tanks will be insulated.

2.2. Sanitary Waste

A sanitary waste and vent system will be provided from fixtures and equipment, with all fixtures trapped and vented to atmosphere. Independent sanitary drainage systems shall be provided as follows:

- A graywater drainage system (serving lavatories, showers, laundry and drinking fountains, etc).
- A sanitary waste system (serving water closets, urinals, service sinks, general use sinks,etc.).

The building will have separate storm and sanitary drainage systems that will combine outside the building at street level before connecting into the combined City sewer system. A house trap will be provided in the sidewalk over the Lower Concourse Level ahead of all lateral connections into the municipal system.

Where possible the building drainage systems will flow by gravity to the building exterior at coordinated locations. All piping will be sized and sloped to drain in accordance with the applicable codes and design flows. Sanitary piping which is unable to drain by gravity to the sanitary system will require a duplex sewage ejector to lift the waste to the required invert elevation.

The Bus Deck Level, the Ground Level Muni Bus Plaza and the Train Platform Level will all be drained through sand and oil interceptors located below the train platforms at the lowest level of the building. Sewage ejector pumps located adjacent to the interceptors will pump the waste water up and out of the building at the Lower Concourse Level.

The sanitary system will be constructed of cast iron soil pipe with no-hub joints with heavy-duty couplings. Pump discharge piping shall be galvanized steel with screw type fittings.

2.3. Storm Water and Gray Water Reuse Strategy

Transbay Transit Center will operate with a holistic water reuse system utilizing both gray water from the building and storm water sources. Refer to the Transbay Transit Center - Non-Potable Water Reuse Systems Report for more details.

The storm water drain system shall be constructed of cast iron soil pipe with no-hub joints with heavy-duty couplings. Pump discharge piping shall be galvanized steel with screw type fittings.

2.4. Natural Gas

Gas will enter the building at the main PG&E Gas Meter Room located at ground level at the west end of the building. The gas supplies to the future retail tenant spaces will be used for cooking purposes only, domestic hot water will be generated using electrically powered water/water heat pumps or electrical water heaters. Each retail tenant will have their own PG&E gas meter.

2.5. Fuel Oil Storage and Distribution

Life safety and other essential equipment within the facility will be furnished with emergency power provided by diesel fired standby generators. Refer to the Transbay Transit Center - Diesel Fuel Systems Report for a more detailed description of the fuel oil systems.

2.6. Cooler Tower Plant

A domestic water make-up line with reduced pressure backflow preventer and isolation valve will be installed to the cooling tower plant on the Lower Concourse Level. A pressure sensor will be monitored by the BMCS to alarm if there is any fluctuation in system operating pressure. A separate water meter will be installed on the make-up water piping to the towers to monitor water usage.

3. FIRE PROTECTION

3.1. Codes and Standards

- 2007 San Francisco Building Code
- 2007 California Building Code
- 2007 California Electrical Code
- 2007 California Fire Code
- 2007 National Fire Protection Association (NFPA) 130
- 2010 NFPA Chapter 72 National Fire Alarm and Signaling Code
- TJPA Owners Project Requirements (OPR) Report
- Transbay Transit Center Fire Life Safety Strategy Report

3.2. Fire Alarm System

The Fire Alarm system will be an addressable system with each initiating device annunciated as an individual zone. The Fire Alarm and Control Panel (FACP) shall provide centralized control and annunciation of fire alarm zones.

The Fire Alarm System will include the following features:

- The system will be specified as “open protocol” to allow the flexibility for interface with future (Office Tower) Fire Alarm systems.
- The Fire Alarm System will utilize “addressable” type technology for initiating devices (each device will be a unique zone. Analog type smoke detectors will be specified to allow remote adjustment of sensitivity levels and alarm verification (to mitigate false alarms).
- The Fire Alarm System will be connected to the Public Address System for emergency communication audible alarming and voice paging throughout the facility and at the Roof Park. When a tone alarm or voice evacuation page is generated from the Fire Commend Center, it will be broadcast over the Public Address system speakers.
- UL and CSFM Listed fire alarm system strobe lights will be used for visual alarms at all locations in the building.
- The Fire Alarm System will provide input to the Emergency Communications System Autonomous Control Unit (ACU) located in the primary and backup Security Operations Center locations to communicate signals from the initiating alarms (sprinkler waterflow, smoke detection, etc. The fire alarm system will also receive input from the ACU to operate visual signaling devices (strobes).
- Request for Local Equivalency #5 (RFLE#5) has been reviewed and approved by SFFD for partial use of public address speakers for fire alarm communications. With the addition of an Emergency Communication System for the building and the TJPA’s request to have full building coverage for fire alarm and other emergency communications, PA system speakers will be used for all emergency and public address audible signaling, and fire alarm speakers will not be utilized. Modifications to RFLE #5 will be submitted to the SFFD to further clarify the use of public address speakers throughout the facility.
- The Fire Alarm System will send a signal to the Security System to initiate automatic unlocking of selected electric door locks upon receipt of fire alarm. The delayed egress devices at exit doors will otherwise not be connected to, or controlled by the Fire Alarm System.
- Provisions for Central Station tie-in (remote dialer and telephone line connections) will be provided.

The fire alarm system shall be fully supervised and include both manually and automatically actuated alarms consisting of:

- A manual pull station will be provided at a central location designated by the Fire Department.
- Connections to fire sprinkler system water flow and tamper switches.
- Area smoke detectors in each elevator machine room, at each door fitted with magnetic hold open devices, at fire curtains and automatic fire doors, and in each interior elevator lobby and elevator smoke curtain for elevator recall. The recall floor will be the Street Level with alternate levels as required by the evacuation plan.
- Duct type smoke detectors at the inlet of all return air duct stub outs, at main return air plenums, and at the discharge of each supply air fan. Activation of these detectors will shut down the associated air handling system.
- Smoke detectors (area and duct mounted type as appropriate) will be provided at fire/smoke dampers in accordance with NFPA 72. Activation of these detectors will close the associated damper.

The activation of any sprinkler flow switch, smoke detection device or manual pull station shall operate the voice communication system alarm and send a signal to the Security System to automatically release electric door locking devices (including delayed egress devices). The fire alarm LED annunciator shall provide indication of the floor of an alarm and the type of alarm, i.e., manual, sprinkler flow, or smoke. The fire alarm system shall be connected to an approved central monitoring service.

The following systems will be connected to the Fire Alarm System in accordance with NFPA and SFFD requirements:

- Fire pump
- Generators.
- Pre-action sprinkler systems
- FM200 fire suppression systems
- Kitchen hood fire protection systems
- Fuel oil leak detection system
- Firefighter's breathing air replenishment systems
- Emergency communications system Autonomous Control Unit
- Public Address system

Firefighter's Telephone System (FTS) is not required and shall not be provided. An emergency responder radio system will be utilized in place of the FTS. A Digital Antenna System will be provided in the building for support of fire and police radios. Refer to the telecom system documentation for additional information.

Visual alarm strobes shall be located in all public use and common use areas of the building, and in non-public areas such as: corridors, restrooms, offices, meeting rooms, elevator lobbies, locker rooms, mechanical rooms, and other interior areas where ambient noise impairs hearing of the fire alarm system.

- Spacing of visual alarm strobes shall be in accordance with NFPA 72. Visual alarm strobes will be synchronized throughout the building (ADA requirement).
- Speakers and Visual Alarm Strobes will be zoned to alarm by floor and building sectors in accordance with the evacuation zoning requirements that are detailed in the Fire Life Safety Strategy report, Section 8, Table 10.

A Fire Control Center will be located on the ground floor at a location approved by the Fire Department. Equipment located within the Fire Control Center shall include:

- Fire Alarm Control Panel
- Fire alarm system keyboard, VDT and Printer
- Fire Alarm Annunciator Panels

- Graphic Interface
- ECS Life Safety Interface (LSI)
- Voice Communication System
- Trainbox Emergency Ventilation System Override (Phase 2)
- Generator Status Panel
- Fire Pump Status Panel
- Elevator Status and Control Panel and all required keys
- Telephone for Outside Communication

A secondary Fire Control Center shall be located in the Security Operations Center to provide a redundant backup location. The redundant Fire Control Center will include all the provisions of the main fire alarm system only be utilized only if the primary Fire Control Center is not functional. The fire alarm system will be configured to lock out the inactive FCC.

3.3. Fire Suppression Systems

All areas of the building will be served by total coverage automatic sprinkler systems. In addition, standpipes will be installed in all exit stairs and as required to maintain the maximum distance between fire hose valve connections.The building fire protection service connection to the municipal water main on Minna Street will be provided with a double check detector assembly located in a dedicated and protected entrance room on the Lower Concourse Level.

Two 1500 gpm fire pumps (one standby) backed-up on emergency power are located in the fire pump room on the Train Platform Level and will boost the mains water pressure. A 45,000 gallon onsite secondary fire water supply will be provided in a concrete tank adjacent to the fire pump room.

The sprinkler system will be divided into six (seven in levels B1 and B2) main zones (also zoned by floor), interconnected by an automatic riser distribution system. Water-flow detection devices will transmit an alarm signal to the building fire alarm control panel upon detection of flow. Valves controlling water supplies to the sprinkler system will be provided with supervisory switches. A trouble signal will be transmitted back to the building fire alarm control panel upon detection of an unauthorized valve closure.

The hydraulically designed sprinkler systems will be in accordance with NFPA-13 and San Francisco Building Code. The building will be predominantly classified as “light hazard” with the exception of areas like kitchens, mechanical rooms and support spaces that will be classified as “ordinary hazard”. Train Platform Level is classified as Ordinary Hazard Group 2.

Bus Deck Level is classified as Extra Hazard Group 1. The current design provides a EH Group I sprinkler system design for the bus deck using a 14 foot by 9.2 foot coverage (129 square feet) (based on Table 8.6.2.2.1(c)) with high temperature (212 degree Fahrenheit), larger orifice (K=8.0) sprinklers (refer to SFFD/DBI RFI#3 for justification).

Light hazard occupancy systems will be hydraulically designed to provide 0.10 gpm/sq.ft. for the hydraulically most remote area of 1,500 sq. ft. with a 100 gpm hose stream allowance.

Ordinary hazard occupancy systems will be hydraulically designed to provide 0.15 and 0.20 gpm/sq.ft. for the hydraulically most remote area of 1,500 sq. ft. with a 250 gpm hose stream allowance.

All sensitive areas (MDF and UPS rooms) will be provided with single interlock preaction system and FM 200 fire suppression systems. The SOC Control Center will be provided with a preaction system.

During Phase 2, the train track areas will be covered by a deluge type system. Each zone will cover approx. 200 ft. of track. Two adjacent areas will be considered for hydraulic calculations. The design criteria is 0.19 gpm/sq.ft. of covered area. This system will be activated manually with activation stations placed at both ends of platforms. This system will be in accordance with NFPA 130 and CBC.

3.4. Firefighters Breathing Air Replenishment System (FBARS)

An FBARS is a standpipe for air permanently installed within a high-rise building or a large horizontal structure. Just as water standpipes deliver water to firefighters during a fire, an FBARS delivers a constant, reliable supply of breathing air. During a fire, air is pumped into the system by the local fire department's mobile air truck on the ground, providing an immediate and continuous supply of breathing air to the emergency crew. Firefighters use system inside the building to refill their air canisters closer to the seat of the fire, eliminating the need to hand-carry replacement canisters up and down stairs, shortening the time it takes to extinguish a blaze, and saving lives and property. The City of San Francisco began requiring these systems in high-rise buildings and underground train stations and tunnels in 2006.

3.4.1.1. Exterior Mobile Air Connection (EMAC)

These units are located on the exterior of the building at ground floor level. It is where local fire departments access the firefighter breathing air replenishment system. Fire department personnel unlock the unit, monitor air quality, connect the department's mobile air truck to the EMAC and immediately begin supplying air to the system.

3.4.1.2. Emergency Air Monitoring System (EAMS)

The EAMS constantly monitors the firefighter breathing air replenishment system for air quality and sufficient pressure, ensuring that safe, breathable air is in ready supply at all times.

3.4.1.3. Air Filling Control Panel

The air filling control panel is a wall unit version of the air filling station where firefighters access the air system. These panels can be designed with 2, 3 or 4 hookups, depending on air pressure requirements and the needs of the local fire department.

4. ELECTRICAL

4.1. Codes and Standards

- 2007 San Francisco Building Code
- 2007 California Building Code
- 2007 California Electrical Code
- 2007 California Fire Code
- 2008 California Building Energy Efficiency Standards (Title 24)
- National Fire Protection Association (NFPA) 130
- National Fire Protection Association (NFPA) 72, 2010 version
- TJPA Owners Project Requirements (OPR) Report
- Transbay Transit Center Fire Life Safety Strategy Report

4.2. Electrical Service and Distribution

4.2.1. Main Electrical Services

The main electrical services have been designed based on two separate proposals to supply electric service to the Transit Center. The original and base design includes service from PG&E via their downtown network service. The alternate service design includes service from SFPUC via radial services that are supplied from PG&E substations. Whichever service provider is selected, they are referenced as the "Utility" in the system descriptions that follow.

- PG&E Service: The Transit Center will be served by four PG&E network vaults. Each vault will be supplied directly by multiple PG&E 35KV or 12KV lines (redundant) and multiple PG&E transformers (redundant). Electric power will be billed at secondary voltage under PG&E's E-20S electric rate schedule.
- SFPUC Service: The Transit Center will house two service entry rooms at the Lower Concourse level that will house 12kV switchgear provided and installed by SFPUC. Provisions in these entry rooms are provided as required by SFPUC. Electric power will be billed at secondary voltage under SFPUC's rate schedule. 12kV service distribution is routed from the entry rooms to the transformer vaults. The vaults are used for either service provider.

In November 2013, the SFPUC proposal was selected as the preferred electric utility provider for the Transit Center. Additional requirements for the SFPUC design have been received by the design team during the months of November and December 2013. The SFPUC is still being developed by their engineering team and it is expected that there will be further design coordination and documentation required to complete the design to accommodate the SFPUC utility service into the project.

Two of the transformer vaults will be located along Minna Street and the third and vault will be located at Natoma Street. A future vault is planned at Beale St. for the Phase 2 portion of the project. The vaults will be three hour rated and constructed in accordance with PG&E standard sub-sidewalk network vault requirements. The vaults will reside under the sidewalk, at the Lower Concourse level, adjacent to the Minna and Natoma Street curbs above.

Round access grates for ventilation and utility maintenance personnel will be provided for each vault. A rectangular hatch for transformer removal/replacement will be provided over each transformer. A lifting agreement with the Utility will require that TJPA (through a drayage company subcontractor) be responsible for removal and replacement of utility transformers and associated access hatches between the vault and an agreed upon location near the curb.

Service supply feeders will be extended from the vaults to the adjacent main switchgear rooms where service will be supplied at secondary voltage (277/480V) for the main switchboards. In addition, empty conduit will be provided from the vault to the retail and fire pump switchboards for utility conductors.

4.2.2. Main Switchgear Rooms

A main switchgear room will be provided adjacent to each Utility vault.

Secondary switchgear will be rated 277/480V, with interrupting capacity as required by the Utility. Secondary switchgear will be freestanding, front and rear accessible, utilizing draw-out type air power low voltage circuit breakers. Electronic system meter modules will be provided for each main switchgear main and feeder circuit breaker for local and remote monitoring of system loads and power characteristics at the BMS. Transient voltage surge suppression systems (TVSS) will be provided at each main switchgear main. An overhead breaker lift /winch system will be provided to allow maintenance/replacement of circuit breakers. Spare switchgear breakers will be provided for each frame size

Retail meter boards will be provided with an individual Utility meter socket for each retail tenant. Meter sockets have been allocated for the designated retail spaces, and spare sockets are included.

4.2.3. Secondary Distribution

Electrical power will be distributed at 277/480V, 3 phase, 4 wire through multiple electrical closets. Distribution panelboards, branch circuit panelboards, and step down transformers will be provided in electrical closets for power supply to equipment loads.

Disconnect Switches: Heavy duty, horsepower rated, quick-make, quick-break, dead-front type. Self-contained unit in a NEMA 1 enclosure (NEMA 3R where installed outdoors).

Dry Type Transformers: 480V, 3 phase, 3 wire, delta connected primary. 120/208V, 3 phase, 4 wire connected secondary. Core shall be high grade, non-aging, grain oriented, silicon steel. Coils shall be wound of electrical grade copper with continuous wound construction. Transformers shall be insulated with a 220ºC insulation system. Temperature rating shall be 115ºC temperature rise above 40ºC ambient.

Panelboards: Corrosion resistant galvanized (zinc finished) sheet steel. Fronts shall be cold rolled steel, finish coated with ANSI 61 grey enamel over a rust inhibitor. Panel fronts will be door-in-door type construction consisting of a one-piece front with two lockable doors. The smaller door shall provide access to overcurrent protection device handles and label ratings. The larger door shall provide access to conductors and wire terminals. Bus bars shall be copper, full size neutral bus. Provide an equipment ground bus in each panelboard. Overcurrent protection devices shall be molded case circuit breakers for branch panelboards and distribution panels.

4.2.4. Grounding

A complete NEC grounding system will be provided. The grounding electrode system shall consist of a ground ring encircling the building below the building foundation in addition to ufer grounds in the foundation slab. The ground ring is also bonded to the steel shoring piles. A ground riser will be provided throughout the building to each electrical room where ground busbars are located. Feeders and branch circuits shall be provided with an insulated grounding conductor run with the circuit conductors, and the grounding conductors shall be in addition to the ground path provided by the continuously grounded metallic raceway system that encloses the phase and neutral conductors.

A separate grounding system will be provided for the Utility vaults and for the SFPUC service entry room. Grounding electrode conductors will extend from the vaults to dedicated ground rods below the foundation slab.

4.2.5. Equipment Connections

Power connections will be provided for all equipment, including but not limited to the following:

- HVAC equipment
- Plumbing equipment
- Fire protection equipment

- Elevators and Escalators
- Owner furnished equipment
- Foodservice equipment
- Illuminated advertising boards, signage pylons
- Motorized doors, louvers and gates
- Kiosks
- Bus Information Display Monitors
- Public Address System
- Security System
- BMS System
- MDF and IDF Rooms
- Convenience and special purpose receptacles
- Battery recharge stations
- Bird Deterrent Systems

4.2.6. Utilization Voltages

- Receptacles, incandescent lighting, and motors less than 1/2 HP: 120V, 1 phase
- HID & fluorescent lighting: 277V, 1 phase
- Motors 1/2 HP and larger: 480V, 3 phase

4.2.7. Raceways

All wire and cable shall be installed in conduit. Conduit shall be 3/4 inch minimum.

Rigid Steel Conduit: Rigid conduit, heavy wall, hot dipped galvanized inside and out, threaded ends, with threaded type fittings. Use for conduit installed exposed below 10 feet above finished floors.

Electrical Metallic Tubing: Continuous, seamless steel tubing, galvanized or sherardized on exterior, coated on interior with smooth hard finish of lacquer, varnish or enamel, with steel, set screw type fittings. Use for general purpose feeders and branch circuits.

Flexible Steel Conduit: Single strip, continuous, flexible interlocked double-wrapped steel, hot dip galvanized inside and out forming smooth internal wiring channel, with steel, compression type fittings. Use in dry locations only, connections to lighting fixtures in suspended ceilings, connections to equipment installed above suspended ceilings, transformer connections, bus duct plug in units, and connections to equipment where vibration isolation is required, maximum length of 6 feet.

Liquid Tight Flexible Steel Conduit: Same as flexible steel conduit except with tough, inert, watertight plastic outer jacket. Fittings shall be cast malleable iron body and gland nut, cadmium plated with one-piece brass grounding bushings threaded to interior of conduit. Use same as flexible steel conduit in damp or wet locations and at motor connections.

Rigid Nonmetallic Conduit: Schedule 40 polyvinyl chloride with solvent cemented type fittings. Use for service to sump pumps at Right-of-Way level, embedded in floor slabs.

Metal clad Cable (MC) Systems: Steel jacketed, copper conductor MC cable systems shall be permitted for use for equipment branch circuit wiring in enclosed, accessible areas in offices and tenant spaces where interior layouts are subject to change. MC cable will also be used where flexible wiring is concealed and fished in curtain wall systems. MC cable shall not be used for homeruns or for electrical wiring in public spaces.

Fire Resistant Cable Systems: To meet the requirements of NFPA 130 for all areas designated with NFPA 130 classification, branch circuits supplied by the building generators shall utilize UL listed, fire resistant cable. Exceptions shall be permitted for raceways and conduits that are concealed in concrete in accordance with the Code.

4.2.8. Wire and Cable

600V minimum insulation rating. Electrical grade, annealed copper, tinned if rubber insulated, THHN/THWN insulation with 90°C insulation required to meet NFPA 130 requirements. Stranded ASTM Class B. Minimum size number 12 for branch circuits; number 14 for control wiring. Conductor sized shall be adjusted as required for voltage drop.

4.2.9. Wiring Devices

Switches and receptacles shall be specification grade. All switches shall be silent acting fully rated 20 amperes. Multiple pole, 3 way, 4 way, and special purpose type switches shall be provided as required. Special purpose receptacles shall be provided as required by the equipment characteristics. Device cover plates shall be stainless steel.

General purpose duplex receptacles will be provided as follows:

- For cleaning and maintenance purposes at a maximum spacing of 100 feet on center.
- Restrooms (GFI type).
- Within 25 feet of mechanical equipment.

Specific use receptacle outlets will be provided for cord and plug equipment as required for specific equipment types and locations.

4.2.10. Emergency and Standby Power System

Three radiator cooled, diesel fuel fired standby engine generator sets rated 277/480V, 3 phase, 4 wire, 60 Hz, 1800 RPM will be provided in dedicated rooms (one at west end, and one at center). A third generator will be provided at the east end of the building for Phase 2. A signal from any automatic transfer switch will start the engine and supply power to the emergency and standby power loads in the event of failure of the normal power source. Each generator will be automatically exercised for a fifteen minute period twice monthly. Each generator will be provided with a radiator mounted load bank sized for 30% rated generator load.

Dedicated automatic transfer switches shall be provided for all emergency, legally required standby and optional standby class loads. An automated load sensing and priority load shed sequence system will be provided at each generator to shed loads (on a sequential basis) should the demand load exceed the capacity of the generator. An electronic system meter module will be provided for each generator set main circuit breaker for local and remote monitoring of the system loads and power characteristics at the BMS.

Emergency class loads are summarized as follows:

- Exit signs
- Egress lighting fixtures
- Fire Management System
- Emergency Communication Systems with associated UPS
- Security Systems associated with life safety

Legally Required Standby class loads are summarized as follows:

- Train Box Emergency Ventilation Systems
- Sump pumps and sewage ejectors
- Elevators (one in each bank)

- HVAC for MDF Rooms
- HVAC for UPS Rooms
- HVAC for Security Operations Center

Optional Standby class loads are summarized as follows:

- UPS systems that don't supply equipment for the Emergency Communications System
- Security Systems that are not associate with life safety

4.2.11. **Power Management System (PMS)**

The PMS will reside on the BMS system. It will include the following features:

- Monitoring and trend logging of power and energy use and characteristics of the substation circuit breakers, primary switchgear vacuum circuit breakers, and generator set main circuit breakers. One line graphic display of electrical distribution system.
- Monitoring and control of standby engine generator systems and automatic transfer switches.
- Monitoring and logging of distribution circuit breakers in the electrical system for LEED measurement and verification compliance.

4.3. Lighting

4.3.1. **Electric Lighting and Controls**

The specialist lighting consultant for TTC will develop the lighting concepts and specifications for light fixtures for all spaces with the exception of back of house areas such as storage and plant rooms.

4.3.2. **Security Lighting**

In the public circulation areas, lighting levels are influenced by the requirements of public safety and security. The lighting design for these areas will be developed in accordance with the recommendations of the project Security Consultant and per the Crime Prevention Through Environmental Design (CPTED) guidelines to promote a sense of occupant well-being, improved public safety and provide sufficient illumination to support CCTV surveillance.

4.3.3. **Lighting Controls**

Lighting control panels will be strategically located throughout the building and will provide either a relay switching function or dimming function as required. The type of dimmer required will be dependent on the type of lighting specified but will generally be an electronic addressable type system. In areas benefitting from the ingress of natural light, daylight dimming controls will be used to reduce energy use.

The lighting distribution panels will be fed from a 480/277 Volts, 3-phase supply and may be transformed locally at the lighting control panel to provide a 208/120 Volts, 3-phase supply if required. The lighting control panels will be standalone with distributed processing capability. They will be networked to a dedicated PC/user interface that is proposed to be located in the facility office in the building. The system will be connected to the building management system to enable sharing information such as zone control status or input from the lighting occupancy sensors.

4.3.4. **Emergency Lighting**

Emergency Lighting will be designed to provide a safe means of escape from the building in the event of a utility power failure.

The initial power to sustain emergency lighting will be provided by back-up batteries until the emergency generators start. The batteries will be located in centralized banks to provide uninterruptable interim illumination (4-minute supply) to maintain emergency lighting through 10 seconds of generator start time.

Selected light fittings connected to the emergency lighting system will be provided in throughout the building - public spaces, support and storage spaces, escape stairways, in plant rooms, along public egress corridors, public bathrooms and in other strategic locations to achieve the desired emergency lighting levels.

The escape exit signage and stair well lighting throughout the facility are equipped with integral emergency battery units and will be served from emergency distribution panels which are also backed up by the centralized battery system to provide an additional level of back-up.

Emergency lighting and exit signs will also be provided on the Park level along the defined path of egress.

In general, emergency light levels are based on the project governing section of the San Francisco Building Code 1006.3 and the San Francisco Fire Code 1006.4 that require "initial illumination that is at least an average of 1 foot-candle (fc) (11 lux) and a minimum at any point of 0.1 fc (1 lux) measured along the path of egress at floor level. Illumination is permitted to decline to 0.6 foot-candle (6 lux) average and a minimum at any point of 0.06 fc (0.6 lux) at the end of the emergency lighting time duration. A maximum-to-minimum illumination uniformity ratio of 40 to 1 shall not be exceeded." This is further augmented by the requirements of the RVA Design Guidelines.

Target emergency light levels at 40:1 maximum-to-minimum uniformity ratio:

- General Public and BOH Circulation Areas: Minimum average horizontal illuminance - 1fc
- Security Operations Center (SOC) and Backup SOC: Minimum average horizontal illuminance - 5fc
- Fire Command Center: Minimum average horizontal illuminance - 5fc
- Building Engineer's Office: Minimum average horizontal illuminance - 5fc
- Stairwell: Minimum average horizontal illuminance - 5fc
- Bus Deck Waiting Areas: Minimum average horizontal illuminance - 3fc
- Roof Park in designated pathways: Minimum average horizontal illuminance - 1fc
- Ground Floor Exterior pathway: Minimum average horizontal illuminance - 1fc
- Train Box: Minimum horizontal illuminance - 5fc

  This higher level of light level is provided in the Train Box as required by OSHA since the egress lighting in Train Box will also be used as construction light.

4.3.5. Exterior Lighting

The exterior lighting concepts and fixture specifications will be developed by the specialist lighting consultant. The lighting will be time controlled via the building lighting control system and will also be linked to a daylight sensing system.

4.4. Retail

The retail spaces within the facility will be serviced on a 'core and shell' basis, with the basic utility supplies being installed as part of the Phase 1 work and the future 'fit-out' being provided by the individual retail tenants in a later phase.

In their 'shell' state the retail spaces will be provided with the following infrastructure to each tenant demised area:

- Empty conduit from 277/480V 3PH retail meter switchboard – One 2" C typical for a 200 Amp service. Larger conduits for retail areas with full cooking.
- Fire alarm network cable for future extension to fire alarm devices within the retail space. Devices shall be the responsibility of the tenant.
- Empty conduit to base building lighting control panel for future interface to building lighting control system. – One 1" C. (Lighting control systems in retail areas will be the responsibility of the tenant).
- 277V connection to emergency lighting circuit. One switched fluorescent striplight on emergency power shall be provided at the entrance to the retail space for temporary use.

The retail meter switchboards provided in the Phase 1 construction shall have meter sockets and bussing sized for the following design load criteria:

	Load (VA)/SF	Load (VA/SF)	Load (VA)	Load (VA)
Retail Type	Ltg & Rec	Cooking Equipment	Mech	Total
A - Full Cooking	5.0		5.00	10.00
	5.0	30.0	5.00	40.00
B - Food Warming	5.0		4.00	9.00
	5.0	10.0	4.00	19.00
C - No Cooking	5.0	0.0	3.00	8.00

4.5. TJPA Offices

The TJPA offices will be serviced on a 'core and shell' basis, with the basic utility supplies being installed as part of the Phase 1 works and the future 'fit out' being provided by the TJPA.

In their 'shell' state the TJPA office space will be provided with the following infrastructure:

- Utility supplied panelboards for lighting and power service located in the building electrical rooms. 277/480V and 120/208V panelboards will be sized to provide 2 W/SF for lighting and 4 W/SF for office power, plus power for tenant HVAC equipment.
- 277V connection to emergency lighting circuit. One switched fluorescent striplight on emergency power shall be provided at the entrance to the tenant space for temporary use
- Spare relays will be provided to provide for connection of TJPA office lighting circuits to the building lighting control system.

The electrical fit-out will consist of extending the branch circuit wiring from the building panelboards for office power, lighting, and for HVAC and plumbing equipment, as well as tenant lighting, local switching controls, and exit signage.

4.6. CalTrain/CHSRA Tenant Space

The CalTrain/CHSRA designated spaces on the Lower Concourse and Train Platform Levels will be serviced on a 'core and shell' basis, with the basic utility supplies being installed as part of the Phase 1 work and the future 'fit-out' being provided by each tenant.

In its 'shell' state the spaces will be provided with the following infrastructure:

- Utility supplied panelboards for lighting and power service located in the building electrical rooms. 277/480V and 120/208V panelboards will be sized to provide 2 W/SF for lighting and 4 W/SF for office power, plus power for tenant HVAC equipment.
- Emergency generator supplied panelboards for lighting and power service located in the building electrical rooms. 277/480V and 120/208V panelboards will be available providing an allowance of 0.25 W/sf for emergency lighting for these areas.

4.7. Other Electrical Systems

4.7.1. Audio / Visual Systems

Audio / Visual system requirements will be provided by the specialist project AV Consultant. 120 volt power will be provided in accordance with the requirements of the AV Consultant and essential power supplies that are deemed necessary.

Two 400 amp, 120/208V 3PH company switches connected the utility power system will be provided at the roof garden level to supply the amphitheater and other assembly area loads.

4.7.2. Security Systems

Security and Access Control system requirements will be provided by the specialist project Security Consultant. 120 volt power connections will be provided in accordance with the requirements of the Security Consultant in addition to any essential power supplies that are deemed necessary.

Perimeter protection systems such as operable bollards, rolling doors, and barrier wedges shall be powered by the generator optional branch of the emergency power system.

4.7.3. IT and Telecom Systems

IT and Telecom system requirements will be provided by the specialist project IT Consultant. Centralized uninterruptible power systems (UPS) will provide conditioned power to these systems. Conduit, sleeves, outlet boxes, terminal strips and empty conduits will be provided in accordance with the requirements of the IT Consultant in addition to any essential power supplies that are deemed necessary.

UPS will be provided for the MDF and IDF room equipment rooms to provide conditioned power and limited battery backup for limited utility power outages (five minutes supply). Equipment that is required to support the emergency communications system shall be provided from separate UPS equipment designated for support of the ECS, and will have four hours of battery backup time as required by code. UPS will incorporate an external bypass circuit for maintenance purposes and the UPS will be connected to both utility and generator power sources.