Tunnels, Overbuilds, Enclosed Stations, and Trainsheds

I. General

A. Design Criteria

1. The Design Consultant will produce all project design criteria in accordance with applicable codes and standards, with the modifications, inclusions, or exemptions noted herein. Where tunnel-specific codes or this document do not clarify all criteria determinations due to the system or asset (which may include tunnel support buildings, overbuilt structures, joint tunnels / stations, or other asset categories), refer to the remainder of EP4000 for code applicability guidance.

2. For existing tunnel renovations and retrofits, the requirements of this chapter are subject to a feasibility and cost analysis by the design consultant as part of the Design Criteria Report. Modifications to the criteria of this chapter are subject to the approval of Amtrak Engineering Services.

3. Refer to Section 0.01, Introduction and Glossary for general definitions. The following terms are specific to Tunnels, Stations, Overbuilds and Trainsheds. An expanded definition is provided to differentiate characteristics specific to Tunnels, Overbuilds, Stations and Trainsheds.

a. Tunnel: A subgrade linear transportation structure, designed and constructed primarily for railroad operations, i.e. the passage for trains. The Tunnel is designed to resist earth and hydrostatic pressures, surcharges from adjacent structures and live loads, and occasionally, point loads from structures directly supported by the tunnel. Depending upon context, "Tunnel" may refer specifically to an individual structure (e.g. a single-track bored tunnel, built in a certain manner), the aggregate of individual structures that provide a complete passageway, or the entirety of the complex, including tunnels, approach structures, ancillary spaces, and tunnel support structures. Note: Non-Train Tunnels, e.g., utility tunnels, pedestrian tunnels, baggage tunnels, etc., are considered ancillary to the function of a train tunnel and may deviate from the requirements established herein, upon approval by Amtrak.

b. Overbuild: A multi-purpose platform structure, designed and constructed primarily to support a non-railroad development over an existing (or planned) railroad right-of-way. The Overbuild is designed to support the occupancy loads of the particular development (such as a residential or commercial building). The Overbuild is constructed by installing columns or walls from the existing ground surface (which may be in an existing trench) that support a platform over the trainway. Definitionally, "overbuilds" do not include overhead bridges which cross the railroad; however, the effects of an adjacent overhead bridge must be factored into the design and/or analysis of the overbuild.

c. Enclosed Station: Is a subset of "Overbuild" where the overbuild encloses station platforms and/or other publicly accessible facilities.

d. Trainshed: Is a subset of "Overbuild" where the overbuild encloses not only platforms and/or other publicly accessible facilities, but also encloses tracks, yards, and other railroad operational spaces.

B. Enclosed Stations, Trainsheds, Tunnels and Overbuilds:

1. Reference Amtrak Engineering Policy 4006 (EP4006), *Overbuild of Amtrak Right-of-Way Design Policy*. Amtrak Engineering Servies Design Manager reserves the right to grant deviations to the requirements in EP4006 on a project specific basis.

a. Code and standard guidance provided within Sections 2 and 3 of this document is also in practice here

2. Reference Amtrak Engineering Policy 3009 (EP3009), *Safety Requirements for Working in Amtrak's New York City Area Tunnels should be applied to all Amtrak Tunnels.*

3. Enclosed Stations, Trainsheds, Overbuilds and Tunnels shall be designed in accordance with NFPA 130, *Standard for Fixed Guideway and transit Passenger Rail Systems.*

II. Tunnel Structure

A. Drained vs. Undrained

1. The evaluation of drained vs undrained structures will be determined jointly with Amtrak Engineering and appropriate stakeholders after a risk register and life-cycle cost analysis has been completed. Life-cycle cost analysis shall include, but not be limited to, the following: operations, maintenance, replacement, hydrogeological and environmental factors (e.g. contaminated groundwater, gases), pre-discharge treatment, and municipal service fees.

B. Watertightness

1. Tunnels, shafts, caverns, cross passages, and other underground structures shall be designed to be watertight throughout the specified design life.

2. Watertightness shall be defined as no damp patches nor visible ingress of water throughout the concrete final lining.

3. Provide watertight connections between the tunnels and all shafts, caverns, cross passages, U-Structures, and other underground structures.

III. Interior Configuration for Tunnels, Overbuilds, Enclosed Stations and Trainsheds

A. Track Clearances

1. Adequate clearances shall be provided for safe passage of rail vehicles, maintenance operations, and shall comply with federal and state railroad minimum clearances and requirements of the National Fire Protection Association (NFPA).

2. Due to cost of underground construction, clearances will be uniquely determined for the particulars of the project, subject to the approval of Amtrak's Clearances Department, after considering:

a. Composite Clearance Diagram which accounts for all rolling stock anticipated to traverse the tunnel, overbuild, enclosed station, or trainshed.

b. The curvature of the alignment

B. Benchwalls - Tunnels will have high/low benchwall configuration

1. The high benchwall is considered the emergency egress path and shall:

a. Be of sufficient width to accommodate the NFPA egress envelope (without adjacent mounted equipment encroaching); and,

b. Be nominally 48 inches above top of rail unless not all of the equipment that will be using the tunnel has a discharge at 48-inches above top of rail. In such cases, coordinate with the operators to determine the appropriate height of the high benchwall.

2. The low benchwall shall:

a. Be of sufficient width to permit personnel to stand clear of the foul of track for the passage of equipment, to circumnavigate stopped/disabled equipment, and access the undercarriage of disabled equipment.

b. Be configured to permit personnel to comfortably step from the track bed (note not top of rail) up to the walking surface of the low benchwall.

3. Benchwalls containing critical communication or electrical assets, or with the potential to come in contact with energized system components, or to be used as emergency egress or first responder access shall be of concrete construction or similarly hardened and utilizing non-conductive materials.

IV. Ventilation

A. Unless otherwise allowed, Tunnel Ventilation will be coordinated with train control signals such that only one train is permitted per vent zone; see NFPA 130 (2023), Standard for Fixed Guideway and transit Passenger Rail Systems, Annex A A.7.2.5. Continuity of ventilation code compliance and modeling through all asset family boundary conditions (Tunnels, Trainsheds, Stations, etc.) shall be analyzed and validated during design.

B. Ventilation Engineering Analysis

1. ventilation fans shall be installed and utilized for emergency ventilation and maintenance operations

2. A Computational Fluid Dynamics Analysis shall be required for the design or modifications of the existing ventilation system or tunnel, overbuild, enclosed station, and trainshed characteristics.

a. A ventilation analysis is required for the emergency ventilation system which includes all ventilation boundary conditions with graphical representation of inlet and exhaust locations. The results shall be presented in a narrative report that outlines all assumptions and findings.

b. Analysis shall include Controls for the Mechanical Ventilation System addressing both local and remote capabilities. Remote control/monitoring shall be from Amtrak designated Fire Command Center (FCC). Remote controls/monitoring shall be provided via Supervisory Control and Data Acquisition (SCADA). It shall be the contractor's responsibility to provide a complete and fully functional system which includes all communications mediums compatible with Amtrak Systems, a local Human Machine Interface (HMI) at FCC and all software.

c. The analysis shall include an egress analysis that is coordinated with the ventilation analysis which provides compliance for egress evacuation time in a tenable environment.

d. Include Section for Commissioning. Amtrak shall be present for all acceptance testing of Life Safety Systems. Commissioning of life safety systems shall be in accordance with NFPA 3, Standard for Commissioning of Fire Protection and Life Safety Systems, NFPA 4, Standard for Testing of Fire Protection and Life Safety Systems and ASHRAE Guideline 1.5 (current edition), The Commissioning Process for Smoke Control Systems. Acceptance testing documents shall be developed and submitted to Amtrak for approval prior to scheduling approval tests. When scheduling acceptance tests, a minimum of 10 calendar days shall be provided prior to the test date.

3. The ventilation system shall maintain a tenable environment for a minimum of 1-hour.

4. The ventilation system design shall address the additional time required for passengers that are unable to self-evacuate and required to shelter-in-place.

5. The Ventilation Computational Fluid Dynamics (CFD) analysis used for sizing fan for tenability shall maintain the smoke layer height 2-feet above the train passenger car doors until ALL passengers and crew have evacuated, including passengers that are unable to self-evacuate. The smoke layer height of 2-feet above the train passenger car doors shall be maintained for a minimum of 1-hour.

6. Design Fire: A train fire is a fire beginning in one car of a train and spreading to other cars in the same train and to other trains that are in the station or on adjacent tracks. The means of egress of the involved train set shall be via the most remote door in a car separated from the car involved in the incident depending upon the type of equipment.

Amtrak will, upon request, define the details of the train set consist and consist equipment to be used as the design basis. The design philosophy of the ventilation system will be the control of the direction of smoke movement (i.e., the prevention of back-layering). The following train fire heat and fire smoke release rates shall be used in the ventilation analysis.

a. The following train fire heat and fire smoke release rates shall be used in the ventilation analysis for Tunnels, Stations, Trainsheds and Overbuilds having one track:

Time	Heat Release Rate	Heat Release Rate
Seconds	MW	MBtu/hr
0	0	0
180	5	17.060
600	5	17.060
780	10	34.120
1200	10	34.120
1380	31	106.200
> 1380	31	106.200

The fuel burn rate shall be 0.7898 kg/s (1.7417 lbm/s). The combustion products release rate shall be 11.2788 kg/s (24.8667 lbm/s). The opaque products release rate shall be 0.1295 kg/s (0.2853 lbm/s).

b. The following train fire heat and fire smoke release rates shall be used in the ventilation analysis for Tunnels, Stations, Trainsheds and Overbuilds having two or more tracks not separated.:

Time	Heat Release Rate	Heat Release Rate
Seconds	MW	MBtu/hr
0	0	0
180	5	17.060
600	5	17.060
780	10	34.120
1200	10	34.120
1560	52	177.476
> 1560	52	177.476

The fuel burn rate shall be 0.0254 kg/(s-MW)[0.0164 lbm/(s-MBtu/hr)]. The combustion products release rate shall be 0.3624 kg/(s-MW) [0.2342 lbm/(s-MBtu/hr)]. The opaque products release rate shall be 0.0042 kg/(s-MW)(0.0269 lbm/[s-MBtu/hr]).

C. Ventilation System Components shall include, but are not limited to

1. All ductwork shall be rated 482 degrees Fahrenheit for a 1-hour fire rating and 392 degrees Fahrenheit for the second hour.

2. Duct work shall be fabricated from 3/16th inch thick hot dipped galvanized steel plate, reinforced with steel angles or channels continuously welded on both sides of the angle or channel.

3. All connecting hardware shall be 316 stainless steel with dielectric sleeves and washers.

4. All ventilation fan gaskets shall be high temperature volcanized gaskets.

5. Expansion joints and flex connectors shall be constructed from 316 stainless steel flanges and flow liners rated for 482 degrees Fahrenheit for a 1-hour fire rating and 392 Fahrenheit for the second hour.

6. Ventilation fans shall be equipped with stainless steel vibration spring for isolation from the building.

7. Debris screens located at both fan inlet and outlet shall be constructed of 316 stainless steel, having 1 x 1 inch mesh openings constructed of number 12-gauge wire. Screen frames shall be constructed from 10-gauge angle. Screens shall be easily removable for maintenance operation.

8. Two speed, high-speed 100% and low-speed 50% of rated motor speed, are required for ventilation fans.

9. Fan drive motors shall have sufficient torque to start the fan across the line and reach high speed within 15 seconds with a voltage drop of up to 15 percent.

10. All damper control motors shall have a 1-hour fire rating and shall not be located in the ventilation fan air flow. All ventilation system damper actuators shall have thermal blankets and water-resistant covers which provide an additional 1-hour fire rating for an overall 2-hour fire rating for the actuator. Insulated steel box covers are prohibited.

a. Damper control motors shall be capable of actuating the dampers against a differential pressure of 14-inches of water gauge, or fan shut off pressure, whichever is greater.

b. Damper control motors shall be designed to run to destruction in an emergency incident.

c. Damper control motors shall fail to open position.

d. Damper control motors shall be capable of fully opening dampers within 10 seconds to prevent fan stall. Fan damper closure shall occur when fan shut down command is actuated, received at the fan, and the revolutions per minute (RPM) is at 50% of rated speed or lower.

e. Dampers shall be constructed of 316 stainless steel and rated for 482 degrees Fahrenheit for a 1-hour fire rating and 392 Fahrenheit for the second hour.

11. Fan aerodynamic stall shall be a consideration in fan design.

12. Ventilation Fan sound levels shall meet the local noise ordinance code requirements, except for emergency mode.

a. Jet Fans shall have a minimum two diameter sound attenuator for both supply and exhaust.

b. Sound attenuators shall be constructed from baffles enclosed by 3/16th inch thick hot dipped galvanized steel plate, reinforced with steel angles or channels continuously welded on both sides of the angle or channel.

13. Fan rooms shall be equipped with a series of overhead cranes and vertically aligned hatches for maintenance operations along with the ability to replace ventilation system equipment without having to remove significant section of the building or disruption to Transporation Operations.

14. High temperature grease shall be utilized.

15. Fan motor speed feedback shall be incorporated into the Fan Control and Monitoring System and displayed on the Human Machine Interface at the Operation Control Center.

16. Fan motors shall be equipped with vibration sensors at the drive and opposite drive end of the motor to detect overall vibration and bearing condition of the fan motor.

17. Ventilation Fan Motors shall be equipped with a series of Resistive Thermal Devices (RTD) typically located at the following:

a. Six stator (motor windings), two per phase, RTD’s

b. One RTD at drive end bearing

c. One at opposite drive end bearing

d. One ambient air temperature RTD

18. All ventilation fans shall be equipped with motor protection relays that shall monitor and protect the fan by providing an alarm and trip (shut down) features. The set points for the alarm and trip features shall be based on the manufacture's requirements. The motor protection equipment shall receive input from the following, but not limited to:

a. Bearing and Stator Temperature

b. Overall vibration

c. Bearing fault detection

d. Power condition including phase reversal, overcurrent protection, thermal overload protection, ground fault, short circuit, excessive acceleration time and under/over voltage protection

19. Ventilation air intakes and exhaust outlets shall be located in accordance with US Department of Transportation, Transit Security Design Considerations and Federal Emergency Management Agency (FEMA) Document 427, Design of Commercial Buildings to Mitigate Terrorist Attacks. All ventilation air intakes and exhaust outlets shall be a minimum of 12-feet above grade level and public access.

D. Power

1. A low voltage power system is required, 480 Voltage System.

2. Ventilation System shall be provided with a secondary power source, an emergency generator.

V. Egress

A. Egress Stairs and doors from trackway, benchwall, or platform to discharge at a public way shall have a minimum 60-inch clear width.

B. Cross-passageways and doors shall be a minimum clear width of 60-inches.

C. Doors exposed to transient pressures due to the piston effect:

1. Utilize a three-point latching system, top, bottom and center. The door latching, all three points, shall be monitored by the SCADA System.

2. Shall be designed to withstand transient pressure from train piston effect and fire rated. Doors shall be equipped with five heavy duty hinges, heavy duty double door closers, door frame buck grouted with concrete (filled), and three-point latching system.

D. Exit hatches are not permitted.

E. Provide directional lighting egress pathfinding system that is incorporated with the high benchwall continuous handrail and integrated with the SCADA Controls for the Ventilation System to coordinate egress direction and ventilation mode.

F. Continuity of egress code compliance and modeling through all asset family boundary conditions (Tunnels, Trainsheds, Stations, etc.) shall be analyzed and validated during design.

VI. Lighting

A. Lighting shall consist of Light Emitting Diode (LED) lamp(s) in a luminaire with at least an IP65 rating.

B. Luminaires shall be spaced to avoid a strobe effect.

C. Luminaires shall be mounted and/or shielded in such a way to prevent glare to locomotive engineers.

D. Proposed lighting is subject to Amtrak Transportation approval and shall include mockups and test runs prior to 100% design.

VII. Drainage

A. Internal Drainage Systems

1. Pumps

a. Submersible rail pumps shall be utilized and supported by the findings of the Design Criteria Report. Head pressure shall be the determining factor type of dewatering system

b. Sacrificial anode protection systems are required to protect pumps, piping and all other metal dewatering system materials subject to corrosion.

c. A secondary power system or pneumatic dewatering system is required.

d. A hoist beam shall be located above the pump for maintenance operations

2. Dewatering pumps shall be sized for the greatest inflow or a minimum of three 250 gpm hose streams utilized in a fire incident.

3. Sumps and Pump Room

a. Sumps shall include a forebay designed to mitigate silt and debris in-flow.

b. Sumps shall be equipped with submersible lighting so that the sump interior can be visually inspected from above.

c. A permanent water high visual measuring system shall be installed inside sumps.

d. A sump skimming net shall be provided and wall mounted in the sump room

e. A hydrocarbon gas detector shall be located in the sump pump room

f. A unit heater with a wall mounted thermostat shall be located in the sump pump room.

g. Pump rooms shall be properly ventilated to allow air flow, preventing equipment from overheating, corrosion of equipment and freezing conditions. Pump Room thermostat and ambient temperature shall be connected to the SCADA System and monitor at remote location.

4. Pump Controls

a. Submersible level transmitter or radar level sensors shall be the primary means for pump operation.

b. A float tree system shall be the secondary means for pump operations

c. The associated sump pump room equipment shall be monitored by the SCADA System to include but not limited to:

i. Room Unit heater and thermostat

ii. Submersible level transmitter for monitoring of the sump water level.

iii. Water flow meters, located on the discharge side of the pump

iv. Pump – Running, loss of power, and thermo overload.

VIII. Support Structures

A. Buildings, structures and rooms that support tunnels, overbuilds, enclosed stations, and trainsheds shall include, but are not limited to

1. Ventilation Facilities

2. Communication Buildings/Huts

3. Signal Buildings/Huts

4. Electric Traction Buildings

5. Pump Buildings

6. Mechanical Equipment Buildings

7. Sub-stations

8. Third-party lease structures/spaces

9. Vertical Access Locations

B. USE and OCCUPANCY CLASSIFICATION: Model building codes do not accurately classify the Use and Occupancy of Railroad Buildings and Structures which are primarily used for maintenance operations. The Use and Occupancy Classification for Support Buildings and Structures shall be Utility and Miscellaneous, Use Group U, as specified in the International Building Code. These buildings and structures are unoccupied and house special industrial processes and shall be consisted as such.

C. Location: Support Buildings and Structures shall be at grade level and flood mitigation systems shall be incorporated to protect again a 100-year flood. Should locating support buildings and structures at grade level be infeasible, Amtrak Engineering Services shall be notified immediately, and a plan shall be developed to provide an operation level of safety that is satisfactory to Amtrak.

D. Restrooms: Inclusion of a restroom shall be at the discretion of Amtrak, particularly for Ventilation Facilities. Restrooms shall consist of a single room with toilet, sink, and a floor sink/utility sink with hose bib.

E. Amtrak Vehicle Parking: Four parking spaces shall be provided for Amtrak vehicles at Support Structures. If the Support Structure is in an urban area, on-street parking shall be arranged with the municipality and signs and curb markings shall designate Amtrak Parking.

F. Fire Department Access: Key boxes, meeting the requirements of the local jurisdiction, shall be located at the exterior side of the discharge level of all emergency exits.

G. Hoists, Cranes, and Elevators:

1. **Hoists - Grade Level to Track Level:** Hoists shall be located at vertical access locations, particularly Ventilation Facilities. Hoists shall provide direct access from Grade Level to Track Level. A single hoist can be used to provide access to two tunnels when tunnels are directly adjacent to each other. Multiple hoists may be required to serve tunnels. Hoists shall be designed for emergency and maintenance operations. Hoists are not intended to be passenger lifts.

2. **Hoists and Cranes:** Hoists and cranes shall be provided for maintenance operations. In multistory buildings, opening for hoists and cranes shall be aligned through the building to provide direct access from grade level to all levels.

3. **Freight Elevators:** Freight Elevators for maintenance activities, particularly in Ventilation Facilities, may be required at Amtrak's discretion. The use of below grade elevators or elevators to track level is prohibited.

H. Fire Protection:

1. **Fire Sprinkler Systems:** Sprinklers shall not be required in rooms and spaces protected by an alternative fire suppression system.
   a. Sprinkler systems in Ventilation Facilities shall be at Amtrak's discretion. If a sprinkler system is not provided in a Ventilation Facility, then a fire alarm and detection system shall be provided throughout the facility.
2. **Fire Alarm Systems:** A fire alarm system with manual pull stations shall be provided in Support Buildings and Structures in accordance with NFPA 72, National Fire Alarm Code. The fire alarm system shall be monitored by the Amtrak local SCADA System, Amtrak National Fire Alarm Monitoring System and a Central Station Monitoring Company or local Fire Department.
3. **Fire Detection Systems:** Fire Detection Systems shall be required at Amtrak discretion. Fire detection equipment shall be suitable for railroad environment.
4. **Standpipe Systems:** Standpipe systems are required in all Support Buildings and Structures in accordance with NFPA 14, Standard for the Installation of Standpipe and Hose Systems
5. **Special Suppression Systems:** Special fire suppression systems shall be required for hazardous buildings and rooms to include but not limited to
   a. Fuel Tank Rooms
   b. Battery Rooms
   c. Sensitive Equipment rooms such as Signal and Communications Buildings and Rooms

I. Equipment installation and removal paths: Support Structures shall be designed with adequately sized pathways (corridors, doorways, floor hatches, etc.) to permit all equipment that will be housed throughout the Support Structures to be installed and removed without disassembling building cladding.

IX. Emergency Generators

A. Emergency Generators are required for secondary power.

B. Emergency Generators shall be installed in accordance with NFPA 70, National Electric Code and NFPA 110, Standard for Emergency and Standby Power Systems.

C. Emergency Generators are required as secondary power for but not limited to:

1. Ventilation Fans

2. Dewatering Pumps

3. Supervisory Control and Data Acquisition Systems (SCADA)

4. Lighting

5. Fire Alarm & Security Systems

6. Uninterruptable Power Supply (UPS) Battery Charger

7. Mission critical equipment required for normal operations

D. A 24-hour full load run-time fuel supply is required for Emergency Generators.

E. Emergency Generators shall use a diesel fueled prime mover.

F. Emergency Generators shall be monitored through the Amtrak SCADA System.

1. Low fuel

2. Generator running

3. Transfer Switch

4. Monitor Generator Manufacture Alarms

5. Thermal Overload

6. Monitor Transfer switch

G. Fuel tanks for emergency generators shall be double wall tanks.

H. A secondary containment system shall be installed around the fuel tank that is capable of holding 100% of the fuel tank volume.

I. Fuel lines from the fuel tank to the generator and fill lines shall be protected from damage. Fuel lines shall be double wall pipe.

J. Fuel Tank Rooms shall be located on an exterior wall.

K. Interior piping for Emergency Generators shall be minimized

L. Emergency Generator Fuel Tank Rooms shall be protected by a special fire suppression system.

M. Emergency Generators shall be at grade level and flood mitigation systems shall be incorporated to protect again a 100-year flood. Should locating emergency generators at grade level be infeasible, Amtrak Engineering Services shall be notified immediately, and a plan shall be developed to provide an operation level of safety that is satisfactory to Amtrak.

X. Controls

A. A Supervisory Control and Data Aquisition System (SCADA) shall be utilized to monitor and control Support equipment which includes, but not limited to:

1. Ventilation System

2. Dewatering System

3. Fire Alarm and Detection Systems

4. Situational Awareness

5. Emergency Generators

6. Fire Standpipe System

7. Special Suppression Systems

8. Stair Pressurization Systems

9. Directional lighting egress pathfinding system

10. Door Position and latching

11. Floodgates

XI. Floodgates

A. The functionality of floodgates shall be evaluated for all subaqueous tunnels in case of tunnel breech and tunnels which have portals within the 100-year floodplain or are otherwise at risk of inundation. The evaluation shall include a risk register and life-cycle cost analysis. Evaluation must also consider the value of equipment and operations being protected by the floodgate and consider alternative means of floodproofing the tunnel and equipment therein. When evaluating the functionality of floodgates, consideration shall be given to all potential hydraulic connections/pathways (intended or otherwise) between adjacent Tunnels and/or other structures,

including but not limited to: conduits, pipes, sumps, equipment rooms, cross passages, stairs, etc. Note: See Support Structures above for additional discussion regarding floodproofing.

B. Floodgates shall provide a minimum of two (2) feet freeboard above the design flood elevation or seal the entire portal opening.

C. Floodgates shall accommodate OCS or provide for a movable section of OCS pursuant to the requirements of ET.

D. Floodgates shall include a track threshold

E. Due to the complex geometry of tunnel portals (e.g., track flangeways, OCS), a fully watertight seal may not be feasible. In those cases, secured space proximate to the floodgate will be provided to house sufficient materials (e.g., sand and sandbags) to maximize the effectiveness of the floodgate.

F. A concept of operations must be included with all design submissions that include or reference floodgates.

XII. Situational Awareness

A. Real time video monitoring systems shall be installed in accordance with Amtrak Digital Technology and Corporate Security requirements.

B. Real-time video monitoring systems shall be provided to monitor the following, but not limited to:

1. Throughout tunnels, overbuilds, enclosed stations, and trainsheds

2. Dewatering pump rooms and sumps

3. Egress Stairs and Cross passageways

4. Perimeter of Support Structures

5. Entrance to Support Structures

6. Other rooms as directed by Amtrak Engineering Services

XIII. Tunnel Fire Detection

A. Smoke Aspirating System: Provide smoke aspirating systems in tunnels with control panels at locations that can be accessed without a tunnel outage or disruption to transportation. Smoke aspirating system will provide early detection and supplement the other Tunnel Fire Detection Systems such as linear heat detection. Smoke Aspirating System smoke signature shall be for a railroad environment to prevent false actuation from diesel exhaust, dirt, and debris. Due to the limitations of smoke aspirating systems, complete coverage of the tunnel may not be achieved.

B. Linear Heat Detection: Provide fiber optic cable linear heat detection throughout tunnels. An engineering analysis shall be provided at the early stage of the project to determine and optimize the location of the linear heat detection cable.

XIV. Signage

A. Place Signage on all Cross Passage Door stating, "Cross Passage to Track X"

B. Place signage on all exit stair door stating location of discharge i.e. "Discharges to XXX Street"

C. Amtrak signage standards are available upon request.

D. Proposed reflective signage is subject to Amtrak Transportation approval and shall include mockups and test runs prior to 100% design.

XV. Tunnel Fire Standpipe System

A. Tunnels shall be equipped with a supervised dry standpipe system. The standpipe system shall be dry and supervised with compressed air. Loss of air pressure will not cause the system to fill but will indicate a potential problem that requires investigation. The dry standpipe will be connected to municipal water supply for the purpose of remotely filling the system through a deluge valve, so that the system is primed for use by the fire department upon their arrival. The municipal water supply to which the system will be connected will not be able to provide "system demand". System demand will be provided by a fire department pumper, which when activated, will cause a check valve protecting the deluge valve to close and all system demand water will be supplied via the hydrant, pumper, and fire department connection.

B. The Tunnel Standpipe System does not meet NFPA nomenclature since the water supply to which the system will be connected will not be able to provide the "system demand", the Tunnel Standpipe System cannot be referred to as "semi-automatic dry".

C. Tunnel Standpipes shall be separate and distinct from fire standpipes for the Support Structures.

D. The Tunnel Standpipe System does not meet NFPA 130 requirements as the system will not be continuous. The Tunnel Standpipe System shall be comprised of a series of segments or legs.

1. The tunnels can be segmented into zones, each of which will be afforded coverage by the standpipe system. The end points of the zones are defined by access points, either portal or shafts.
2. There will be one or more Mechanical Equipment Rooms (MERs) at each end of each zone. The MERs provide for the remote filling of the standpipe system, by utilizing deluge valves connected to municipal water supply.
3. Since each zone will have an MER at each end, it is appropriate to consider the standpipe for each half-zone, or "segment". Each segment provides coverage for half a tunnel zone.
4. Spacing between segments shall be a maximum of 50-feet to allow for interconnecting segments by the fire department if needed.
5. The standpipe system will be charged with air or inert gas and supervised on a 24/7 basis to ensure system integrity. Monitoring and control of the standpipe system shall be from the Amtrak designated Fire Command Center (FCC).

E. Filling of the Tunnel Standpipe System can be done remotely, via the SCADA System, at the Amtrak Fire Command Center and locally in the MER from a manual release or at the deluge valve.

F. Hydraulic Analysis, which includes calculations for the standpipe systems are required during design to ensure that the systems will perform as specified. Current water flow test data, within 12 months, from the municipality shall be provided with the hydraulic calculations.

G. Fill-time calculations shall be provided with the Tunnel Standpipe Hydraulic Analysis.

H. Pipe utilized for the Tunnel Standpipe System shall be hot dipped galvanized schedule 40 pipe.

I. The Tunnel Standpipe System shall be bonded and grounded in accordance with the requirements of Amtrak Electric Traction.

J. Placards shall be placed above all fire department connections which state the maximum operating pressure for the Tunnel Standpipe System segment.

K. The Fire Standpipe System shall be tested and approved by the local fire department. When scheduling acceptance tests, a minimum of 10 calendar days shall be provided prior to the test date.

XVI. Emergency Response Equipment

A. The following emergency response equipment shall be provided in tunnels include but are not limited to:

1. Rail Tool and Supply Carts – locate at Portals and hoist to track level. Rail carts to be provided in protective cabinets that can be secured.

2. Directional Signs – Directional signs shall be located throughout the tunnels to indicate the direction and distance to the nearest exits. Placement of directional signs shall be approved by Amtrak Engineering Services.

3. Ladders – Fiberglass ladders, 6-feet long, shall be provided every 200-feet in the tunnel to provide access to benchwalls and trains in an emergency. The ladders shall be yellow, have non-slip surfaces on treads and integrated handrails and be secured to the tunnel wall with chain and two locks. The locks, one being keyed to the Amtrak 102 Key, the other to the common transportation key shall be interlocked together so that opening either lock will release the ladder.

4. Portable 20 lb. Fire Extinguishers – 20 lb ABC Dry Chemical fire extinguishers shall be placed throughout the tunnels every 100-feet.

5. Electrical receptacles – electrical receptacles shall be provided throughout the tunnel every 200-feet.

6. Forward Command Centers – to be provided at discretion of Amtrak Engineering Services and local Fire Department.

7. Public Address System – to be provided at the discretion of Amtrak Engineering Services.

8. Radio equipment – Radio equipment shall be provided in accordance with Amtrak Communications requirements.

XVII. Stair Pressurization Systems

A. Utilization of stair pressurization systems in Support Structures shall be determined by Amtrak Engineering Services based upon the characteristics of the stair.

XVIII. Electrical Conduits

A. Non-metallic or corrosion protected conduit shall be used .

B. Fire rated fiberglass reinforced epoxy conduit with a low smoke zero halogen yield shall be considered.

C. Polyvinyl Chloride (PVC) conduit is not permitted.

XIX. Railroad Systems

A. Use of OCS Sectionalizing Switches within the limits of the tunnel shall be approved by Amtrak's Electric Traction Department.

B. Coordination of signaling, vent zones, and Positive Train Control shall be approved by Amtrak's Communications and Signals Department.

C. Equipment operating temperature range shall be selected to minimize if not obviate the need for heating, venting, and cooling equipment rooms.