19.0 Tunnel Enhanced Fire Safety System

19.1 General

This Section identifies the requirements for the standpipe system, ancillary components and modifications to the existing fixed fire suppression system. All elements of the system shall be designed, furnished, and installed in accordance with the requirements of the Contract, Governmental Approvals, and applicable Codes, Standards and Laws.

The Contractor shall be responsible for all analyses, reports, designs, drawings, detailing, clearances, tolerances, and specifications of the FFSS and the procurement, fabrication, installation, testing, and commissioning of components to provide a fully functional system that meets the Project requirements.

19.2 Concept of Operations

The objective of the standpipe system is to replace the existing hydrants currently located within the roadway of the North and South tunnel. The existing hydrants and associated water supply piping will be abandoned after successful completion and commissioning of the new standpipe system. The standpipe system shall not interfere with the existing operation or sequence of the fixed fire suppression system.

Fire Department Hose Connections (FDC) shall be located within the roadway, spaced such that no location on the protected roadway is more than 150 feet from the hose connection with a spacing not exceeding 275 feet and coordinated with the existing hydrant locations.

The standpipe system shall include all components required for system operation, monitoring, and control and shall utilize the existing water supply system.

Contractor shall design, procure, install, and test a complete standpipe system, including, but not limited to:

- Connection to existing water supply system
- Piping and hose connections in both the North and South bores
- Valves and appurtenances for automatic operation upon opening of a hose connection valve
- All required structural supports
- Protection against freezing
- Required monitoring of valves, pressure, and other elements.

The standpipe system shall operate automatically, upon opening of a fire department connection valve in the roadway without personnel intervention or communication to the Control Room.

All piping, including the fire department connections shall be located on the wall, above the barrier, opposite of the walkway in the North and South bores. Piping shall be concealed within the wall panels and provided with a cover plate to match the existing color, finish, and style of the existing wall panels. All exposed piping and fittings, except for the fire department connection, shall be painted to match. Provide signage on the wall at all new standpipe locations.

All piping, valves, electronic and other components subject to freezing shall be protected.

Modifications to the existing fire alarm system for monitoring of any new valves, pressure devices, etc. shall not interfere or modify the existing fixed fire suppression sequence of operation.

19.3 Design Criteria

The new standpipe system shall be designed to operate independently of the existing fixed fire suppression system, as it relates to control and operation. Water shall be delivered automatically upon opening of a fire department connection valve in the roadway, without requiring a separate action such as activating an electronic switch or communication to the control room personnel.

The existing Fixed Fire Suppression System (FFSS) is designed to provide water to a maximum of two overhead deluge systems within the roadway and consists of a supply loop located within the roadway plenum spaces supported by a fire pump. The existing water supply is from the existing tank and provides a maximum operation time of sixty minutes while operating two deluge systems, plus 500 gpm of hose stream. The hose stream water, or supply to the existing hydrants is not augmented by the existing fire pump. Current operational protocol is to manually shut down the operation of any overhead system(s) prior to utilizing a handline for fire department operations.

19.3.1 Connection to Existing Water Supply

It is anticipated that the standpipe system will connect in-line to the existing supply loop within the ventilation plenums. Connection to the existing supply loop shall not adversely affect the operation of the system. The Contractor shall perform hydraulic calculations showing the design parameters of the existing system are not affected by the addition of any new piping, valves, fittings, or other components for each of the existing system remote areas. These shall be compared to the as-built system calculations. Any upgrades required to maintain the existing function of the FFSS, such as fire pump modifications, shall be included in the design.

The design shall be based on operation of the standpipe system, flowing a maximum 500 gpm, without simultaneous operation of the overhead deluge systems.

The Contractor shall develop and submit hydraulic calculations including:

- Calculations of all FFSS remote areas to include all new piping, valves, fittings, etc. with comparison to the as-built calculations.

- Calculations showing discharge and pressure of the operation of the most remote fire department connection(s) with the fire pump running
- Calculations showing discharge and pressure of the operation of the most remote fire department connections(s) without the fire pump running
- Calculations showing the discharge and pressure of the operation of the fire department connections within each remote area of the FFSS with the overhead system operational, to include both one and two deluge zones operating simultaneously.

19.3.2 Piping and Hose Connections within the Roadway

The standpipe system hose connections shall be located on the wall opposite of the walkway within each bore, above the barrier and outside of the minimum required roadway width. The piping, except for the hose connections shall be concealed or partially concealed within the wall panels. Any exposed piping shall be provided with a cover plate to match the existing color, finish, and style of the existing wall panels. Piping at the ceiling level, which cannot be concealed in a wall panel shall be painted to match.

The Contractor shall develop and submit a rendering showing pipe locations in the roadway, as well as color and material samples for each typical location for approval by CDOT prior to NPT2

19.3.3 Valves, Piping and Equipment located within the Plenum

All valves, piping, and equipment located within the plenum shall be protected from freezing. The existing equipment and piping within the plenum are protected from freezing utilizing a hot water recirculation system and insulated valve enclosures using radiant heat from the supply pipe. It is anticipated that the standpipe system will be connected to the existing supply piping. Any connection to the existing supply piping shall not dimmish the design heating capability of the existing system. Any existing insulation that is disturbed during the installation of the system shall be replaced with a material of similar mechanical and thermal properties to the existing insulation system.

The Contractor shall develop and submit heat loss calculations showing any changes to the freeze protection existing system and showing that all new components will be protected from freezing to CDOT prior to NPT2.

19.3.4 Structural Supports and Bracing

All new piping, valves and equipment within the plenum shall be independently supported from the plenum wall. No piping or equipment shall add additional load to the plenum divider wall or the plenum floor system. Calculations for all structural supports shall be provided by a Structural Engineer and include the effects of the wind forces generated while the fans are operations. Piping and supports shall be designed to account for expansion and contraction due to thermal and pressure forces. Piping and supports shall be designed to provide restraint against pipe movement due to forces of flow, pressure, expansion and contraction and other forces.

The Contractor shall develop and submit structural calculations for all supporting elements of the standpipe system to CDOT prior to NPT2.

19.3.5 Modifications of the Existing Fire Alarm Control System

Modifications to the existing fire alarm control system necessary to monitor any new valves, pressure devices, etc. shall not modify, in any way, the existing fixed fire suppression system sequence of operation.

All equipment and materials used in the standpipe system shall be compatible with the existing FFSS.

19.4 Codes and Standards

The Contractor shall perform engineering analyses and classify all subsurface configurations as road tunnel, in accordance with NFPA 502, or other appropriate standards, and apply other applicable Standards of the Industry.

The Contractor shall develop and submit for Approval to CDOT within 60 days after NTP1, the list of codes and standards proposed for the design, construction and commissioning of the standpipe system.

19.5 Design Baseline Report

The Contractor shall prepare and submit a Design Baseline Report to CDOT for Approval within 90 days after NTP1. The Design Baseline Report shall provide a system description that includes at a minimum the following elements:

- System block diagrams for the standpipe system
- Methods of freeze protection
- Structural support and bracing systems
- Monitoring and control systems
- Proposed system operation
- Hydraulic calculations
- Proposed modifications to existing tunnels and buildings

19.6 Emergency Response Plan

The Contractor shall be responsible for modifying the existing ERP to include the operation of the standpipe system. Contractor shall attend ERP coordination meetings to discuss the details of the standpipe system and tunnel emergency procedures.

19.7 Existing Tunnel Systems

The Work includes coordination (and in some cases interconnection) with all existing tunnel facilities and equipment, including the following:

- Tunnel ventilation system
- Tunnel lighting
- Programmable Logic Controllers (PLCs)
- Tunnel signage, signals, and control
- Tunnel communications and control (including tunnel Control Room)
- Tunnel washing machine and procedures
- Fire Alarm and Detection System

19.7.1 Ventilation System

The EJMT has an existing tunnel ventilation system that operates in a transverse configuration. There are existing centrifugal ventilation fans located above both the east and west portals. Fresh air is supplied to the tunnel from an air duct located above the roadway. In the north tunnel, fresh air is conducted to the roadway level from air ducts located at the sidewall. In the south tunnel, fresh air is supplied to the roadway level via air ports in the floor of the fresh air duct. In both north and south tunnels, vitiated air is removed from the roadway level via ducts located in the floor of the exhaust air duct.

The capacity of the existing tunnel ceiling support system is limited by critical connections at the ceiling hangers embedded in the center divider wall. Service loads applied to the duct floor during construction shall not result in loading on the critical connections that would exceed loading from a uniform load over the plenum floor area equivalent to 62 pounds per square foot divided by a 1.7 load factor. The determination of equivalent uniform loading shall consider the exhaust and supply sides of the plenum separately. The Contractor shall submit a Construction Sequencing Plan that provides details of service loads applied to the plenum floor during all phases of construction including stockpiling of materials, tools, equipment, labor, and all other loads.

The Construction Sequencing Plan shall be submitted to CDOT, for Approval, a minimum of 30 days prior to NTP2. Particular care shall be taken that the loads established in the Approved Construction Sequencing Plan are not exceeded. The Construction Sequencing Plan shall indicate the procedures that the Contractor will follow to ensure that loadings are not exceeded. Service point loads on the plenum floor are also limited to the punching shear capacity of the plenum floor section reduced by a 1.7 load factor; maximum anticipated construction and final point loads shall be determined and provided in the Construction Sequencing Plan.

The total dead load applied to the plenum floor (and to the ceiling in the plenum transition areas) by the finished system shall be limited to two pounds per square foot over the surface area of the entire floor (for exhaust and supply side, considered separately). Weight of water in piping shall not be included in the calculation of the system dead load.

The existing ventilation system maintains CO concentrations below the maximum acceptable levels during all non-emergency traffic conditions, including congested, stopped, and normal flowing traffic. During these traffic conditions, the EJMT ventilation system maintains the CO level below 50 parts per million. When work parties are present, CO levels are maintained at or below 35 parts per million.

19.7.2 Ventilation Control

The current method for operation and control of the existing tunnel ventilation system will not be changed as part of the standpipe system.

19.7.3 Cross Passages

Tunnel cross passages connect the existing tunnels. Tunnel cross passageways and, as applicable, other spaces within the roadway, may be used for FFSS equipment. Emergency ingress/egress capability shall be maintained. Any use of the cross passages and any equipment location requires CDOT Approval.

19.7.4 Water Supply System

The existing tunnel standpipe system at the EJMT is charged from a 120,000 gallon storage tank located above the west portal. This storage tank is filled with water collected from a diversion dam on Straight Creek. CDOT has existing water rights on Straight Creek of 0.03 cubic feet per second.

19.7.5 SCADA Interface

Provide a new interface between the existing fire alarm and detection system and the SCADA system. The interface shall be compatible with the existing Edwards fire alarm control equipment. All work must be performed by technicians that are certified on all systems integrated with the fire alarm and detection system, including Edwards fire alarm system and the LIOS fiber optic heat detection system.

19.8 Testing and Commissioning

19.8.1 Testing

19.8.1.1 Construction Acceptance Test

The Construction Acceptance Test shall be performed using the constructed system in the EJMT, at least 30 days prior to the Interim Acceptance of the Project. This test is in addition to any tests needing to be performed under NFPA 13. The overhead deluge and standpipe system must be operating to ensure adequate pressures and flows are available to both sprinkler and standpipe flows. No fires shall be started in the EJMT for this test. A test is considered successful when the minimum flow rates and pressures are achieved.

19.8.2 Commissioning

All mechanical, electrical, and software systems shall be tested as part of a complete commissioning program. Commissioning testing shall be performed in accordance with NFPA 13, 72 and 502.

Commissioning tests shall include at a minimum the following elements:

- Component and equipment
- Communication links
- Status, control, alerts, and alarms
- Interfaces between subsystems
- Integration among new and existing subsystems

Commissioning shall be carried out by an independent third party commissioning agent with demonstrated experience in commissioning tunnel systems within the past five years. The Contractor shall complete commissioning of all systems for CDOT Acceptance prior to Interim Acceptance.

The commissioning agent shall prepare and submit a Commissioning Test Plan and Schedule for Approval to CDOT a minimum 90 days before the start of any testing. The test plan shall be based on the technical specifications and performance characteristics of all devices, equipment, parts, assemblies, systems, subsystems, software and devices supplied and installed under this contract. Testing shall be carried out by the Contractor and witnessed and documented by the commissioning agent.

All elements subject to testing shall be included in the testing schedule. Weekly commissioning meetings shall be held beginning 90 days prior to the scheduled start of testing to review the status of the testing and planning for future tests.

All commissioning documentation shall be submitted to CDOT for Acceptance following testing and prior to Interim Acceptance.

19.9 Maintenance and Operations Training

The Contractor shall provide Maintenance and Operations training a minimum of 90 days prior to Interim Acceptance. The Contractor shall provide a Maintenance and Operations Training Plan and Syllabus 30 days prior to beginning training for review by CDOT. The training shall be conducted by the manufacturer's technical service personnel or factory authorized representatives for all of the systems installed in the EJMT. The Contractor shall provide a minimum of 80 hours of training for each Tunnel Enhanced Fire Safety System subsystem.

The Contractor shall include in the training; operation instructions, theory of operation, system description, preventive maintenance procedures, troubleshooting and repair of all equipment specified herein. The Contractor shall include with the training all material

and manuals required for each participant. Dedicated systems training for CDOT system administrators shall cover computer systems, hardware, communication networks, and software systems.

19.10 Manuals and Documentation

The Contractor shall provide the draft standpipe system Maintenance and Operations Manual to CDOT for review and Approval 120 days prior to Interim Acceptance. The Contractor shall provide five printed and bound copies and one electronic copy in native editable format of the final Maintenance and Operations Manual within 90 days after CDOT Approval. The Maintenance and Operations Manual shall include catalog cuts, final as-built shop drawings, hardware and software instruction manuals for all systems supplied and installed, stored on USB memory, equipment maintenance, and recommended spare parts. Interim Acceptance of the Tunnel Enhanced Fire Safety System will not be provided until the Maintenance and Operations Manual has been Approved.

The Maintenance and Operations Manual shall include a complete parts list. The parts list shall include a list of all parts supplied under the Contract, down to the lowest level part or assembly that is user-replaceable. The parts list shall include part numbers, description, system application or use, manufacturer, and supplier. The parts list shall identify sole-source and propriety parts. For all sole-source and proprietary parts, compatible or alternative parts shall be identified. The estimated service life of parts that have a service life less than 30 years shall be identified.

The Maintenance and Operations Manual shall include a complete consumable supplies list. The supplies list shall include a list of all materials required for routine maintenance of the equipment supplied under the Contract. The supplies list shall include material name, description, function, application rate and frequency, manufacturer, and supplier.

19.11 Deliverables

The Contractor shall submit the following to CDOT for Review, Approval, and/or Acceptance:

Table 19-2: Deliverables by the Contractor

Deliverable	Review, Acceptance, or Approval	Schedule
Codes and Standards List	Approval	60 days after NTP1
Design Baseline Report	Approval	90 days after NTP1
Construction Sequencing Plan	Approval	Minimum 30 days prior to NTP2
Construction Acceptance Test	Acceptance	Minimum 30 days prior to Interim Acceptance
Commissioning	Acceptance	Prior to Interim Acceptance

Deliverable	Review, Acceptance, or Approval	Schedule
Commissioning Test plan and schedule	Approval	90 days before start of testing
Commissioning Documentation	Acceptance	Following Testing and Prior to Interim Acceptance
Maintenance and Operations Training Plan and Syllabus	Review	30 days prior to beginning training
Maintenance and Operations Manual	Approval	120 days prior to Interim Acceptance

All deliverables shall also conform to the requirements of Book 2, Section 3.