SR 99 Tunnel Technology

James M. Sims, P.E., Tunnel Systems Engineer
Today’s FOCUS

• The Big Picture
  • Tunnel Systems Overview
  • Traditional Intelligent Transportation Systems (ITS) for the SR 99 tunnel
Building a new SR 99 Corridor
Building the North NORTH PORTAL
Building the North OPERATIONS BUILDING
Building the NORTH PORTAL

North portal receiving pit, May 10, 2016

- Tunnel operations building
- Southbound lanes
- Northbound lanes
- Utilities and maintenance

Ventilation
Building the North OPERATIONS BUILDING
Building the South SOUTH PORTAL
Building the SOUTH PORTAL

Southbound deck, March 16, 2016
SB Utilidor
Electrical Rooms

Egress Corridor

NB Utilidor
Areas of Refuge & Valve Stations

Invert Utility Corridor

Ventilation Duct/Plenum

Pump Station

Southbound

Northbound

Alaskan Way Viaduct Replacement Program

Tunnel Design
Enclosed emergency walkways with independent ventilation system

Tunnel’s emergency exits

TUNNEL EVACUATION
TUNNEL EVACUATION
Today’s FOCUS

- The Big Picture
- **Tunnel Systems Overview**
- Traditional ITS for SR 99 tunnel
• Brief overview of all the SR 99 Tunnel Systems
• Majority of these systems could be considered ITS
SR 99 Tunnel

SYSTEM TECHNOLOGY
Tunnel Ventilation Systems

Maintenance Air System
• Air Supply/Pressurization – Utilidors and Equipment Rooms

Roadway Ventilation w/ Environmental Monitoring Stations
• (CO, NOX, and PM)
Tunnel Ventilation Systems

Centrifugal and Jet Fan Units

- Emergency Single Point Extraction Ventilation
- (Smoke Extraction)
Tunnel Fire Suppression Systems

- Roadway Deluge System
- Wet Sprinkler System

Portal & Tunnel Drainage Systems

- Storm-water Pump Stations
- Low Point Pump Station
- Hydrocarbon monitoring w/ Ventilation

SR 99 Tunnel

MECHANICAL SYSTEMS
Power Distribution and Lighting

- 26 KV Medium Voltage Switchgear
- 26KV to 480V Distribution Switchgear
- Main-Tie-Main Alternate Utility Substations – Emergency Power
Power Distribution and Lighting

- 5 KV Medium Voltage Distribution
  - Tunnel Electrical Rooms - Voltage Drop
- Emergency Generator / UPS Power Systems
  - Tunnel Closure, Security and Maintenance
- Stepped Tunnel Lighting System

---

**SR 99 Tunnel**

ELECTRICAL SYSTEMS
• Automatic and Remote Manual Fire Control System
• Ringed Nodal Fire Alarm Control Panels
• Fiber Optic Linear Heat Detector Systems
• Exit Door LED Marker Lights and Strobes
• Local Agency and WSDOT Two-Way Radio System
• AM/FM Rebroadcast Override System
• Paging Phone Systems
  o Emergency, Maintenance, General
• Public Address System
• Private Wireless Cellular Service
Access Control Systems (ACS)

- Card Readers
- Electric strikes and mechanical locks

Intrusion Detection Systems (IDS)

- CCTV Cameras
- Position Switches
- Motion Detectors
• Power Distribution, Emergency Power, Lighting
• HVAC, Smoke Control
• Fire Control - Detection and Protection
• Wet, Dry and Pre-action Sprinkler systems
• Communications - Network
• Security - Access Control, Intrusion Detection
• Elevators and Cranes
- Supervisory Control and Data Acquisition (SCADA)
  - SIDER A w/ redundant PLC Control
- Fire Control - Simplex Grinnell True Site Work Station
- Lenel Security Management System
- Building Information/ Energy Management Control (BIM/ EMCS)
- DMX Building Façade Lighting Control
Primary tunnel systems operations will be from the WSDOT NWR traffic management center in Shoreline.
Connection to WSDOT Shoreline TMC

Dual Ethernet Fiber Communications Rings to WSDOT Shoreline TMC
Connection to WSDOT Shoreline TMC
• Tunnel Fiberoptic Network Rings (Mostly Bi-directional)
  • Tunnel (Video, SCADA)
  • Fire Control
  • PLC Remote I/O
  • Two-Way Radio
  • ITS
Today’s **FOCUS**

- The big picture
- Tunnel technology overview
- **Traditional ITS for the SR 99 Tunnel**
• Intelligent Transportation Systems (ITS) Inside The Tunnel

• Intelligent Transportation Systems (ITS) Outside The Tunnel

• Generator and UPS power is provided for ITS inside the tunnel and just outside the tunnel.
• Video Based - Incident Detection System
• Closed Circuit Television System CCTV (Pan Tilt and Zoom)
• Video Management Systems and Servers
• Tunnel Control Signs (TCS)
• Lane Control Signs (LCS)
• Traffic Data Stations - Induction Loops

Intelligent Transportation Systems
INSIDE THE TUNNEL
• Primary visual aid for tunnel operators at the Dayton TMC
• Verification of TCS and LCS messages
• Camera Position Pre-sets:
  o View preset locations with tunnel alarms/notifications
  o SCADA system be capable of automatically offering the tunnel operator up to two camera views of a incident event

SR 99 Tunnel CLOSED-CIRCUIT TELEVISION SYSTEM
Video Based - Incident Detection System
- Citilog - MediaTunnel
- First line of protection in mitigating traffic issues within the tunnel
- IDS detects the following:
  - Low Visibility
  - Stopped Vehicle/Traffic
  - Wrong Way Vehicle
  - Pedestrians
  - Debris
Primary tunnel communication’s means for driver information.
Tunnel Control Signs (TCS)

Provide information to motorists, including traffic advisories, speed control, lane control, alternate route messages, information and instructions during emergencies.
Lane Control Signs (TCS)

- Stop traffic
- Shift or redirect traffic
- Variable speed limits

SR 99 Tunnel
Active Traffic Management (ATM)

• SCADA system will use lane control signs to vary speed limit in the SR99 tunnel.

• Speed limits will be based on the current traffic conditions given by the vehicle sensors installed in the roadway.

• The ATM algorithm brakes the tunnel up into 4 zones.

• The speed limits in the tunnel will be adjusted based on measured traffic data within the 4 blocks.
Traffic Data Stations
• Portal Traffic Signals - Portal Tunnel Control Signs (TCS)
• Ramp Metering – (NB On Ramp)
• Portal Traffic Control (Access) Gates

• Traffic Signal Pre-emption
• Electronic Tolling – Toll Rate Signs
• Portal VMS
• CCTV

Intelligent Transportation Systems
AT TUNNEL PORTALS
Tunnel Control Signs

AT SOUTH PORTAL
Building the **SOUTH PORTAL**
S-NB99 PORTAL - ELEVATION

Tunnel Control Signs

AT TUNNEL PORTALS
Northbound on-ramp

SR 99 tunnel

RAMP METERING
SR 99 tunnel

RAMP METERING
Ramp Meter Approach
(SR 99 tunnel on-ramp at Royal Brougham Way)

- The tunnel portal signals will be used for ramp metering signal
- The tunnel portal signal will be controlled by the ramp meter controller cabinet
- The tunnel Control (SCADA) system will provide control signal to ramp meter controller that tunnel is closed.
- Upon receiving the control-signal that tunnel is closed, the ramp meter will either shut down or provide red ball on the portal signals.
- This control-signal is similar to pre-emption control-signal to a traffic signal controller
North Portal

TRAFFIC CONTROL GATES
VMS/Blank-out sign at the North Portal

Southbound VMS

VARIABLE MESSAGE SIGN
North Portal

TRAFFIC SIGNAL PRE-EMPTION
South Portal
TRAFFIC SIGNAL PRE-EMPTION
North Portal

ELECTRONIC TOLLING
South Portal

ELECTRONIC TOLLING
ITS Scenario: Fire in the tunnel
Automatic Fire Response for Deluge System:

- Fire detection by fiber optic linear heat detectors over roadway lanes.
- PAS alarm sequence w/ acknowledgement, investigation and failsafe timers provide tunnel operator a chance to stop or advance deluge in a roadway fire zone.
Remote Manual Response for Deluge System:

- Tunnel Operator is made aware of a fire from IDS, CCTV, Pull station, public, etc.
- Tunnel Operator can direct remote manual fire response from GUI.
Under a fire scenario (automatic or remote manual response) the following will occur:

• The tunnel ventilation system will extract smoke from fire zone.

• Tunnel control signs inside the tunnel would display “X” stop message.
Under a fire scenario (automatic or remote manual response) the following will occur:

- The portal traffic signals would display red ball
- The portal tunnel control sign would display Tunnel Closed
- The operator would have the option to close the gates
Under a fire scenario (automatic or remote manual response) the following will occur:

- VMS outside the tunnel would display closure message
- VMS and blank-out signs on side streets leading to the tunnel would alert traffic that the tunnel is closed
- Traffic signals outside the tunnel would be pre-empted, not to serve the on-ramps to the tunnel
Under a fire scenario the tunnel operator is provided the option to evacuate the tunnel.

- Reasons for Evacuation: Major fire, gas or chemical spills, or acts of terrorism
The tunnel operator would direct motorist to leave their vehicles and use the tunnel emergency exits by the following:

- Strobe and LED around exit doors would flash
- TCS and LCS would display messages for evacuation
- AM/FM radio rebroadcast: pre-recorded evacuation messages
- PA speakers: pre-recorded evacuation messages
Design Partners:

- RFP: WSP (Parsons Brinkerhoff)  
  (with support from HDR and other consultant firms)

Construction Partners:

- Seattle Tunnel Partners (Tutor Perini and Dragados USA)
- Design Engineer of Record: HNTB
- SCADA, ITS and System Integration: SICE

WSDOT Support:

- Hatch Mott Macdonald
- WSDOT NWR/HQ Traffic Design and Operations
QUESTIONS?

Website: www.AlaskanWayViaduct.org

Twitter: @BerthaDigsSR99

Email: viaduct@wsdot.wa.gov

Hotline: 1-888-AWV-LINE