

Personnel Life Safety Systems Summary in Parallel Linear Collider Tunnel Housings

The following summary outlines personnel life safety protection systems for parallel tunnel Linear Collider housings. The scope is intentionally inclusive as no single safety system is likely to be adequate alone, and no single type of hazardous event is likely to occur in isolation alone. Part A identifies various systems, and part B includes related discussion. Various references are added.

A) As an example, adequate personnel life safety protection systems for an emergency event such as a tunnel housing fire would include the following:

- Area Smoke Detection (VESDA),
- Area Heat Detection,
- Totally Enclosed Water Cooled Equipment Rack Smoke Detection (VESDA),
- Totally Enclosed Water Cooled Modulator Heat & Smoke Detection (VESDA +),
- Totally Enclosed Power Transformer Heat & Sudden Pressure Detection,
- Automatic Local Alarm Annunciation (tunnel housing strobe & horn),
- Remote Alarm Annunciation (on-site fire-EMS, control room strobe & horn),
- Manual Local Alarm Activation (tunnel housing pull box),
- Automatic Fire Suppression (water sprinklers),
- Tunnel Water Collection & Drain System (wall gutters, tunnel sumps, exterior pumps),
- Tunnel Water Level Detection & Alarm,
- Manual Fire Suppression (CO2 extinguishers),
- Remote Reversible Tunnel Ventilation Blowers w/ Back-up Power,
- Sectionalizing Fire Doors,
- Low Oxygen Detection & Alarm,
- High Gas Concentration Detection & Alarm,
- Tunnel Area Lighting,
- Tunnel Emergency Area Lighting w/Battery Back-up, Fixed & Portable,
- Tunnel Emergency Exit Signage Lighting w/Battery Back-up,
- Tunnel Emergency Exit Path Lighting & Signage w/Battery Back-up,
- Tunnel Video Surveillance Cameras,
- Battery Powered Tunnel Conveyance Vehicles,
- Tunnel Emergency Lockers – w/1 Hour Air Packs, First Aid, Stretchers, etc.
- Worker Training & Written/Practical Exam (for tunnel access by personnel),
- Worker Tunnel Access Card Key & Entry Door Bar Code Scanner,
- Worker Personal Communications (each w/ individual cell phone in tunnel),
- Worker Personal Lighting (flashlight &/or helmet light),
- Tunnel Communications (dedicated, 911 only, wall phones),
- Tunnel Emergency Beam-Off Push Button Stations,
- Tunnel Emergency Personnel Protection Beam-Off Crash Bar Doors,
- Beam Shut-Off Ion Chambers,
- Periodic Tunnel-to-Tunnel Exits,
- Periodic Tunnel-to-Surface Exits,

B) The most basic protective measure for a worker to implement for personal safety during a tunnel housing emergency is to simply vacate the tunnel housing. For an able bodied worker, the travel distance to reach the closest tunnel-to-surface exit has been taken to be no more than 1.3 kilometers (0.8 mile, 12 minute walk, 6 minute ride) for a near surface, 33 kilometer LC tunnel housing having 13 exit points. For a 46 kilometer LC deep tunnel housing having 12 exit points, this maximum travel distance is taken to be no more than 2.5 kilometers (1.6 miles, 24 minute walk, 12 minute ride). In addition both the 33 km and 46 km tunnel housings include tunnel-to-tunnel exits to provide alternate exit paths. Where included, these tunnel-to-tunnel exits are intended to be located roughly half-way between the surface exits.

Summary & Conclusion

The travel distances above are similar to those previously designed for the SSC in Texas. The tunnel to surface exits there were a maximum of 2.5 miles apart.

In an emergency some workers may be injured or detained in some way so that a simple direct exit response is not available. Surviving when encumbered in some way that prevents a direct exit will require that most of the life safety systems listed in A above be available and functioning. The exits alone, described in B above, would not be adequate to ensure personnel life safety regardless of their number or the travel distance to reach them. However when A & B above are combined, the personnel life safety protection in a parallel tunnel Linear Collider housing is determined to be adequate.

Excerpts from Various References (most stringent if applicable):

CAC for Mine Safety Orders (does not apply to LC but only to mining) – Ore removal mining operations in any extra hazardous gassy classification requires that escape exits exist at 1000 foot intervals.

CAC for Tunnel Safety (applies during LC construction only if very gassy) - Tunnel construction in any extra hazardous gassy classification requires a refuge chamber or alternate escape route within 5000 feet of a tunnel portal.

Excerpts from Various References (less stringent):

ANSI C2 NESC – Two-direction egress must be provided at all points in a tunnel.
29CFR1926.800 – Safe means of egress must be provided from all work spaces.
30CFR-Chapter 1 Part 75 – Two separate escapeways, one with fresh intake air.
30CFR-Chapter 1 Part 57 – Two separate escapeways of less than 60 minutes.