- Central Section -
Fixed Installation Noise (D25) Design Process – Fixed Plant

EHSQ Meeting, July 2012

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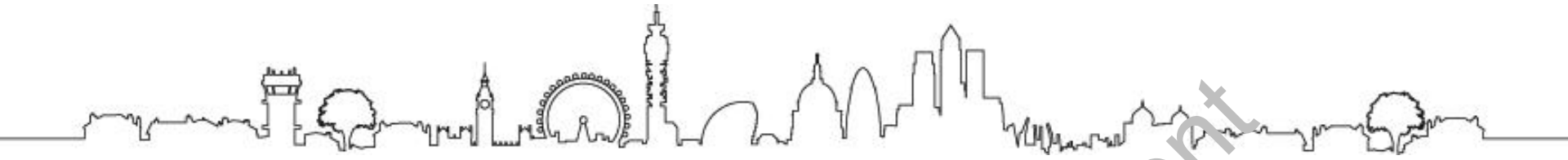

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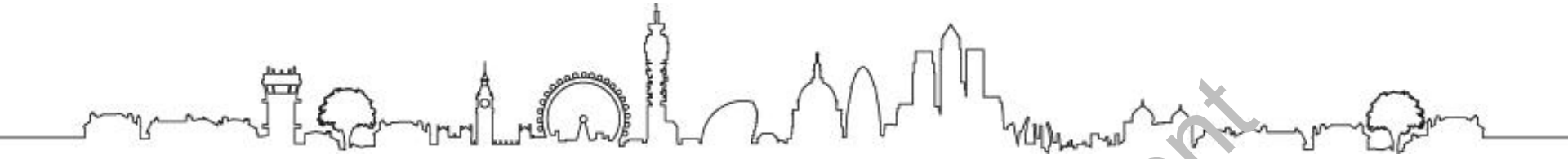
  Application of Crossrail Design Criterion to the Design Process

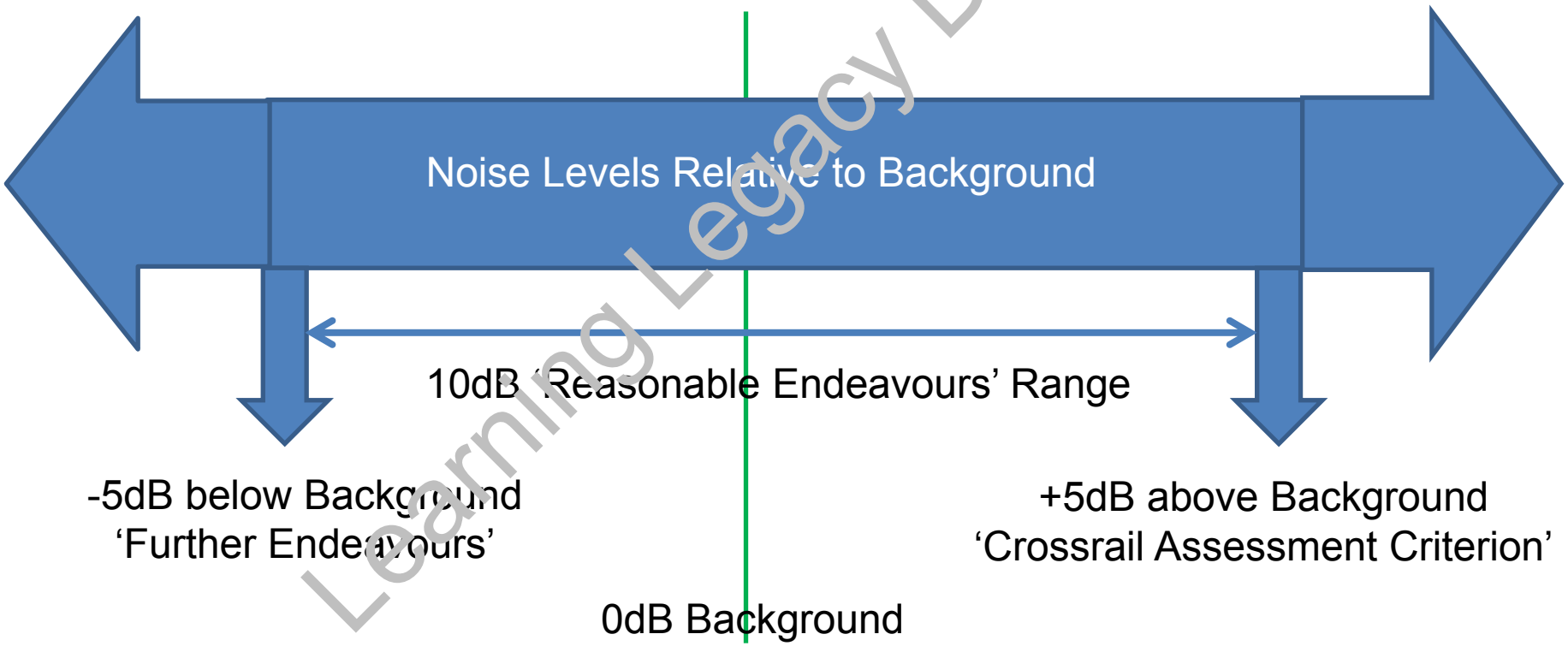


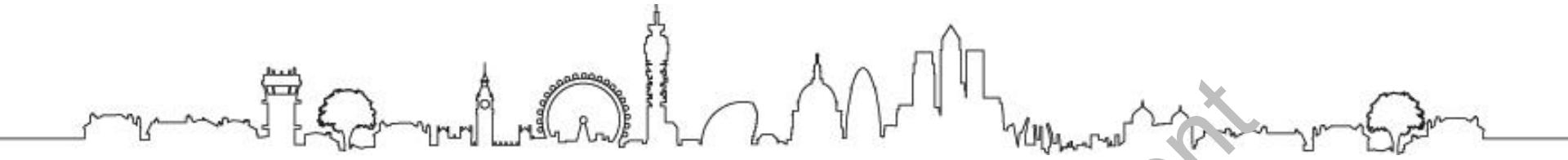
IPD25 – Targets & Status Update

Part 1

IPD25 – Targets

- **D25 Targets – BS4142 Approach**

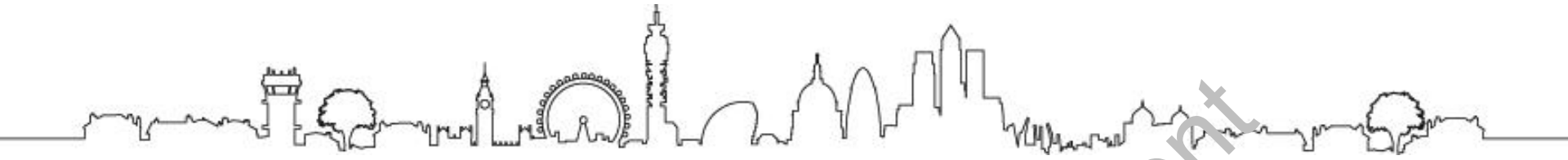




IPD25 – Fixed Installations

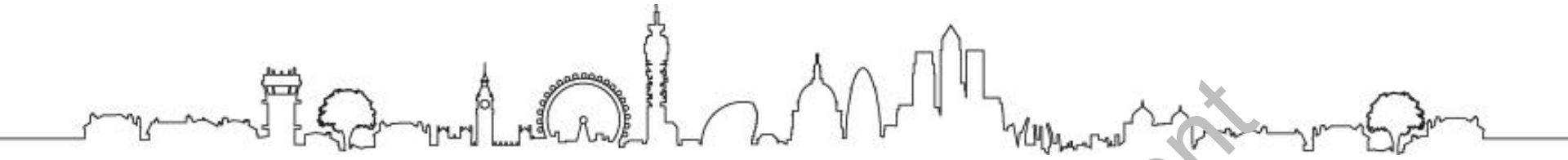
Main Fixed Plant Noise Sources:

- Tunnel Ventilation Fans,
- Mechanical Plant at Crossrail Buildings (e.g. ventilation and air conditioning equipment)
- Electrical Trackside Equipment
- Power Supply Facilities (e.g. Transformers)



IPD25 – Assessment Assumptions

- **Conservative approach currently adopted for Reference Design:**
  - **IPD25 refers to '*normal operation*'**
  - **However, FDC assessments are based on Tunnel vent congested-mode, late at night or early morning**
  - **In practice, a very unlikely scenario, hence considered to be worst-case**
  - **Conventional plant assumed 24/7**



IPD25 – Assessment

- **Preliminary assessments are based on:**
  - **BS4142 Rating Method**
  - **Cumulative impact of site development**
  - **Determined at worst-affected receptor**
  - **+5dB character correction in all cases**
  - **Typical operational hours over a week**
  - **Predicted for the worst 5-mins (night)**
  - **Additional allowances for calculation uncertainty**

IPD25 – Status Update

- Engagement of Framework Design Consultants (FDCs)
- Development of Reference Designs by FDCs for Power, Portals, Stations and Shafts
- Presently 22 Development Sites have been considered
- 10 - Forced Ventilation Shaft Sites
- 12 – Sites with other Fixed Installations

IPD25 – Status Update

- **Development of the Method for Establishing Background Noise Levels for IPD25**
- **FDC Background Noise Surveys/Reporting using the standard grid of $L_{A90,1hr}$ dB values:**

Time	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Weekday Background	58	54	5[illegible]	[illegible]4	54	57	60	63	64	64	64	64	64	64	63	63	63	63	63	63	61	61	61	60
Weekend Background	60	[illegible]	[illegible]	57	55	55	56	56	59	61	61	60	60	60	60	60	59	60	61	61	60	59	59	59

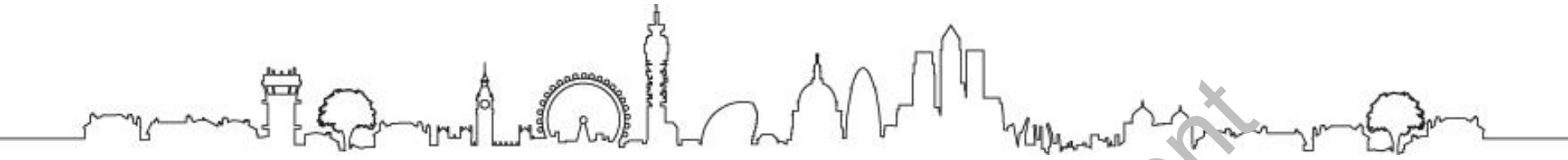
IPD25 – Status Update

- **‘Jointly Established’ & Agreed Background Noise Levels with Local Authorities**
- **Preliminary D25 Noise Assessments of FDC Reference Design – Reviewed by CRL**
- **Individual D25 Presentations to Local Authorities by Station FDCs**
- **Next step: D25 Communication to Local Authorities of Preliminary Assessment Findings (Worst-case Cumulative Levels)**

IPD25 – Status Update

- **IPD25 Contract Specifications Completed and Included in the relevant tender packages (ITTs) as follows:**

1. Deep-Level Stations
2. Shafts and Portals
3. Surface Rail and Surface Stations
4. Tunnel Ventilation (Systemwide)
5. Traction Power Transformers



Engineering & Contractual Context

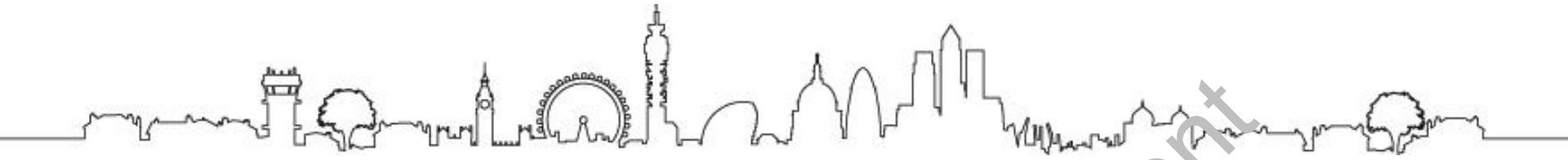
Part 2

Engineering & Contractual Context

Context: IPD25 Introduction - Paragraph 1.5

"*To avoid a significant noise impact from the tunnel forced ventilation fans, noise attenuators will be designed and installed on each side of the tunnel ventilation fans, as necessary to meet the Crossrail assessment criterion for fixed plant*"

The preliminary assessments support the above, indicating that the tunnel ventilation fans are the most significant fixed installation noise sources on the Crossrail project

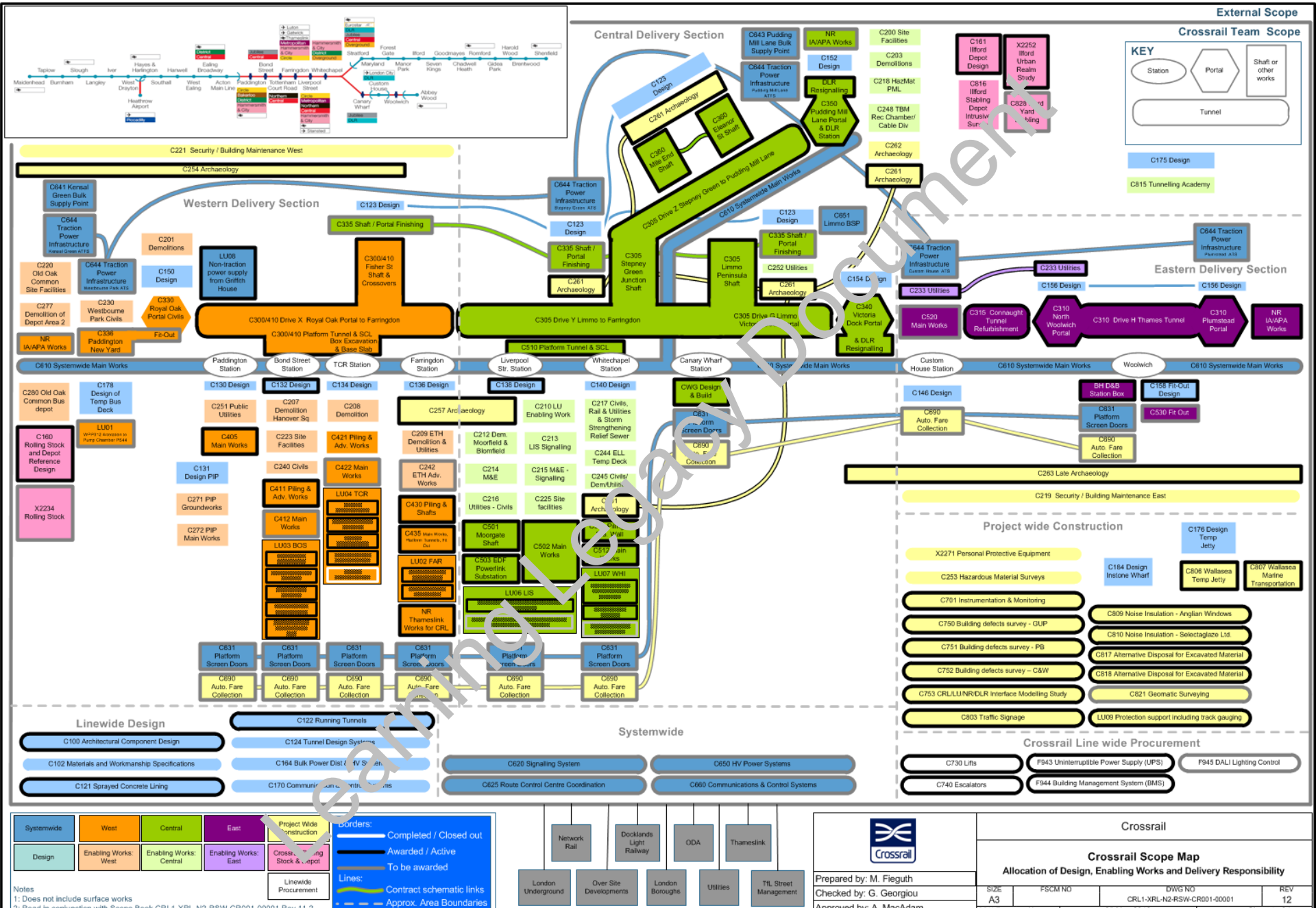


Crossrail - Central Section Works

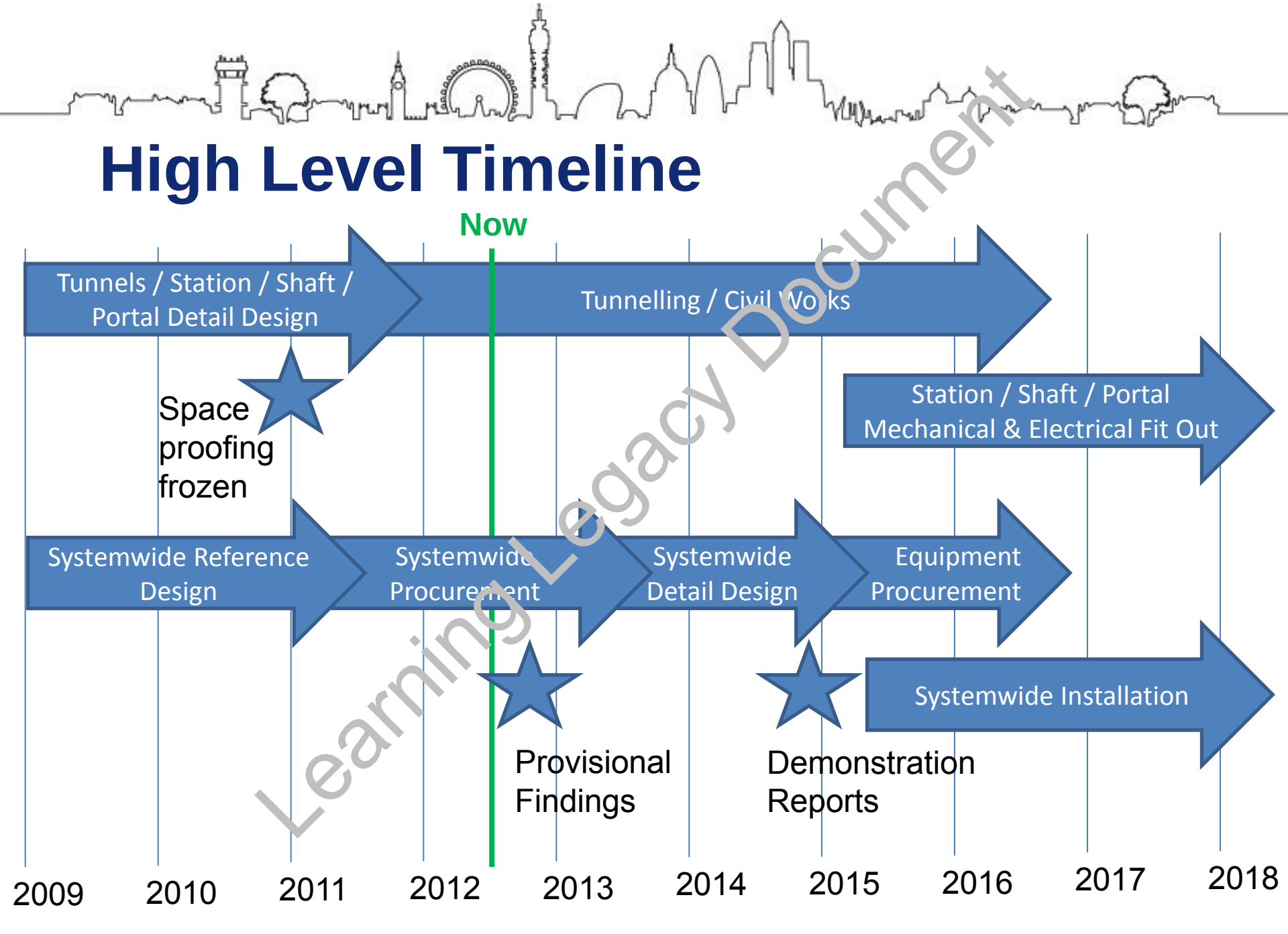
- Tunnel structures and station, intermediate shaft and portal structures & mechanical and electrical systems

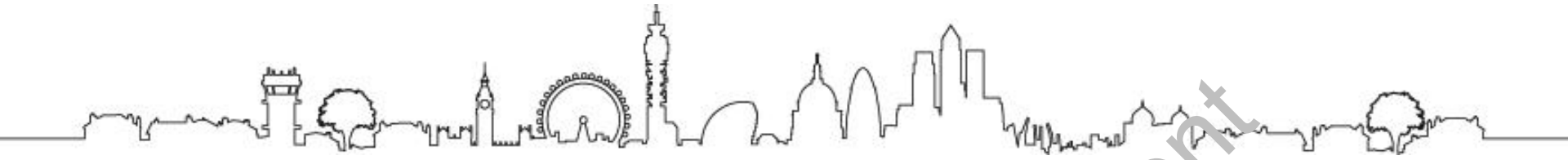
- Systemwide (railway systems, tunnel systems)

- Complexity:
  - Complex packaging of delivery responsibility
  - Complex project timeline



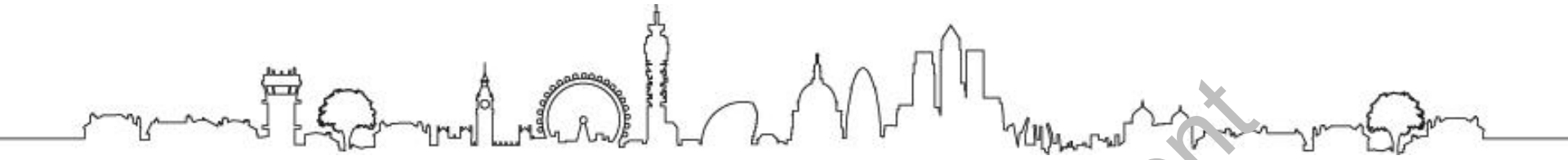
High Level Timeline





Summary of Responsibilities

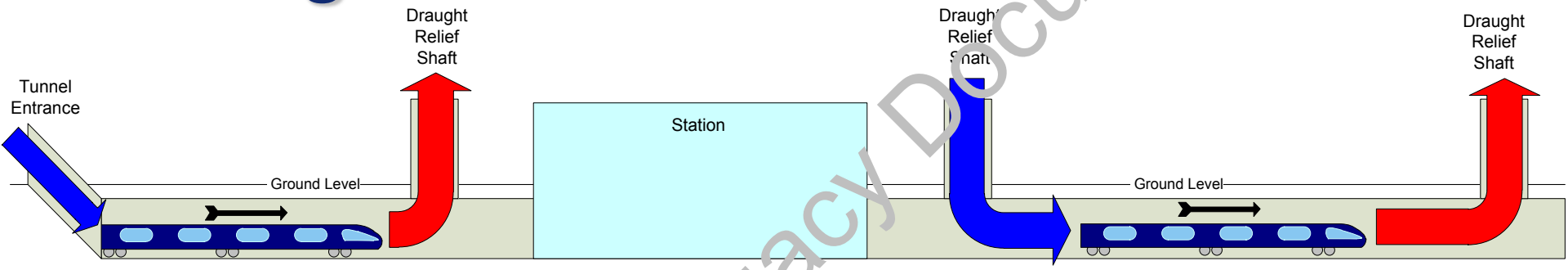
- C610 – Systemwide Main Works Contract includes detail design and provision of the Tunnel Ventilation System for central section
- Station contractors will be responsible for the buildings' ventilation and air-conditioning plant
- Preliminary assessments by station and shaft designers indicate that the Tunnel Ventilation System is the fixed installation with the dominating noise contribution
- C610 and station contractors will interface



Tunnel Ventilation System

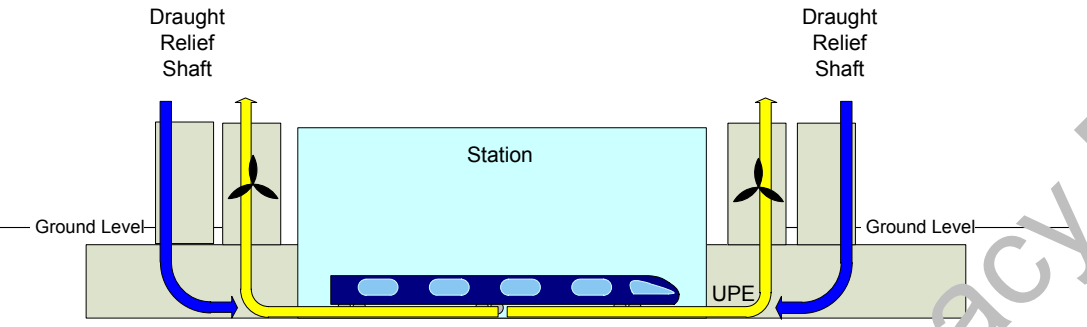
- Required to:
  - Relieve pressure resulting from train movements
    → Draught Relief Shafts
  - Remove heat dissipated by running trains
    → Under Platform Extract
  - Cool trains stationary in tunnel (Cooling / Congestion)
    → Cooling
  - Control smoke from a train fire
    → Smoke Control (Emergency Situation)
  - Provide ventilation during tunnel maintenance activities
    → Maintenance Ventilation

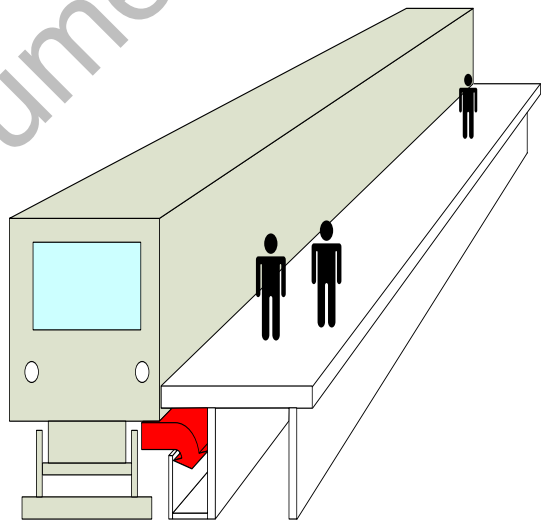
Draught Relief Shafts



- Needed to relieve the pressure generated by train movements
- Provides passive ventilation and cooling

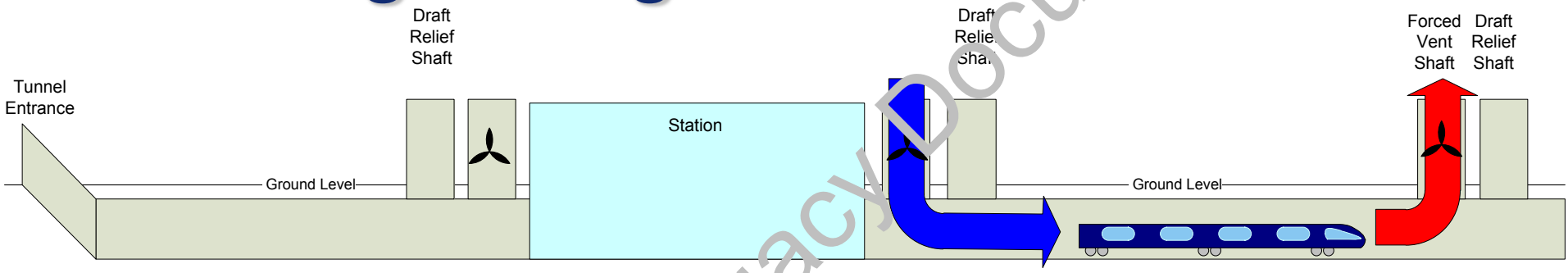
Under Platform Extract





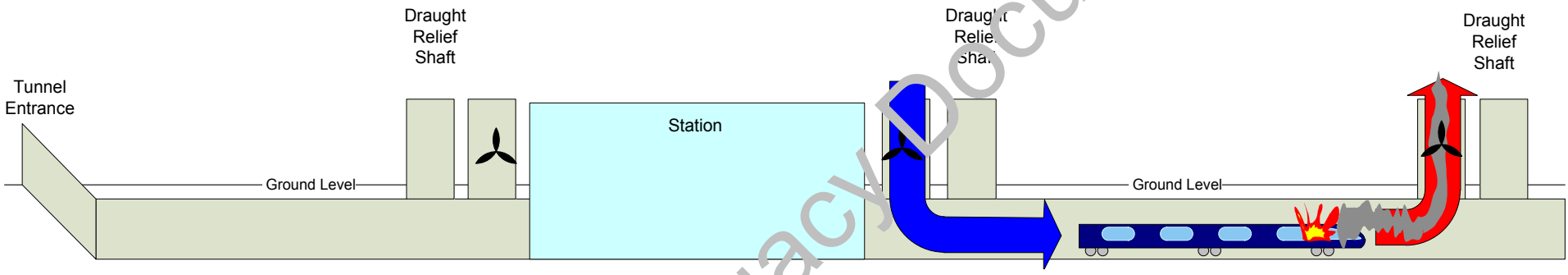
- Required to remove heat from trains stopped at the station
- Provides active cooling of tunnel

Cooling / Congestion



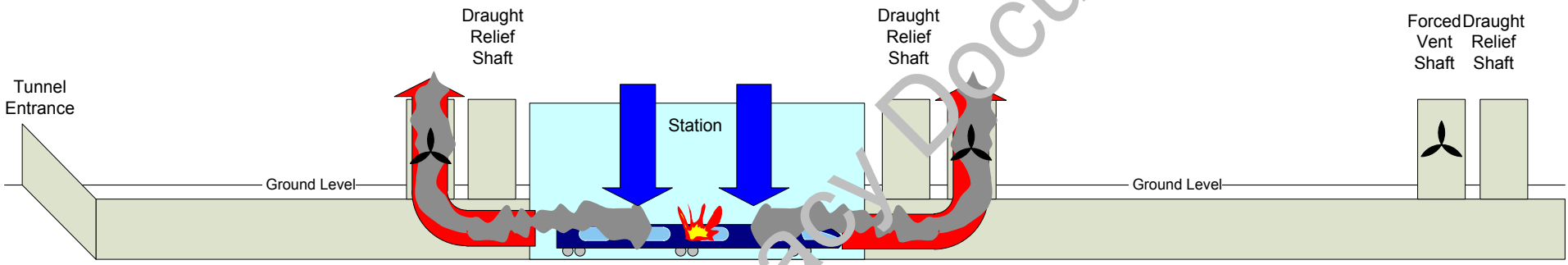
- Required to cool trains stationary in Tunnel
- Only required if Train remains stationary in the tunnel for more than 6 minutes

Smoke Control - Fire in Tunnel



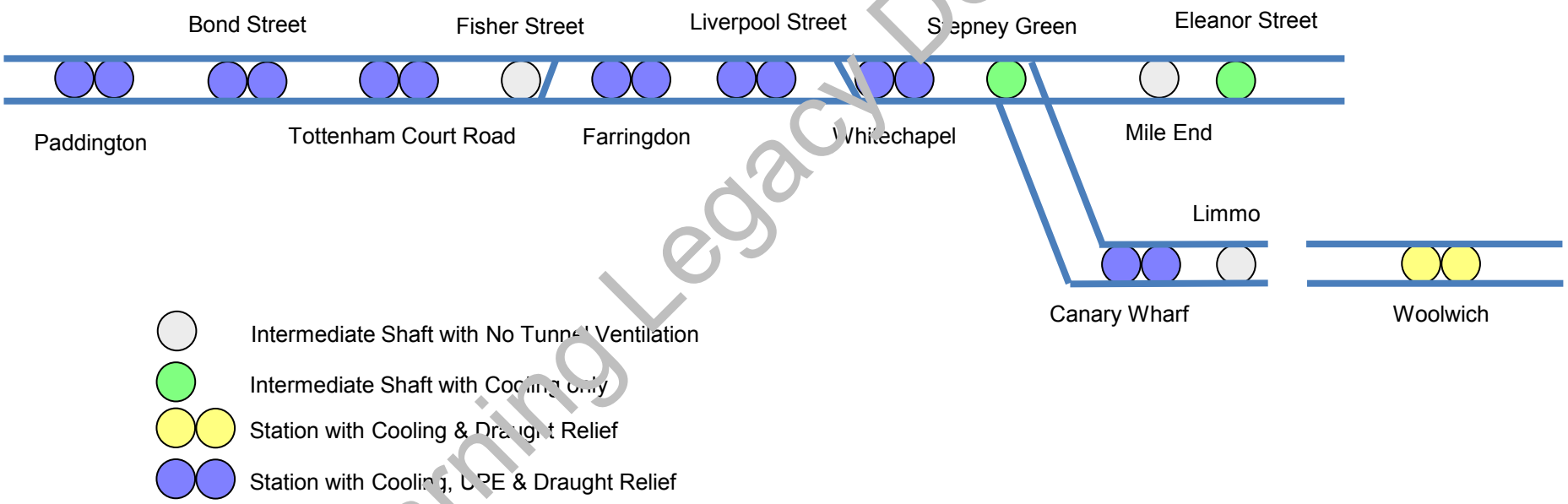
- Required to Control Smoke

Smoke Extract - Fire in Station

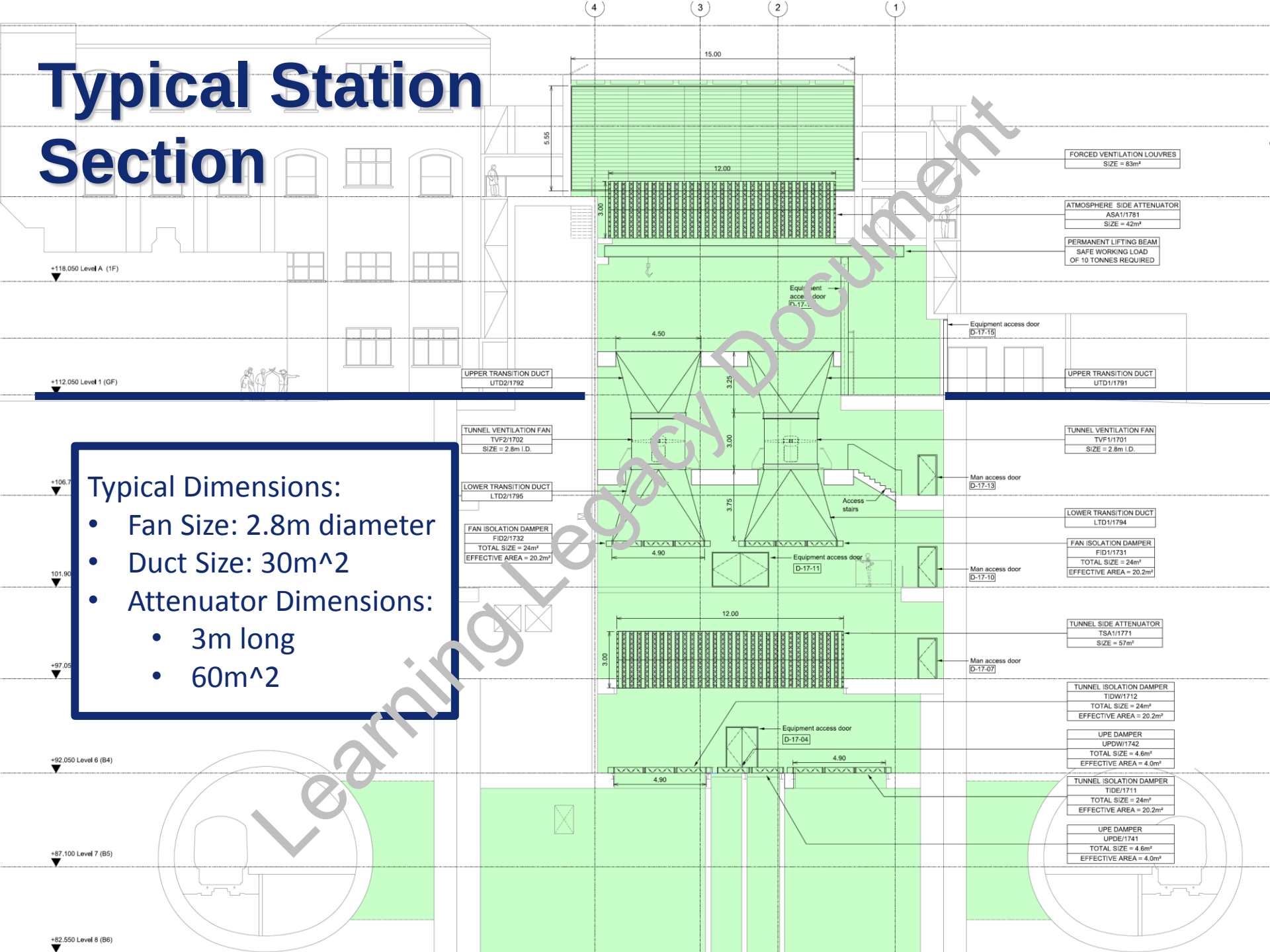


- Required to extract smoke
- Keeps station evacuation routes clear of smoke

Route Map

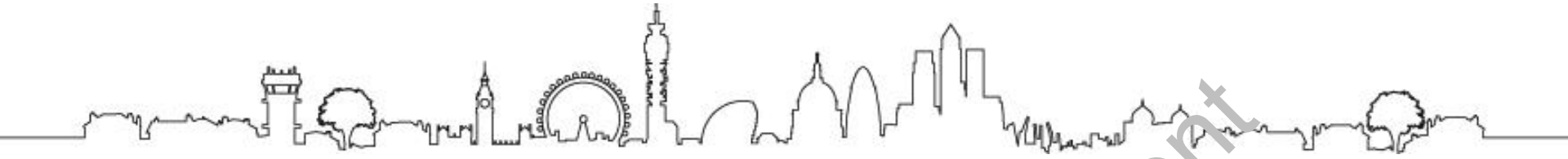


Typical Station Section



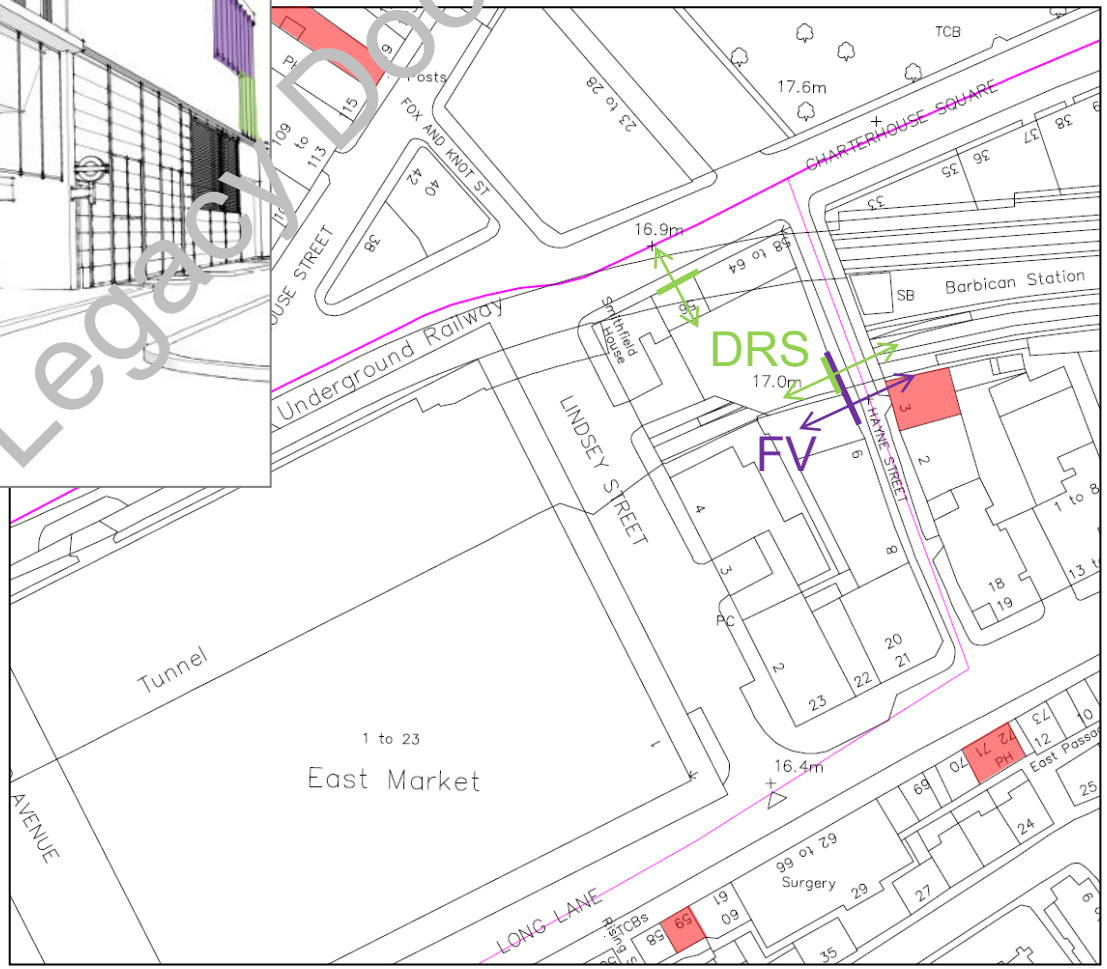
Typical Dimensions:

- Fan Size: 2.8m diameter
- Duct Size: 30m^2
- Attenuator Dimensions:
  - 3m long
  - 60m^2

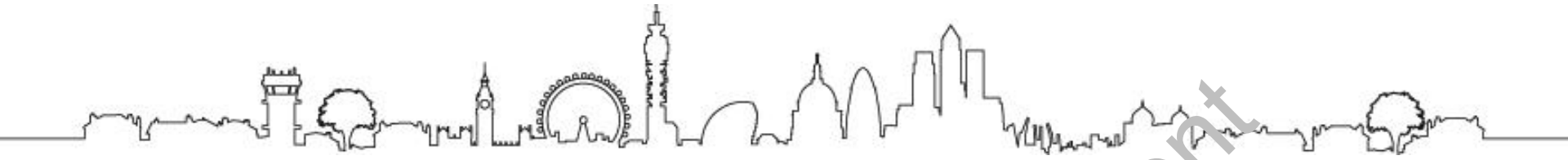


Long Lane - View from Southeast along Hayne Street

Residential receptor



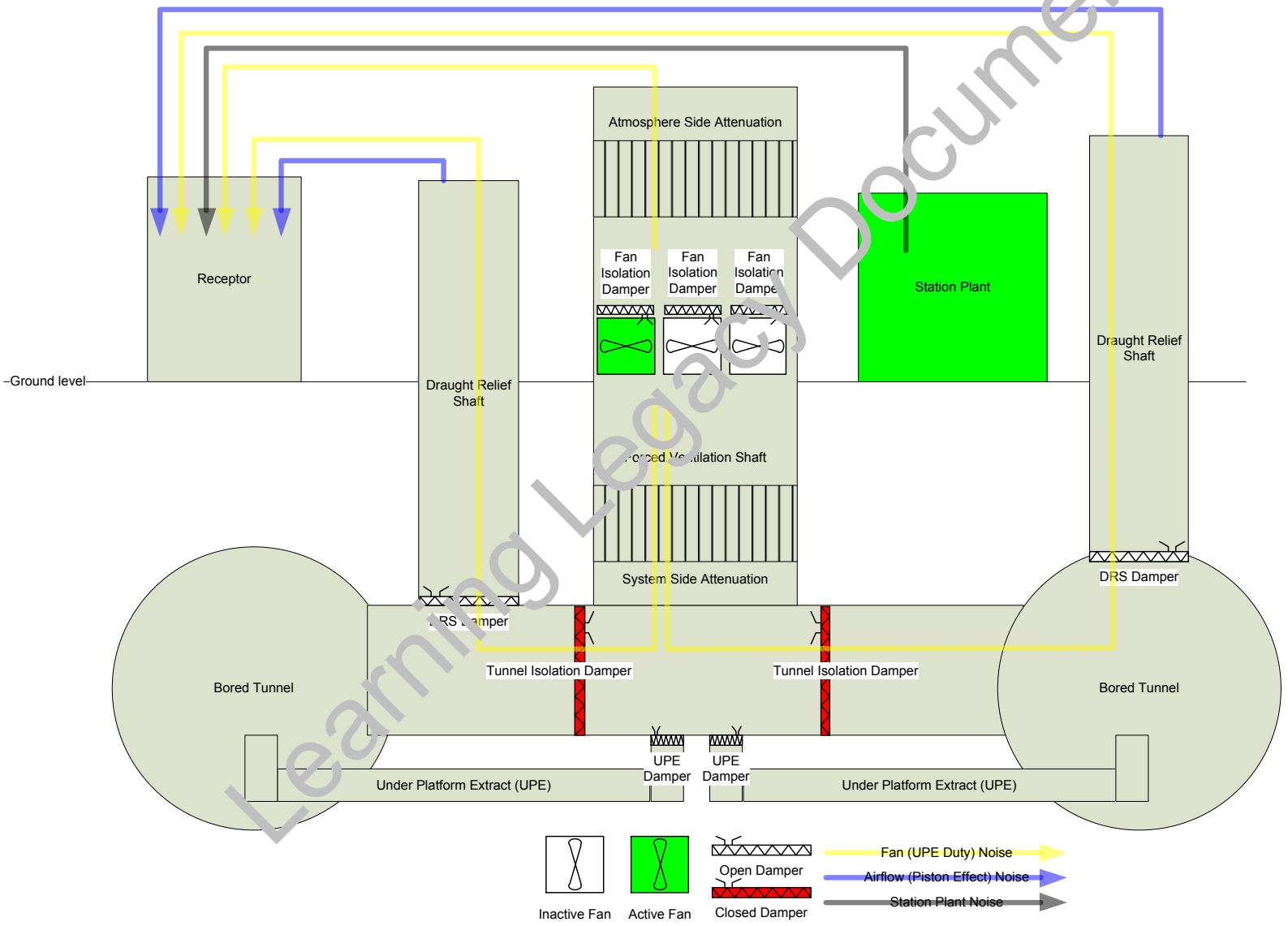
Typical intake / outlet arrangement



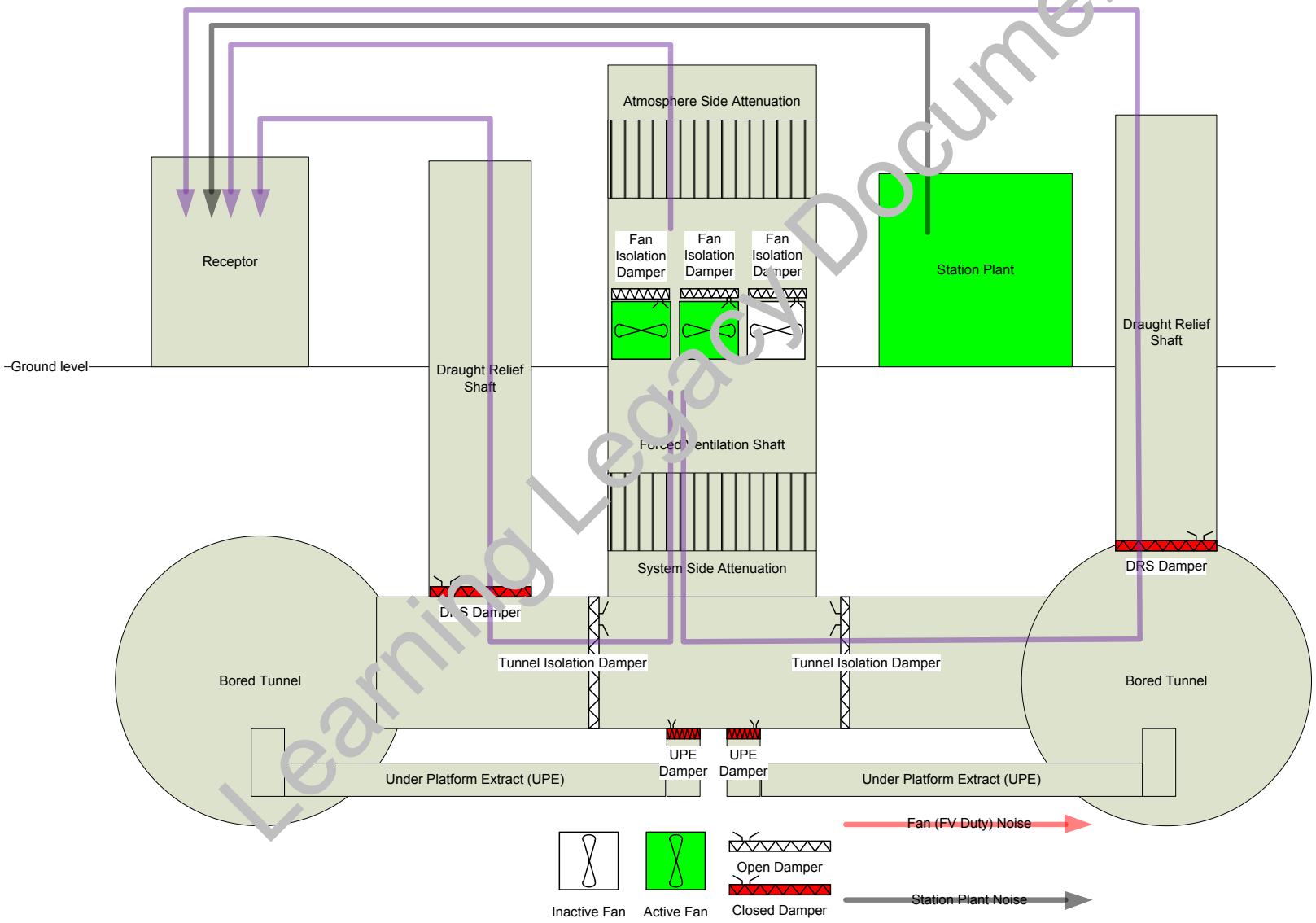
Operational Modes

- Under Platform Extract (UPE)
  - Cooling of trains running normally
- Cooling / Congestion (Worst Case Noise)
  - Cooling of stationary trains in tunnel
- Maintenance
  - Ventilation of tunnel maintenance activities
  - Tunnel Ventilation System test
- Smoke Control
  - Noise not considered because emergency response

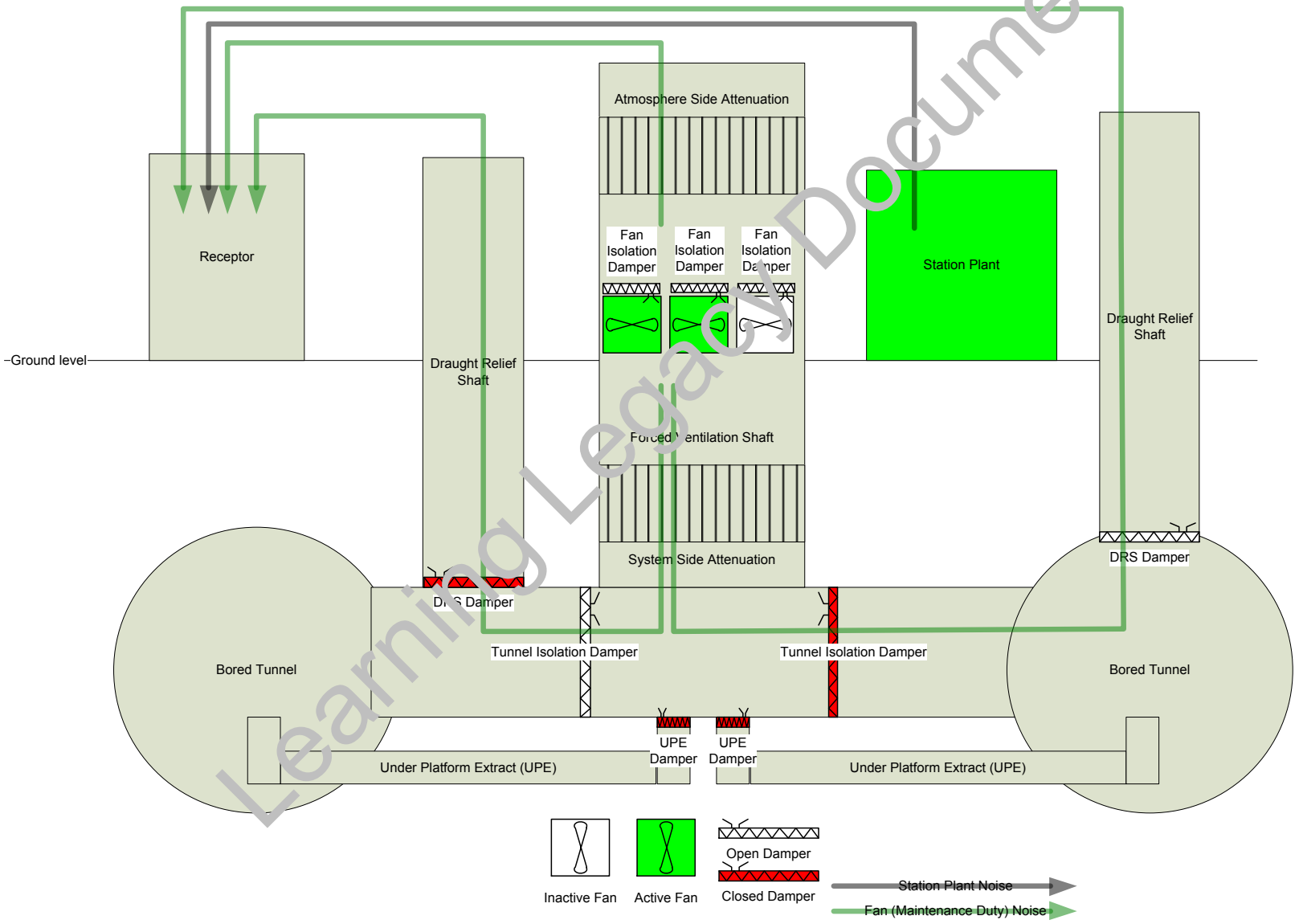
Noise Propagation Paths - Under Platform Extract Mode

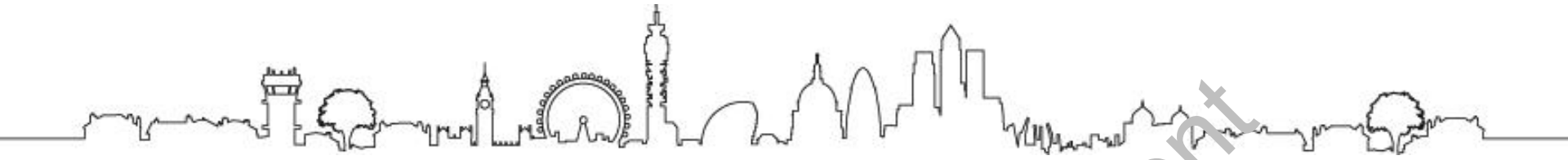


Noise Propagation Paths - Cooling Mode (Worst Case Noise)



Noise Propagation Paths - Maintenance Mode (reduced duty)

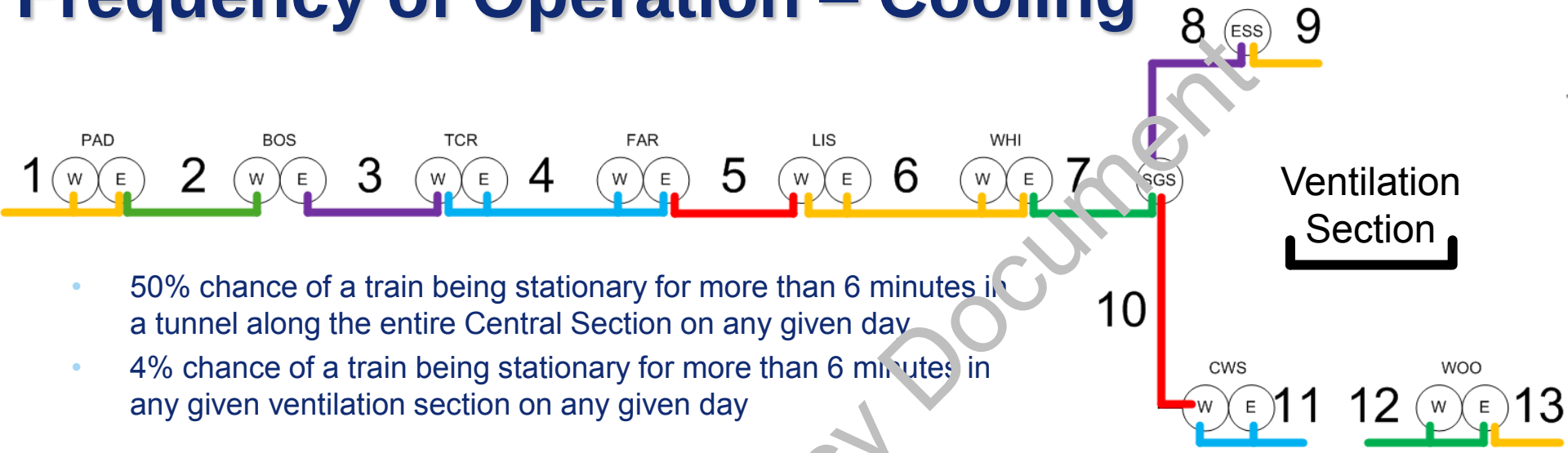




Frequency of Operation

- Under Platform Extract (UPE)
  - On during operational hours at all stations except Woolwich
- Cooling / Congestion
  - Infrequently (see next slide) to respond to congestion / train fault
- Maintenance
  - Engineering Hours
  - Depends on tunnel maintenance schedule and type of maintenance activity

Frequency of Operation – Cooling



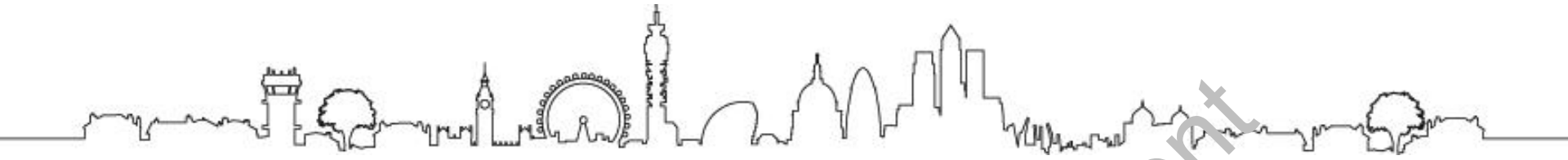
- 50% chance of a train being stationary for more than 6 minutes in a tunnel along the entire Central Section on any given day
- 4% chance of a train being stationary for more than 6 minutes in any given ventilation section on any given day

- Ventilation Shafts serving 1 Ventilation Section have a 4% probability of activation in cooling mode on any given day
  → Statistical interval between activations in cooling mode is 26 days

- Ventilation Shafts serving 2 Ventilation Section have a 8% probability of activation in cooling mode on any given day
  → Statistical interval between activations in cooling mode is 13 days

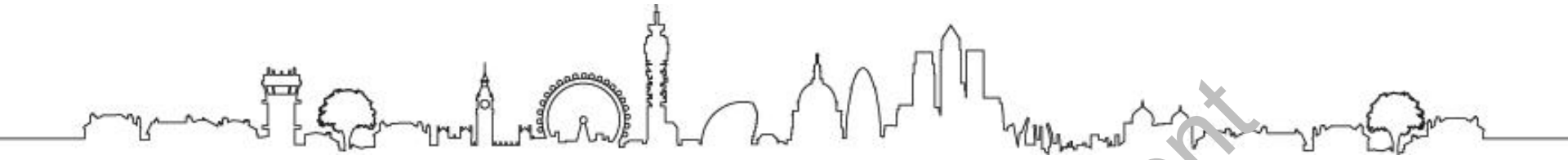
- Ventilation Shafts serving 3 Ventilation Section have a 12% probability of activation in cooling mode on any given day
  → Statistical interval between activations in cooling mode is 8 days

→ Each individual shaft will operate in Cooling / Congestion Mode infrequently.



IPD25 - Crossrail Design Process

Part 3



IPD25 - Crossrail Design Process

Protocol for the Application of Crossrail Design Criterion to the Design of Fixed Installations

Section 3 of IPD25 (Assurances 463 & 464)

Section 3.2 list seven specific requirements of the protocol

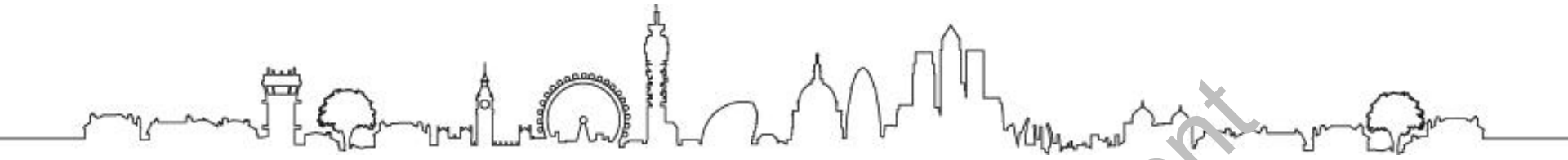
Crossrail Design Process

- **When designing all fixed installations the nominated undertaker will be required to:**

- **D25 Design Protocol (Bullet Point 1)**

  - **"*Incorporate the design criterion into contract documents such that it will apply to the design of all the fixed installations that are to be installed and operated in any location within the Crossrail development*"**

CONTRACT REQUIREMENT (+5dB)



Crossrail Design Process

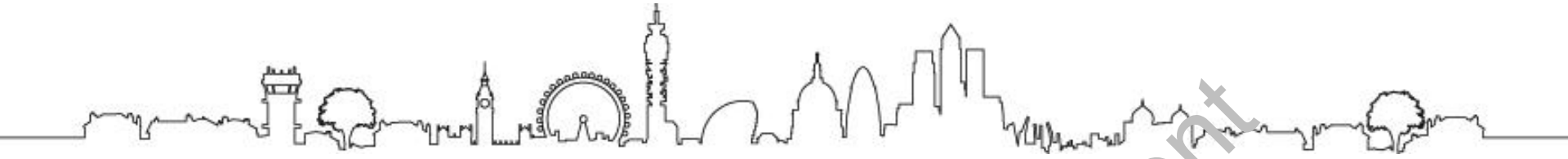
- **D25 Design Protocol (Bullet Point 2)**
  - ***"When designing fixed installations, take the <u>further endeavours</u> which are referred to in paragraph 2.6 or 2.9 (as the case may be) to reduce the noise below the design criterion in paragraph 2.5"***

CONTRACT REQUIREMENT (-5dB)

Crossrail Design Process

- **D25 Design Protocol (Bullet Point 3)**
  - ***"Translate the design criterion into specific requirements in specifications for the procurement and operation of Crossrail plant, equipment and machinery for fixed installations taking into account the further endeavours referred to in bullet point 2 above"***

SPECIFICATIONS



Crossrail Design Process

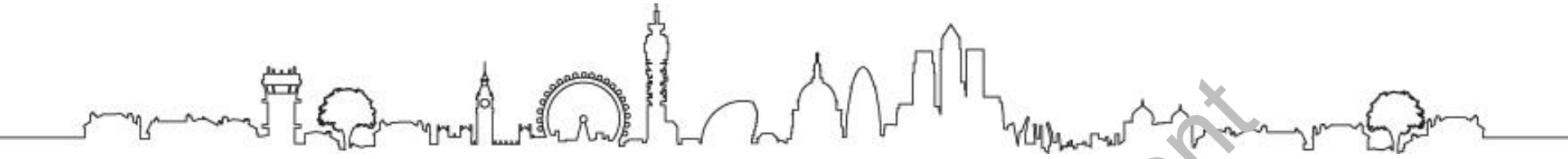
- **D25 Design Protocol (Bullet Point 4)**
  - **"*Determine the relevant $L_{A90,T}$ levels to be jointly established with the relevant local authorities*"**

BACKGROUND

Crossrail Design Process

- **D25 Design Protocol (Bullet Point 5)**
  - ***"Procure, install and commission plant, equipment and machinery, including noise attenuation equipment that meets the specific requirements referred to in bullet point 3 above"***

IMPLEMENTATION



Crossrail Design Process

- **D25 Design Protocol (Bullet Point 6)**
  - ***"Provide details of the measures undertaken to ensure that, under all reasonably foreseeable circumstances, the design process and procurement process for fixed installations is adequate to achieve compliance with the design criterion taking into account the endeavours referred to in bullet point 2 above (including proposals for maintenance and monitoring) to the relevant local authority whose comments will be taken into account"***

PROCESSES

Crossrail Design Process

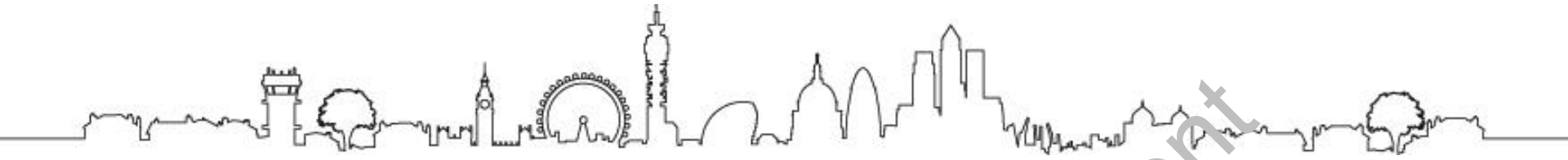
- **D25 Design Protocol (Bullet Point 7)**
  - **"*Before the fixed installation may be operated, satisfactorily complete the standard suite of acceptance tests required for such plant and provide information on those tests to the relevant local authority*"**

VALIDATION

Crossrail Design Process

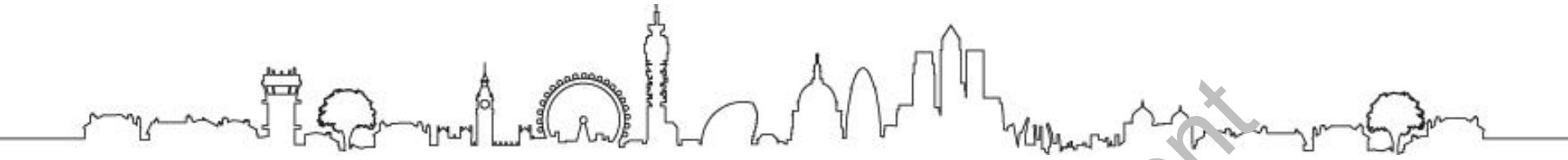
- **D25 Design Protocol - Summary**

1. Contract Requirement (+5dB)
2. Contract Requirement (-5dB)
3. Specifications
4. Background
5. Implementation
6. Processes
7. Validation



Crossrail Design Process

- **Specific D25 Contract Specifications:**
  - **Inclusion of all IPD25's Assurances in ITTs including '*Crossrail Assessment Criterion*' of +5dB and 'further endeavours' to achieve -5dB**
  - **Inclusion of agreed background noise reports in ITTs (contractual levels)**
  - **Inclusion of preliminary FDC assessments in ITTs (information only)**
  - **Setting of 'Noise Design Criteria' taking account of potential cumulative effects**

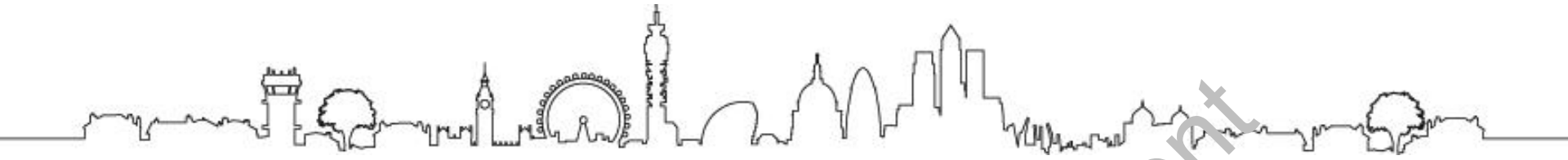


Crossrail Design Process

Specific D25 Contract Specifications:

- **Tunnel Ventilation:**
  - Targets of +5dB and -5dB have been set as per IPD25
- **Stations & Facilities:**
  - Aim where practicable to meet -10dB (i.e. 5dB more onerous than IPD25's 'further endeavours') and be no more than -5dB

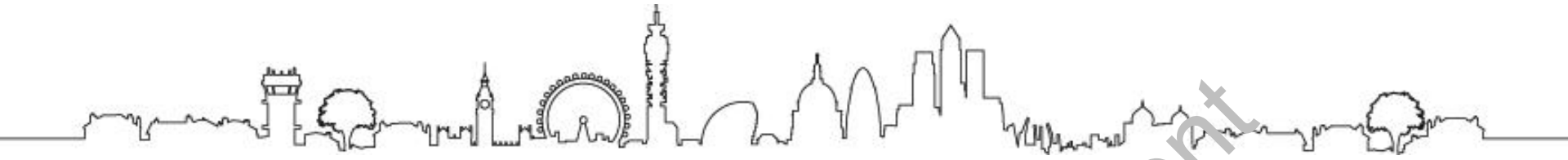
The -10dB target is driven by the need to meet IPD25 requirements on a cumulative basis. The specifications require the various contractors to interface with each other and work in a collaborative manner to meet IPD25



Crossrail Design Process

Specific D25 Contract Deliverables:

- ‘Fixed Installation Noise Justification’ report, if applicable (i.e. any targets are not met)
- ‘Fixed Installation Demonstration’ report
- Above to be delivered 7&4 months prior to procurement
- ‘Commissioning & Acceptance Testing’ report to demonstrate compliance



Crossrail Design Process

Information provided to Local Authorities:

- Design information (including above reports) to the relevant local authorities, where -5dB cannot be met, despite further endeavours:
  - Calculated BS4142 Rating Levels
  - Frequency/Duration of Tunnel Ventilation Fans (congested mode)
  - Performance of Noise Mitigation Equipment
  - Limitations to any Further Mitigation being Practicable

- Information on the commissioning and acceptance tests

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