Cut and Cover Tunnel Cleaning Train

Requirements

	Name	Position	Signature	Date	Comment/Reference
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Consulted during Requirements Capture and Development

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Agreed Requirements Received by	[redacted]	Programme Manager	[redacted]	1/10/09

Revision Record

Version	Date	Author	Comment
Issue A	18 September 2009	[redacted]	First Issue Updated following final requirements review workshop held on 17/09/2009
Draft 04	17/09/09	[redacted]	Fourth draft
Draft 03	11 September 2009	[redacted]	Changes from draft 02 identified thus
Draft 02	10 September 2009	[redacted]	Second draft, reviewed by GR and ES and amended to be more specific towards cut and cover train and particular motive stock
Draft 01	8 September 2009	[redacted]	First draft, created following advice to tender for two separate tunnel cleaning trains

Overall Requirements

Requirement
1. The overall requirements for tunnel cleaning are contained in document AEN-7000-LUL-REQ-00001 - Overall Tunnel Cleaning Capability - Business Requirements. Any cut and cover tunnel cleaning train shall comply with the requirements defined in both the Overall Tunnel Cleaning Capability – Business Requirements document and this document.

Business Requirements

The replacement tunnel cleaning train shall

Requirement	**Comment**	**Possible Assessment Criteria**
2. Cleaning formation shall be in operational service no later than December 2011	Delivery date specified is earlier than Tube TCT as it is hoped an off-the-shelf product may be available	
3. Cleaning formation shall have a minimum usable life of not less than 25 years covering an annual distance of up to 15,000 km travelling to /from work sites and up to 2,500 km whilst undertaking cleaning duties	*Query - distinguish between life of cleaning consist and life of motive power units?* *Minimum – 25 years; target 40 years; 250 shifts/year; allow an average of 80 km/shift travel plus 10 km/shift routine cleaning*	
4. Be capable of accepting upgrades to the cleaning equipment/system	Part of the whole life support element	
5. Shall not cause damage or interference to any assets in the course of travelling or working anywhere on the LUL network	Displacement of ballast, damage to signal or power cables, damage to signalling equipment, damage to sensors mounted on track or within station limits, damage to CCTV cables	
6. Shall not cause damage or interference	Primarily EMC and noise issues	

to any neighbours in the course of travelling or working anywhere on the LUL network		
7. Be capable of accessing cut and cover tunnels on LUL network	By avoiding a requirement to operate anywhere where the LUL trains run, this could avoid any need for VAB approval	
8. Be capable of cleaning the cut and cover tunnel within a defined 'area of influence' of the SSR passenger stocks. This includes:- • track beds (4') and the 6' between adjacent tracks • ground between 4' and tunnel walls • tunnel walls up to and including all cable runs	Track bed (4') is the priority area in cut and cover tunnels 6' could be cleaned in 2 by 3' passes from either track **Note** – need to ensure that the definition of track bed as used in this project is clearly stated S Stock "area of influence" to be defined Looking to SUP to provide max cable run height (believed to be circa 2m)	
9. Ensure that the material collected is stored and handled in accordance with the requirements for hazardous materials		
10. Supplier shall provide whole life support in respect for the TCT and its cleaning plant	Essential to ensure ongoing availability of relevant expertise for this specialist equipment Suggest that the cleaning equipment supplier should be made responsible for undertaking routine cleaning and maintenance of the cleaning equipment and system throughout the agreed life of the cleaning formation	

	Whilst there will be a cost associated with this, this approach should reduce the risk of the cleaning system not being correctly or adequately maintained, resulting in its service life being less than that targeted	
11. The design of the TCT shall be demonstrated to be ALARP		

Cleaning Performance Requirements

Requirement	Comment	Possible Assessment Criteria
12. Following the operation of the TCT, the residual particulate matter size in the tunnel air, 15 minutes after the completion of cleaning operations, shall be no worse than it was prior to tunnel cleaning being undertaken.	Query – is this a type test requirement or a routine test? Who will conduct these measurements?	
13. The cleaning performance shall be maintained over the range of cut and cover tunnel sizes	Variation in cut and cover tunnels to be defined within ITT	
14. The design and operation of the replacement TCT shall be such as to maximise the removal of dust and refuse from the cut and cover tunnels		

Dirt Disturbance and Removal Requirements

Requirement	Comment	Possible Assessment Criteria
15. The process for disturbing and removing dirt and refuse from the cut and cover tunnels shall ensure that there is minimal disturbance of the air at either end of the complete TCT thereby ensuring unrestricted vision both ahead and behind from the cabs of the TCT		
16. Shall not displace dust onto adjacent cut and cover track(s) i.e. the area not currently being cleaned		
17. Shall not cause dust to be dispersed onto station platforms whilst operating in cleaning mode		
18. Shall not cause dust to be dispersed onto station platforms whilst travelling to/from site	May need to agree what would amount to an "unreasonable level" of dust	
19. TCT shall ensure that tunnel dust is not left on the railhead following the passage of the TCT train	If disturbed tunnel dust is left on the railhead at the end of an EH shift then this will form a very effective grinding paste when the service starts operating with the potential for serious damage to the railhead.	

Cleaning Capability Requirements

Requirement	Comment	Possible Assessment Criteria
20. It is **essential** that the TCT has the capability to deliver effective cleaning for all of the following areas **Sub Surface Lines** • Track bed (4 foot) plus the area up to 1000 mm outside of both running rails • Tunnels walls up to a height of at least 1.5 metres from the ground • Cable runs and tunnel mounted equipment up to a height of 2 metres from the ground	For cut and cover only train do we wish to increase the cleaning requirements? At locations where the tunnel wall is within 500 mm of the side of a passenger train Heights to be checked/confirmed	
21. The TCT shall concentrate on areas S-Stock air intakes and air outlets with the potential to disturb dust. I.e. • Track bed (forced traction cooling) • Tunnel walls and ceilings (HVAC)	Need to identify the specific areas on S Stocks Technical Specification to identify key air intake/outlet locations on S Stock (information is available). S Stock "area of influence" to be defined	
22. **As a minimum**, the TCT shall have the capability to collect and handle the following masses of dust and refuse collected whilst undertaking routine cleaning. Dirt – estimate between 10 - 20 Tonnes	**Note – the mass that will need to be stored may be a potential issue** These depend on length of shift, number of shifts, speed of cleaning and number of passes required. ***Note*** *- need to define "refuse" (newsprint, plastic*	

Refuse – estimate between 4 – 8 Tonnes	*bags, food wrapping, plastic bottles, cans)* *A survey to investigate this further may be useful. Establishing how much refuse is currently removed by litter pickers could also help.*	
23. **As a minimum**, the TCT shall have the capability to collect and handle the dust and refuse collected during a single EH shift whilst deep cleaning. This may comprise the following masses of dust and refuse Dirt – 10 Tonnes Refuse – 2.5 Tonnes	Note that whilst the mass of dirt that will be collected may fall from those initially experienced, the levels of refuse may remain more constant **Note – the achievable capacity is likely to be an issue for discussion between selected supplier and LUL**	
24. The TCT shall provide "full" indicators for both the dust and refuse collection systems.	When the indicators should activate, there should still be enough capacity remaining for one EH cleaning shift	
25. If the supplier considers it highly beneficial, alternative or supplementary cleaning methods to disturbance and suction should be suggested	Note that although water, or solvents etc may be more efficient, approving them for use on the Underground may prove impracticable	
26. The environment of the sub surface tunnels shall be defined so as to identify possible issues which could alter the characteristics of the dust to be collected	Presence of water or grease will make the dust harder to remove and if ingested could harm the dust collection system if this is not considered as part of the design. Possible presence of stalactites	

Station Area Cleaning Requirements

Requirement	Comment	Possible Assessment Criteria
27. Within Sub Surface Stations the track bed and the "platform structure between the nosing stones and the track bed" shall be cleared of litter and dust.	There may be a need to isolate certain cleaning nozzles so areas above platform level are not disturbed	

Cleaning System Control

Requirement	Comment	Possible Assessment Criteria
The cleaning system and equipment control shall enable the cleaning output for particular sectors of the tunnel to be isolated	e.g. In stations, it may need to be possible to only have cleaning of the track bed and tunnel walls below 700 mm above rail operative	

Cleaning Operation Requirements

A range of options, in respect of km of tunnel to be cleaned per year, is being produced separately and will need to be provided as a reference document. (calculations are being produced by Ed Smith). This will vary the assumed speed of cleaning and the number of passes required to achieve the required standard of cleanliness.

Constraints

Constraint	Comment	
28. Tunnel cleaning to commence by December 2011	Assume tender goes out in October 2009, contract is agreed by March 2010, and TCT takes 18 months to deliver	
29. Overall train length shall not to exceed 90m as a maximum	Based on C stock being 94m. Do not wish to exceed this due to limited length of sidings and stabling points and gives operational flexibility Need to establish where the TCT will normally be stabled (i.e. home depot)	
30. It is **desirable** that the overall train length does not exceed 55m	Would allow 2 battery locos (17 m length each) and remain within 90 m	
31. Overall train length (including motive power vehicles) to be at least 20 metres	Compatibility with signalling system operation	
32. Overall train formation to contain a minimum of 4 axles	Ensure track circuit operation during traffic hour moves. Note battery locos have 4 axles each.	
33. Maximum axle load within train not to exceed 16 Tonnes		
34. The size of the TCT shall be such as to be comply with the defined gauge limits for cut and cover tunnels	Need to ensure correct gauging limits are referenced	
35. The TCT shall be capable of traversing the defined most severe curves	Needs to cover all routes and all relevant depots	

(horizontal and vertical)		
36. The TCT shall be capable of traversing the defined worst case curve transitions	Needs to cover all routes and all relevant depots	
37. The TCT shall comply with the defined wheel unloading limits so as to minimise the risk of derailment		
38. It is **desirable** for the train to provide a through gangway to allow it to operate in dead end sidings		

User Requirements

The replacement tunnel cleaning train shall

Requirement	**Comment**	
39. Be capable of operating at the defined speeds whilst travelling to and from its work site	Traction, braking and wheel unloading performance (risk of derailment) will be critical aspects	
40. It is **essential** for the TCT to be capable of being towed (dead) to and from site during traffic hours by existing LU battery locomotives	First/last train scenario; battery loco operation; battery loco interface (mechanical, pneumatic, electrical)	TCT to be fitted with automatic air brake compatible with battery locomotives (RSE/STD/039)
41. It is **desirable** for the TCT to be capable of running to or from site during traffic hours under its own power	First/last train scenario Requires EMC and Signalling Compatibility for all routes	
42. **As a minimum**, the TCT formation shall be capable of travelling at a speed	Cut & Cover TCT will be moved by new motive power	

of at least 70 kph while travelling to or from site		
43. Be capable of undertaking cleaning whilst the current rails are "live"	TCT may be diesel powered but may have to work in live sections If diesel powered need to establish safe working arrangements for ventilation of exhaust fumes	
44. Provide a suitably protected, safe working environment for its operators, so that the potentially harmful effects of dirt, dust noise, heat and fumes are eliminated or reduced to safe levels		
45. Provide a suitably controlled working environment for its operators, so as to provide a comfortable working environment	Cab air conditioning is likely to be required for use whilst undertaking tunnel cleaning	
46. Provide monitoring of the operators working environment, so as to detect deteriorating conditions		
47. Be provided with appropriate measures to minimise the risk of a dust explosion		
48. Be provided with an automatic fire suppression system compatible with operation in a cut and cover tunnel environment		
49. Be provided with an automatic fire detection system which provides accurate location detection of any fires		

50. Be provided with an automatic fire suppression system (controlled by the fire detection system) which, when operated, will not adversely affect collected dust within the cleaning and collection system		
51. Automatic fire suppression system should seek alternative primary methods to water	Application of water by LFB on the original TCT caused dust to "set like concrete" causing major damage to the equipment.	
52. Be provided with waste handling facilities to ensure that waste collected remains contained during its removal from the train and subsequent transportation	**Query** – is the provision of the depot facilities for receiving and handling the dust and refuse collected part of the scope of this project? If so, how are these facilities being scoped?	
53. Be capable of operation with 2 crew members	One crew member in either cab either of whom can drive or operate, depending on direction of travel	
54. Be capable of holding a minimum of three crew members in each cab	Single Train OSPs require three crew members in the cab?	
55. As a minimum, be capable of:- • accelerating to 50kph within 45 seconds. • accelerating to 60kph within 100 seconds. • accelerating to 70kph within 200 seconds. All these figures are for level track in the open.	Based on results of train performance simulations run by Neil Ainsworth. (TCT Train Performance Comparison - Results.xls)	
56. Be capable of operating continuously at a defined (low) speed whilst in "cleaning" mode		

57. It shall be possible to adjust the required low speed to achieve the optimum practical cleaning effectiveness	Suggest a range of between 1 and 10 kph in 0.25 kph increments	
58. Not exceed the defined maximum noise levels	Operators cab and external noise levels to be specified ([redacted])	
59. The complete TCT shall be equipped with the capability to operate with all of the train protection systems fitted on the SSL network	Currently Tripcock, due for upgrade ~ 10 years; will need SSR ATP eventually	
60. Achieve the required availability	There will be a total of 250 EH shifts available for use by the TCT each year. The TCT shall achieve an availability such that it is available for use on not less that 240 of these (96%)	
61. The complete TCT shall be capable of being driven and operated from either end of the train		
62. The cleaning formation shall be capable of cleaning when operating in either direction	Necessary to enable repeat passes when cleaning a section	
63. The required standard of cleaning shall be achieved without the use of water, solvents or other fluids	Need to agree how the defined standard of cleaning is to be defined – or are we in practice going to determine what is possible and then determine the required usage of TCT to bring the tunnels up to an acceptable condition?	
64. TCT shall provide a waste storage capacity sufficient for at least 12 hours operation	Need to avoid requiring too great a waste capacity which could then impact or conflict with other requirements (e.g. maximum train	

	length) If limited to less than this amount, this would require frequent (> 1/week) access to a location at which it can be discharged	
65. Provide the maximum practical waste capacity within the permitted length of the cleaning consist		
66. Be provided with depot handling facilities to enable collected waste to be removed and the train restored to an operational condition in a time not exceeding 1 hour	1 hour is suggested target time	
67. Have a defined maintenance regime which enables routine maintenance to be undertaken in not more than 8 hours	As far a possible, maintenance should be easy to undertake; note that between EH shifts there will be significant time to both empty and undertake maintenance on the TCT. Frequent small chunks of maintenance may be a practical option but will need to consider requirements for maintenance pit road access	
68. Be provided with an emergency brake system which achieves the defined stopping distances for the permitted range of speeds	Traffic hours operation requirement	
69. Be provided with an emergency brake system which complies with the requirements for a continuous and automatic brake	Traffic hours operation requirement	
70. In the event of a major failure preventing self recovery of the TCT, it	Will require cut and cover TCT to be fitted with Wedgelock coupler	

shall be possible to mechanically couple any existing SSR passenger stock, and S Stock, to the cut and cover TCT to enable it to be pushed out		
71. Be provided with appropriate isolation facilities so that any single failure shall not prevent the train being able to move	Recommend that cleaning formation is as simple a piece of rolling stock as possible and provide any isolation facilities at the outer ends of the cleaning formation so as to minimise difficulties of accessing these	If train is fitted with an automatic air brake system, then this will essentially need to comprise main line and train line isolating cocks.
72. Wheel unloading performance shall comply with the requirements defined for the full range of routes and speeds	Essential that there is no credible risk of derailment as a result of vehicle characteristics. Project to ensure detailed requirement included in technical specification	
73. Be provided with a service brake system which achieves the defined performance		
74. Be constructed of materials which comply with the fire performance requirements		
75. Be provided with monitoring systems so as to detect failures in the cleaning system		
76. Be provided with condition monitoring system so as detect deterioration in the performance of the cleaning system		
77. Tunnel cleaning train shall be designed such that its operation is not adversely affected by the environment in which it will be operating	High levels of dust generated during cleaning must not adversely affect the operation of the train.	

78. Tunnel cleaning equipment shall be reliable in operation		
79. Maintenance regime for the tunnel cleaning train and the tunnel cleaning equipment shall ensure that the availability and reliability targets are satisfied		
80. If appropriate (to the solution proposed), the cleaning consist shall be provided with the means, whilst in cleaning mode, to detect and avoid obstacles fitted on the tunnel walls	Tunnels are fitted with numerous items of equipment (e.g. cable runs, signals, bracketry, noise screens)	
81. Whilst travelling to/from site, any moveable components shall remain with the defined gauge	Intended to ensure that items such as moveable arms or ducts are prevented from moving during transit	
82. Maximum length of complete TCT shall be compatible with the routes over which it is required to operate and the locations where it will be stabled and maintained		

Sponsor/Client Requirements

Requirement	**Comment**	**Possible Assessment Criteria**
83. Sponsor shall act as Client	PMF and Project Gates processes	
84. The procurement processes for the TCT shall comply with the relevant processes	OJEU etc	
85. Compliance with defined Standards	Relevant Standards to be identified; detailed	Pragmatic approach required so as to avoid

	requirements to be extracted	"over specifying" through referencing inappropriate Standards
86. Tender Assessment criteria shall be defined and included within ITT		
87. Design review, Acceptance, Testing and commissioning requirements shall be defined and included within ITT		
88. Technical Specification to include information regarding the original LU TCT, including operational experience	This may be less relevant for a sub surface TCT	
89. Technical Specification to include information concerning the analysis of tunnel dust		

Emergency Response Unit (ERU) Requirements

Requirement	Comment	Possible Assessment Criteria
90. Cut and cover tunnel cleaner shall be provided with identified jacking points for use during re-railing		
91. Process for re-railing TCT, and equipment required, to be defined		
92. Adequate information as to the location of any hazardous materials shall be provided		
93. Information re suitable vehicles or trains which can be used for push outs and associated procedures		
94. Adequate information training to be provided to ERU	Details to be developed with ERU during project	

Overall Train Length Requirements

Requirement	Comment	Possible Assessment Criteria
95. The maximum complete train length shall be aligned with where the train will need to be stabled during cleaning operations	Initial Access and Logistics workshop held 08/09/09 CW Lengths document	
96. As a **maximum**, the overall train maximum length shall not exceed 90 metres in length	Need to carefully review where the TCT needs to be able to go, reverse and stable (e.g. may need to exclude access to certain sidings)	

97. It is **desirable** that the complete TCT does not exceed 55m metres in length		
98. Overall train length to be at least 20 metres	Signalling system requirement	

Overall Train Mass Requirements

Requirement	**Comment**	**Possible Assessment Criteria**
99. The (empty) mass of TCT shall be minimised as far as possible.		
100. The (empty) mass of the TCT shall not exceed 125 tonnes (i.e. excluding mass of collected dust and rubbish)		
101. The fully laden mass of the cleaning consist shall not exceed 175 tonnes	Fully Laden TCT must be able to be hauled by battery locos in case of failure	

Operational Requirements

(Line Based) – These requirements have been updated following the Access and Logistics workshop held on 8th September 09

Generic limitations

- maximum permissible siding length and associated signal berthing constraints; ideally limit TCT to length of 6 car C Stock

Requirement	Comment	
102. Operation on SSR (Metropolitan, Circle, District Lines)	Area to be cleaned is a significant distance from possible depots; operation in traffic hours required; whilst tripcock/trainstop railway, transfer in traffic hours presents no problem; likely to require SSR ATP for future.	

Operator Requirements

The replacement tunnel cleaning train shall

Requirement	Comment	Possible Assessment Criteria
103. Be capable of being driven from either end		
104. Location for cleaning system controller	Rear motive power vehicle (rear cab?) when travelling in either direction	
105. Communications between operator and cleaning controller	Cab to cab; Connect radio (hand helds to be provided)	
106. Be provided with a low speed drive capability for use during cleaning	Hydrostatic drive similar to those used on a wide range of plant machines?	
107. The low speed drive capability	Suggested low speed control between 1 and 10	

shall be capable of automatically maintaining any set speed over the range of track gradients which will be experienced.	kph, in 0.25 kph increments	
108. The low speed drive capability shall be based on systems with a proven record of reliable operation in harsh operating environments	Reliable operation of the low speed drive will be critical to achieving the required usage of the TCT	
109. The TCT shall provide an appropriate operators' environment for the work being undertaken	Noise, sealing, temperature air conditioning, controls, sight lines, driving position	
110. The TCT shall be provided with a Train Protection Switching System at each driving cab	Initially only Tripcock but with provision for SSR ATP selection,	
111. TCT shall be provided with CCTV so that the cleaning controller can view both ahead and behind the TCT	This needs further refinement if confirmed	
112. Comprehensive operational information and training shall be provided		

Maintainer Requirements

The replacement tunnel cleaning train shall have

Requirement	**Comment**	**Possible Assessment Criteria**
113. Train maintenance regime defined		

114. Maintenance procedures developed and demonstrated		
115. Required level of spares holding shall be defined and provided		
116. Comprehensive maintenance information, manuals and training shall be provided		
117. Modular component replacement		
118. Equipment effectively sealed against dust		
119. Ability to remove/exchange individual vehicles or equipment modules	Query – is this needed? Is this desirable – e.g. have separate deep tube and cut and cover cleaning vehicles?	
120. TCT shall normally be stabled in the open and, as such, shall be subject to the normal range of weather. Its design shall be such that none of the vehicles or equipment shall suffer any adverse effects as a result of the train being stabled under these conditions	Rain, snow, dew, mist, fog, snow, prolonged sunshine shall not cause degradation of the cleaning equipment or systems	
121. Appropriate cleaning equipment and processes shall be identified for cleaning the train with adverse effects on its systems or equipment		
122. TCT shall be capable of having its wheels turned on existing UFWL installations at LU SSR depots	Need to agree which UFWLs	

Asset Interface Requirements

The replacement tunnel cleaning train shall satisfy the following

Requirement		Comment	Possible Assessment Criteria
123.	EMC	Compliance with EN 50121 Compliance with appropriate London Underground standards pertaining to signalling assets for EH/TH operation Note – Regardless of whether the cut and cover TCT only runs in EH it should be EM compliant	
124.	Signalling Compatibility	Signal Interference – Acceptance criteria to be developed for each signalling system Applicable for self powered operation in TH	
125.	Track	Minimum curve radii (lines, depots and sidings) for both horizontal and vertical curves to be defined Track twist to be defined WRI Wheel unloading Maximum axle loads	
126.	Conductor rails		
127.	Tunnels	Gauging – permissible size (sub surface)	
128.	Depot	Facilities for waste handling, re-fuelling (If required) and maintenance	
129.	WRI - TCT shall be fitted with	It is recommended that the installation of solid	

comprehensive measures to provide adequate wheel/rail lubrication to counter the potential damage from the disturbed tunnel dust	stick lubrication, for both flange and tread, throughout the formation should be required	
130. Environment of the cut and cover tunnels shall be defined in the Technical Specification		
131. Shall be capable of working on and handling traction supply variations. Currently a nominal 630V. Future upgrade to parts of the network to 750V. Maximum voltage encountered when other trains are braking regeneratively is 900V.	Technical specification should also reference the minimum voltage which the TCT could encounter.	

Opportunities

Requirement	**Comment**	**Possible Assessment Criteria**
132. Whilst in low speed cleaning mode there may be scope to use TCT to capture other data – e.g. laser based tunnel surveys? General tunnel inspection?	Is this an idea which should be considered and developed?	

Rolling Stock Requirements (Complete formation - including motive power vehicles)

Requirement		Comment
133.	Asset Interfaces	Track, Gauging, EMC, Signal compatibility issues (see earlier section)
134.	Specification	Pragmatic approach required; need to avoid over-specifying through calling up inappropriate Standards or over-onerous requirements
135.	Train performance	Defined in earlier section, based on train performance simulations
136.	Recovery facilities	Enable train to be recovered in the event of failure resulting in its immobilisation by any existing SSR passenger stock and S Stock. ERU to be provided with data and training to remount train onto rails, in case of derailment.
137.	Braking	Shall provide an emergency brake performance sufficient to enable traffic hours operation Shall provide a service braking system to enable effective control of the train's speed during travel to and from site Shall provide a parking brake system sufficient to secure the complete formation on a 1 in 30 gradient. Normal requirement is to achieve an established level track deceleration of between 1.3 – 1.4 m/s^2 with an emergency brake application time of ~ 1.5 seconds
138.	Structural integrity	Suppliers shall indicate the Standards they normally use for designing cleaning vehicles
139.	Bogie	Suppliers shall indicate the Standards they normally use for designing cleaning vehicles
140.	Wheel unloading	There must be no credible risk of derailment
141.	Equipment security	Suppliers shall indicate the Standards they normally use for designing cleaning vehicles
142.	Coupling interface	To enable rescue/recovery by other vehicles or trains
143.	Noise	Low level of noise required given night time operation of train
144.	Arc protection	Requirement to be developed by project
145.	Cab environment	Suppliers shall indicate the Standards they normally use for designing cleaning vehicles
146.	Traction performance	Required acceleration rate; maximum speed; maximum adhesion demand in motoring Link to the mass of cleaning formation to be hauled (empty mass plus maximum load of dust and rubbish)
147.	Emissions	(if diesel powered); Suppliers shall indicate the Standards they normally use for designing cleaning

		vehicles
148.	Wiring Installation	Suppliers shall indicate the Standards they normally use for designing cleaning vehicles
149.	Fire performance/materials	Suppliers shall indicate the Standards they normally use for designing cleaning vehicles
150.	Traction Supply Voltage	If power is derived from the current rails then the equipment must be suitable for operating on traction supply voltages up to 900V.