ID	Requirement Text	Rationale	Supporting Information
TRS-CET-46	Where trains are required to split in a worksite, automatic couplings shall be provided to prevent the need for staff members to climb between the vehicles.		
TRS-CET-47	Vehicles shall be capable of rescuing other Crossrail engineering trains.		Coupling adaptors may be required for screw-coupled vehicles depending on the coupling solution. Maximum draw weight of 200 tonnes. In accordance with GMRT2400, all vehicles shall be capable of being coupled to a vehicle fitted with a drawhook compliant with BS EN 15566:2009+A1:2010 clause 5.2.
TRS-CET-29	4.5.7 Ventilation		
TRS-CET-50	Vehicle emissions shall not cause the COSHH 8 hour workplace exposure limits to be exceeded either in running mode at speed or working mode at rest.		The ventilation system can be assumed to provide 35 cubic metres per second of fresh air through the site.
TRS-CET-51	Engine emissions shall, as a minimum meet the European category 3b limits for rail traction engines.		
TRS-CET-31	**4.6 Safety**		

ID	Requirement Text	Rationale	Supporting Information
TRS-CET-93	The supplier shall support Rail for London in developing a safe system of work.	To ensure that the vehicles can be operated safely within the Crossrail environment.	The railway undertaking and plant operator is not yet in place, and therefore no safety management system exists for the vehicle to fit into. As such, safety requirements may emerge during the design process that must be taken into account.
TRS-CET-64	4.6.1 Fire Safety		
TRS-CET-66	Fire suppression systems shall not use the following methods for active fire suppression: White Powder CO2	This system is likely to reduce visibility during evacuation and leave a lasting residue in the tunnel.	
TRS-CET-72	Fire detection systems shall provide an input into the signalling system.	To provide immediate indication of a fire alert to the control room to enable passenger trains to be kept in a separate ventilation section.	Format of the interface to be agreed with the CBTC signalling supplier.
TRS-CET-152	Systems to restrict the volume of fuel carried by the machine shall be provided where practicable.	Potentially required as a mitigation listed in the outcome of the fire QRA	
TRS-CET-160	Fire suppression systems shall be installed in enclosed spaces on the vehicle.		

ID	Requirement Text	Rationale	Supporting Information
TRS-CET-174	Any outbreak of fire shall be prevented from exceeding 8.8MW output within 30 minutes of detection.		Risk assessment should demonstrate that the probability of the fire exceeding this rate is tolerably low and fire will not exceed this level within the time required for the crew to evacuate the tunnel.
TRS-CET-175	Adequate protection shall be provided to the fuel tank (and other fluid tanks) in the event of derailment.		This requirement has been specifically included because of the emergency walkway, which in the event of a derailment could increase the risk of damage/puncture of fuel tanks. Risk assessment should identify any necessary modifications.
TRS-CET-32	**4.7 Human Factors**		
TRS-CET-129	Dust and emissions shall be prevented from entering the cab.		
TRS-CET-83	Operating tasks shall be designed in accordance with HF principles, allowing for 5th per cent female to 95th per cent male usage.		
TRS-CET-200	All signalling equipment shall be integrated into the cab in accordance with HF principles.		
TRS-CET-84	A driver training position shall be provided in driving cabs, with sufficient visibility and access to emergency stop functions.	To enable supervision during operation for training and competence assessment.	

ID	Requirement Text	Rationale	Supporting Information
TRS-CET-33	**4.8 RAM**		
TRS-CET-177	The Engineering Trains shall undertake self test upon start up and report any issues with the vehicle that may prevent successful completion of the task.		
TRS-CET-55	No single point of failure shall prevent completion of maintenance tasks that must be completed for handback into passenger service.		
TRS-CET-56	In the event of engine failure, engineering trains shall be capable of self-rescue.		In the event of unit failure, the train shall have sufficient traction in the remaining end to move from the railway back to the stabling location.
TRS-CET-176	Maximum Active Repair Time for any line replaceable unit (LRU) shall not exceed 13 hours.		The Plumstead shed contains a maintenance pit, overhead crane, various manipulators, jacks and fork-lift access to the sides.
TRS-CET-178	Line replaceable units shall be capable of being replaced at the Plumstead maintenance facility.	To minimise lost time in the event of component failure	The Plumstead shed contains a maintenance pit, overhead crane, various manipulators, jacks and fork-lift access to the sides.
TRS-CET-179	Engineering trains shall have a shift completion rate of 98%.		The shift completion rate allows for a higher failure rate so long as failures do not affect passenger services.
TRS-CET-91	Engineering trains shall have a mean time between service affecting failures (MTBSAF) of 2400 hours.		This is based on an 8 hour operational shift, and should not include failures internal to the signalling system.

ID	Requirement Text	Rationale	Supporting Information
TRS-CET-92	All modules and vehicles shall have a minimum availability of 280 operating shifts per year.		To facilitate this, all maintenance short of overhaul shall be undertaken at the Plumstead maintenance facility to minimise lost of availability due to transit. Specific maintenance facilities necessary to achieve this should be defined at an early design stage to enable this. Average availability figures must consider unavailability due to heavy overhaul activities.
TRS-CET-211	Vehicle maintenance plans shall not require off site overhaul more frequently than every eight years and for no more than four consecutive weeks.	To ensure no extended periods without access to engineering trains.	
TRS-CET-119	Regular Maintenance regimes shall not prevent a vehicle being available for more than 4 consecutive days.		Allowance for heavy overhaul off site should not be included in this requirement. Plumstead depot provides general facilities for maintenance including inspection pits, lifting equipment and tools and power/lighting.

ID	Requirement Text	Rationale	Supporting Information
TRS-CET-180	The supplier shall provide an obsolescence management service and document this in a Post-manufacture support plan.		The Post Manufacture Support Plan shall assess the expected useful life of the equipment. Identify support items associated with the equipment that will present potential problems due to inadequate sources of supply after shutdown of manufacturing lines. Develop and analyse alternative solutions for anticipated support difficulties during the remaining life of the equipment. Develop a plan that ensures effective support during its remaining life along with the estimated funding requirements to implement the plan. As a minimum, this plan shall address manufacturing, hardware and software support, repair centre, data modifications, supply management, configuration management and obsolescence.
TRS-CET-95	The supplier shall minimise the need for special tools and equipment, and shall provide any necessary for maintenance or operation.		
TRS-CET-98	Spare parts shall be made available for a minimum of 15 years following delivery.	To minimise component obsolescence and need for future modification.	

ID	Requirement Text	Rationale	Supporting Information
TRS-CET-181	All vehicles shall have a minimum design life of 25 years.		
TRS-CET-110	Vehicle and infrastructure monitoring systems shall be capable of being uploaded via wifi.		
TRS-CET-111	Secondary means of removing data from the vehicle shall be provided through physical connection/removable disc.		
TRS-CET-153	Systems shall be designed to use commonly available (COTS) parts where practicable.	To improve spares availability.	
TRS-CET-96	**4.9 EMC**		
TRS-CET-97	The vehicles shall be compatible with the electromagnetic environment of the Crossrail Central Operating Section and any other routes over which the machine is expected to run.		
TRS-CET-108	**4.10 Environment**		
TRS-CET-109	All lubricants and hydraulic oils shall have a minimal environmental impact and where possible shall be biodegradable or have long life properties to minimise disposal of oils and lubricants.		

ID	Requirement Text	Rationale	Supporting Information
TRS-CET-74	Vehicle noise and fuel consumption shall be minimised when stabling with power on.	Vehicles are likely to need to wait in Westbourne park for a path for up to an hour. Means of maintaining power whilst shutting down the main engine will reduce noise and fuel consumption.	Batteries with sufficient charge, additional generator sets, or partial shut-down where multiple engines are provided could reduce noise and consumption whilst still feeding auxiliary systems including as a minimum: signalling, comms, HVAC, lighting, Train Management System.
TRS-CET-182	Means of detecting and preventing leaking fluid shall be provided in the event of a hydraulic failure.		The operator should be made aware of potential loss of fluid as soon as practicable, with affected areas automatically isolated to prevent further loss to minimise the risk of fluid loss within the tunnels. Spill kits should be available to enable spilled fluids to be contained and removed.
TRS-CET-213	Noise levels measured 7.5m from the track centreline during working shall not exceed 75dB.	This is the same as the target for stationary noise generated by a locomotive stated in the Rolling Stock - Noise TSI. The vehicle will generally be working at night. Many parts of the network are in noise sensitive areas.	This requirement should be demonstrated in accordance with section 5 of EN ISO 3095.
TRS-CET-68	**4.11 Documentation**		
TRS-CET-69	Training shall be provided for operation and maintenance of the vehicle(s) and all modules.		Details of the level of training required are provided in CRL1-RFL-O8-RSW-CR001-50001

ID	Requirement Text	Rationale	Supporting Information
TRS-CET-105	Recovery manual describing the means by which the vehicle can be removed from track in order to clear the route for traffic.		Documentation should be provided in xml format (printable to pdf) and compatible with portable readers compliant with Raildex (see http://www.raildex.com/)
TRS-CET-34	**4.12 Standards and Assurance**		
TRS-CET-39	Design and build of all vehicles shall comply with relevant TSIs.		Compliance will be determined by the Notified Body who will provide certification to demonstrate compliance.
TRS-CET-162	Design and build of all vehicles shall comply with relevant NNTRs.		Compliance will be determined by the Designated Body who will provide certification to demonstrate compliance.
TRS-CET-163	Design and build of the vehicles shall be compliant with the European Machinery Directive for both operation and maintenance.		
TRS-CET-99	Design and build of the vehicles and equipment shall comply with RIS-1702-PLT.		Evidence of compliance must be provided in the form of certification from an accredited Plant Acceptance Body (PAB). The process is described in RIS-1710-PLT
TRS-CET-40	Compatibility files shall be produced in accordance with GERT8270 to demonstrate compatibility with the Crossrail Central Operating Section infrastructure.		The Manufacturer shall act as the Proposer as defined in the standard.

ID	Requirement Text	Rationale	Supporting Information
TRS-CET-82	Vehicles shall be demonstrated to be compatible with Network Rail infrastructure over the Crossrail routes.		Compatibility files must be produced and signed off by the relevant IM representative. "Introducing new vehicles or changes to vehicles" provides guidance on the Network Rail process for demonstrating compatibility. Additional considerations beyond Crossrail compatibility include signal sighting and track circuit compatibility. The Crossrail routes from Stratford to Liverpool Street High level are not required should the gauge infringements require design modification.

Appendix – Contracted Technical Solution

The table below describes or references the agreed technical solution to be implemented by the Manufacturer in order to meet the requirements within this TRS, along with an assessment of the solution and its ability to meet the requirements.

ID	Requirement Text	Contract Award Status	Description of contracted solution
TRS-CET-59	**4.13 Maintenance Tasks**		
TRS-CET-130	Engineering trains shall be capable of delivering and replacing plain rail sections (maximum length of 18m) to site at all locations in the Central Operating Section within the constraints of engineering hours.	**Fully Compliant**	The solution is based on the system described in ROBEL_6.2_Vehicle Concept_V2.pdf on pages 10-12 and on the drawing ROBEL_6.2_Typenblatt_clousre_rail_transport_V2.pdf, based on the method described in ROBEL_9.1_Case Study 2_V2.xlsx

ID	Requirement Text	Contract Award Status	Description of contracted solution
TRS-CET-131	Engineering trains shall be capable of delivering half-switch and crossing sections to site within the constraints of engineering hours.	**Fully Compliant**	The solution is based on the system described in ROBEL_6.2_Vehicle Concept_V2.pdf on pages 7-8 and based on the method described in ROBEL_9.1_Case Study 1_V2.xlsx. Also based on the following compliance statement: "The gantry cross beam has a dimension of approximately [redacted] and can span across from the S&C Cavern to the Track trolleys for loading and unloading switch and crossing units to either side. The S&C components can be positioned for loading and unloading from both sides and can be orientated with switch toes at front or rear on the S&C transport wagon for a facing or trailing junction scenario. The gantries are operated manually and synchronized by the supervisor communicating and instructing individual gantry controllers to ensure a balanced lift." There are two additional options: [redacted] (i) Automated lifting with electrical hoists on each gantry (ii) Automatic synchronized control.

ID	Requirement Text	Contract Award Status	Description of contracted solution
TRS-CET-132	Lifting equipment shall be capable of being used to replace switch and crossing units at all locations in the Central Operating Section within the constraints of Engineering Hours.	**Fully Compliant**	Document: ROBEL_9.1_Case Study 1_V2 ROBEL_9.1_Typenblatt G Switch Transport_V2 ROBEL_6.2_Vehicle Concept_V2.pdf Presuppositions for using the Gantries: 1) No cant of the track at switches existing 2) Nearly the same lifting points on old and new 1/2 set of switches are necessary 3) The 1/2 set of switches were stored in Plumstead or have to brought to Plumstead in a separate shift 4) According to the installation location additional actions have to be done (e.g. use of additional wooden blocks, etc.) 5) It has to be allowed to shore up with the Gantries on the sleepers, between the sleepers and also in the four-foot on track-switches 6) A variation of the lifting points of the 1/2 set of switches of approx. +/- 0,5 m should be allowed Please see also document: TRS-CET-132_Question TfL_Longitudinal movement of the G Switch

ID	Requirement Text	Contract Award Status	Description of contracted solution
TRS-CET-133	Engineering trains shall be capable of being used to replace sections of contact wire (minimum 50m) in the rigid overhead conductor in the tunnels within the constraints of Engineering Hours.	**Fully Compliant**	Engineering trains are capable of being used to replace sections of contact wire (minimum 50m) in the rigid overhead conductor in the tunnels within the constraints of Engineering Hours. Please see additional information of different vehicles FUMA, IFO and KVB as reference. Document: ROBEL_6.2_Reference Vehicles for Catenary TRS-CET-133_Question TfL_Replacement of overhead catenary
TRS-CET-14	Engineering trains shall be capable of being used to replace a 10 m section of overhead conductor bar within the constraints of Engineering Hours.	**Fully Compliant**	The requirement can be met with the designed vehicles and lifting platform. Please see additional document Replacing ROC. TRS-CET-014_Replacing ROC
TRS-CET-184	Engineering trains shall be capable of inspecting and clearing the tunnel drainage system.	**Fully Compliant**	Yes fulfilled, that Engineering trains are capable of inspecting and clearing the tunnel drainage system. Please see document Reference Drainage Cleaning. Document: ROBEL_6.2_Tunnel drainage system with lower capacity

ID	Requirement Text	Contract Award Status	Description of contracted solution
TRS-CET-135	Engineering trains shall be capable of being used to deliver replacement transformers to the switchrooms located adjacent to the running tunnels within the constraints of engineering hours.	**Fully Compliant**	The engineering trains are capable of being used to deliver replacement transformers to the switchrooms located adjacent to the running tunnels. The transport of the transformer will be on the wagon and uploaded with an existing forklift inside the tube. Between the wagon an the platform we will install a ramp for easy access. Please see documents: TRS-CET-135_Question_Tfl_Transport Wagon
TRS-CET-185	Engineering trains shall be provided with stillages for transportation and delivery of platform screen and screen door components to platforms.	**Fully Compliant**	The Engineering trains are provided with stillages for transportation and delivery of platform screen and screen door components to platforms. The transport of the door panels will be on the wagon with special transport-frames and uploaded with an existing forklift inside the tube. Between the wagon an the platform we will install a ramp for easy access. Details have to be fixed with TfL (e.g. exact data of glass panels, ...) Please see document: TRS-CET-185_Question_Tfl_Transport Wagon

ID	Requirement Text	Contract Award Status	Description of contracted solution
TRS-CET-186	Engineering trains shall be capable of being used to clean the track side of the platform screen doors.	**Fully Compliant**	The engineering trains are capable of being used to clean the track side of the platform screen doors. The cleaning of the platform screen doors will be done with the lifting platform or with the crane with workman basket. For cleaning a high pressure cleaner with a separate water-tank on the loading platform will be self-sufficient. Please see document: TRS-CET-186_Question TfL_Cleaning of the platform screen doors
TRS-CET-212	Engineering trains shall be capable of being used to deliver replacement feeder cables to site.	**Fully Compliant**	The engineering trains are capable of being used to deliver replacement feeder cables to site. Please see document of Reference Vehicles for transporting cable drums. Document ROBEL_6.2_Transport of Cable Drums TRS-CET-212_Question TfL_Deliver replacement feeder cables to site

ID	Requirement Text	Contract Award Status	Description of contracted solution
TRS-CET-136	The engineering train shall be capable of being used for intrusive high level inspections and cleaning of all high level assets, including OLE, rigid overhead conductor, platform edge screens, cable management system and tunnel lighting.	**Fully Compliant**	The engineering trains will be capable of being used to inspect high level assets using the basket attachment to the crane or the scissor lift platform described on page 14 of The ROBEL Vehicle Configuration Catenary Maintenance (ROBEL_6.2_Vehicle Concept_V2.pdf) See also documents: ROBEL_9.1_Case Study 3 TRS-CET-136_Question_Size_of_basket
TRS-CET-114	Elevating platforms shall provide staff access to the tunnel crown in running tunnels and S&C caverns.	**Fully Compliant**	The elevating platforms are providing staff access to the tunnel crown in running tunnels and S&C caverns. Please see document Reference Vehicles with Lifting Platform. Documents: ROBEL_6.2_Lifting Platform (scissors lift)_V2 ROBEL_6.2_ROBEL_6.2_Reference Vehicles for Catenary TRS-CET-114_Question TfL_Reaching_Crown_of_tunnel

ID	Requirement Text	Contract Award Status	Description of contracted solution
TRS-CET-13	Lifting equipment shall be capable of delivering (on and off tracking) trolley equipment and heavy small plant for maintenance use.	**Fully Compliant**	Lifting equipment is capable of delivering (on and off tracking) trolley equipment and heavy small plant for maintenance use. Please see document Lifting Equipment. Document:TRS-CET-13_Question TfL_Lifting Equipment
TRS-CET-1	**4.14 Function**		
TRS-CET-3	4.14.1 Power Cars		
TRS-CET-21	Powered vehicles shall be capable of slow speed operation (creep control) for accurate positioning.	**Fully Compliant**	Powered vehicles are capable of slow speed operation (creep control) for accurate positioning.
TRS-CET-22	Vehicles and modules shall be capable of remote control at slow speed in possessions.	**Fully Compliant**	The vehicles and modules shall be capable of remote control at slow speed in possessions. Acc. to our concept only the vehicles equipped with a crane/lifting platform have a separate remote control
TRS-CET-30	Power cars shall be capable of providing power and positioning information (derived from the signalling equipment) to a separate monitoring vehicle or equipment mounted on the vehicle.	**Fully Compliant**	The requirement will be met if the systems and their interfaces are defined by TfL

ID	Requirement Text	Contract Award Status	Description of contracted solution
TRS-CET-120	Power cars shall be capable of acting as pilot vehicles for units not fitted with Crossrail signalling equipment.	**Fully Compliant**	Power cars are capable of acting as pilot vehicles for units not fitted with Crossrail signalling equipment. The Track Vehicles (power cars) can be used as pilot vehicles for other trains and machines. Standard draw gear, Scharfenberg coupling between the units and brake pipe connection is provided. If further connection is required, it has to be clarified with TfL. Please see documents Reference Vehicles. Document: ROBEL_6.2_Reference Vehicles
TRS-CET-4	4.14.2 Lifting		
TRS-CET-158	All maintenance modules and equipment shall be demountable where possible.	**Fully Compliant**	all maintenance modules and equipment is demountable where possible. Crane and welfare are not demountable, lifting platform (scissors lift) is demountable.
TRS-CET-161	Where lifting cranes are proposed that cannot rotate 180 degrees within the running tunnel, they shall be capable of being secured for running mode with the boom facing in the appropriate direction for the task.	**Fully Compliant**	where lifting cranes are proposed that cannot rotate 180 degrees within the running tunnel, they shall be capable of being secured for running mode with the boom facing in the appropriate direction for the task. See ROBEL_6.2_Typenblatt_clousre_rail_transport_V2.pdf

ID	Requirement Text	Contract Award Status	Description of contracted solution
TRS-CET-112	Lifting equipment shall minimise load swing.	**Fully Compliant**	Lifting equipment is minimizing load swing. For rail lifting, hydraulic tongs are provided, see ROBEL_9.1_Case Study 2_Figure 25 (rail tongs).pdf
TRS-CET-18	Lifting and other equipment capable of moving outside the vehicle gauge shall be prevented from coming into contact with fixed assets.	**Fully Compliant**	Lifting and other equipment is capable of moving outside the vehicle gauge shall be prevented from coming into contact with fixed assets. Crane has a general height and side limitation.
TRS-CET-45	Lifting operations shall be controllable by a single operator.	**Fully Compliant**	Lifting operations is controllable by a single operator. The gantry system can be operated by a single operator
TRS-CET-155	Lifting equipment shall be capable of having different attachments fitted to maximise flexibility.	**Fully Compliant**	The Lifting equipment is capable of having different attachments fitted to maximise flexibility. The crane can be easily equipped with different attachments (see brochure of Palfinger) for maximise flexibility. Please see additional document of additional crane equipment. Document: ROBEL_6.2_Crane Equipment TRS-CET-155_Question TfL_Crane
TRS-CET-187	Lifting equipment shall be fitted with lighting to illuminate the lifting area.	**Fully Compliant**	Lifting equipment is fitted with lighting to illuminate the lifting area.
TRS-CET-192	4.14.3 Drainage Clearance		

ID	Requirement Text	Contract Award Status	Description of contracted solution
TRS-CET-193	Clean water tanks provided for drainage clearance shall have a capacity of at least 3,000l.	**Fully Compliant**	Yes fulfilled, Clean water tanks provided for drainage clearance has a capacity of [redacted] We have made such a system for an other project. See document Tunnel Drainage System. Document: ROBEL_6.2_Tunnel drainage system with lower capacity
TRS-CET-194	The grey/waste tank shall have capacity of at least 110% of the clean water tank.	**Fully Compliant**	The grey/waste tank has a min. capacity of [redacted] of the clean water tank. We have made such a system for an other project, with a capacity of [redacted] litres of waste water. See document Tunnel Drainage System. Document: ROBEL_6.2_Tunnel drainage system with lower capacity
TRS-CET-196	Water jetting systems shall be capable of operating at 2000 psi, with a discharge rate of 200 litres per minute.	**Fully Compliant**	Water jetting systems is capable of operating at [redacted] psi, but with a discharge rate of [redacted] litres per minute. We have made such a system for an other project.

ID	Requirement Text	Contract Award Status	Description of contracted solution
TRS-CET-209	Water jetting system shall be capable of reaching the drainage channels and catch pits up to 50m from the vehicle.	**Fully Compliant**	Water jetting system is capable of reaching the drainage channels and catch pits up to [redacted] from the vehicle. Please see additional document of drainage cleaning. Document: ROBEL_6.2_Tunnel drainage system with lower capacity
TRS-CET-197	Waste removal equipment shall be capable of removing wet and dry debris from drainage channels and catch pits.	**Fully Compliant**	Waste removal equipment is capable of removing wet and dry debris from drainage channels and catch pits. Please see additional document of drainage cleaning. Document: ROBEL_6.2_Tunnel drainage system with lower capacity
TRS-CET-210	Waste removal systems shall be capable of reaching the catch pits located in the 4 foot.	**Fully Compliant**	waste removal systems is capable of reaching the catch pits located in the 4 foot. Please see additional document of drainage cleaning. Document: ROBEL_6.2_Tunnel drainage system with lower capacity

ID	Requirement Text	Contract Award Status	Description of contracted solution
TRS-CET-208	Suction systems shall be capable of operating at 80kPa.	**Fully Compliant**	Suction systems is capable of operating at [redacted] max. working pressure and [redacted] burst pressure. We have made such a system for an other project, but with lower working pressure [redacted] and lower burst pressure [redacted].
TRS-CET-5	4.14.4 Elevating Platforms		
TRS-CET-113	Vehicles on which elevating platforms are fitted shall be capable of moving at slow speed with platforms extended, with staff present on the platform.	**Fully Compliant**	Vehicles on which elevating platforms are fitted are capable of moving at slow speed with platforms extended, with staff present on the platform.
TRS-CET-154	Elevating platforms shall be provided with cleaning equipment suitable for use on the electrification systems, screen doors, lighting systems and other assets at high level in the tunnels.	**Fully Compliant**	Elevating platforms are provided with cleaning equipment suitable for use on the electrification systems, screen doors, lighting systems and other assets at high level in the tunnels.
TRS-CET-188	Elevating platforms shall be fitted with lighting capable of illuminating the platform surface and the assets being maintained.	**Fully Compliant**	Yes confirmed
TRS-CET-8	**4.15 General Requirements**		

ID	Requirement Text	Contract Award Status	Description of contracted solution
TRS-CET-86	Lighting shall be provided around each car to illuminate the walking surface around the vehicle.	**Fully Compliant**	Lighting is provided around each car to illuminate the walking surface around the vehicle. Please see Illumination of MMS Network Rail as example. Document: ROBEL_6.2_Illumination MMS-UK ROBEL_6.2_Luminous Intensity_Example
TRS-CET-215	Engineering Trains and their modules shall be configurable to work with the adjacent line open where possible.	**Fully Compliant**	The Engineering Trains and their modules are configurable to work with the adjacent line open where possible. Adjacent line blockage for crane and platform implemented. Please see document Reference of adjacent line blockage of crane/lifting platform. Document: ROBEL_6.2_Reference of adjacent line blockage of crane & lifting platform TRS-CET-215_Question TfL_Adjacent Line open working

ID	Requirement Text	Contract Award Status	Description of contracted solution
TRS-CET-216	Engineering Trains shall provide the facility for level access to the emergency evacuation walkway.	**Fully Compliant**	Engineering Trains are providing the facility for level access to the emergency walkway. Please see document vehicle access. Documents: ROBEL_6.2_Vehicle access TRS-CET-216_QuestionTfL_Level_acces_to_emergency_walkway

ID	Requirement Text	Contract Award Status	Description of contracted solution
TRS-CET-35	All train formations shall be configured to include a welfare module with toilet facilities and a place for food preparation and consumption.	**Fully Compliant**	All train formations are configured to include a welfare module with toilet facilities and a place for food preparation and consumption. Please see Case Studies and Typenblatt. Documents: ROBEL_6.2_Vehicle Concept_V2 ROBEL_6.2_Typenblatt Power Car A ROBEL_6.2_Typenblatt Power Car B ROBEL_6.2_Typenblatt Power Car E ROBEL_6.2_Typenblatt Transport Wagon_V2 ROBEL_6.2_Typenblatt Rail Transport_V2 ROBEL_6.2_Typenblatt G Switch Transport_V2 ROBEL_6.2_Typenblatt Contact Wire replacement_V2 ROBEL_6.2_Typenblatt Drainage Cleaining_V2 ROBEL_9.1_Case Study 1_V2 ROBEL_9.1_Case Study 2_V2 ROBEL_9.1_Case Study 3 Please see document: TRS-CET-35_Question TfL_Details_welfare_module

ID	Requirement Text	Contract Award Status	Description of contracted solution
TRS-CET-61	Maintenance trains shall be a variable formation to allow them to be configured to undertake specific tasks.	**Fully Compliant**	Maintenance trains are so designed to allow them to be configured variable to undertake specific tasks. It is possible to arrange the 6 offered vehicles (4x TSU and 2x trailer) in any configuration. The only thing that must be noted is that there have to be a cab on each side of the composite for travelling in both directions. - There can be 3 or more wagons in one composite. But if you intend to use non-ROBEL-wagons, further examinations have to take place. (brake system, vehicle coupling, signal cables for multiple traction...) Please let us know if this should be taken into consideration. - A third (or fourth) power car could be part of the train. Please see additional document Reference Vehicles. Document: ROBEL_6.2_Reference Vehicles
TRS-CET-67	Powered vehicles shall provide a power supply for additional lighting equipment.	**Fully Compliant**	Powered vehicles are providing a power supply for additional lighting equipment. Please see additional document of vehicle illumination. Document: ROBEL_6.2_Vehicle Illumination

ID	Requirement Text	Contract Award Status	Description of contracted solution
TRS-CET-206	Task lighting shall be provided to illuminate the work site behind the vehicle.	**Fully Compliant**	Task lighting are provided to illuminate the work site behind the vehicle.
TRS-CET-75	Engineering trains shall be capable of transporting at least 12 staff to site (excluding driver).	**Fully Compliant**	Yes fulfilled, Engineering trains are capable of transporting at least 12 staff to site (excluding driver). Please see document Typenblatt an Case Studies. Documents: ROBEL_6.2_Vehicle Concept_V2 ROBEL_6.2_Typenblatt Power Car A ROBEL_6.2_Typenblatt Power Car B ROBEL_6.2_Typenblatt Power Car E ROBEL_6.2_Typenblatt Transport Wagon_V2 ROBEL_6.2_Typenblatt Rail Transport_V2 ROBEL_6.2_Typenblatt G Switch Transport_V2 ROBEL_6.2_Typenblatt Contact Wire replacement_V2 ROBEL_6.2_Typenblatt Drainage Cleaining_V2 ROBEL_9.1_Case Study 1_V2 ROBEL_9.1_Case Study 2_V2 ROBEL_9.1_Case Study 3 TRS-CET-75_Question TfL_staff_welfare_area

ID	Requirement Text	Contract Award Status	Description of contracted solution
TRS-CET-77	Engineering trains shall be capable of powering small plant and power tools.	**Fully Compliant**	Engineering trains are capable of powering small plant and power tools. We confirm fully electric, pneumatic and hydraulic supply for rail replacement works. Please see document: TRS-CET-77_Question TfL_Pn_Hy_Supply
TRS-CET-78	All engineering train configurations shall contain a storage module for hand tools and equipment.	**Fully Compliant**	All engineering train configurations are containing a storage module for hand tools and equipment. Please see additional document Typenblatt. Documents: ROBEL_6.2_Vehicle Concept ROBEL_6.2_Typenblatt Power Car A ROBEL_6.2_Typenblatt Power Car B ROBEL_6.2_Typenblatt Power Car C ROBEL_6.2_Typenblatt Power Car D ROBEL_6.2_Typenblatt Wagon ROBEL_6.2_Typenblatt Rail Transport ROBEL_6.2_Typenblatt G Switch Transport ROBEL_6.2_Typenblatt Contact Wire replacement ROBEL_6.2_Typenblatt Drainage Cleanining

ID	Requirement Text	Contract Award Status	Description of contracted solution
TRS-CET-157	Engineering train shall be capable of transporting welding/cutting equipment.	**Fully Compliant**	Engineering trains are capable of transporting welding/cutting equipment. Results of case studies will be taken into account during overall risk assessment (HAZARD Log) by independent safety assessor.
TRS-CET-76	All engineering train configurations shall have a cab at either end in transit to allow for return journey.	**Fully Compliant**	please see drawings of the Unit Documents: ROBEL_6.2_Vehicle Concept_V2 ROBEL_6.2_Typenblatt Power Car A ROBEL_6.2_Typenblatt Power Car B ROBEL_6.2_Typenblatt Power Car E ROBEL_6.2_Typenblatt Transport Wagon_V2 ROBEL_6.2_Typenblatt Rail Transport_V2 ROBEL_6.2_Typenblatt G Switch Transport_V2 ROBEL_6.2_Typenblatt Contact Wire replacement_V2 ROBEL_6.2_Typenblatt Drainage Cleaning_V2
TRS-CET-9	All modules and equipment shall be vehicle/wagon mounted and classed as an On Track Machine to facilitate running under supervision of the signalling system(s).	**Fully Compliant**	all modules and equipment is mounted and classed as an On Track Machine to facilitate running under supervision of the signalling system(s).

ID	Requirement Text	Contract Award Status	Description of contracted solution
TRS-CET-115	All modules shall provide sufficient locking, indication and interlocking where necessary to prevent train operating in running/transit mode with components not safely stowed in transit/running position.	**Fully Compliant**	All modules are providing sufficient locking, indication and interlocking where necessary to prevent train operating in running/transit mode with components not safely stowed in transit/running position. We have fulfilled this issue in different projects in the past. Please see also additional document Locking of Sidewalls MMS. ROBEL_6.2_Locking of Sidewalls MMS_Example
TRS-CET-202	Engineering trains shall provide a safe means of accessing the track, other than via the driver's side door.	**Fully Compliant**	Uncoupled engineering trains provide a safe means of accessing the track, other than via the driver's door. Shown in: TRS-CET-216_Question TfL_Level_acces_to_emergency_walkway
TRS-CET-2	**4.16 Performance**		

ID	Requirement Text	Contract Award Status	Description of contracted solution
TRS-CET-19	All train configurations to be used for Crossrail maintenance shall be capable of operating in running mode at a minimum of 80 km/h.	**Fully Compliant**	All train configurations to be used for Crossrail maintenance are capable of operating in running mode at a minimum of 80 km/h. Please see also traction diagram an reference vehicle MMS for Network rail (with a top speed of 100 km/h). Document: ROBEL_6.2_Traction Power Diagram ROBEL_6.2_Reference Vehicle W6a
TRS-CET-58	All train configurations to be used for Crossrail maintenance shall have a traction performance sufficient to operate between passenger trains without impacting services.	**Partially Compliant**	We confirm an acceleration rate below [redacted] m/s2 in all proposed configurations from [redacted] km/h. Rate above [redacted] km/h is not yet confirmed.
TRS-CET-128	Engineering Trains shall be capable of hauling a load of up to 300 tonnes along Crossrail Infrastructure.	**Fully Compliant**	Yes confirmed, that 300 tonne train is capable of being hauled over CRL infrastructure at creep speed. Please see traction power diagram. Document: ROBEL_6.2_Traction Power Diagram TRS-CET-128_Question TfL_300 T Haulage

ID	Requirement Text	Contract Award Status	Description of contracted solution
TRS-CET-145	All Engineering Train configurations necessary for maintenance of the central section shall have a guaranteed emergency brake rate of at least 6%g.	**Fully Compliant**	Yes fulfilled, preliminary design data confirms brake rate of [redacted]%g will be met. Please see additional document Brake Calculation. Document: ROBEL_6.2_Brake Calculation Power Car ROBEL_6.2_Brake Calculation Transport Wagon
TRS-CET-203	For the application of the service brake, the traction cut-off time shall not exceed 1 second.	**Fully Compliant**	For the application of the service brake, the traction cut-off time does not exceed 1 second.
TRS-CET-204	For the application of the service brake, the brake build-up time shall not exceed 3 seconds.	**Fully Compliant**	We confirm 3 seconds acc. to GMRT 2045 App. C.1.5. Please see additional document Brake Calculation. Document: ROBEL_6.2_Brake Calculation Power Car ROBEL_6.2_Brake Calculation Transport Wagon
TRS-CET-164	Sanding equipment shall be installed in accordance with GMRT2461.	**Fully Compliant**	Yes fulfilled, Sanding equipment is installed in accordance with GMRT2461. Please see document: TRS-CET-164_Question TfL_Sanding Equipment

ID	Requirement Text	Contract Award Status	Description of contracted solution
TRS-CET-171	A WSP systems shall be fitted complying with BS EN 15595 and taking account of the guidance in the national foreword regarding UK adhesion levels, shall be provided on all axles to control the level of traction and braking during conditions of reduced wheel to rail adhesion.	**Fully Compliant**	A WSP systems is fitted complying with BS EN 15595 and taking account of the guidance in the national foreword regarding UK adhesion levels, shall be provided on all axles to control the level of traction and braking during conditions of reduced wheel to rail adhesion.
TRS-CET-23	**4.17 Infrastructure Interfaces**		
TRS-CET-24	4.17.1 Track		
TRS-CET-37	All vehicles shall achieve route availability (RA) 5 as defined in GE/RT8006 where practicable.	**Fully Compliant**	All vehicles achieve a route availability (RA) 5 as defined in GE/RT8006.
TRS-CET-63	Vehicles shall be designed to transit and work on the gradients present on Crossrail.	**Fully Compliant**	Vehicles are designed to transit and work on the gradients present on Crossrail. Please see additional documents. Documents: ROBEL_6.2_Brake Calculation Power Car ROBEL_6.2_Brake Calculation Transport Wagon ROBEL_6.2_Traction Power Diagram ROBEL_6.2_SAMPLE Approval MMS-UK

ID	Requirement Text	Contract Award Status	Description of contracted solution
TRS-CET-121	Use of lifting equipment shall not cause axle loading to exceed 22 tonnes.	**Fully Compliant**	Yes fufilled, use of lifting equipment does not cause axle loading to exceed 22 tonnes. Please see Axle Load Calculation. Document: ROBEL_6.2_Axle Load Calculation - Engineering Train Type A ROBEL_6.2_Axle Load Calculation - Engineering Train Type B ROBEL_6.2_Axle Load Calculation - Engineering Train Type C (which is now named Type E) ROBEL_6.2_Axle Load Calculation - Transport Wagon
TRS-CET-25	4.17.2 Signalling		

ID	Requirement Text	Contract Award Status	Description of contracted solution
TRS-CET-36	Driving cars shall be fitted with Crossrail central section CBTC signalling equipment in accordance with the interface specifications: C620-SIC-R2-RSP-CR001-50088 (Airlink radio) C620-SIC-R2-RSP-CR001-50089 (TMS) C620-SIC-R2-RSP-CR001-50090 (DMI - if ETCS provided) C620-SIC-R2-RSP-CR001-50091 (ETCS - where provided) C620-SIC-R2-RSP-CR001-50098 (RST Interface)	**Fully Compliant**	Driving cars are fitted with Crossrail central section CBTC signalling equipment in accordance with the interface specifications: C620-SIC-R2-RSP-CR001-50088 (Airlink radio) C620-SIC-R2-RSP-CR001-50089 (TMS) C620-SIC-R2-RSP-CR001-50090 (DMI) C620-SIC. The CBTC will by supplied by TfL.
TRS-CET-147	An indication light shall be provided in the cab to report the health status of the onboard CBTC equipment.	**Fully Compliant**	space for indication light will be reserved, power available and wiring pre-installed to allow easy fitment
TRS-CET-62	Driving cabs shall be fitted with Automatic Warning System (AWS) and Train Protection and Warning System (TPWS).	**Fully Compliant**	Driving cabs are fitted with Automatic Warning System (AWS) and Train Protection and Warning System (TPWS).
TRS-CET-127	Driving vehicles shall be designed to be retrofitted with ETCS onboard equipment.	**Fully Compliant**	Driving vehicles are designed to be retrofitted with ETCS onboard equipment. Please see additional ETCS reference document. Document: ROBEL_6.2_Reference ETCS

ID	Requirement Text	Contract Award Status	Description of contracted solution
TRS-CET-53	A train integrity wire shall be provided between cabs for all train formations, with an associated input into the onboard signalling systems.	**Partially Compliant**	[redacted] In normal operation the Engineering Train will have two separate Train Protection Systems. This means each Power Car has its own CBTC. Depending on the driving direction of the Engineering Train, the CBTC of the leading Power Car is active.
TRS-CET-73	A separate speed display, showing primarily mph, shall be provided in the cab, becoming active upon isolation of the onboard CBTC signalling equipment.	**Fully Compliant**	A separate speed display, showing primarily mph, is be provided in the cab, becoming active upon isolation of the onboard CBTC signalling equipment. Please see design proposal. Document: ROBEL_6.2_Proposal Speedometer

ID	Requirement Text	Contract Award Status	Description of contracted solution
TRS-CET-205	The on train data recorder, provided to meet the requirements of GM/RT242, shall additionally be capable of recording the following information: CBTC signalling indications to the driver CBTC signalling transmissions between the unit and the trackside infrastructure Information appropriate to support fault allocation between the trackside and onboard CBTC signalling equipment.	**Fully Compliant**	The on train data recorder, provided to meet the requirements of GM/RT242, is additionally be capable of recording the following information: CBTC signalling indications to the driver CBTC signalling transmissions between the unit and the trackside inf
TRS-CET-214	The vehicle start-up procedure shall allow the vehicle to be moved within 2 minutes of opening the cab.	**Fully Compliant**	we confirm a start-up procedure of 2-3 minutes but: additional pneumatic supply required (full air reservoirs) required no Train radio considered no TPWS/AWS considered no CBTC considered Train preparation checks not included Also the driving direction can be changed in 2-3 minutes from the view of the technique of the vehicle, but Train Radio, TPWS/AWS, CBTC and check-ups are not included.
TRS-CET-125	4.17.3 Power		

ID	Requirement Text	Contract Award Status	Description of contracted solution
TRS-CET-126	All engineering train configurations shall contain an earthing pantograph at both ends of the train, deployable only in working mode.	**Fully Compliant**	all engineering train configurations are contain an earthing pantograph at both ends of the train, deployable only in working mode.
TRS-CET-26	4.17.4 Tunnels & Gauge		
TRS-CET-52	All vehicles shall be provide a minimum 100 mm dynamic clearance to the upper sector of the Crossrail structure gauge, and 50 mm to the lower sector in running mode at all speeds up to the vehicle maximum speed or line speed, whichever is lower.	**Fully Compliant**	all vehicles are providing a minimum 100 mm dynamic clearance to the upper sector of the Crossrail structure gauge, and 50 mm to the lower sector in running mode at all speeds up to the vehicle maximum speed or line speed, whichever is lower.
TRS-CET-118	All vehicles shall be compatible with the W6a gauge defined in GE/RT 8073 in running mode.	**Fully Compliant**	all vehicles are compatible with the W6a gauge defined in GE/RT 8073 in running mode. Please see Reference Vehicle of Network Rail. Document: ROBEL_6.2_Reference Vehicle W6a
TRS-CET-27	4.17.5 Communications		

ID	Requirement Text	Contract Award Status	Description of contracted solution
TRS-CET-43	All driving cabs shall be fitted with GSM-R voice radio.	**Fully Compliant**	all driving cabs shall be fitted with GSM-R voice radio. Please see design proposal. Document: ROBEL_6.2_GSMR Design Proposal
TRS-CET-44	Wireless communication systems shall be provided for any activities requiring synchronised movement between several pieces of equipment (e.g. tandem lifts).	**Partly Compliant**	Yes possible, but our concept is with a manually chain hoist per Gantry. Any use of tandem lifting equipment, which is synchronizing as a minimum the lifting/dropping operation, is available as option (electrical chain hoist). Headsets for operators also available as option. [redacted]
TRS-CET-172	The Unit shall have provision for future fitment of two AVI tags per Unit fitted on opposite sides.	**Fully Compliant**	the Unit has a provision for future fitment of two AVI tags per Unit fitted on opposite sides. We can install the TAG on the vehicle.
TRS-CET-173	The Unit's AVI tags shall be located so they are not shielded or obstructed by any body side fittings, vinyl livery film or body side sacrificial coatings.	**Fully Compliant**	the Unit's AVI tags are located so they are not shielded or obstructed by any body side fittings, vinyl livery film or body side sacrificial coatings. We can install the TAG on the vehicle.
TRS-CET-28	4.17.6 Rolling Stock		