MAINTENANCE VEHICLE FOR THE ATHENS TRAMWAY OVERHEAD CATENARY NETWORK ACCOMPANIED BY ONE TRAILER VEHICLE CARRYING A CABLE WINDING/UNWINDING MACHINE

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1. Introduction - General

The present tender is about the supply of one (1) Maintenance Vehicle for the Athens Tramway overhead catenary network, as well as of one (1) trailer vehicle carrying a cable winding/unwinding machine, which shall be pulled by the Maintenance Vehicle on the public roads network, as well as on the Athens Tramway tracks.

It is imperative that the trailer cable winding/unwinding machine and the Maintenance Vehicle are fully compatible in terms of all railway and road applications and restrictions.

The trainset (i.e. Maintenance Vehicle – Trailer Unwinding Machine) shall not exceed / violate the envelope of the Tramway vehicles. In addition the inwards and outwards throws of the said trainset shall not exceed the Tramway Vehicle throws (see Annex A).

The said trainset shall be delivered to ATTIKO METRO S.A by the Contractor accompanied by the relevant circulation permit – homologation issued by the Greek Ministry of Infrastructures and Transport.

2. Maintenance Vehicle for the Overhead Catenary Network

2.1 General description

The Maintenance Vehicle shall consist of one road vehicle – carrier, which shall be fitted with:

- retractable flanged wheels enabling the vehicle to run on tracks, while they shall not impede the Vehicles circulation on the public roads
- one cab which shall accommodate a mobile workshop and shall be capable of carrying personnel
- one platform lift, suspended on a telescopic electro hydraulic swinging arm
- overhead contact wire measuring equipment
- other auxiliary equipment

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The Maintenance Vehicle shall offer the following capabilities and features, as a minimum:

2.1.1 Shall be capable of flawlessly running on the Athens Tramway network, in which the maximum longitudinal track gradient is 8,5% and the minimum track curve radius is 20m.

2.1.2 Shall be capable of moving and performing all its functions without exception on the road pavement and on the track. Under no circumstances during the performance of any work shall the axial forces exerted on the road pavement or on the tracks exceed the maximum permissible axial loads.

2.1.3 Driving the Maintenance Vehicle on the tracks shall be achieved by deploying the retractable flanged wheels, which shall be suspended on and hydraulic device capable of quickly lowering the wheels on the tracks and shall be monitored from the driver's cab. The Maintenance Vehicle's driven wheels, which are deployed when the Vehicle is moving on the road pavement, shall remain in contact with the tracks and shall deliver the driving force. All retractable steel wheels shall participate in the Vehicle's breaking and shall be fitted with an anti-slip system, while whenever the retractable steel wheels are also driving wheels, they shall also be fitted with an anti-spin system. In any case, the design and operation of the driving system on the tracks shall be such to ensure the smooth and safe operation of the Maintenance Vehicle (starting and breaking) at all locations on the network, including the locations with the maximum gradient, even in wet track conditions.

2.1.4 When the Maintenance Vehicle is driven on the road pavement and while it pulls the trailer winding/unwinding machine, it maximum speed shall be at least 80km/h, while when the Vehicle is driven on the Tramway tracks, its maximum speed shall be at least 30Km/h.

2.1.5 The Maintenance Vehicle shall be capable of moving at a low speed with the work platform raised at a height that permits the technical personnel to access the overhead contact wire, irrespective whether the Vehicle is traveling on the road pavement or on the tracks. In any even, compliance with the relevant European Legislation and Directives is mandatory.

2.1.6 Whenever the Maintenance Vehicle is traveling on tracks with the platform lift at its lower point, its envelope shall not exceed the Tramway vehicle envelope (*see.* Annex A), while its height, assuming

that all fitted equipment is deployed, including the platform protection cage, shall no exceed 3.60m from the Top of Rail (ToR).

2.1.7 The overall length of the Maintenance Vehicle shall be the minimum possible, taking into account the superstructures that shall be fitted on the Vehicle – Trailer, in order to provide maximum flexibility of movement on the tramway corridor. (A length of no more than 8m is desirable.) The final dimensions of the Maintenance Vehicle shall be subject to ATTIKO METRO S.A approval, in accordance with optimum layout drawings to be submitted by the manufacturer.

2.1.8 When driven on the tracks and pulling the cable winding/unwinding machine, the Vehicle shall be capable of replacing lengths of the overhead contact wire of the Athens Tramway system, without the need for assistance by any third machine on wheels.

2.1.9 The roof of the driver's cab and the roof of the work crew cab shall be accessible to the technical personnel, shall be fitted with anti-slip flooring and shall remain slip free in wet conditions.

2.1.10 All electro-hydraulic systems of the Maintenance Vehicle shall fully controlled by the Vehicle/trailer's main thermal engine.

2.1.11 In addition, the Maintenance Vehicle shall be fitted with an array of rechargeable batteries, whose capacity shall be adequate to power by themselves the movement / control of the platform lift under full load for a period of 150 minutes, when the diesel engine of the Vehicle is shut. This battery array shall be recharged when the diesel engine is running; moreover, it shall be equipped with a charging circuit with a power socket, enabling the batteries to be recharged via an external power source 230Vac-1ph.

2.1.12 In case of power loss or other failure of the hydraulic system, e.g., mechanical failure of the pump, it shall be possible to operate all hydraulic powered systems of the superstructre (retractable wheels, extendable footing, platform lift, etc.) via a convenient and separate for each system manual auxiliary release system, so that is shall be always possible to return all components to their resting position or to safely remove the Maintenance Vehicle from the network.

2.1.13 It shall be possible to mechanically couple the Maintenance Vehicle with an inoperative tramway vehicle by means of an appropriate coupler, which shall be part of the deliverable equipment (see. §2.6). In his offer, the Bidder shall declare the maximum gradient along which the Maintenance Vehicle shall be capable of safely starting an

immobilized inoperative tramway vehicle, either by pushing or pulling it.

2.1.14 Two (2) work flood lights shall be fitted on the outside of the Vehicle on the roof of the driver's cab, whose luminance level shall be sufficient for every activity of the Maintenance Vehicle. These two (2) flood lights shall be directed by means of electrical motors and the relevant controls shall be situated in the driver's cab. The protection rating of the flood lights as well as of their entire electrical installation shall be IP64, or higher.

2.1.15 The Maintenance Vehicle shall be fitted with beacons, flashing arrows, audible alarms and all other features required by the regulations of the involved Ministries.

2.1.16 Storage cabinets shall be fitted on the both sides of the Vehicle/Trailer's frame, as well as along the entire length of the platform lift. These cabinets shall be watertight and fitted with either roller or hopper type access doors, allowing for the storage of equipment, tools and spare parts. It is desirable, if feasible, that at least one cabinet or part thereof shall have a minimum integrated length of 2.5m, in order to store poles for placing earthing devices, or other long tools. The roof of the cabinets shall be fitted with anti-slip flooring that shall remain slip free under wet conditions and shall be accessible to technical personnel. All access doors and drawers shall be fitted with locks with a common triangular key or other similar type. The final layout of the cabinets and their space configuration shall be subject to AM's approval, after the submission of the respective drawings by the manufacturer.

2.1.17 The Maintenance Vehicle shall be equipped with properly dimensioned pulleys, installed at the contact points where movement of the contact wire to be suspended/placed is expected to take place (vehicle, cab, platform lift, etc.)

2.1.18 The Maintenance Vehicle shall be fitted with single phase generator (alternator), minimum rating 4kVA / 230V/ 50Hz , low noise level, equipped with stabilizing jumpers, suitable for the safe operation of an inverter type welding device and for powering the various auxiliary loads (installed sockets at various spots on the Maintenance Vehicle) via an isolation transformer.

The following paragraphs contain the detailed specifications of the Maintenance Vehicle's main components.

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2.2 Vehicle Carrier

The Maintenance Vehicle Carrier:

2.2.1 Shall be supplied by a manufacturer possessing extensive experience in the production of special trucks, demonstrated by his list of supplied trucks / customers. The manufacturer shall have a technical base installed in Athens, authorized to carry out maintenance and repair works on the specific supplied Vehicle - Carrier.

2.2.2 Shall be equipped with a specially configured driver's cab with one or two driver seats, depending the finally selected configuration. The final configuration of the cab and the mobile workshop shall be subject to AM's approval, in accordance with the optimum layout drawings to be submitted by the manufacturer.

2.2.3 Shall be of a modern technology, equipped with semi-automatic serial gearbox coupled with a diesel engine, which shall fully conform to all European Directive and the Greek legislation related to pollutant and noise emissions, as well as the energy efficiency.

2.2.4 Shall be equipped with Anti-Block Breaking system (ABS) and the driving wheel shall be equipped with anti-spin system.

2.2.5 Shall be equipped with a steering system with wide Camber- Caster angles, so that it is easy to place it from the tracks on the pavement and vice versa.

2.2.6 Shall be equipped with extendable hydraulic footing, permitting the extension of the platform lift when the Vehicle is not placed on the tracks and shall be interfaced and controlled by the vehicle automatic leveling system, based on the applicable safety levels.

2.2.7 The front and rear end of the vehicle shall be fitted with standard mechanical coupling devices with pin, compatible with the coupling bars of the trailer and the tramway vehicles, able to cope with all anticipated loads.

2.2.8 Shall be fitted with all required infrastructure so that when pulling the trailer vehicle with the cable winding/unwinding machine described in §3 herein, the breaking function of the trailer vehicle is synchronized with the breaking function of the Maintenance Vehicle and the proper operation of the vehicle's volume and breaking lights is ensured.

2.2.9 Shall be fitted with two (2) electrically protected schuko sockets, 230Vac 1ph 16Amp, watertight industrial type, IP64, installed on the outside and on both sides of the Vehicle - Carrier.

2.2.10 Shall be fitted with a complete redundant electro-hydraulic line for any future purpose, equipped with all pertinent equipment such as electro-hydraulic valves and quick-release couplers.

2.2.11 Shall be fitted with a HVAC unit for the driver's cab.

2.3 Platform Lift

The platform lift:

2.3.1 Shall be rectangular, 4m ±5% long and 1,25m -5% wide. Any equipment installed on the platform shall not infringe the above envelope.

2.3.2 Shall be placed on a hydraulic telescoping arm with a rotation range of 360 degrees as a minimum, fitted with the necessary monitoring and safety systems. When the telescopic arm is fully extended, the floor of the platform shall be at a minimum height of 9m above the Top of Rail (ToR). All movements of the arm, as well as all monitoring and safety systems shall be controlled by a PLC. The electro-hydraulic system that drives the telescopic arm shall be fitted with an auxiliary, manual safety system, which shall be capable of returning the platform to it resting position is case of power loss.

2.3.3 Shall be rotating, with a minimum rotation range of 380°.

2.3.4 Shall be fitted guard-rails made of non-conductive material, preferably synthetic, extra durable and resistant to the elements.

2.3.5 Shall be fitted with one vertical telescopic lifting device, installed at one of the platform's transverse edges, capable of further lifting the overhead contact wire by 0.8m as a minimum. Its free end shall be fitted with the appropriate equipment for lifting and sliding the contact wire (e.g., clamp, pulleys, etc.). Moreover, it is desirable to have the option to use the lifting device as a fixed point for the suspension of the manual tensioning devices, at location of the network where no other such fixed point is available, always respecting the tolerances to be given by the manufacturer. The controls of the aforementioned equipment shall be located on the works platform.

2.3.6 Shall have a bearing capacity of 400kg, plus the loads generated due to holding / sliding of the contact wire on the vertical lifting deice. The

total resulting bearing capacity shall be assumed to be the *nominal* bearing capacity of the work platform lift at all its possible working positions. In addition, protection shall be provided for work stoppage in case the load on the platform exceeds its nominal bearing capacity. The bidder shall include in his offer a loading diagram for the telescopic arm – platform lift.

Shall be equipped with an automatic leveling system, constantly active whenever the platform is in any kind of movement. Moreover, the platform lift shall be automatically leveled in case tilting due to load shifting while the platform is at standstill.

2.3.7 It shall be alternatively controlled by means of the following three (3) full control consoles, all of which shall be included in the deliverables: (i) Wired console, installed on the vehicle-carrier, (ii) Wired console, fully integrated into the Platform Lift & (iii) Wireless console, heavy duty, with high protection against interference. Its range of operation shall be at least 15m. The wireless control console shall be also fitted with the appropriate suspension belts to be worn by the user. All platform lift control consoles shall be fitted with a mushroom type emergency button, which shall remain active even when the console is inactive.

2.3.8 Shall be equipped with an intercom system for communication between the driver's cab and the user on the platform lift, fitted with a sound amplifier.

Shall be fitted with two (2) electrically protected schuko sockets, 230Vac 1ph 16Amp, watertight industrial type, fed by the Maintenance Vehicle's alternator via an isolation transformer.

2.3.9 Shall be equipped with lights whose layout and luminance level shall be sufficient for every activity by the personnel on the platform. In addition, the platform lift shall be equipped with at lease two (2) multidirectional floodlights of low energy consumption.

2.3.10 It shall be fitted with an anti-slip floor which shall remain slip-free even in wet conditions.

2.3.11 Shall be equipped with the necessary signal lights.

2.3.12 Shall be electrically insulated and fully certified as per the relevant European and international standards (1000 V AC / 1500V DC).

2.4 Mobile Workshop – Personnel Transport Cabin

One cabin housing one mobile workshop, capable of transporting personnel shall be fitted on the frame of the vehicle-carrier.

The mobile workshop space can be unified with the driver's cab and accessible from it, or it may be completely independent, accessed from a separate door at its back. The final configuration of the space is subject to AM's approval, after the submission by the manufacturer of alternative optimum layout drawings.

In any event, the mobile workshop space shall have the following features, as a minimum:

2.4.1 Shall be located behind the driver's cab.

2.4.2 Shall have at least one independent access door

2.4.3 Shall be configured so as to accommodate two (2) persons seating on retractable seats with safety belts.

2.4.4 Shall have at least 1 side window.

2.4.5 Shall be air conditioned

2.4.6 Shall be fitted with a sturdy work bench equipped with a heavy duty forge vice (clamp).

2.4.7 Shall include a specially configured area for the storage of spare parts, tools and other equipment.

2.4.8 Shall be fitted with lighting fixtures whole luminosity level shall be sufficient for any type of work.

2.4.9 Shall be fitted with at least two (2) schuko industrial type sockets IP64, 230V / 16A 1ph, fed by the Maintenance Vehicle's alternator via an isolation transformer.

2.5 Overhead Contact Wire Measuring Equipment

The Maintenance Vehicle shall be equipped with a Measuring Device capable of measuring at the height, the stagger and the cross-section/wear of the overhead contact wire, when the Maintenance Vehicle is traveling on the tracks at speeds of 10km/h and above. The measurements frequency shall be equal or higher than 600 measurement/s, rendering feasible to obtain accurate measurements of the network whenever the Maintenance Vehicle is traveling at speed of 10km/h and above. Each measurement shall automatically correlated to a chainage, in relation to the route's starting point.

The operator shall be able to monitor the measurements in real time, by means of dynamic graphs or otherwise. Concurrently, it shall be possible during the measurements trip to produce audible alarms in case the measurements are outside the permissible limits, as they shall have been set by the operator.

The measurements shall be saved in a storage medium; it shall be possible to transfer the measurements data to a computer via a USB stick, as soon as the measurements are completed at the end of one shift. The capacity of the storage medium shall be sufficient to allow the storage of measurements taken on the network at a minimum length of 20 Km.

The software that comes with the measuring device shall be able to process the measurement data in such a way as to automatically present, as a minimum, the measurements falling outside the permissible limits, which will have been set by the operator.

Moreover, it shall be possible to export the data in Excel format, so than they can be further processed by the maintenance personnel.

The Measuring System's control panel and screen shall be preferably installed on the side of the co-driver.

At the time when the various devices are finally configured and located on the Maintenance Vehicle, it shall be examined whether it is feasible to install a pantograph (of the same type as the pantograph on the tramway vehicles) on the drive's cab roof or on the roof of the mobile workshop, in order to carry out tests and measurements. The pantograph shall be controlled from the driver's cab. It shall be securely and permanently locked at its lower position, to avoid inadvertent raising. It shall be seated on a sturdy base, shall be easily replaceable in case of damage and shall be electrically insulated from the rest of the Vehicle.

2.6 Other Auxiliary Equipment

In the framework of the supply of the maintenance vehicle for the overhead catenary network and the trailer vehicle carrying a cable winding/unwinding machine, and at no extra charge, the following items shall be delivered:

2.6.1 Two (2) towing bars, whose one end shall be compatible with the mechanical coupling devices installed on the vehicle – carrier, while their other end shall be compatible with couplers of the tramway vehicles (see Annex A).

2.6.2 Fire Extinguishers – Flashlights – Triangle

3. Towed Hydraulic Machine for Cable winding/unwinding

3.1 The Machine for Cable winding/unwinding shall be pulled or pushed on the road pavement or on the tracks by the Maintenance Vehicle described above. Its main destined works shall be the removal and/or installation of overhead catenary cables on the Athens Tramway network and its extensions. This Winding/Unwinding Machine shall fulfill the following requirements:

3.2 Shall be manufactured by a recognized manufacturer – factory with experience in specialized railway machinery; this experience shall be demonstrated from the firm's clientele.

3.3 Shall be able to travel and execute all its works on road pavements and on tracks. Under no circumstances during the performance of any work shall the axial forces exerted on the road pavement or on the tracks exceed the maximum permissible axial loads.

3.4 Shall be able to suspend a drum of a maximum diameter of 2m and gross weight of up to 3t. The overall height of the trailer vehicle shall not exceed 3,5m, when it travels on tracks and is loaded with a drums of a maximum specified diameter; the envelope of the loaded trailer vehicle shall not be larger than the envelope of the tramway vehicles (see Annex A).

3.5 Shall be equipped with hydraulic arms, capable of loading the drums from the street level to the trailer vehicle, of putting them securely on the unwind position and of unloading them.

3.6 Shall be equipped with a hydraulic drum rotation mechanism, rendering possible cable winding/unwinding. Winding/unwinding shall be possible even if the cable in tensile stress condition, leading to further cable tensioning or loosening. The winding/unwinding mechanism shall be fitted with hydraulic breaks to avert drum return, which shall be activated instantly and automatically as soon as the wind/unwind command is raised, keeping the cable under tension. It shall also be possible to release the hydraulic breaks when zero force is applied on the drum, i.e., when the cable is not tensioned. This shall permit the free manual rotation of the drum.

3.7 Shall be able to apply a tensioning force of up to 500daN on the cable to be installed, winding thus the cable on the drum. The winding/unwinding speed shall be selected by the operator and shall remain constant.

3.8 It shall be alternatively controlled via three (3) consoles that control all movements and monitor and winding/unwinding process by means of an

appropriate device; these consoles shall be included in the supplied equipment: (i) Wired console, installed on the trailer vehicle, (ii) Wired console, fully integrated into the trailer vehicle & (iii) Wireless console, heavy duty, with protection against interference. All control consoles shall be fitted with a mushroom type emergency button, which shall remain active even when the control console is inactive.

3.9 Shall be equipped with an adjustable height pole for guiding the cable when it is winded/unwinded, fitted with bearings. The horizontal position at the rolling point of the cable shall be adjustable, so as the enable placing of the cable at the desired positions. It shall be possible to adjust the height of the rolling point during cable winding/unwinding to a height rendering possible the placement of the cable at the desired position, taking into account that the height of the overhead contact wire ranges from 4,00m to 6,00m (The networks nominal height is 5,50m). In case of power loss, retraction of the guiding pole to its resting position shall be achieved by means of a convenient, manual, auxiliary system.

3.10 Shall be fitted with a diesel engine, which shall autonomously serve all installed on the trailer vehicle systems, and shall be accompanied by all necessary equipment making this engine autonomous (e.g., starter, alternator, battery, fuel tank, etc.). 80% of the engine's nominal power shall suffice to autonomously serve all hydraulic systems installed on the trailer vehicle, when these systems work under their maximum load. The diesel engine shall fully conform to all European Directives and the Greek legislation related to noise and pollutants emissions and energy efficiency.

3.11 Shall be fitted with flanged steel wheels, suspended on a hydraulically driven quick rerailment device. The hydraulic pistons and any other activators shall be fitted with protective swabs. In case of power loss or other failure of the hydraulic system, e.g., mechanical failure of the pump, wheel retraction and release from the tracks shall be achieved by means of a convenient manual auxiliary release system, so that is shall be always possible to return the winding/unwinding machine on the road pavement and tow it.

3.12 Shall be pulled by the Maintenance Vehicle described in § 2 herein, at speeds of up to 80 and 30 km/h on the road pavement and on track, respectively.

3.13 Shall be fitted with ABS breaks that will be active when the vehicle is driven on a road pavement and on the tracks, and are powered/controlled by the Maintenance Vehicle described in §2. In addition, it shall be fitted with parking breaks to keep it securely stopped when not coupled to any pulling vehicle.

3.14 It shall be configured in a manner excluding the possibility of overturning when it is pulled at a maximum speed, both on a road pavement and on the tracks, under its maximum specified load.

3.15 Shall be fitted with beacons, flashing arrows and any other signaling system foreseen by the EU regulations and the Greek legislation.

3.16 Shall be fitted with at least two multidirectional floodlights, whose luminance level shall suffice to perform all foreseen activities, in addition to the signal and work lights foreseen by the international regulations.

3.17 Shall be fitted with tail lights, break lights, direction flashers and volume lights.

4. Documentation - Deliverables

The Maintenance Vehicle shall be accompanied by detailed mechanical and electrical "as-built" drawings for all onboard devices and equipment, as well as by detailed manuals related to its operation, preventive maintenance and repair, as well as by parts lists. Moreover, the supplier shall also deliver any software used in the various electronic systems of the Maintenance Vehicle ((PLC, Measuring device, etc.).

5. Training

The Maintenance Vehicle's manufacturer is obliged to provide complete training to the technical personnel suggested by the Operation Company (STASY A.E), on the operation of the Maintenance Vehicle and all onboard equipment, including the trailer vehicle with the winding/unwinding machine, as well as on its maintenance and repair.

6. Warrantee

The Maintenance Vehicle and the Trailer vehicle with the winding/unwinding machine, must be accompanied by a good operation guarantee for a period of at least 3 years. The Contractor binds himself to provide spare parts for a period of 15 years.

7. Certifications

The entire trainset (i.e., The Maintenance Vehicle and the Trailer vehicle with the winding/unwinding machine) shall be fully certified by the manufacturer, as well as by a accredited Certification Agency for

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Railway equipment. This accredited Certification Agency shall be approved by AM at the beginning of the contract works, on the basis of its demonstrated experience in similar equipment, proven by means of a list of pertinent certifications.

The Manufacturer is obliged to submit all certificates required on the basis on the EU directives and the European/International Regulations governing this Supply.

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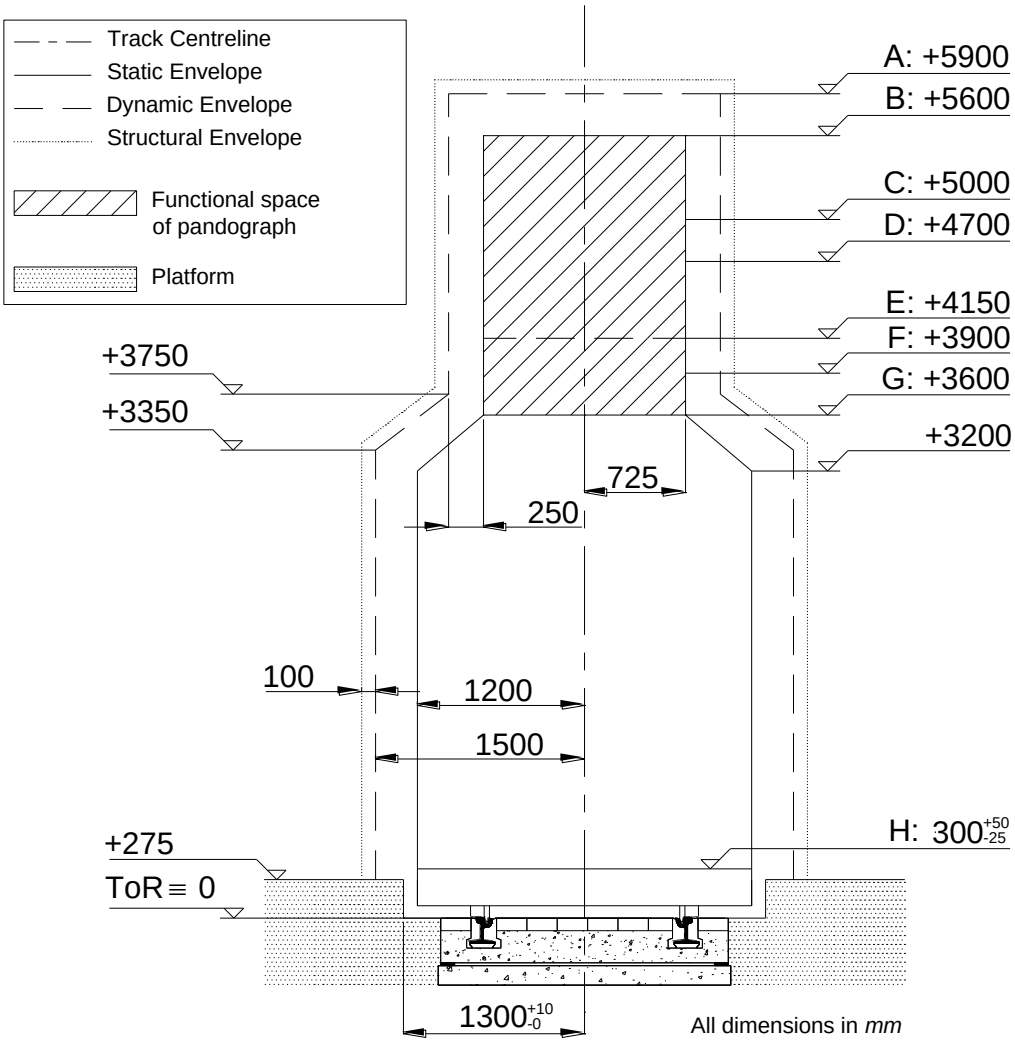
Annex A: Technical Data – Existing Tramway Vehicles

Vehicles' Static and Dynamic Envelope

The vehicle's static and dynamic envelope, the TOR level and the locations of the stops platforms shown in Figure 1 are those taken into account during the design and construction of the existing tramway network. This also applies to the maximum permissible vehicle throws presented in Table A.1. It is pointed out that the width of each safety corridor adjacent to the structure gauge shall be 600mm.



A: Upper limit of dynamic gauge underneath permanent structures
B: Height of the overhead contact wire at suburban streets
C, D: Height of the overhead contact wire at municipal streets
E: Upper limit of dynamic gauge in tunnel sections
F: Lower position of the overhead contact wire
G: Vehicle height with pantograph at rest
H: Vehicle floor level at its entrances

Figure A.1: Vehicles Static and Dynamic Gauge

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The maximum permissible throws in curved tracks are shown in the following table.

Table A1: Maximum vehicle throws in curved tracks

Curve radius (m)	Center Throw (mm)	End Throw (mm)
25	1388	1475
26	1380	1465
27	1374	1455
28	1367	1447
29	1361	1439
30	1356	1431
31	1351	1424
32	1346	1417
33	1342	1411
35	1334	1399
36	1330	1394
38	1323	1384
40	1317	1375
42	1311	1367
44	1306	1360
45	1304	1356
48	1297	1347
50	1294	1341
60	1278	1318
75	1262	1295
80	1258	1289
90	1252	1279
100	1247	1272
150	1231	1248
200	1224	1236
300	1216	1224
400	1212	1218

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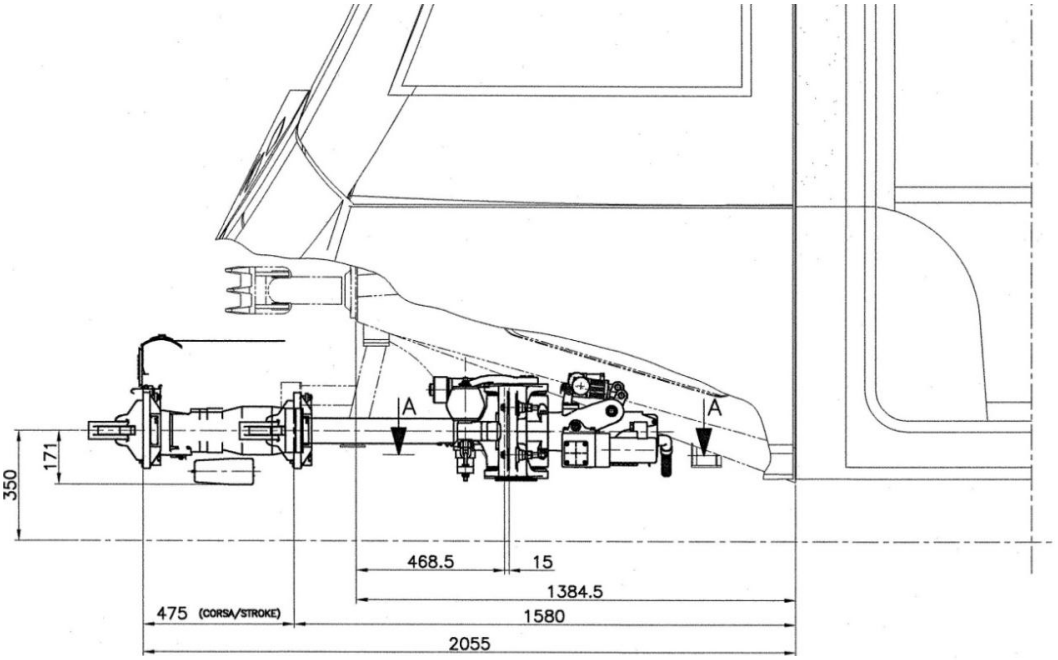
500	1210	1215
750	1207	1210
1000	1205	1208
2000	1203	1204
4000	1202	1202

Coupler interface

The Series I vehicle are equipped with an automatic coupler type 371 by Dellner. The following drawings show the mechanical interface with Series I vehicle.



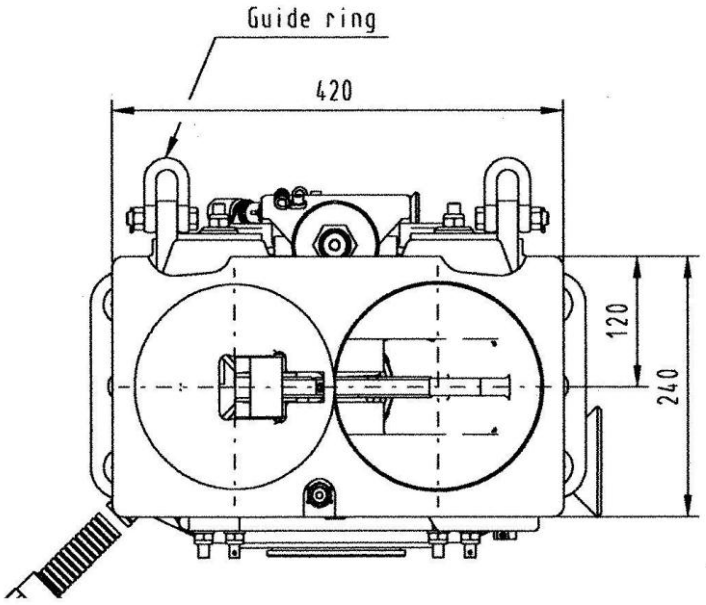


Figure A.2: Side and front view of the automatic coupler on the existing vehicles (371 Dellner)