Design, Performance, Materials and Workmanship Specification of Electromechanical and Railway Systems

- TR_S_DP015550 - SEWAGE
- TR_S_DP015551 - WATER SUPPLY
- TR_S_DP015552 - COMPRESSED AIR SYSTEM
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Spec. Code	Specification Description
TR_S_DP015550	**SEWAGE**

CONTENTS

1 SCOPE

The purpose of this specification is to describe the technical requirements for the supply and installation of piping and fittings for the sewage network of storm water and waste water for both exposed and embedded ducts.

2 REGULATIONS

The sewage installation of storm water and waste water shall be designed and manufactured in accordance with the provisions herein, as described in the next chapters, and the Technical Directive, namely:

- TOTEE 2412/86*:* "Drainage installations for buildings and sites"

All materials and works must obligatorily comply with the foreseen contract standardization and the particular requirements of ATTIKO METRO S.A..

3 STANDARDS

- ELOT EN 124:2015: "Gully tops and manhole tops for vehicular and pedestrian areas"
- ELOT EN 858:2005: "Separator systems for light liquids (e.g. oil and petrol)"
- ΕΛΟΤ EN 877/A1:2008 «Cast iron pipes and fittings, their joints and accessories for the evacuation of water from buildings - Requirements, test methods and quality assurance».
- ELOT EN 1253:2015 "Inlets and Gullies for buildings"
- ELOT EN 1329-1+A1:2018: "Plastics piping systems for soil and waste discharge (low and high temperature) within the building structure - Unplasticized polyvinyl chloride (PVC-U) - Part 1: Specifications for pipes, fittings and piping"
- ELOT EN 1401-1/E3:2019 "Plastic piping systems for non-pressure underground drainage and sewerage. Unplasticized polyvinyl chloride (PVC-U). Specifications for pipes, fittings and the system"
- ELOT EN 1451:2018 "Plastics piping systems for soil and waste discharge (low and high temperature) – Polypropylene (PP)"
- ELOT EN ISO 1461:2009 "Hot dip galvanized coatings on fabricated iron and steel articles - Specifications and test methods"
- ELOT EN 1610 E2:2015 "Construction and testing of drains and sewers"
- ELOT EN 10220:2004 "Seamless and welded steel tubes. Dimensions and masses per unit length"
- ELOT EN 10226:2004 "Pipe threads where pressure tight joints are made on the threads"
- ELOT EN 10240:1998 "Internal and/or external protective coatings for steel tubes. Specification for hot dip galvanized coatings applied in automatic plants"
- ELOT EN 10242/A2:2003 "Threaded pipe fittings in malleable cast iron"

- EN 10255+A1:2008 “Non-Alloy steel tubes suitable for welding and threading - Technical delivery conditions”
- ELOT EN 12050:2015 “Wastewater lifting plants for buildings and sites”
- ELOT EN 12056:2000 “Gravity drainage systems inside buildings”
- ELOT EN 12201:2011 “Plastics piping systems for water supply and for drainage and sewerage under pressure. Polyethylene (PE)”
- ELOT EN ISO 12944:2018 “Paints and varnishes - Corrosion protection of steel structures by protective paint systems”
- DIN 19522:2010 “Cast iron drainage pipes and fittings without socket”
- ETEP 04-01-04-01: Building piping systems under pressure with polypropylene tubes
- ETEP 04-02-01-01: Building piping systems with linear plastic tubes using free flow
- ETEP 04-04-01-01: General requirements for domestic sewerage systems
- ETEP 04-04-01-02: General requirements for non-domestic sewerage systems
- ETEP 04-04-04-01: Floor gullies, odour-trap
- ETEP 04-04-05-01: Outdoor manholes of building sewerage systems
- ETEP 04-04-05-02: Inspection-cleaning outlets of buildings sewerage piping, inside or without manholes
- ETEP 08-06-02-02: Pressurized u-PVC pipe networks for sewage
- ETEP 08-06-08-01: Warning tape above buried utilities
- ETEP 08-06-08-06: Prefabricated concrete manholes
- ETEP 08-06-08-07: Prefabricated manholes made of polymer-reinforced concrete (PRC)
- ETEP 08-07-01-01: Grey cast iron gully tops
- ETEP 08-07-01-04: Ductile iron gully tops
- ETEP 08-07-01-05: Manhole steps

4 CALCULATION DATA

In order to calculate the waste water sewage network, the following shall be taken into account:

a. Connection value **AWs** for cleaner’s wash basin: **0.5**

b. Nominal diameter of connecting pipe: **DN50**

For the calculation of the storm water discharge network, maximum rainfall **r** equal to **300 l/s, ha** shall be assumed.

5 MATERIALS – EQUIPMENT

5.1 Pipes

The pipes to be utilized shall be in accordance with the specifications presented in the following table:

Position	Installation	Material	Standard
Embedded, gravity flow	Storm water	U – PVC, 6 ATM	ELOT EN 1329
	Waste water	U – PVC, 6 ATM	ELOT EN 1329
	Sewage	U – PVC, 6 ATM	ELOT EN 1401
Embedded, under pressure	Storm water Sewage	Polyethylene pipe 16ATM (PE100) HDPE	ELOT EN 12201
		Polypropylene pipe 16ATM (PE100) PP-HT	ELOT EN 1451
Exposed	Storm water	Galvanized steel pipe, medium grade	ELOT EN 10240 ELOT EN 10255
		Painted ductile iron	ELOT EN 877 DIN 19522
	Sewage water	Painted ductile iron	ELOT EN 877 DIN 19522

Note: In case of U - PVC pipes with a diameter smaller than or equal to Ø110 mm, a welded connection shall be provided, while pipes with a diameter larger Ø125 mm, the connection shall be ensured by a rubber waterproofing o-ring.

5.1.1 U-PVC Pipes

Sewage pipes made of U-PVC per EN 1329-1 to be used within building structures for connection with a splice and a ring shall comply with the requirements set in the table below:

Nominal diameter DN	Outer diameter (mm)	Minimum wall thickness (mm)	Pipe weight (kg/m)	Water content (l/m)	Pipe + water weight (kg/m)
40	40	1,8	0,35	1,04	1,39
50	50	1,8	0,44	1,69	2,13
65	63	1,8	0,56	2,77	3,33
70	75	1,8	0,67	4,00	4,67
100	110	2,0	0,99	8,82	9,81
125	125	2,5	1,54	11,30	12,84

Sewage pipes made of U-PVC per EN 1329-1 to be used outdoor building structures for connection with a splice and a ring, properly sized in line with the requirements set in the table below:

Nominal diameter DN	Outer diameter (mm)	Minimum wall thickness (mm)	Pipe weight (kg/m)	Water content (l/m)	Pipe + water weight (kg/m)
40	40	3,2	0,58	0,89	1,47
50	50	3,2	0,74	1,49	2,23
65	63	3,2	0,94	2,51	3,45
70	75	3,2	1,13	3,69	4,82
100	110	3,2	1,53	8,43	9,96
125	125	3,2	1,92	11,04	12,96
150	160	4,0	3,07	18,14	21,21

Pipes made of U-PVC per EN 1401-1 for underground networks for connection with a splice and a ring, properly sized in line with the requirements set in the table below:

Nominal diameter DN	Outer diameter (mm)	Minimum wall thickness (mm)	Pipe weight (kg/m)
100	110	3,2	1,70
125	125	3,3	1,94
150	160	4,0	2,98
200	200	4,9	4,50
250	250	6,2	7,36
300	315	7,7	11,07
350	355	8,7	14,07
400	400	9,8	17,83
500	500	12,2	27,80
600	630	15,4	33,50

Outdoor, buried, horizontal sewage networks shall consist of rubber pipes for underground networks made of hard PVC with a flange and an integrated ring, as specified in the chapter on sewage.

5.1.2 Galvanized steel pipes with seam, medium grade

Galvanized steel pipes with seam, medium grade, per EN 10255-M shall be used at vertical sections (gutters). Connecting fittings (elbows, semi-tees, fittings for modifying the pipe cross-section etc) shall be also made of the same material while their dimensions shall be compatible with the corresponding pipes of the remaining network.

Nominal Diameter DN (mm)	Thread diameter R (inches)	Outer Diameter D (mm)	Inner diameter d (mm)	Wall thickness T (mm)	Pipe Weight (kg/m)
50	2	60,3	51.3	4,5	6,19
65	2 ½	76,1	67.1	4,5	7,95
80	3	88,9	78.9	5,0	10,3
100	4	114,3	103.5	5,4	14,5
125	5	139,7	128.9	5,4	17,9
150	6	165,1	154.3	5,4	21,3

5.1.3 Piping made of polypropylene for industrial waste (PP-HT)

Pipes made of polypropylene (PP-HT) stabilized at high temperatures without any admixtures (non-flammable), shall be suitable for chemical toxic waste with a pH value of up to 12, with any resilient pads, as per EN 1451.

Connecting fittings (splices, elbows, semi-tees, Ψ, cleaning tees etc) shall be also made of polypropylene of the same quality, as thick as the respective pipes, suitable for connection through elastic pads. All special items shall be serially manufactured.

Polypropylene pipes, fittings and resilient pads shall be resistant up to 95° C.

5.1.4 High density polyethylene pipes (HDPE100) 16atm - SDR11

High density polyethylene pipes (HDPE100) shall be suitable for operating pressure 16atm per EN 12201-2. Fittings shall be also made of PE, with built-in electrical resistance for welding.

The minimum thickness of the walls and the weight of the pipes shall be in accordance with the following table:

Nominal Diameter DN (mm)	Outer diameter (mm)	Wall thickness (mm)	Pipe weight (kg/m)	Water content (l/m)	Pipe + water weight (kg/m)
15	20	2,3	0,15	0,19	0,34
20	25	2,7	0,24	0,30	0,54
25	32	3,4	0,39	0,50	0,89
32	40	4,2	0,61	0,78	1,39
40	50	5,2	0,93	1,23	2,16
50	63	6,5	1,48	1,96	3,44
65	75	7,6	2,1	2,81	4,91
--	90	9,2	3,02	4,02	7,04
80	110	11,1	4,49	6,05	10,54
100	125	12,7	5,8	7,79	13,59
--	140	14,1	7,27	9,81	17,08
125	160	16,2	9,47	12,78	22,25
150	180	18,2	12	16,19	28,19
--	200	20,2	14,8	20,00	34,80
--	225	22,7	18,7	25,32	44,02
200	250	25,1	23,1	31,34	54,44

--	280	28,1	28,9	39,32	68,22
250	315	31,6	36,6	49,77	86,37
300	355	35,6	46,4	63,23	109,63
--	400	40,1	59	80,28	139,28
350	450	45,1	74,6	101,62	176,22

5.2 Equipment of storm water and waste water sewage network

5.2.1 General

The fittings to be used shall comply with the requirements of TOTEE 2412/86, unless otherwise specified and as defined below.

All fittings made of U - PVC to be used in networks shall comply with EN 1329-1, EN 1401-1 and EN 1452-2.

Fittings made of galvanized steel pipes to be used in networks shall comply with EN 10242.

5.2.2 Floor drains

As fittings, floor drains protect the floor draining locations of the sewage installation. They must be easily cleaned through their special orifices or by quick disassembly. No orifices are required to the floor drains, where the surface of the water they detain, is always visible. It is necessary for the water level in these drains to be kept constant, in order to serve as an odor trap.

Floor drains are installed inside longitudinal grooves with trays. They shall be of split type and equipped with a flange and their body shall be of stainless steel with flange, while they shall have a stainless steel grating, with removable stainless steel strainer and odor trap.

5.2.3 Floor grating

Linear floor gratings shall be installed along the entire length of the longitudinal axis of each trench.

Gratings shall have openings (eyes) 16mm x 76mm (13mm x 71mm net opening). Grating shall be 30mm thick.

The grating shall be made of hot dip galvanized stainless steel as per ELOT EN ISO 1461 or of stainless steel AISI 304.

5.2.4 Odor traps for hydraulic receptors

These shall be U-shaped, made of plastic resistant up to 100° C.

With regard to connection pipes up to 50 DN, the minimum water seal height shall be 70mm.

The inner diameter of a U-shaped tubular trap shall not be less than 50mm.

In any case, the inner diameter of the outlet of odor traps of such shape shall be equal to the diameter of the corresponding connection pipe.

5.2.5 Floor clean outs (plugs)

Clean outs are placed at the locations where, depending on the pipe layout, access is foreseen for inspection, cleaning and general maintenance of the network.

The purpose of installing such clean outs is to facilitate the entrance of unblocking tools and for this reason they must be placed at easily accessible spots, while care should be taken not to obstruct their use.

In general, clean outs must be provided for in the following locations:

a) At the highest point of a multiple connection piping system.

b) At the vertical drainage pipes, or at any vertical section of the collector pipes, or the main collector pipe.

c) At the central collector pipe, at intervals of 20 meters, at least.

d) At the central collector pipe, before the point it changes direction and towards the route of the waste material, whenever this change of direction is greater than 45°.

e) The cleaning openings are placed so as they are always accessible.

5.2.6 Ventil caps

The terminations of the vertical ventilation columns or of the extensions of waste water columns at the building rooftop terrace structures shall be protected with a cap made of a galvanized wire mesh or with PVC caps. Ventilation terminations shall be properly manufactured so as to prevent storm water entering the building.

5.2.7 Pumping stations

Each pumping station shall consist of two identical submersible pumps, a control and automation panel, as well as the necessary features and fittings for pump installation.

Pumps shall be submersible, of single stage, 1500 RPM/min, with closed circuit cooling jacket using the appropriate cooling medium, with large suction throughlet, floor fixed mounting/discharge piping and stainless steel guide bars.

- Pump casing : Grey cast iron GG 25
- Impeller, closed type single or double vane : Grey cast iron GG 25
- Rotor shaft : Stainless steel
- Double mechanical seal one cooled with oil : SIC/SIC
- Nuts and screws : AISI 316 Stainless steel
- Ring seal : BR (nitril)
- Required degree of protection : IP 68
- Suction throughlet diameter of impeller : minimum Φ70mm or as arises on the basis of the pertinent design
- Capability of up to 10 starts per hour
- Lifting guides : AISI 316L stainless steel

The appropriate level switches shall be foreseen for the starting of the operation of each pump.

The levels for start-up and stop of the auxiliary pump shall be higher than the corresponding levels of the main pump, so that the auxiliary pump starts operating only when the main pump does not suffice and stops before it.

The pumping system shall be accompanied by a suitable waterproof control and automation panel (IP 55 rated, meeting in full the corresponding specifications).

5.3 Construction of network

5.3.1 Pipe supports

All pipe supports shall be hot dipped galvanised and shall have either pipe clamps with rubber lining or U-bolts, according to TOTEE 2412/86.

The spacing of supports shall not exceed the following:

Pipe diameter	Horizontal runs	Vertical runs
DN40, DN50	1.5m	2.0m
DN65 - DN100	1.8m	2.5m
DN125 - DN150	2.5m	3.5m

The above spacing is for guidance purposes and is not to be exceeded; however, it may be necessary to provide additional supports to suit on site situations.

5.3.2 Concrete for Pipe Encasement

The concrete class to be used shall be at least C 16/20 in compliance with GCTS.

6 EXECUTION

6.1 Pipe and fittings Installation

The installation of all pipe work shall follow the requirements of this specification and shall be in accordance with the best-accepted practice.

In case of embedded pipes, excavation shall be free of water and other foreign materials immediately before pipes are installed or placed.

All around the pipe, a quarry sand bed shall be used, properly placed in situ, to ensure firm and uniform support of piping. The sand thickness shall not be less than 15 cm.

Concrete thrust blocks for elbows, tees, valves and appurtenances on buried piping shall be provided, as recommended by the manufacturer.

All exposed pipe runs shall be arranged so as to be parallel both with one another and with the building structure. All vertical pipes shall be plumb.

Pipe runs shall follow the lines of walls vertically and horizontally and shall be graded as necessary for draining and venting. The minimum clearance between a pipe and any adjacent finished building surface, fixing or pipe, shall be 35 mm, between the extreme features of the structure (e.g. supports).

Pipe runs shall in all cases be installed with a view to co-ordination with all other networks, whether provided by the same work crew or by others.

Ground-off and cut-off ends of pipes shall be deburred and smoothed-out. Pipe installations shall be free from rust, scale, corrosion and other defects and internal obstructions.

Connections to existing facilities shall be made with fittings to be installed in line with the manufacturer's instructions and recommendations.

Whenever pipes of dissimilar materials are to be jointed, the joint shall be made using special fittings in accordance with the manufacturers' instructions.

Branch, main branch and main soil, waste and ventilating pipes shall be of the materials and diameters in line with design drawings and shall be fixed in accordance with manufacturers' instructions and EN 12056-2.

Pipe and fittings shall be set to line before joints are made up and shall not exceed the strength set by the manufacturer for pipes and fittings. Pipe ends and joints shall be prepared in accordance with the manufacturer's instructions.

Branching of the ventilation ducts, as this is required, shall be connected, within the range of 75mm and 450mm from the top of the traps.

Central branch ventilating pipes shall pass above the overflow level of traps, fittings and of all their connections with the sewage and waste water pipes.

Pipes shall be cut in line with the manufacturer's instructions, the requirements of their manufacturing standards and the foreseen tools. Moreover, cold galvanizing coating shall be applied on cut galvanized pipes. The Contractor shall be held responsible for any such defective or faulty pipes and, in any case, he shall replace them in view of meeting the requirements of this specification.

Careful consideration must be given to the suspended pipe work. In depot areas, the pipe work installation must permit the free flow of liquids at a satisfactory velocity. The minimum installation gradient of 1.5% shall be achieved.

Where deemed necessary, sleeves shall be installed at the points where pipes cross walls and in view of ensuring proper waterproofing.

The recognition of pipes shall be made with the use and installation of coloured stripes tapes, according to ISO 14726.

6.2 Protection and maintenance

As the installation of pipe work proceeds, all open ends shall be sealed with plugs to prevent ingress of foreign matter. Under no circumstances shall paper, wood or other materials be used for this purpose.

For embedded pipes in soil and to prevent damage and displacement from loads, piping protection shall be used by providing steel sleeve for the total length of the crossing. The steel sleeve shall have an anti corrosion treatment by the application of one coat of bituminous paint applied in compliance with the manufacturer's requirements. If required, cast in situ concrete shall be poured around the steel sleeve.

Water pipes at crossings with sewer pipes, below or less than 0.5 m above the sewer pipe, shall be encased in concrete to the extent applicable and practicable up to 3 m.

Steel pipes for storm water and waste water sewage shall be electrically isolated from the network of the city. The interruption of electrical continuity (isolation) shall be ensured

through the use of polyethylene pipes properly installed throughout the entire length of the building.

According to TOTEE 2411/86, a copper conductor of a minimum cross-section of 6 mm^2 shall be used in order to achieve an equipotential network. All steel pipes shall have electrical continuity and shall be connected to the building grounding loop via the aforementioned copper conductor.

Necessary precautions shall be taken to prevent the sewage and storm water pipe work from coming into contact with the reinforcement of the building.

Pipes, supports and fittings shall be cleaned from dirt before painting where required. Painting works shall be carried out in line with the manufacturer's instructions.

7 TESTING OF THE SEWAGE NETWORK

7.1 General

Due to their operational and structural particularity, waste water sewage facilities do not lend themselves for a reliable testing of their complete operation. To this end, it is necessary that prior to the final testing specified below, partial tests throughout all the phases of the project are carried out concerning the quality and functionality of the structure, since these limit the impact on the entire functionality of the impossibility to carry out tests.

Once the facilities are installed, air tightness tests shall be carried out simultaneously on the entire facility.

Upon successful completion of the air tightness tests, a test to check for satisfactory performance of the network shall be carried out.

7.2 Testing during construction

Between the successive pits of the network tests shall be carried out in line with the provisions of EN 1610.

Duct ends are sealed. The section to be tested is filled with water and then a pressure of 0.5 atm is applied for at least 15 minutes for the test to be considered successful. Through this test, the watertightness of the connections is checked.

The tests described above shall be carried out in all the sections of the network that are to be embedded.

At various construction phases, the watertightness of the connections should be especially checked, effective support of the pipes, required gradient, protection against the introduction of foreign matter and maintaining the cross section of pipes free from items protruding from the inside, especially in the areas of the connectionsc.

7.3 Air tightness tests

It is recommended that air tightness tests are carried out on the entire installation. Their aim is to verify the water tightness of the network.

All odor traps shall be checked on their functionality. Once they are filled with water, all the remaining opening shall be closed (e.g. column terminations) with rubber gaskets.

In order to ensure the air tightness at the last lowest termination of the piping (e.g. mechanical siphon) a small quantity of water shall be introduced into the installation.

At the termination of a vertical column, a special tee shall be connected fitted with a ball valve at each one of its two branches. The one branch is connected through a flexible pipe with a calibrated manometer and the other branch with an air pump. Through the pump air is introduced in the installation until the indication on the manometer reaches 375Pa (38 mm H_2O) when air supply is interrupted. The test is considered successful when the pressure is kept stable for a period of three minutes minimum.

Identifying any possible leakage points is ensured through the use of capsules with strong smelling gases (not gas for U-PVC pipes) or by previously coating possible leakage points with a foaming agent always under the pressure of 38 mm H_2O.

7.4 Satisfactory performance testing

The purpose of this test is to verify whether the required isolation level is ensured in all the odor traps of the installation. The height of 25mm is set as the relevant sufficient remaining height.

This is a multiple test effected in parts on connecting pipes, vertical columns and on horizontal collecting piping.

During the execution of the test, a number of neighbouring hydraulic receptors connected to the same branch (horizontal or vertical) is selected for simultaneous discharge.

In case of horizontal piping, the most remote receptors are selected, while in case of vertical column, the receptors closest to the column are selected.

In case of public buildings, based on table 24 of TOTEE 2412/86, the following receptors are selected for simultaneous discharge in correlation with the total number of hydraulic receptors accommodated in the horizontal section or the vertical column to be tested:

Total number of hydraulic receptors	Number of hydraulic receptors discharged simultaneously	
	Toilet pans	Wash basins
1 to 9	1	1
10 to 18	1	2
19 to 26	2	2
27 to 52	2	3
53 to 78	3	4
79 to 100	3	5

Hydraulic receptor discharge means:

a) Opening the seal of its outlet until the time for test to start and on condition that the receptor has previously been filled up to the overflow level

b) Setting in operation the toilet cistern for cleaning the toilet pan in sanitary areas when the test starts and until the toilet cistern is empty.

Further to the completion of the successive trial filling/discharging cycles, the installation shall be sealed, as in the case of the air watertightness test, and no further water shall be added to the network and air shall be introduced by application of pressure up to 25mm H_2O (246 Pa).

The test is considered successful is the pressure is maintained for at least three minutes.

Spec. Code	Specification Description
TR_S_DP015551	WATER SUPPLY

CONTENTS

1. SCOPE

The purpose of this specification is to describe the technical requirements for the supply and installation of pipes, setting/regulation instruments and accessories used for the water supply network.

2. REGULATIONS

The installation shall be designed and constructed in accordance with the provisions of this document as well as the technical instructions and regulations mentioned here below:

- T.O.T.E.E. 2411/86 "Cold and hot water distribution installation for buildings and sites"
- The formal regulations applicable in the country of origin of the machinery, devices or instruments for which there are no formal regulations in the Greek State.

3. STANDARDS

- EN 806 "Specifications for installations inside buildings conveying water for human consumption"
- ELOT EN 1074 "Valves for water supply - Fitness for purpose requirements and appropriate verification tests"
- ELOT EN 10240 "Internal and/or external protective coatings for steel tubes - Specification for hot dip galvanized coatings applied in automatic plants"
- EN 10255 "Non-alloy steel tubes suitable for welding and threading - Technical delivery conditions"
- EN 12201 "Plastics piping systems for water supply and for drainage and sewerage under pressure - Polyethylene (PE)"
- EN 13828 "Building valves - Manually operated copper alloy and stainless steel ball valves for potable water supply in buildings - Tests and requirements"
- ETEP 04-01-04-02 "Building piping systems under pressure with flexible, reinforced plastic tubes"
- ETEP 04-01-05-00 "Building piping systems under pressure with welded, galvanized steel tubes"
- ETEP 08-06-07-02 "Cast iron gate valves"
- ELOT EN 31 "Pedestal wash basins - Connecting dimensions"
- EN 248 "Sanitary tapware – General specification for electrodeposited coatings of Ni-Cr"
- ELOT EN 14296 "Sanitary appliances - Communal washing troughs"

- ELOT EN 14688 "Sanitary appliances - Wash basins - Functional requirements and test methods"
- ELOT EN 13310 "Kitchen sinks - Functional requirements and test methods"
- ΕΛΟΤ EN 61386.22 «Conduit Systems for Cable Management – Part 22: Special Requirements – Pliable Conduit Systems»
- ETEP 1501-04-04-03-01 "Sanitary ware, common"

4. CALCULATION DATA

The calculations for water supply networks are foreseen as follows:

a. Cold water supply for the washing trough in the cleaner's room: 0.15 l/s

b. Receptacle pressure: 10 **(m water column)**

c. Water velocity at the water distribution networks is as follows:

- Main networks: 1,5 ÷ 2 m/s
- Secondary networks: 0,9 ÷ 1.3 m/s

5. MATERIALS - EQUIPMENT

5.1 Pipes

The pipes to be used shall be as specified in the following table:

LOCATION	MATERIAL	STANDARDS
Exposed	Galvanized steel pipe with seam (medium type)	ELOT EN 10255-M ELOT EN 10240
Embedded (*)	Polyethylene pipes 16 ATM (PE100)	ELOT EN 12201

(*)With regard to embedded pipes within the building floor or within the ground, PE pipes shall be installed inside a corrugated protection conduits per EN 61386-22.

5.1.1 Galvanized steel pipes with seam, medium type

Pipe manufacturing shall comply with the specifications of ELOT EN 10255-M.

Nominal Diameter DN	Diameter (inches)	External diameter (mm)	Wall thickness (mm)	Pipe weight (kg/m)	Water content (l/m)	Pipe & water weight (kg/m)
6	1/8"	10,2	2,0	0,40	0,03	0,43
8	1/4"	13,5	2,3	0,64	0,06	0,70
10	3/8"	17,2	2,3	0,84	0,12	0,96
15	1/2"	21,3	2,6	1,20	0,20	1,40

20	3/4 "	26,9	2,6	1,56	0,37	1,93
25	1"	33,7	3,2	2,41	0,59	3,00
32	1 1/4"	42,4	3,2	3,10	1,02	4,12
40	1 1/2"	48,3	3,2	3,56	1,38	4,94
50	2"	60,3	3,6	5,03	2,21	7,24
65	2 1/2"	76,1	3,6	6,44	3,73	10,17
80	3"	88,9	4,0	8,38	5,14	13,52
100	4"	114,3	4,5	12,20	8,70	20,90
125	5"	139,7	5,0	16,60	13,21	29,81
150	6"	165,1	5,0	19,80	18,88	38,68

5.1.2 High density polyethylene pipes (HDPE100) 16atm – SDR17

High density polyethylene pipes (HDPE100) shall be suitable for 16atm operating pressure in accordance with EN 12201-2. Fittings shall be also made of PE (of electrofusion type) with integrated electrical resistance for welding.

The minimum wall thickness and pipe weight shall be in accordance with the following table:

Nominal Diameter DN	External diameter (mm)	Wall thickness (mm)	Pipe weight (kg/m)	Water content (l/m)	Pipe & water weight (kg/m)
15	20	2,3	0,15	0,19	0,34
20	25	2,7	0,24	0,30	0,54
25	32	3,4	0,39	0,50	0,89
32	40	4,2	0,61	0,78	1,39
40	50	5,2	0,93	1,23	2,16
50	63	6,5	1,48	1,96	3,44
65	75	7,6	2,1	2,81	4,91
--	90	9,2	3,02	4,02	7,04
80	110	11,1	4,49	6,05	10,54
100	125	12,7	5,8	7,79	13,59
--	140	14,1	7,27	9,81	17,08
125	160	16,2	9,47	12,78	22,25
150	180	18,2	12	16,19	28,19
--	200	20,2	14,8	20,00	34,80
--	225	22,7	18,7	25,32	44,02
200	250	25,1	23,1	31,34	54,44
--	280	28,1	28,9	39,32	68,22
250	315	31,6	36,6	49,77	86,37
300	355	35,6	46,4	63,23	109,63
--	400	40,1	59	80,28	139,28
350	450	45,1	74,6	101,62	176,22

5.2 Shut-off / regulation instruments and accessories

The shut-off / regulation instruments and their individual fittings shall comply with the requirements of the following table:

Component description	Requirements	Shut-off / regulation valves
Body & screwed-on cap	Brass, as per EN 12165	Ball valve
Ball	Brass, as per EN 12165, micro-smooth finish, chrome plated	
Cap and stem	Brass, as per EN12164	
Ball gasket	Pure Teflon, with a hardness not less than 50 Shore D	
Handle	Epoxy painted reinforced aluminium	
Nut	Self-locking type	
Pressure test	As per EN 12226	
Body & screwed-on cap	Brass, as per EN 12165	Full bore ball valve up to DN50 (Φ2")
Ball	Brass, as per EN 12165, micro-smooth finish, chrome plated	
Cap and stem	Brass, as per EN 12164	
Ball gasket	Pure Teflon, with a hardness not less than 50 Shore D	

On all embedded polyethylene pipes, the shut-off valves shall be steel, flanged rubber gate valves and shall be placed on a fixed base within the manhole.

The flexible pipes connecting the isolation valves and the water mixer valves shall be of a certified manufacturer; they shall be flexible braided stainless steel pipes with flexible hose lined internally, capable to withstand a temperature of 110º C and operating pressure of 10bar.

5.3 Piping Accessories

All fittings to be used in galvanized steel pipe networks shall be galvanized, malleable cast iron, in accordance with EN 10242.

All fittings to be used in polyethylene pipe networks (PE100) HDPE shall be in accordance with EN 12201-3. They shall be of electrofusion type with integrated electrical resistance and all fittings shall bear Bar-coded product (manufacturer) labels for automatic welding machinery.

Unless otherwise specified, in straight pipe runs, the maximum spacing between pipe supports shall not exceed the following:

Nominal Diameter	Horizontal Runs	Vertical Runs
DN15, DN20	1.0 m	1.5 m
DN25, DN32	1.5 m	2.0 m
DN35, DN40	2.0 m	2.5 m
DN50 - DN80	2.0 m	2.5 m
DN100 – DN150	2.5 m	3.5 m

The above spacing is for guidance purposes only and is not to be exceeded; however, it may be necessary to provide additional supports to the project needs.

Pipe sleeves for passing through building materials (walls or floor embedded pipes) shall be made of heavy duty U-PVC in compliance with ELOT 1329.

Sealants to be used between the piping and their pipe sleeves shall comply with the requirements of TOTEE 2411/86.

5.4 Sanitary appliances and taps

All hydraulic receptors and fittings to be installed should comply with the relevant specifications and the standards of the aforementioned paragraph and shall be suitable for the type and operability of the specific areas. They should be selected based on the specifications related to hygiene, ease of use, cleaning and durability.

For each hydraulic receptor, a shut-off valve shall be provided for each cold water supply. The hydraulic receptors shall be of water conservation type and the flow control devices shall be integral with the appliance.

Sanitary appliances shall be constructed of dense, durable, non-absorbent materials (Water absorption < 0.5%) and shall have smooth impervious surfaces free from concealed pooling surfaces.

All porcelain enamel surfaces on appliances shall be acid resistant.

All exposed fittings should be made of chrome-plated cast brass. Screws, escutcheon plates, taps, traps (siphons), exposed piping etc. should be made of brass and their final layer shall be chrome-plated and shiny.

Flexible pipe connections shall be of approved manufacturer, accompanied by relevant certificates, consisting of stainless steel flexible corrugated pipe outside and non-toxic elastic pipe inside of material suitable for 110º C and 10bar operating pressure.

Bucket Sink

Bucket sink to be used in the cleaner's room shall be of overflow type with dimensions approx. 34 x 44cm, of vitreous china, white coloured, of wall hung type and with matching size chrome plated "P"-trap.

Bucket sink shall be provided with only cold water faucet.

Cold Water Bib Cock

It shall be of a single hole, with one handle and a small supplier. It shall be accompanied by a small chain and a plug. Its body and valve shall be brass, chrome-plated, with nominal diameter ½''.

Installation of Sanitary Appliances & Taps

Sanitary appliances shall be installed according to the manufacturer's instructions and recommendations and in compliance with TOTEE 2412/86.

Support fittings shall be installed, supplied by the manufacturer, if feasible.

Equipment and appliances shall be secured to supporting surfaces with, unless otherwise specified, wedge type stainless steel expansion bolts (Upat) or stainless steel special bolts, in compliance with the manufacturer's recommendations and according to Technical Specifications for anchoring.

Unless otherwise specified, water supply pipes shall be installed at right angle to the wall and floor.

Tests for proper operation of installed sanitary appliances shall be performed in accordance with the respective manufacturer's instructions.

Foreign material shall be removed from the surfaces of the sanitary appliances. Unless otherwise specified, the manufacturer's label shall be left intact, until completion and acceptance of the work.

For protection of the installed sanitary appliances against damages, prior to delivery and acceptance of works, the manufacturer's protection bands on the edges of the appliances shall be left intact, until acceptance of the works and the doors of the rooms including such appliances shall be locked.

6. EXECUTION

6.1 Pipe installation

Water supply pipe installation shall be in compliance with EYDAP Regulations ED/5/22/1984, OGG 528/1-2-84 and Circular 20366/4306-1984 and the requirements of this specification.

The layout of pipe work and arrangement of equipment, as indicated upon the tender drawings, are indicative only. Therefore, the Contractor shall confirm the adequacy of these proposals or provide equivalent alternatives for the consideration of AM.

In case of embedded pipes in soil, excavation shall be free of water and other foreign materials immediately before pipes are installed or placed. All around the pipe, a quarry sand bed shall be placed properly compacted to ensure firm and equable support of piping. The sand thickness shall not be less than 15cm. Concrete thrust blocks for elbows, tees, valves and supplementary fittings shall be provided, where required.

In case of exposed pipe runs, pipes shall be parallel with each other and with the building structure. Pipe runs shall follow the lines of walls vertically and horizontally and shall be graded depending on the supply needs. The minimum

spacing between a pipe and any adjacent finished building surface, supports or other pipes, shall be 35mm.

Pipe runs shall in all cases be arranged in co-ordination with other services, whether provided by the same Contractor or by others.

Ground-off and cut-off ends of pipes shall be deburred and smoothed-out. Pipe installations shall be free from rust, scale, corrosion and other defects and internal obstructions.

Connections to existing facilities shall be made with fittings to be installed in line with the manufacturer's instructions and recommendations.

Whenever pipes of dissimilar materials are to be jointed, the joint shall be made using special fittings in accordance with the manufacturers' instructions.

Joining of the polyethylene fittings shall strictly follow the manufacturer's recommendations concerning the clean surfaces and the fusion time of the parts. The fusion process shall be accepted only with the use of welding machines and accessories with a Bar-code. Polyethylene pipes shall be buried in the ground immediately after the exit point from the water supply pumping station and up to the entry into the relevant receptor.

Pipe sleeves, escutcheons and seals shall be applied for passing through building materials, where appropriate.

For reasons of aesthetics, (primer - paint) coating is foreseen for non-insulated steel pipes.

Pipes and fittings shall be aligned and graded before connections are made. Angular distortion of joints shall not exceed the recommendations of the pipe and fittings manufacturer. Pipe ends and joints shall be prepared in accordance with the manufacturer's recommendations.

Pipes shall be marked with coloured stripes, in accordance with ISO 14726.

6.2 Installation of Shut-off / Regulation Valves & Instruments

All valves shall be installed in such a manner as to be accessible. All shut-off and regulation instruments shall be installed in accordance with the manufacturer's instructions to secure ease of access at all places for operation and maintenance reasons.

Any defective work shall be removed and replaced with work that corresponds to the requirements of the specifications.

Care shall be taken for the protection of the works against works executed by others.

6.3 Protection and maintenance

As the installation of water supply pipe work and fittings proceeds, all open ends shall be sealed.

At the end of each workday, unfinished pipe works shall be protected against damage, contamination and moisture by the use of covers.

For embedded pipes in soil and to prevent damage and displacement from loads, piping protection shall be used by providing steel pipe sleeve for the total length of the crossing. The steel pipe sleeve shall have an anti-corrosion treatment by the application of one coat of bituminous paint applied in compliance with the manufacturer's requirements. If required, cast in situ concrete should be poured around the steel pipe sleeve.

Water pipes at crossings with sewer pipes, when running below or less than 0.5m above the sewer pipe, shall be encased in concrete.

Water pipe work shall be electrically insulated from the city network, either at the supply inlet point, or at the equipment item, where they terminate. This interruption of the electrical continuity (electrical insulation) shall be made by using PE pipe. According to TOTEE 2411/86, copper conductor of 6mm^2 shall be used in order to achieve equipotent. All metal piping shall have an electrical continuity and shall be connected – through the abovementioned conductor – to the building earthing.

In case of connection between pipes of dissimilar materials (e.g. steel - copper), electric isolation of the two materials shall be secured with proper dielectric materials and parts.

Necessary precautions shall be taken to prevent the metallic water pipes from coming into contact with steel reinforcement of structural elements.

Pipes occasionally used which are exposed to frost shall be supplied through a shutt-off instrument, shall be equipped with a discharge device and shall be labelled with an instruction sign placed adjacent to the shut-off device.

Water supply ducts, as well as pipes, that have to be installed outdoor shall be protected against freezing. Pipes exposed to frost shall be of full discharge capacity.

At the end of the structure and upon completion of the hydraulic tests, pipes shall be drained and flushed to remove foreign materials and then the whole network shall be sterilised using direct application of Chlorine or equivalent method. Unless otherwise specified, the disinfectant solution shall be kept in the pipe for at least 24 hours. Following this sterilisation period, the residual chlorine content shall be not less than 5 parts per million. Then, the line shall be drained and thoroughly flushed with water, until the residual chlorine content is similar to that obtained from EYDAP network.

Supports and fittings of the water supply network shall be thoroughly cleaned from dirt before painting, where required. Paint shall be applied as per its manufacturer's instructions.

6.4 Water supply network - Hydraulic test

Upon partial or total completion of the installation, the Contractor ought to proceed using his own instruments, at his own care and expenses, to the required tests, which shall be repeated, until all required results are met in full.

The measurements and test procedure shall be carried out as per ELOT EN 805 and in line with TOTEE 2411/86. The relevant procedure includes the following:

a. Rinsing and cleaning of the entire network. Before the installation is set into operation, all piping shall be thoroughly cleaned and flushed to remove foreign

materials left from the construction process. Air release valves are placed after the installation is cleaned.

b. Filling the installation with water. The main water shutt-off valve shall be turned ON gradually. To avoid pressure peaks and damage, careful full air release is required to be performed at the most remote point where the highest level was measured.

c. Pressurization of the tested part under 15atm pressure for 30min and 11.5atm pressure for 24h. Control via pressure gauge.

Any occurred leakage shall be rectified by the Contractor and the test shall be repeated, until water tightness is achieved in full. After each test (successful or unsuccessful), a hydraulic test protocol is filled in.

After the final successful hydraulic test, the application of paint and pipe insulation at the joints is extended.

CODE	SPECIFICATION TITLE
TR_S_ DP015552	**COMPRESSED AIR SYSTEM**

TABLE OF CONTENTS

1. SCOPE

The purpose of this Specification is to describe the technical requirements for the supply and installation of the piping-work and of the instruments intended to cut off/set of the fittings, utilized in the compressed air network.

2. STANDARDS

- ELOT EN 331 E2 Manually operated ball valves and closed bottom taper plug valves for gas installations for buildings.
- EN 10255 Non-Alloy steel tubes suitable for welding and threading - Technical delivery conditions.
- ETEP 04-01-05-00 Building piping systems under pressure with welded, galvanized steel tubes.

3. MATERIALS - EQUIPMENT

3.1 Tubes

The compressed air distribution network shall consist in the following fittings:

- Piping work made of galvanized steel tubes per EN10255-M (of medium type) and galvanized fittings suitable for welding and threading. The minimum width of the tubes' walls and the weight of the tubes shall be in accordance with the following table:

Nominal Diameter DN	Diameter (in inches)	External diameter (mm)	Walls width (mm)	Tube Weight (kg/m)	Content in water (l/m)	Weight of tube + water (kg/m)
6	1/8"	10,2	2,0	0,40	0,03	0,43
8	1/4"	13,5	2,3	0,64	0,06	0,70
10	3/8"	17,2	2,3	0,84	0,12	0,96
15	1/2"	21,3	2,6	1,20	0,20	1,40
20	3/4 "	26,9	2,6	1,56	0,37	1,93
25	1"	33,7	3,2	2,41	0,59	3,00
32	1 1/4"	42,4	3,2	3,10	1,02	4,12
40	1 1/2"	48,3	3,2	3,56	1,38	4,94
50	2"	60,3	3,6	5,03	2,21	7,24
65	2 1/2"	76,1	3,6	6,44	3,73	10,17
80	3"	88,9	4,0	8,38	5,14	13,52
100	4"	114,3	4,5	12,20	8,70	20,90

- Gradient of the horizontal piping system to consumption: 2%.
- Air-intake from the top part of the horizontal branches, with automatic hydration / vaporization at the end of each lowering process.
- In each air-intake, there shall be an isolation valve, complete air set, consisting of a filter – regulator 1 - 8bar, an automatic lubricator and a quick - coupler.

Spec. Code	Specification Description
TR_S_DP210000	FIRE PROTECTION

CONTENTS

1 GENERAL SPECIFICATIONS - REGULATIONS

The present Technical Specification concerns the fire protection measures which must be introduced at the new building to be constructed on the land plot where Elliniko Depot is located, which will serve as stabling shed for tramway vehicles.

The facility shall be constructed in line with the applicable Greek regulations and more precisely in line with:

- The regulation on the Fire Protection of Buildings (Presidential Degree 41/2018)
- The regulations of the Fire Brigade in force
- Technical Instruction no. 2451/86 of the Technical Chamber of Greece (TOTEE 2451/86)

Any issues not covered by the aforementioned regulations shall be addressed according the suggestions of ATTIKO METRO S.A. and the Fire Brigade.

2 SCOPE

The facility shall include:

- Permanent Water Supply Facility of the Fire Fighting Network with Fire Fighting Hose Cabinet (FHC) – category II
- Firefighting Tool Stations and Fire Extinguishing Means
- Portable Fire Extinguishers

The Contractor shall prepare an Active Fire Protection Design on the aforementioned scopes which will be approved by ATTIKO METRO S.A. and the Fire Brigade. In this framework, it is noted that any requirement related to the installation of safety and emergency lighting fixtures (escape route and emergency exit signage) is not examined under this specification, but will be included in the corresponding building lighting design that the Contractor will also prepare.

The Permanent Water Supply Facility to be installed shall constitute a new section of the existing Permanent Water Supply Facility of the depot. In particular, a new 4-inches branch shall depart from the existing fire fighting collector in Building 4 (Building 4 includes the Heating Plant, the Fire Fighting Pumping Station and the Water Supply Station) which will be routed in line with the provisions of the design to be prepared and shall serve the Fire Fighting Hose Cabinets (FHC) – category II to be installed.
The critical calculation data of the permanent water supply network for the water fire fighting network, where installed, are as follows:

- The minimum required pressure at the entry point of the most remote FHC shall be assumed to be equal to 4.4 bar.
- The water supply of each FHC - category II is assumed to be equal to 380lit/min.

The number of the fire fighting hose cabinets shall be set so as to ensure that all building locations are distanced less than 30 meters away from the closest Fire Fighting House Cabinet; this distance should be covered by a 20 m hose and a 10m length of water throw at the most remote Fire Fighting Hose Cabinet (4.4 bar) using the appropriate nose type. To this end and in line with ATTIKO METRO S.A. estimations, at least four (4) Fire Fighting Hose Cabinets must be installed. However, in any case, the number and the locations where FHCs

shall be installed shall be set in the design that the Contractor will prepare and implement and which will be subject to AM's and the Fire Brigade's approval.

Fire Fighting Tool Stations and Fire Extinguishing Means shall be installed in line with the applicable provisions. ATTIKO METRO S.A. estimates that it is required to install two (2) Fire Fighting Stations; the first one shall be a simple one and the second one shall be reinforced in line with Fire Brigade Provision no. 14. In any case, however, the number and the locations where Fire Fighting Stations shall be installed shall be set in the design to be prepared and implemented by the Contractor. Before its implementation, the design shall be subject to AM's and the Fire Brigade's approval.

The locations and the number of the portable fire extinguishers shall be designed and installed in line with the applicable provisions. ATTIKO METRO S.A. estimates that portable fire extinguishers shall be properly installed so that the distance of every point of the protected area is not greater than 15m from the closest portable fire extinguisher. In any case, the number and the locations where Fire Fighting Stations shall be installed shall be set in the design to be prepared and implemented by the Contractor. Before its implementation, the design shall be subject to AM's and the Fire Brigade's approval. In addition, at the new pits of tracks 5, 7 and in the existing pit of track 6 one (1) 6kg dry fire extinguisher per vehicle length, i.e. four (4) additional fire extinguishers should be taken into account.

3 PIPES – PIPE FITTINGS

The characteristics of the pipes shall comply with the provisions of the following table:

Use	Pipe Material
Underground - Embedded	Polyethylene HDPE 16atm-PE 100 as per EN 12201-2
Exposed	Medium duty galvanized grooved steel pipes according to EN 10255. Galvanized steel pipes of medium duty per EN 10255, threaded, up to 2''. Hot dip galvanization shall comply with the requirements of EN 1461 or EN 10240. It is stressed that grooving at the ends of the pipes shall be effected prior to the hot dip galvanization process.

In general, all embedded networks shall be made of polyethylene.

Medium duty galvanized steel pipes, with standard commercial dimensions, shall be used in the remaining exposed network. Standardized pipe dimensions shall be selected, such as DN 65, 100, etc. All steel fittings shall be of the type that is suitable for grooves, shall bear a rubber sealing ring and shall be of ductile cast iron in line with Standards ASTM A-536, Grade 65-45-12. All fittings shall be 20 bar pressure resistant and of red color.

It is stressed that identification of the fire fighting pipes shall be effected by the use and placement of coloured stripes, per ISO 14726.

Steel pipes with seam of medium diameter
The manufacturing of the pipes shall comply with the requirements of ELOT EN 10255.

High Density Polyethylene Pipes (HDPE100) 16atm – SDR11

High Density Polyethylene Pipes (HDPE100) shall be suitable for effective operation at 16atm, per EN 12201-2. Fittings shall be made of PE, suitable for electro-fusion with built-in electrical fusion.

Special fittings and Valves

The valves at the firefighting line ends shall be bronze DN 50 and DN 65 (depending on the category), of angular type, approved by the Fire Brigade.

All the valves shall bear aluminium half-coupling of the STORZ type, according to EN 671, of appropriate cross-section, to which the firefighting hose shall be fixed.

The manometers used in the remote FHC shall be glycerine filled stainless steel.

The firefighting pipe supports shall be made of heavy-duty steel profiles, hot dip galvanized. They shall mainly be made of steel and their fixation shall be achieved by means of U-bolts.

4 FIRE HOSE CABINETS

Fire hose cabinets shall meet all the requirements set out in TOTEE 2451/86, Part A/5.1, 5.2, 5.3, ELOT EN 671 and the fire fighting related provisions.

All the parts of the FHC shall be of a type approved by the Fire Brigade.

The FHCs for class II systems shall consist in a metal cabinet suitable for recessed or wall-mounted outdoor installation and shall include the following items, as a minimum:

- The hose of 1 ¾" diameter and 20-meter length, having special coupling fittings at its ends (half coupling storz). Operating pressure 20 bars, test pressure 50 bars. This hose shall be reeled round the hose reel.
- One special isolating (globe) valve 2", hand-wheel, trim (endwise inclination) with Storz couplings.
- The hose reel to accept the wrapped hose, of heavy duty make and rotated round a vertical axis as to be brought out of the fire box together with the hose.
- The water spray nozzle with 4 spray positions contracted and expanded accordingly for straight line water shooting or FOG water curtain in accordance with the above requirements.

The FHC shall be made of galvanized steel sheet, 1.5mm thick, with folded ends. The paint shall be oven-baked epoxy in red color.

The door leaf shall be made of galvanized steel sheet, 1.5mm thick. It shall have its ends twice folded and shall be placed inside the doorframe.

The door shall be supported by internal safety hinges made of thermoplastic material and an Φ6mm axis of galvanized steel incorporated in the fire cabinet and the doorframe (upper and lower ends). Moreover, it shall have opening capability of 180^0.

The hose reel shall be made of pressed steel sheet 1.5 mm thick. Its diameter shall follow the length of the hose used and shall be rotating freely.

The hose shall be made according to EN 14540 of highly strong 100% polyester non-elastic fibers configured in a circular uniform woven pattern without nodes, impregnated with acrylic polyurethane resin in red color and shall have rubber lining. Its lining shall be made of EPDM or other rubber materials, while the width of the lining shall be over 0.5mm with a uniform smooth surface. The material to be used shall have been manufactured recently, i.e. within 12 months prior to the date of the tests commencement and commissioning. Its length shall be

20m and shall be of a type approved for use by the Fire Brigade. For Class II, the diameter of the pipe shall be 1 ¾''. Operating pressure 20 bars and test pressure 50 bars.

The hose shall have fast coupling on both sides. These couplings shall be of the STORZ type, made of an alloy of aluminum according to the requirements of the Fire Brigade. The connection of the hose to the storz shall have two stainless steel collars of AISI 304 quality.

The water spray nozzle shall be made of an alloy of aluminum or of copper brass and of an adjustable spray diameter (FOG). The spray nozzles shall have four operating positions (Full jet- spray jet- curtain- shut off) and shall be of a type approved for use by the Fire Brigade.

The water discharge valve (shut off valve) shall be made of copper brass, of a type approved by the Fire Brigade, while its diameter shall be equivalent to the hose size it serves.

The FHC dimensions shall allow easy use of the fittings and appliances contained therein.

In the thread pipe connections, for improved sealing, waterproofing (sealing) materials shall be utilized, in line with EN 751 standard series; these materials shall be accompanied by the respective certifications concerning the aforesaid use.

The FHCs installed in external areas shall have drain holes.

The FHC shall be mounted on the walls with galvanized steel anchors, galvanized steel nuts and washers. Each fire cabinet shall be supported by at least four (4) anchors, not smaller than M8X60mm.

5 FIREFIGHTING STATIONS FOR TOOLS AND FIRE FIGHTING MEANS

Firefighting tool stations shall be installed at locations set in cooperation with ATTIKO METRO S.A. and the Fire Brigade, in line with Fire Fighting Provision 14/2014.

All the parts of the Firefighting Stations shall be of a type approved by the Fire Brigade.

The equipment shall be according to Regulations (Fire Fighting Provision 14/2014) and approved by the Fire Brigade. The material of the firefighting tool cabinet shall be the same as that of the FHC. The door shall be capable of 180° opening.

Every firefighting tool cabinet shall include the following equipment:

- Two (2) protection helmets, in line with ELOT EN 397
- Two (2) battery torches, led type
- One (1) fire-resistant rescue blanket, per DIN 14155
- One (1) shovel
- One (1) hatchet
- One (1) hoe
- One (1) crowbar
- One (1) lath-hammer
- Two (2) breathing apparatuses, per ELOT EN 136
- Where required in the design (where all fire fighting stations installed in the Depot should be also taken into account), an enhanced Fire Fighting Station shall be installed, in line with Fire Fighting Provision 14/2014, integrating an open-circuit breathing apparatus of minimum capacity/pressure 6l/300 bar.

The firefighting station cabinets installed in outdoor areas shall have drain holes.

6 PORTABLE FIRE EXTINGUISHERS

Portable fire extinguishers shall be installed at specific locations inside the building.

The type and quantity of the fire extinguishers shall be based upon the fire fighting principles, the instructions of the Fire Department and in accordance with the Fire Fighting Provisions in force.

Portable fire extinguishers shall be mounted in easily accessible positions, on special wall brackets, near exits from protected areas and in escape corridors.

Spec. Code	Specification Description
TR_S_DP260526	EARTHING AND LIGHTNING PROTECTION

CONTENTS:

1. General

This Section describes in detail and defines the requirements for the earthing, bonding and lightning protection of the new shed of the Tramway Depot to ensure the protection of the personnel and the equipment against electric shock.

Earthing shall be designed and carried out as per the requirements of the relevant earthing standards applicable in Greece for the railway construction and operation.

2. Standards – Regulations

Joint Ministerial Decision 50/12081/642	Indoor Electrical Installations Safety-Related Issues. Establishment of the Obligation for the Installation of Residual Current Devices (RCDs) and Installation of Foundation Earthing
ELOT TP 1501-04-50-01-00	Roof circuits of Lightning Protection Systems
ELOT TP 1501-04-50-02-00	Conductors of Lightning Protection Systems
ELOT HD384 E2	Requirements for electrical installations
ELOT EN 50163/A1	Railway applications – Supply Voltages of Traction Systems
ELOT EN 62305	Lightning Protection
	Part 1: General Principles
	Part 2: Risk Management
	Part 3: Physical damage to structures and life hazard
	Part 4: Electric and electronic systems within the structures
DIN 18014-2014	Foundation earth electrode
ELOT EN IEC 62561	Lighting protection system components requirements for connection components
	Part 1: Requirements for connection components-2017
	Part 2: Requirements for conductors and earth electrodes-2018
	Part 3: Requirements for isolating spark gaps
	Part 4: Requirements for conductors fasteners
	Part 5: Requirements for earth electrodes inspection housings and earth electrodes seals
	Part 6: Requirements for lightning strike counters
	Part 7: Requirements for earth enhancing compounds
BS 7430-2011+A1:2015	Code of practice for protective earthing of electrical installations

NF C 17 102 (07-1995)	French Standard NF C 17 102 (07-1995) Lightning protection Protection of structures and open areas against lightning using early streamer emission air terminals

3. Description of earthing and lightning protection

3.1 Lightning protection

For the lightning protection of the new metal shed of the Depot, one (1) additional non-radioactive surge arrestor of enhanced ionization with a radius of protection of at least 130 meters shall be placed on a supporting pole which shall be made of stainless steel, at least 16m high.

The supporting pole shall be fitted with self-supporting tendons with tensioners.

The installation of ionization lightning rods is specified for the protection of common structures up to 60m high, as well as of open spaces, based on the French Standard NF C 17 102.

The surge arrestor (due to the large radius of protection) should be accompanied by a corresponding long-term laboratory determination certificate.

The location of the new surge arrestor, in combination with the existing surge arrestors, shall ensure the protection of the new metal shed against lightning. The mounting base of the surge arrestor shall be made of concrete and its dimensions shall be 1m x 1m and 2m deep. Next to the mounting base of the new surge arrestor, three manholes of 30cm x 30cm each will be constructed, forming a 3m equilateral triangle. Within each of the 3 manholes will be a grounding steel copper plated electrode (Ø17mm), at least 1500mm long. The top of the ground rods inside the manholes shall be accessible for inspection and maintenance. The head of the surge arrestor shall be connected to the ground rod terminal via a Cu 70mm^2 bare copper conductor and a copper ground control test clamp. In the cathode conductor Cu 70mm^2, a magnetic lightning recorder and lightning current counter shall be inserted.

The cathode conductor shall be surrounded by a protective pipe 2 meters above the ground.

The ground rods shall be connected to each other by bare copper 50mm^2 Cu electrolytic stranded conductors, running at a depth of approximately 60cm from the ground surface. If the required ground resistance value (10 Ohm) is not reached, the required number of 1500mm ground rods (which will be joined to the above rods by extension joints) shall be added, so that the ground resistance value can be within the acceptable limit.

3.2 Earthing

As regards grounding around the new metal shed at a distance of approximately 1m and at a depth of 0.5m into the ground, a 40x4mm steel hot-dip zinc-plated tape (500gr/m^2) St/tZn 40x4mm shall be placed, suitable for installation both in and out of the ground, with standardized steel hot-dip zinc-plated St/tZn band supports.

Each metal column of the new metal shed shall be connected to the perimeter steel hot-dip zinc-plated tape (500gr/m^2) 40x4mm St/tZn band through a steel hot-dip zinc-plated St/tZn Ø10mm conductor (with a cross-section equal to 78m^2) and the appropriate connections and fittings. The connections of the above St/tZn Ø10mm (with a cross-section equal to 78m^2) conductors to the metal columns shall be made by aluminothermic welding. To prevent corrosion of the St/tZn conductors Ø10mm at the surfacing point, a self-tapping insulating seal is installed 20cm before and 20cm after the conductors' surfacing.

This perimeter steel hot-dip zinc-plated (500gr/m^2) St/tZn 40x4mm band shall be also interconnected via a steel hot-dip zinc-plated (500gr/m^2) St/tZn 40x4mm band and suitable connectors at least at two different points with the existing perimetric galvanised steel 40x4mm band.

4. Earthing and lightning protection - Materials and fittings

4.1 Earthing electrode

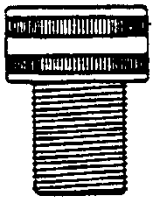
The steel ground electrode of circular cross section shall have a diameter of Φ17mm and shall be at least 1500mm long (as specified in the Technical Description), electrolytically copper-plated and threaded (3/4" W) at both ends for elongation by threaded thread. Coating thickness: 250 μm.

The use of a copper rod electrode coated with a copper tube is prohibited.

4.2 Electrode coupler

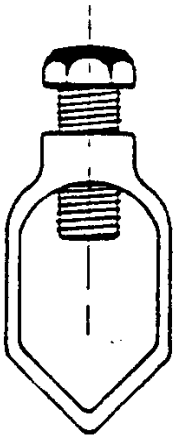
The coupler shall be of copper alloy with internal thread 3/4" W suitable for elongation of steel ground electrodes, copper-plated, of a corresponding diameter.

4.3 Driving stud earth electrode



The 3/4 "W driving stud shall be suitable for mounting on a ground copper-plated electrode of corresponding diameter. The driving stud shall be steel and screwed on the corresponding copper alloy coupler, having previously been screwed to the ground electrode.

4.4 Clamp for tightening the conductor with the electrode



The copper clamp will be threaded for a 3/4 "W ground electrode, suitable for clamping a corresponding copper-plated ground electrode with a single-stranded or multi-stranded copper conductor up to 70 mm^2. Clamping of the electrode to the copper conductor shall be accomplished with a copper hexagonal screw.

4.5 Earthing manhole

The earthing manhole shall be used for visual inspection of the ground at its connection point, checking the tightening of the conductor with the earthing device at the connection point and provides the ability to correctly measure the ground resistance. It shall be embossed with the earthing marking. It shall be made of PVC and its dimensions shall be 30cm x 30cm.

4.6 Bare copper ground conductor

The bare copper grounding conductors shall be 70mm^2 or 50mm^2 in diameter -subject to the requirements of the Design - made of 98% conductivity copper over pure copper and shall be multi-stranded. The connections between the conductors shall be heavy-duty and shall be made either by hot welding or by using special copper fasteners.

4.7 Ground rod clamp

Copper alloy clamp suitable for connecting copper-plated ground rod Φ17mm with copper multi-straned conductor.

4.8 Bare copper ground conductor

Bare steel hot-dip zinc-plated ground conductors shall have a cross-section of 78mm^2 or Φ10mm - suitable for installation both in and out of the ground. For connecting the metal columns to the steel hot-dip zinc plated (500gr/m^2) St/tZn 40x4mm band around the new metal shed of the Tramway Depot.

4.9 Steel hot-dip zinc-plated St/tZn (500gr/m^2) band

Steel hot-dip zinc-plated (500gr/m^2) 40x4mm St/tZn band, suitable for installation both in and out of the ground, with standardized steel hot-dip zinc-plated St/tZn band supports, to be placed around the new metal shed of the Tramway Depot.

4.10 Conductor / band clamp

Steel hot-dip zinc-plated St/tZn clamp type H-100kA Φ10/40, suitable for installation both in and out of the ground, to connect the perimeter steel hot-dip zinc-plated (500gr/m^2) St/tZn 40x4mm band with bare steel hot-dip zinc-plated ground conductor with a cross-section 78mm^2.

4.11 Band/band clamp

Steel hot-dip zinc-plated St/tZn clamp type H-100kA 40/40, suitable for installation both in and out of the ground, for bonding steel hot-dip zinc-plated (500gr/m^2) St/tZn bands 40x4mm.

Spec. Code	Specification Description
TR_S_DP270001	WIRELESS NETWORK SYSTEM (WIFI)

TABLE OF CONTENTS

1. SCOPE AND PURPOSE

1.1 The Contractor shall design, supply, install, put to test and set into operation a state-of-the-art wireless local area network system (WIFI), which shall be used to cover real time communications among OCC and the various systems of vehicles stabled at Elliniko Depot shed.

1.2 The data exchange between the vehicles systems operating modules and the OCC shall be carried out via the WIFI communication system. This data will cover a range of detailed functional information (status, operating systems of vehicles etc.), updating information (passenger information, routes etc.) and diagnostics' information (failures, systems' operational status etc.). The final data content shall be agreed with ATTIKO METRO S.A. during the Contractor's design phase.

1.3 All areas covered by the Depot stabling shed for Tramway vehicles, shall be equipped with the appropriate devices and relevant software for the management of the wireless local area network system (WIFI). The wireless local area network system (WIFI) shall be used to ensure wireless communication and duplex data transmission between the systems of the Tramway vehicle and a central (local) system for the management and control of the wireless local area network system (WIFI).

1.4 The devices and equipment related to the wireless local area network system (WIFI) shall be installed in such a manner so as not there are dead spots, respecting the necessary distances and overlapping for full coverage at each point of the shed, as well as in the surrounding area of the Depot during the approaching of the vehicle in the Shed.

1.5 The wired link between the wireless local area network system (WIFI) and the local control area (centre) shall be ensured via the appropriate new fiber optic network, allowing real time data transfer to the equipment in the control area. The Contractor shall provide the equipment of the local control centre for management of the wireless network system (WIFI) by the personnel and the subject data shall be then routed to the Operation Control Centre (OCC).

1.6 The Contractor shall design and install the fiber optic cable by using the existing routing infrastructures, if any, or otherwise by using new infrastructures to be placed by him. Moreover, the Contractor shall provide the necessary equipment for digital transmission, as well as additional copper cabling.

1.7 The Contractor shall provide the appropriate outdoor cabinets to supply the wireless local area network system (WIFI), as well as the necessary active network equipment for data transfer to the workstation for the system management in the area of local control (centre).

1.8 The wireless local area network system (WIFI) shall be installed and set into operation by the Contractor in accordance with the Project needs and the

specification requirements. The exact location, the total number of devices and equipment, as well as the operation and control method shall be finalized in the Contractor's Detailed Final Design, based on the restrictions set in the following paragraphs.

1.9 Prior to commissioning, the Contractor shall submit for approval the detailed test procedures that shall include the methodology, the relevant test sheets, the related Standards that are followed, the acceptance limits of the measurement parameters, as well as any other relevant information required.

1.10 During the execution of the Project, the Contractor must take into account and comply with the existing institutional and legal framework for antenna related issues of the Hellenic Telecommunications and Post Commission and for issues related to the confidentiality of communications of the Hellenic Authority for Security and Privacy in Communications.

1.11 The provided wireless local area network system (WIFI) shall be expandable using appropriate devices and equipment ensuring compatibility that may be added to this system in the future. As a minimum, the expandability shall meet the requirements for full coverage of all Depot areas and its outer perimeter, and of the additional Tramway stops that may be required within the area of the former Elliniko Airport under re-configuration, as well as the requirements for the connection of the Tramway Line with the Metro stations (ARGYROUPOLI/ELLINIKO). In this framework, the Contractor shall work with any future Contractor undertaking any additional extension of the Tramway network to ensure functionality (in terms of hardware and software) of the entire system.

2. GENERAL TECHNICAL CHARACTERISTICS

2.1 Current specifications concern the supply, installation, customization, programming and delivery of the wireless local area network system (WIFI) for full uninterrupted operation covering entirely the areas around the shed in outdoor conditions, on a 24/7 basis, for duplex data transfer between the vehicles stabled in the shed area and the OCC.

2.2 A number of wireless access points (Wi-Fi APs), ensuring adequate wireless coverage (>99%) of the entire Depot shed area (stabling area), shall be installed at optimum spots within the shed, as well as wherever it is deemed necessary, along with all necessary hardware and software, taking the following into account:

- Required power and signal sensitivity.
- Uninterrupted data transfer and total capacity of the network.
- Channel interference.
- Wireless network security.
- Central management of the wireless network.

2.3 The wireless local area network system (WIFI) covering the aforementioned areas shall uninterruptedly undertake the duplex data transmission to the OCC; provision is made for the WIFI to be digital, of IP technology, complying with 802.11 (a/b/g/n/ac) communication protocol. The WIFI shall consist of the following, as a minimum:

- Outdoor wireless access points.
- Outdoor antennas of wireless access points.
- Outdoor wireless base station (if required by the Detailed Final Design).
- Wireless Network Bridges (if required by the Detailed Final Design).
- Wireless router (if required by the Detailed Final Design).
- Wireless repeaters (if required by the Detailed Final Design).
- Workstation to be used for operation and management.
- Local storage system.
- Management, Processing and Diagnostic software.
- Uninterrupted Power Supply (UPS). UPS and back-up equipment (e.g. rack, A/C, peripherals for supply & data cabling).
- Network equipment (e.g. LAN Switch and safety device (Firewall/Virtual Private Network - VPN).
- Cabling.

2.4 When a vehicle enters the Depot shed area, its equipment would be in a position to be connected automatically with the wireless local area network system (WIFI) provided by the Contractor to download data (daily transaction, log file) and receive the necessary operation parameters.

2.5 The Wi-Fi APs of the Depot shed shall be linked with the AP controller through an IP protocol, where all their settings shall be properly managed. There shall be a wired link between the Wi-Fi APs in the Depot shed and the

network infrastructure terminating at the Control and Management Centre of the entire system.

2.6 The wireless infrastructure to be implemented shall be based on the state-of-the-art WiFi technology standards and shall meet the following requirements:

- Reliability of equipment.
- High performance of the network.
- High level of security, with regards to accessing the related devices, through powerful and automated certification mechanisms.
- Central management of the infrastructure and flexibility in changing the system's operations and parameters.
- Flexibility and expandability.

2.7 All the aforementioned devices shall be set based on a predefined security and authorization policy, so that the wireless network of the Depot can be used only by authorized equipment. Any other non-authorized equipment shall be rejected and shall be logged for further investigation of the intrusion.

2.8 During the implementation of the project, a site visit in the subject areas should be organized by the Contractor, to identify the precise needs in the specified location of WiFi APs. The Contractor should also analyze and register the existing systems, compatibility, types of trains in relation to their subsystems.

2.9 The design concerning the architecture of the wireless local area network system (WIFI), the selection and number of the appropriate equipment, as well as its installation and customization shall be carried out in cooperation with the Contractor, following AM's approval and confirmation. Any modifications and changes that have been identified should be incorporated and implemented during the Detailed Final Design phase.

2.10 In order to implement the aforementioned requirements, it is necessary to install and properly customize the devices of the wireless local area network system (WIFI) equipment provided by the Contractor.

3. OUTDOOR WIRELESS NETWORK DEVICES' SPECIFICATIONS

3.1 The architecture to be implemented shall be based on the latest standards of wireless networking. The WIFI infrastructure shall be established to support the wireless data transmission to/from the vehicle. For the data receive/transmit (operation parameters, daily schedules), the vehicle equipment shall be connected with the PC at the OCC through this network.

3.2 The topology of the wireless network shall provide the central management of the network, so that it is possible to monitor the network in real time during periodic controls, to immediately detect any eventual failure at individual parts of the wireless network, as well as to immediately change the parameters of all devices, in case of emergency.

3.3 The WIFI shall consist of the workstation (PC), the LAN switch, the Firewall/VPN, a printer, the Wi-Fi APs and a storage disc, including the relevant database application.

3.4 All hardware and software shall be installed at the OCC, except from the equipment of the Wi-Fi APs which shall be installed mainly in outdoor areas of the Depot and the shed. The Wi-Fi APs shall be collected onto a switch to be installed in an outdoor cabinet near the shed and shall subsequently terminate at the OCC via a fiber optic cable.

3.5 The Wi-Fi APs have been installed at selected points of the shed along with the entire necessary hardware and software, to provide sufficient wireless coverage to the vehicle equipment in the stabling areas. When the vehicle enters a Depot area, the equipment of the vehicle is connected with the Wi-Fi network, and then communicates with the PC in the OCC for data downloading (daily transaction, log file) and receipt (operation parameters, updating of the black list).

3.6 The Wi-Fi APs of the shed shall support the IEEE 802.11 (802.11a/b/g/n/ac) specifications concerning the wireless communication and shall be wired through the infrastructure of its LAN network. The Wi-Fi APs shall be connected with the AP controller through IP protocol, managing all settings of the Wi-Fi APs in the shed.

3.7 The outdoor Wi-Fi APs of high performance 802.11a/b/g/n/ac would be capable of providing an optimized wireless environment to ensure the connection between the Depot and the OCC for data collection and transfer to/from the on-board equipment.

3.8 The wireless networking shall be based on the latest standard 802.11n (MIMO 3x3) to provide a high bandwidth (>150Mbps). However, older networking standards 802.11a/b/g should be also supported, so that the network can be also used by vehicles with older equipment still operating.

3.9 In particular the Wi-Fi APs shall support the MIMO (Multiple Input, Multiple Output) mode – a technology using advanced signal processing with multiple antennas to improve transfer. The MIMO utilizes the multiple transmission technology to reduce the need to re-transmit packages and improve the precision of the wireless signal.

3.10 The Wi-Fi APs shall have at least three (3) outdoor antennas for transmission at 2.4GHz and 5GHz. Antennas provide a variety of choices to extend the signal range and configure the area to be covered. The Contractor shall ensure any compatibility with the existing WIFI system.

3.11 The AP devices should be suitable for outdoor areas. For this reason, it is possible to use integrated antennas suitable for installation in this area. These devices shall be positioned at locations making them highly discrete and being less visible by the maintenance and operation personnel, without however affecting the performance of the network.

3.12 The wireless infrastructure should be capable of giving priority to the emergency information. For this reason, it should be equipped with data movement identification and priority mechanisms, in order to identify sensitive applications and receive the highest priority.

3.13 The wireless infrastructure should support priority of movement in at least four (4) different QoS levels, while the WMM (WiFi Multimedia) protocol should be also supported for the provision quality of service in VoIP and Video services for future use.

3.14 Wireless infrastructure should support dynamic and automatic configuration mechanisms of the AP's transmission and operation parameters, to automatically settle any random problems. In particular, there must be a scheme identifying whether an AP has failed creating a "coverage gap" in the related area, and to automatically increase the transmission power of the neighboring APs, to fill the said gap until the damage is repaired. Moreover, support should be provided to a mechanism controlling the channels in the 2.4GHz and 5GHz bandwidth and dynamically assign to the APs the channels with the lowest possible interference.

3.15 Wireless infrastructure should support management mechanisms via the SNMP standard, while it shall be possible to follow-up the network operation via a graphic display tool, providing to the operation and maintenance personnel the possibility to monitor the use of the wireless network in real time.

3.16 The AP Controller should be capable of collecting, configuring and monitoring all AP operations. The creation and storage of the controller's backup log shall be necessary.

3.17 The AP Controller shall be responsible for the remote management and monitoring of the Wi-Fi APs, as well as the control of Wi-Fi devices – clients

which can be connected with the Depot's WiFi network. The wireless infrastructure should be capable of detecting RF interferences, acknowledge their source and the location of the source, as well as of effectively dealing with interferences. Thus, the effectiveness and performance of the wireless network shall be increased as the Signal-to-Noise Ratio (SNR) increases.

3.18 Each AP WLAN should be capable of supporting devices simultaneously connected with the network, whose number shall be recommended by the Contractor and shall be approved by ATTIKO METRO S.A.. In any case, the data transmission speed shall be reduced below the value required for the transmission of data at any point or high traffic data area. In case the transmission speed is lower than the indicated data transmission speeds, the Contractor shall be held responsible for all measures to correct or specify the antenna fine tuning, or even increase the number of Wi-Fi APs.

3.19 The WIFI should provide a bandwidth control per connection. The network should permit authentication using SSIDs.

3.20 The Contractor should ensure that there is no interference among the APs prior to the installation. The Contractor shall be responsible for finding a solution to eliminate interferences, including –but not exclusively- the redefinition of non-overlapping channels, providing additional Wi-Fi APs with lower transmission power and/or replacement of devices, where required.

3.21 Interferences to be detected and addressed by the wireless infrastructure can come either from adjacent wireless networks (Wi-Fi Interference), or other devices operating at the same frequency, such as microwaves, DECT wireless phones, wireless detectors, cameras etc.

3.22 Wireless infrastructure should support detection mechanisms and dealing with malicious attacks from external Access Points (rogue access points detection).

3.23 Data transmission between the APs and the central control and management infrastructure should be encrypted with recognized encryption system to provide extra security with regards to the network control data.

3.24 At security level, the wireless infrastructure should support a number of schemes encrypting the movement and users' certification, as well as security. More specifically, the following Protocols should be supported:

- WPA/WPA2 PSK
- WPA/WPA2 Enterprise
- 802.1x
- EAP
- AES
- RADIUS Authentication, Authorization, Accounting
- Web Authentication/Self-Signed Portal

The final selection by the Contractor should be agreed with ATTIKO METRO S.A..

3.25 Wi-Fi APs shall be able to connect with an exterior power supply unit to supply with power, the Power Over Ethernet (PoE).

3.26 As a minimum, outdoor wireless APs shall meet the following specifications:

- Operation frequency: 2.4 GHz and 5 GHz
- Data transfer speed: >150 Mbps
- Antenna type: External, Internal, omni, directional, dipole
- Number of antennas: ≥ 3
- Antenna gain: at least 5dBi each
- Security: WEP, WPA-PSK, WPA-TKIP, WPA2 AES, 802.11i
- Bridging distance: 150-200m
- Portals: 2 Ethernet ports 10/100/1000
- Suitable for outdoor areas
- Suitable for mast or wall
- Operation at temperatures ranging between -10^{o}C and +60^{o}C
- Operation at humidity conditions ranging between 10% and 85%
- Supply: suitable for Power over Ethernet (PoE)
- Protocols: 802.11 b/g/n
- Compatible with protocol 802.3af
- Protection from dust and liquid: IP66
- Protection against overvoltage.

3.27 The already installed Wi-Fi APs of the WIFI system shall meet the international standards in order to provide constant wireless link with the vehicle's equipment, adhering to the European and International Safety Regulations.

3.28 The network under construction shall support safe connections at the wireless network level. In order to ensure the actual wireless network security, it is required to use data encryption and modification techniques at application level (e.g. connections with secure sockets, servers supporting HTTPS, SFTP instead of FTP etc.) and all terminals should now support equivalent techniques.

3.29 The entire wireless infrastructure equipment should comply with the international construction and safety standards and, more specifically, it must comprise CE marking, WiFi certification, as well as certifications concerning electromagnetic compatibility with other electronic equipment (EMC/EMI).

4. WORKSTATION – CONTROL SYSTEM ADMINISTRATOR

4.1 The workstation to be installed at OCC by the Contractor shall consist of a central PC, definitely server grade, and shall have installed the management software which is compatible with the vehicle's software, collecting useful information (failure, systems' operational status etc.) about the vital operations of all sub-systems of the vehicle (e.g. brake/traction, door system, HVAC etc.).

4.2 The PC/workstation shall be equipped with the latest operating Windows system and the necessary system software. The installation of the WIFI operating system and software in the PC constitutes the Contractor's responsibility.

4.3 The workstation shall consist of desktop reliable heavy-duty PCs, running on a standard off-the-shelve operating system, color printers for at least A3 paper size etc. The workstation shall be identical –as to the hardware and software- and all functions shall be executed at the optimum pace. Any cabling in the control area (centre) to be required for data transmission shall be included in the scope of the Project.

4.4 The Contractor shall provide at least one (1) digital monitor, LED type, of very high resolution and definition, so that the transmitted image is usable. Monitors shall be connected with the workstation of the central management system and shall have, as a minimum, the following characteristics:

- Dimensions: 24" to 32"
- Resolution: Full HD 1920 x 1080
- Image refresh rate: 200Hz
- Inage control settings: luminosity, contrast, color brightness
- HDMI input port
- Power supply: 220-240V AC, 50/60 Hz.

4.5 The Contractor shall provide a mouse and a keyboard, which are necessary for the operation, customization and configuration of the system through recorders and the central PC.

4.6 The Workstation shall have the capacity to automatically transmit all information and movements collected by the on-board equipment directly to the OCC. This PC shall be equipped with its own local storage system for the automatic collection of data and shall execute specific works, as these have been predefined by the OCC's workstation (PC), including the following basic operations:

- Automatic collection of all information and movements from the equipment
- Updating and operation data

- Downloading of updates and operation data to the equipment. Display and recording of all operation related events
- Monitoring the PC hardware and software status
- Data and time synchronization with the workstation
- Retrieval and printing of daily reports and statistics.

4.7 The workstation shall also support the management of the Wireless network System using the appropriate software. The basic functions and characteristics of the workstation include the following:

- Management of roles and users
- Alarm management
- Diagnostics operation
- Maintenance.

4.8 In particular the central unit or PC (server type) shall manage the system's user rights, the alarm events, the duplex communication, as well as the intelligent security system rules etc.

4.9 The PC shall be supported by a UPS system with a capacity of 180min and shall have at least two (2) HDDs in array, to avoid data loss and to protect their integrity.

5. SOFTWARE

5.1 The workstation shall include all necessary software, applications and interface to ensure data collection and transfer to/from the vehicle's equipment.

5.2 The workstation shall be capable of informing the Depot about the software versions of each sub-system and, in case of a newer version at the OCC's database; this version can replace the already existing one following the user's confirmation via the Wi-Fi network.

5.3 With regards the systems for which it is required to proceed with the automatic updating of information, e.g. information systems concerning passengers, itineraries etc., these shall be determined by the Contractor during the Design phase.

5.4 Emphasis must be given on the security of the vehicles' wireless communication system with the Depot. It should be protected against malicious acts, or acts involving tapping or interference, such as unauthorized access by persons not belonging to the Operations or Maintenance Personnel.

5.5 The supply of the appropriate software is required for the management of the entire provided equipment and the WiFi APs, to be installed in the OCC. The provided software shall consist of a uniform system, which should incorporate the NMS system and the functionality of the Wireless Controller.

5.6 The software should be easy-to-use both for the user and the administrator. It should allow the user to easily and quickly deal with the various events and record data in external storage media and data bases.

5.7 The software shall be capable of monitoring all types of equipment, up to 3 different systems, which shall supervise the following:

- The switches and the local network where it shall be expanded
- The Firewall/Security Gates in the OCC and the network security services
- The equipment for radio links.

5.8 The management platform should provide a graphical display of the network devices, the network and its services, should monitor them and provide information about their faults. The display must be comprehensive and give the network managers a representative overview of the status of the network and its services. Its capacities -with regards to the network monitoring- should indicatively be as follows:

- Automatic tracking of devices and services
- Graphic display of the topology at different levels
- Events Handling and Management

- Representation of problems in real time
- Collection and display of statistics related to the network use and saturation.

5.9 The basic operation of the provided platform shall be the management of the network and its services. The basic management operations for the entire equipment shall be as follows:

- Management of the operational system (upgrading, adding modules etc.)
- Versioning of the equipment setup and back-up
- Back-up logs of the management software and its configuration
- Moreover, the management platform should provide a suitable “interface”, so that it is possible to expand it and connect it with third party devices.

5.10 The system shall be supported by a powerful and comprehensive NMS diagnostic system to supervise the proper operation, acknowledgement and registration of faults, collection, management and registration of communication data.

5.11 In this framework, the Contractor should implement the appropriate technical and organizational measures, in line with the applicable GDPR legislation for the security and protection of the log files of the aforementioned data.

5.12 In general, the software should allow the administrator to update it in a useful manner with new corrections and versions.

5.13 The software installation in all PCs is the responsibility of the Supplier and the Contractor.

5.14 The Contractor shall present to ATTIKO METRO S.A. for approval his proposal to link the menu with the software architecture. The details for the different practices and functionalities shall be specified during the design phase.

6. NETWORK INFRASTRUCTURE

6.1 The network infrastructure shall be exclusively used by the WIFI system. It consists of network switches. The switches shall be connected via single-mode fiber optic cable installed and terminating at 19' racks at appropriate locations within the area of the depot, to be determined in cooperation with and further to the approval of ATTIKO METRO S.A..

6.2 The basic composition of the system shall consist of a central switch type layer-2 in the workstation area and a peripheral switch type layer-2 with air-conditioned cabinet – outdoor rack near the shed. The peripheral switch shall collect the load of the Wi-Fi APs and shall be connected via a single-mode fiber optic cable with the central switch to be connected with the workstation and the recording devices.

6.3 The central switch should provide the required bandwidth, the QoS and the routing based on the policy related to the transfer of all types of information, such as video, voice, data, image etc.

6.4 The central switch should support basic routing protocols, i.e. unicast IP, VLAN, Spanning-Tree Protocol (IGMP), access control lists (ACL), DHCP and SNMP interface, IEEE 802.1Q and IEEE 802.1p.

6.5 The peripheral Access switches shall be developed to provide high performance interconnection between the central switch and the access points AP WLAN.

6.6 The peripheral Access switches shall consist of Ethernet ports 8/12/24/48 x 10/100/1000Base-T, with at least 1 x port 1000Base-T/1000Base-SX SFP Gigabit Ethernet connected with the central switch.

6.7 The Access switches shall support the configuration VLAN, PoE, Spanning-Tree and shall comply with IEEE 802.af/IEEE 802.3af, which supplies power through a uniform UTP copper cable for WLAN AP.

6.8 The access switch shall be used to connect the APs. The Contractor shall specify the maximum power charge of the devices to be connected with the PoE access switches. The Contractor shall provide additional PoE access switches if the overall power charge by the PoE devices exceeds the maximum power charge of the PoE access switch.

6.9 All switches shall be industrial type, modular type and suitable for various types of interface cards/units, providing flexibility in their hardware configuration and assembly. Moreover, they shall be equipped with the appropriate type and number of ethernet ports, in accordance with the requirements for data transfer between interfacing systems and in line with the Detailed Final Design. During the delivery of the Project, redundant ports

shall be provided equal to 20% of all ports, per type of port and location where they shall be available.

6.10 The switches shall be extremely reliable, shall not require any optional maintenance and the environmental conditions for operation shall be as follows:

- Temperature: -20^{o} C to +60^{o} C (outdoor).
- Temperature: -10^{o} C to +50^{o} C (indoor).
- Related humidity: >85%.

6.11 The Contractor shall provide distributors, plugs, terminals (to the patch panel and the cameras) of the network cables, including also the proper devices for protection against overvoltage to protect cabling, the network switch and the camera. The Contractor shall be responsible for designing these devices, selecting and supplying the protection items against overvoltage and installing them.

6.12 For reasons of additional protection against surges and interference, the switch shall also be equipped with:

- Metal frame at the RJ45 ports to be connected with the metal frame of RJ45 couplers to be plugged
- Earthing connection Point
- IP20 protection.

6.13 The Contractor shall provide a fiber optic cable for interconnecting all switches, with at least 12 fibers, shielded, with rodent and moisture protection. The fiber optic cable shall have SM fibers with Operating Wavelength 1310nm or/and 1550nm.

6.14 For reasons of installation of the fiber optic cable, the Contractor shall use the existing routing infrastructure and, if this is insufficient and an additional one is required, the Contractor shall install a new routing, upon agreement with ATTIKO METRO S.A..

6.15 The Firewall policy should be applied to check the network traffic, thus prohibiting various public users to access the interior parts of its network.

Spec. Code	Specification Description
TR_S_DP270002	CLOSED CIRCUIT TELEVISION SYSTEM (CCTV)

CONTENTS:

1 SCOPE AND PURPOSE

1.1 The Contractor shall design, supply, install, test and commission a state of the art Closed Circuit Television System (CCTV), that will be used for real time visual surveillance and inspection in the areas of Elliniko Depot and mainly in the new shed where trains will park 24 hours/ day, 7 days/week. Camera images from these areas shall be recorded at specially defined locations.

1.2 All areas of the Depot shed shall be equipped with the appropriate devices and the relevant management software shall be used for the CCTV system. The main purpose of the CCTV system shall be to control and protect, remotely from the Operations Control Centre, against non-authorized entry-exit in areas of critical importance for the stabling of tramway vehicles.

1.3 The Contractor shall supply cameras - fixed and PTZ ones depending on the depicted point - for recording images from inside the shed for safe stabling of the tramway vehicles. Cameras shall be installed covering all hidden corners or blind spots and shall satisfy all necessary distances for full coverage.

1.4 The interface between the CCTV cameras and the control area (centre) shall be ensured via the appropriate, new fiber optics network through which each camera shall be connected allowing real time transmission of camera images to the equipment of the Control Centre. The Contractor shall provide the pertinent equipment in the Control Centre for the system operation by the personnel.

1.5 The Contractor shall design and implement the installation of fiber optic cable using the existing routing infrastructure, if available, and shall manufacture a new routing infrastructure when the relevant infrastructure is missing. Moreover, the Contractor shall provide the necessary equipment for digital transmission and any copper cabling needed.

1.6 The Contractor shall supply the necessary outdoor cabinets for the power supply of the cameras and the necessary active equipment for the transmission of data and images to the camera workstation and management software.

1.7 The CCTV system shall meet the regulations related to image quality, storage period, encryption level, data continuity (legal/ police requirements) and shall adhere to the legislation on personal data protection (GDPR). Cameras shall be properly installed as to be protected against vandalism.

1.8 The CCTV system shall be installed and set in operation by the Contractor in line with the project needs and the specification requirements. The exact location and total number of cameras, their operation and surveillance method shall be finalized at the Detailed Final Design Level in due respect of the limitations specified in the following paragraphs.

1.9 With regard to the tests executed before the system is set into operation, the Contractor shall submit for approval the detailed test procedures, including method statement, test standards, applicable standards, acceptance levels of the measurement parameters and any other necessary required item.

1.10 The central CCTV system to be supplied shall be expandable with the installation of additional cameras in the future. As a minimum, any expansion shall meet the requirements for full coverage of all areas in the Depot and the Depot outer perimeter, as well as of any additional tramway stops likely to be required and which are located within the area of Elliniko airport under development up to the connection of the Tramway line with the Metro stations (ARGYROUPOLI/ELLINIKO). Within this framework, the Contractor shall cooperate with any future Contractor to be assigned with this additional extension in order to ensure the expandability (in terms of materials and software) of the entire system.

2 GENERAL TECHNICAL CHARACTERISTICS

2.1 Current specifications concern the supply, installation, customization, parameterization, testing and commissioning of the CCTV system uninterrupted operation that will ensure surveillance of the outdoor areas of the shed during day and night providing high coloured images regardless of lighting and the prevailing weather conditions.

2.2 The CCTV system covering the aforementioned areas shall store image and video continuously on a 24-hour basis. It shall be digital, network-based, of IP technology and it shall consist of the following components:

- Fixed and PTZ cameras
- Network-based Digital recording of images (NVR)
- Workstation also used as operation console
- Monitor for video screening
- Image and video management and processing software
- Uninterrupted Power Supply System (U.P.S)
- Network equipment
- Cabling (Fiber Optics).

2.3 The above requirements can be met on condition that the respective system components are properly installed and customized.

2.4 A total of eight (8) IP HD outdoor cameras shall be installed. A number of cameras shall be connected via star connection at the switch with a network copper cable or an optical fiber cable for outdoor use and UV resistant.

2.5 Camera inputs shall be recorded to a Network Video Recorder (NVR) connected to a central switch; It shall be either equipped with built-in hard discs or hard discs shall be ensured separately through the connection with the workstation. The option shall be finalized at the Detailed Final Design level for optimum results and further to AM's approval.

2.6 Respectively, camera images shall be assigned in two (2) monitors at the OCC from which personnel shall monitor and manage camera images in real time as well as stored videos and incidents. Monitors shall be connected to the NVRs and to the central computer/workstation.

2.7 The VMS software shall carry out management from the workstation/computer. However, it shall also be possible to perform the management from the recorders. To this end, central computer/workstation shall be server-grade and the Contractor shall ensure that it is properly equipped to fully meet the operational requirements of the system.

2.8 All incidents shall be recorded locally and shall be stored on a database for future evaluation. At the same time, video originating from any area shall be available either live or in playback mode at the control room, since the system shall provide the possibility for simultaneous online connection with all facilities via special software (remote client).

2.9 The central computer/workstation shall meet the necessary specifications for compatibility and compliance with the software requirements and the interface requirements, e.g. 2 monitors for the cameras (if they are not connected to the NVR), network card(s) for connection to the NVRs and the switch, etc.

3 CAMERA SPECIFICATIONS

3.1 Cameras shall be coloured, suitable for day/night operation, digital, network-based, of high resolution and IP technology.

3.2 All devices shall have CE and EMC marking in line with the EU directives.

3.3 The following characteristics shall be shown on all cameras (bullet or dome), unless otherwise specified:

- Outdoor use
- IP and PoE technology
- Dual Stream (dual codec)
- Color/B&W, On/Off/Auto, IR-cut filter removable (ICR)
- Full compatibility with the ONVIF standard
- Possibility for night video recording with camera built-in IR or with an external IR projector of the appropriate range. Infrared shall be activated automatically.
- Optics
  - 2 Mpixels resolution minimum
  - CMOS 1/3" sensor
  - Remote zooming (≤3) – (≥6,1mm), network operated zooming fully open diaphragm F≤1,4
  - Automatic switching to day/night mode, ultra low-light sensitivity
  - Coloured image ≤0,3LUX (Fully open diaphragm, 1/30sec, 50IRE)
  - AF focus or network-operated zooming
  - Automatic diaphragm setting.
- Image
  - Day/night
  - Resolution 1080p (1920X1080), 720p(1280X720)
  - Possibility for automatic adjustment of the signal value (Automatic Gain Control - AGC)
  - Counterbalancing dark objects from light backgrounds
  - White balance Auto / manual
  - Auto electronic shutter speed
- Video
  - Compression H.264, MJPEG
  - Video frame rate 15fps minimum and/or
    25fps or more for 1920×1080 resolution
  - Quality image adjustment/ Bit Rate
- Video Analytics
  - Motion detection, area selection
  - Intrusion
- Slot for Micro SD memory card.
- Interface possibility with PC
- Network
  - RJ-45 10/100Base-T connection and PoE possibility

- Protocols: IPv4, IPv6, TCP/IP, UDP, RTP, RTSP, NTP,HTTP,HTTPS, SSL, DHCP, FTP, SMTP,ICMP, IGMP,SNMP, DNS, DDNS
- Supporting the following protocols: IPv4/v6, HTTP, HTTPS, QoS Layer 3, DiffServ, FTP,SMTP, Bonjour, UPnP, SNMPv1/v2c/v3 (MIB-II), DNS, DynDNS, NTP, RTSP, RTP, TCP, UDP, IGMP, RTCP, ICMP, DHCP, ARP, SOCKS,
- Security SSL/TLS

- Environmental requirements
  - Possibility to operate at temperatures ranging from -10°C to +50°C,
  - Operable relative humidity range 10 - 85% RH
  - IP 66 protection
  - IK10 vandal proof
- Signal Noise (S/N) ratio: 50 dB minimum.
- Digital Noise Reduction (DNR).
- Certificates of compliance: EN 55022, EN 55024, EN 60950-1, EN 61000-6-1,EN 61000-6-2, FCC Part 15 Subpart B Class B, VCCI Class B,C-tick AS/NZS CISPR 22, ICES-003 Class B.

3.4 Fixed Cameras (dome or bullet type)

The Shed perimeter shall be covered using fixed coloured day/night cameras installed at the roof and fixed on suitable mounts. Where the relevant infrastructure is not available, cameras shall be installed inside a waterproof casing equipped with a mounting bracket. Cameras shall meet the following minimum technical characteristics:

- They shall be digital, day/night, for outdoor use close to marine environment.
- They shall include video motion detection and active tampering alarm function.
- They shall have H.264 support, Motion JPEG streams and shall be compatible with the existing or the new VMS.
- They shall have an auto iris lens.
- They shall be equipped with Varifocal lens.
- They shall be able to accommodate variable focus lenses depending on the area coverage requirements applicable to each camera.
- They shall have a built-in dehumidifier.
- They shall have an OnVIF profile capable of integrating algorithms for images on the same camera; cameras shall be compatible with the existing or the new VMS.
- Minimum illumination: Color: 0.1 lux, B/W: 0.02 lux, F1.2
- Security: Password protection, IP address filtering, digest authentication, HTTPS encryption.
- They shall feature the virtual - digital zoom function, manual and auto, with preset check points.
- They shall feature the following image settings: Compression, color, brightness, sharpness, contrast, white balance, backlight compensation, fine tuning of behavior at low light, rotation, mirroring of images, text and image overlay, exposure zones, exposure control, privacy mask.

3.5 Non-Fixed (Speed/PTZ) Cameras (dome or bullet type)

Inside the shed and at specific locations at least two (2) new preferable dome coloured cameras shall be installed for the surveillance of the area and its set purpose. These cameras shall be protected by a suitable waterproof housing and shall be supported on a mounting bracket. Cameras shall not have a mounting bracket depending on the location specified for their installation. Cameras shall satisfy the following minimum technical characteristics:

- They shall be digital, PTZ, day/night, for outdoor use close to marine environment.
- The mode for automatic detection and monitoring and the mode for simultaneous recording of the entire camera field (picture in picture).
- The possibility for image/frame zooming at least 18x visual and 12x digital, with auto focus.
- An OnVIF profile capable of integrating algorithms for images on the same camera; cameras shall be compatible with the existing or the renewed VMS.
- Possibility for integrating algorithms for image in the same camera.
- Security: Password protection, IP address filtering, HTTPS encryption IEEE 802.1X network access control, digest authentication, user access log.
- PTZ characteristics: E-flip, 100 preset Pan positions: 360° endless, 0.05° – 450°/s Tilt: 220°, 0.05° - 450°/s, 18x analogue zoon of image frame and 12x digital zoom of image frame.
- PTZ functions: Guard Tour, Control Queue, on-screen directional indicator.
- Image settings: Wide dynamic range, manual shutter time, compression, color, sharpness, white balance, exposure control, exposure zones, backlight compensation, rotation, text and image overlay, image freeze on PTZ.
- Speed of horizontal/vertical motion: Manual, 0.5°/sec ~ 90°/sec, Minimum speed 200°/sec.
- Rotation angle: 360° continuous
- Camera with heater capabilities.

4 NETWORK VIDEO RECORDER (NVR)

4.1 Camera images shall be recorded on a network video recorder (NVR) supporting the recording, monitoring and reproduction of IP high resolution cameras.

4.2 The NVR unit, as proven from the relevant certificates, shall be interfaced and controlled through the network from the central control panel at the workstation.

4.3 Video signals recording analysis shall be totally independent from the analysis of network-transmitted image (TCP/IP), which may also be set in each video channel independently.

4.4 The speed for live video streaming on the monitor shall be greater than or equal to the maximum speed for recording.

4.5 Recorded digital image shall be stored in a built-in hard disk in compressed form. The compression algorithm shall be of the latest version MPEG4 or H.264 Advanced Video Codec for the best possible compression of data.

4.6 The total capacity of built-in hard disks shall be at least 10 TB. To maximize the storage capacity of hard disks, it will be possible to choose the compression protocol H.264/H.265/MJPEG. Simultaneous recording of video signal through network (remote recording) shall be possible, i.e. at the hard disc of the interfaced PC.

4.7 The aforementioned unit shall be able to execute simultaneously the following functions:

- Real-time display
- Recording
- Reproduction
- Backup (output) of video files
- Simultaneous file recording and real time display.
- Coordinated reproduction of the video recorded by multiple cameras.
- Possibility to search the recorded material based on date, time, period with no recording, incident and to perform a smart search.
- Possibility for digital zoom during reproduction of the recorded video.
- Possibility for faster or slower than normal reproduction of the recorded video (Fast Forward or Slow Motion). Possibility for several reproduction speed rates (including the normal reproduction rate).
- Possibility to conceal selected cameras. Image from these cameras shall be recorded but shall not be displayed on the operator's monitor.
- Image transmission either at a Constant Bit Rate or at a Variable Bit Rate.
- It will include a file for the recording of system functions (recorded incidents, remote or local connection, etc), which will be also accessible from the remote management application.
- Possibilty building-in video analysis systems for cameras and its own analysis of the video algorithms.
- Possibilty to prevent unfragmented video archiving, so as to ensure long-term system operation without maintenance.
- Support of peripheral clients through the network.

4.8 The NVR system shall satisfy the following minimum technical characteristics:

- At least recording speed 100Mbps
- Internal hard drive for video storage - Installed capacity at least 10TB

- ONVIF compatibility
- HD image resolution
- Compression H.264 and MJPEG
- Multiple streaming from the same camera for recording, display and backup of at least 2 streams
- Constant Bit Rate or Variable Bit Rate image transmission
- Interface ports: at least three USB ports – USB 2.0 or 3.0
- Built-in DVD recorder (DVD-RW) for copying and exporting data
- HDMI display port
- Ethernet 2 x RJ-45 10/100/1000Mbps
- IP devices automatic tracking
- Network Protocols IPv4, TCP/IP, HTTP, RTSP, UPnP, UDP, SMTP, NTP, DHCP, DNS, IP filter, PPPoE, FTP
- Data security, image and audio encryption and passwords for users and Administrator
- Operating temperature range 5^{o} C ως $+40^{0}$ C and humidity <85% RH
- Power Supply 100-240V AC ±10% 50/60Hz
- Accessories: Keyboard and Mouse
- Wide-angle screens and cameras' touch screens.

4.9 The access to the NVR system shall be controlled via a username and a password. The option shall be provided to assign different access levels with different permissions for each level. The permissions specified through the access levels shall the following, but not limited to them: Image file search / playback, alarm acknowledgement, image retrieving on screen, exporting recorded image and programming files, access to the NVR menu, NVR customization, logging options selection, customizing alarm events, database management, system configuration adjustment, assigning names and narratives per camera or event, switching the logger off. The system administrator shall have access to all permissions; it shall not be possible to delete the administrator, while it shall be possible to change only the access password.

4.10 The offered equipment shall include all necessary software and licenses for the remote control of the system, including the software for the workstations. The remote control software operating system shall be at least Windows 10.

4.11 The NVR shall be able to simultaneously record and play back (recorded or real-time) images without affecting the image quality, as well as to create and maintain a log file of all events (user access, user actions, alarms, etc).

4.12 NVR shall be controlled both locally (from the physical location of each device), as well as centrally over the network. Central control shall be implemented via computers where the appropriate management software is installed.

4.13 Information such as alarm, camera title and date / time shall be incorporated in the NVR. It shall be possible to stop logging / overwriting data when the hard drive is full. The user shall receive a message whenever there is a failure or when the hard disk is full. It shall be possible to export the contents of the hard drive a USB device. The NVR shall come with special dedicated software permitting remote control and surveillance of a recorded or 'live' video feed from a camera over the TCP/IP network.

4.14 The system shall support the function of defining the maximum number of days in which a recorded video is available. Under no circumstances (even when free space in the hard disk is available) shall there be a video file available for more than the predefined days (e.g. 14 days). This configuration can be implemented individually for each camera (e.g. camera 2 can record up to 7 days, while camera 4 to 15 days).

5 WORKSTATION - SYSTEM MANAGEMENT AND RECORDING FOR THE AREA SURVEILLANCE

5.1 The workstation to be installed by the Contractor shall consist of an industrial type PC which shall be of server grade class and shall have the VMS-Video Management Software installed.

5.2 The workstation computer shall have the latest Windows (at least Windows 10) operating system and the necessary software of the system installed. Installation of the operating system and the VMS software on the computer is the Contractor's responsibility. The Contractor shall ensure that the computer is properly equipped to fully carry out all the functions of the system.

5.3 The workstation shall consist of, among others, standard desktop and reliable computer, heavy-duty, with off-the-self operating system installed, of color printer at least A3 size paper, etc. Communication with the cameras shall be carried out via the local fiber network to be installed. The workstation will be identical in terms of hardware / software and all functions shall be optimally executed. The possible wiring within the control center required for data transmission, forms part of the project scope.

5.4 It shall meet the required specifications so as to be fully compatible with the software, as well as the interface requirements, e.g. 2 monitors for the cameras (if not connected to the NVR), network card (s) for NVR connection to the switch etc.

5.5 The system shall be supervised by two (2) high resolution monitors at least 24". In case the Video Management Software (VMS) runs on the computer, the 2 separate monitors for the cameras shall be connectable to the computer. In this case as well, each camera shall be assigned to a different monitor, i.e., each monitor shall display a different image.

5.6 The Contractor shall provide at least two (2) digital high resolution and sharpness LED monitors, for best image quality. The monitors shall be connected to the central control system's workstation and depending on the user's choice shall display a full-screen image, a combination of 4, 8, Full Screen images. The monitors shall satisfy the following characteristics as a minimum:

- 24 to 40 inches
- Full HD 1920 x 1080
- Refresh Rate 200Hz
- Adjustable brightness, contrast and color rendering
- HDMI port
- 220-240V AC, 50-60 Hz

5.7 The Contractor shall supply the mouse and keyboard required for the operation, customization and adjustment of the system via the logging devices and the host computer.

5.8 The Workstation shall support the management of cameras via the appropriate software for managing the entire system. Key features and characteristics of the workstation include:

- User and role management
- Alarm management
- Playback Operation
- Diagnostic functions

- Maintenance

5.9 The playback station shall be capable of displaying moving image ('video'), and the following functions shall be available:

- Normal “forward” / “rewind”
- Fast “forward” / “rewind”
- Image freezing and pausing
- Frame forward / rewind display
- Search based on time and date
- Various display modes, selection of only one camera, synced image display, etc.
- Switching camera feeds at specific times, without executing a new time search
- Zoom function.

5.10 The Workstation shall support embedded Video analytics /intelligent CCTV systems technology. It shall consist of a central unit, where it will be possible for one or more system operators and administrators to be connected for future use.

5.11 In particular, the central unit or computer (server type) shall manage the system user rights, alarm events, two-way communication characteristics, the intelligent security system rules.

6 SOFTWARE

6.1 The Contractor shall supply a Video Management Software (VMS) running on the NVR or on the server. It shall also be possible to locally view / manage client VMS cameras. In case where link with the camera is lost, video shall be exported from the camera's local memory card and generally the camera it shall be possible to get managed and maintained via a local connection to a laptop camera.

6.2 The software shall be user-friendly, both at the user and administrator level. It shall permit the user to manage events and export easily and quickly all associated video files to external storage media.

6.3 Any Video Management Software (VMS) licenses shall cover the full capacity in cameras of the NVR and hard discs, regardless of the number of cameras originally installed.

6.4 If the client VMS is not web-based and licenses are required, at least three (3) licenses for shall be provided for this software, which shall be installed on respective computers provided by the Contractor.

6.5 Direct (local) connection of a laptop to a camera shall also be possible, in order to export video files from the local memory card on the camera, to perform software upgrades and maintenance, in general. If this feature is not web-based, the relevant software running on the most recent Windows (at least Windows 10 or later) environment shall be provided. In case this software requires a license, at least two (2) licenses shall be provided. The Contractor shall supply one (1) suitable laptop, with the necessary software installed.

6.6 The option shall be provided to capture images, along with data related to date, time, camera ID, and camera location. Time and location synchronization data shall be received from another system. All images shall be stored in one single location, in a shared data storage medium.

6.7 It shall be possible to remotely access the data loggers via a special security procedure, such as user identification and password, using a special key, so as to enable viewing the recorded data later on another computer system.

6.8 It shall be possible to export individual image or video files in their usual file format (e.g. "JPEG", "AVI", "MPEG"), to be digitally stored.

6.9 The VMS software shall be fully compliant with the ONVIF standard; at startup it shall run a diagnostic routine and shall perform at least the following functions:

- On-screen selection of the number of live image cameras and their layout
- Remotely-controlled zoom and focus functions for each camera
- Remote customization of cameras
- Remote programming/ customization of the video analytics
- Adjustment of video fps/quality for each camera
- Remote control of PTZ cameras (future use)
- Programmable, constant of even-based recording
- Action planning in case of an event
- Real time display of events
- Recording on the basis of the video analytics event from cameras, as well as storage for future retrieval and export
- Adjustable length of recording before and after the event
- Time-bases search of events

- Play, fast/slow play, fast/slow rewind, frame by frame, full screen, zoom
- Simultaneous playback of video feed from multiple cameras
- Backup of simultaneously recorded video from multiple cameras on a USB memory stick
- Extracting a picture from a video stream and backup on external storage media
- Automatic searching of cameras and their IP address
- Access control by means of distinct passwords for at least two user levels: plain user and administrator
- User/administrator access Log file

6.10 The software shall enable the administrator to easily update it with new upgrades and releases.

6.11 The Contractor is responsible to ensure the correct and complete function of the software on all computers, cameras and NVR.

6.12 The system shall be supported by a robust and comprehensive diagnostic system for monitoring proper function, fault detection and storage.

6.13 The Contractor shall propose to AM for approval, the menu structure and the software architecture. Details concerning the various uses and functions shall be determined during the design phase.

7 NETWORK INFRASTRUCTURE

7.1 The network infrastructure shall be exclusively used by the CCTV system. It shall consist of network switches. The switches shall be interconnected via single-mode fiber optic cable installed and terminated on 19″ racks.

7.2 In its basic configuration, the system shall have central layer-2 switch near the workstation and a layer-2 peripheral switch in an air-conditioned outdoor cabinet/rack near the shed. The peripheral switch shall collect the load of all cameras and shall be connected via the single-mode optical fiber to the main switch, which shall be connected with the workstation and NVR and storage media.

7.3 Switches shall be industrial (for outdoor use) and regular, modular type and shall accept various types of card / interface units, providing flexibility in the configuration of their hardware and assembly. They shall also be equipped with the appropriate type and number of ethernet ports, in accordance with the data transfer requirements of the connected systems and according to the DFD. Upon delivery of the project, redundant ports equal to 20% of the total number of ports shall be made available, per type and location of each port.

7.4 The switches shall be of high reliability, shall not require any optional maintenance work and the operating environmental conditions shall be:

- Temperature - 10° C to +60° C
- Relative humidity: > 85%
- IP 67 (for the outdoor use)

7.5 The Contractor shall provide distribution frames, connectors, terminals (on patch panels and cameras) of the network cables, along with the appropriate overvoltage protection devices to protect the cabling, network switch, camera and other sensitive sections. The design of these devices, the selection and supply of overvoltage protection circuits and the installation of the devices constitute the Contractor's responsibility and shall be effected upon ATTIKO METRO S.A.'s approval.

7.6 For additional protection against overvoltage and interference, the switch must have:

- metal frame on the RJ-45 connectors so that it is connected to the metal frame of the RJ-45 ports
- earthing connection of the switch frame (earthing terminal or screw)
- IP 20 protection

7.7 Connection among switches shall be implemented by the contractor by means of a shielded fiber optic cable containing at least 12 fibers, providing protection against rodents and moisture. The fiber optic cable shall be equipped with single-mode (SM) fibers with a working wavelength of 1310nm and / or 1550nm.

7.8 As regards the installation of the fiber optics cable, the Contractor shall use the existing cable routing infrastructure and – in case this does not suffice - he shall construct new routes, having previously proceeded to the subject design and having ensured the pertinent approval by ATTIKO METRO S.A..

Spec. Code	Specification Description
TR_S_ DP015250	SIGNALLING AND POINT MACHINE CONTROL SYSTEM, DEPOT MANAGEMENT SYSTEM AND TRAIN IDENTIFICATION SYSTEM

TABLE OF CONTENTS

1. SIGNALLING AND POINT MACHINE CONTROL SYSTEM – DEPOT MANAGEMENT SYSTEM – TRAIN IDENTIFICATION SYSTEM

1.1. SCOPE OF TECHNICAL SPECIFICATIONS

The Technical Specifications of the Signalling and Point Machine Control System define the basic design principles, the operational and technical requirements of the equipment related to the execution of the Project by the Contractor, as it is described in the Scope of the Project of the Technical Description.

1.2. REGULATIONS, CERTIFICATIONS AND STANDARDS OF COMPLIANCE

The Signalling and Point Machine Control subsystems, the Depot Management subsystems and the Train Identification subsystems shall be designed, constructed and commissioned on the basis of the most modern Greek, European and international regulations and standards in the order of prevalence presented herein.

The Contractor shall state in writing and in a detailed manner in a separate paragraph in each relevant document of his documentation the standards, which each equipment item and its design comply with. The relevant references shall include the number of the standard and its title.

All systems shall have Electromagnetic Compatibility certifications for railway applications employing overhead supply networks. The Contractor shall document all prevention measures to eliminate the effects of electromagnetic interference.

Radio-frequencies related systems must have safe emission certificates on their frequency spectrum while the use of the emission bandwidth shall be documented.

1.3. DESIGN PRINCIPLES AND REQUIREMENTS

1.3.1. Basic Signalling Principles and Drive-On-Sight (Driving on the Driver's Visual Responsibility)

The basic signalling principles to be applied in the expansion of the Depot shall be compatible with the basic principles of the existing network, as these are stated in the applicable Tramway Operation Regulation. In general, a permanent speed restriction inside the Depot applies with a maximum permissible speed limit of 15km/hour.

Drive-On-Sight as basic principle of train movement means that the train driver is responsible for keeping distances between trains moving at the same direction and for adhering to the train circulation rules, restrictions and train priority circulation in routes exclusively reserved for tramway vehicles, in mixed traffic zones and in Depots.

Vehicles' conventional direction of travel is signalled at specific sections where light signalling is available and with which drivers ought to comply with. At the remaining sections, during vehicles conventional direction of travel, driving on-sight applies, as mentioned above.

Vehicle opposite direction of travel is not signalled and is executed based on specific procedures, unless otherwise clearly specified.

More precisely, during the project execution period, the operation of the Depot shall be adjusted in line with the provisions of §1.4.3.

The starting and the destination points of a route define the start and the end of the vehicle's route. Signalling conditions define the permissible conditions for train movement from the starting to the destination point of the route.

In the framework of the Detailed Final Design, the Contractor shall submit for approval a complete route table (with logic conditions) for the implementation of all permissible signalled routes, describing the entire interlocking logic of the equipment. For each route the remaining permissible and non permissible signalled routes shall be stated, on condition that they include common route or protection elements. All non signalled routes and individual shunting movements without an interlocking logic shall be included in this table or in another table with clear references to it.

In the design of the system the Contractor shall also take into consideration the implemented signalling logic at the interface boundary between the project and the existing project.

1.3.2. Critical Design of Systems

The design of the signalling systems shall follow the "fail-safe" design principle, so that the system responses are safe also during system failure. This means that all inputs (conditions) and outputs (responses) shall operate based on this design principle.

This specific design principle for critical systems is applied on both hardware and software of the system and should be documented accordingly by the system's designer with all due references to the implementation methods of each design.

1.3.3. Systems' design supporting future upgrading - modification - expandability

Control and surveillance systems shall be properly designed so as to support, depending on the system's architecture, the expansion and upgrading of the equipment and the functions served.

The hardware shall be able to be modified so that any additional equipment may be interfaced with the existing one. The software shall be customized so that any modification – expansion – upgrading does not necessitate re-programming of all functions.

1.3.4. Point Machine Control System

1.3.4.1. Brief Description

In the framework of a tramway system, the Point Machine Control System functions as a route controller and basically controls the movement of the motorized items of the point machines and the position of the turnouts for safe and sound routing of the tramway vehicles.

The system consists of individual control units of a point machine or a combination thereof controlling and supervising one or more point machines and other signalling equipment.

The system is interfaced with the outdoor devices so as to receive all inputs and to transmit all outputs further to the appropriate processing. It is also interfaced with the Depot Management System for remote control and supervision of the outdoor units and devices.

The Contractor shall install the Point Machine Control System depending on the geographical location of the point machines and may group the individual control units in one or more joint cabinets. Each cabinet shall have a joint power supply circuit and shall be interfaced with the remaining operational units (outdoor devices) through terminal strips.

1.3.4.2. Basic Functions

The Point Machine Control System carries out the following basic functions without being exclusively limited to them:

- Activates the electric point machines at the desirable position and activates the point indicators for informing the driver on the point position.
- Communicates with the light signalling system to receive and process management instructions (activation) of the light signals for traffic control.
- Protects the operation of the electric point machines through the train position detection system, namely the electrical interlocking of the point machine movement to prevent operation when trains pass by the area of the crossing.
- Local automatic operation of the electric point machines (in case local operation is required) through a local operation panel placed adjacent to the point machine. For activation of this operation mode, all logic conditions allowing movement of the point machine shall be met.
- Communicates with the Operations Control Centre (OCC) to transmit real time data on the supervised position of the electric point machines and the other signalling items.
- Communicates with the Operations Control Centre (OCC) to execute commands for vehicle route setting.
- Communicates with the Operations Control Centre (OCC) to transmit diagnostic data of the system and its sub-systems.

1.3.5. Point Machines

1.3.5.1. Brief Description

The Contractor shall install a total of twenty two (22) point machines at an equal number of turnouts of the new Depot expansion trackwork and one (1) point machine to provisionally replace the existing point machine no. 6 at the entrance of the Depot, as described in the Technical Description.

Point machines shall be complete and shall be equipped with all their fittings and accessories and with their entire control and interface equipment. The types of the point machines to be used are stated in paragraphs §1.3.5.2, §1.3.5.3 and in para. §1.3.5.4.

The exact Kilometric Positions of the point machines shall be finalized at the Detailed Final Design phase.

1.3.5.2. Electric Point Machines

The Contractor shall install eleven (11) electric point machines (at an equal number of converging tracks) at the ladder turnout of the trackwork at the entrance - as foreseen in the contract - of the new Depot expansion.

These point machines shall feature a position detector and shall not bear a mechanical interlocking. Electric point machines shall be controlled by the Point Machine Control System, as stated in para. §1.3.4.

At the future exit turnout of the Depot, at the outer track of the new expansion no electric point machine shall be installed; however, provision shall be made for future installation. To this end, switch point clamps shall be installed at the trackwork. At the current phase, these are not incorporated in the design of the system.

1.3.5.3. Manually-operated Point Machines

The Contractor shall install eleven (11) manually-operated point machines (at an equal number of diverging tracks) at the ladder turnout of the trackwork at the exit - as foreseen in the contract - of the new Depot expansion.

These point machines shall not bear a mechanical interlocking and shall be trailable using the appropriate damping devices - mechanisms.

1.3.5.4. Manually-operated Point Machines with return mechanism

The Contractor shall install one (1) manually-operated point machine without mechanical interlocking and shall be fitted with a spring-back mechanism which shall return the switch point to the pre-set after trailing.

The basic pre-set position shall be at a straight line position when vehicles exit the Depot. When vehicles enter the Depot, the mechanism shall be trailed and once vehicles have passed it, the mechanism shall be reset to the straight line position.

1.3.6. Point Indicators

1.3.6.1. Brief Description

The Contractor shall install eleven (11) two-aspect point indicators adjacent to an equal number of electric point machines. Point indicators shall be complete, equipped with all fittings and accessories and their entire control and interface equipment.

The Point Indicators shall operate via a circuit, which will set their brightness and be controlled by an outdoor light sensor. Their day/night operation shall reduce brightness down to a level, allowing for the pertinent indications to be visible and distinct under low-light conditions.

The circuit controlling switching shall be fitted with the appropriate settings, so that light increase/decrease for a short time period may not allow for instant switching. Instant switching not related to constant changes in the illuminance of the surrounding area must be avoided.

The exact kilometric positions of the point indicators shall be finalized at the Detailed Final Design phase.

1.3.6.2. Basic Functions

Point Indicators signal the position of the switch rails of the turnout and shall bear the following indications:

- "W1" for proceeding straight ahead with speed restriction of 15 km/hour
- "W2" for right diverging with speed restriction of 15 km/hour or
- "W3" for left diverging with speed restriction of 15 km/hour

1.3.7. Vehicle Position Detection System

1.3.7.1. Brief Description

The Vehicle Position Detection System detects whether a vehicle is present on a specific area of the track, so as to transmit the information to the Point Machine Control System, and to process and execute its responses. The System consists of the track equipment (track circuits or mass detectors) and the rack equipment.

The Vehicle Position Detection System shall be complete, equipped with all its fittings and accessories and the entire control and interface equipment.

1.3.7.2. Track Circuit

The Track Circuit detects the presence of a vehicle on a track section due to shunting of the vehicle axles. The Contractor shall ensure and document the functional compatibility with the existing and the new Rolling Stock to be supplied (34 and 25 vehicles respectively).

The Contractor shall install the necessary number of track circuits for route reservation and release by the Point Machine Control System.

Depending on the technical solution that the Contractor shall propose, the minimum number of track circuits is estimated to thirteen (13), out of which one (1) is the blocking track circuit in the area of the light signal before the first entrance turnout of the ladder turnout and twelve (12) release circuits after each diverging switch.

1.3.7.3. Mass Detector

Mass detectors detect the presence of a vehicle on a line section due to the existence of a steel mass. The Contractor shall ensure compatibility with the existing Rollick Stock.

The Contractor shall install at each turnout activated by an electric point machine a mass detector at the appropriate position within the turnout.

Depending on the technical solution that the Contractor will propose, an alternative solution of track circuits is allowed for the point machine electrical blocking.

1.3.8. Light Signalling System

1.3.8.1. Brief Description

The Light Signalling System concerns the light signals informing the driver on vehicle routing. Where light signalling is foreseen, the driver shall comply with the light signal aspects.

The Contractor shall install one (1) three-aspect light signal before the first entrance turnout of the ladder turnout of the expansion. The visual display unit shall be installed on a steel mast at the appropriate sight and orientation height.

The Contractor shall configure a new location for the existing light signal S1 and shall undertake to execute all dismantling, transportation and reinstallation works at the new proposed location.

The new location of the light signal shall be designed and implemented so as to be configured after the last turnout of the exit ladder turnout of the expansion and to continue to operate as an entry light signal to the existing project.

The exact Kilometric Position of the light signal S1 shall be finalized at the Detailed Final Design phase and shall include the entire equipment related to its position (i.e. base and mast, local control panel and illuminated board, track circuit, cabling etc.).

The Light Signaling system shall operate via a circuit, which will set the brightness of the light signals and be controlled by an outdoor light sensor. Their day/night operation shall reduce brightness down to a level, allowing for the pertinent indications to be visible and distinct under low-light conditions.

The circuit controlling switching shall be fitted with the appropriate settings, so that light increase/decrease for a short time period may not allow for instant switching. Instant switching not related to constant changes in the illuminance of the surrounding area must be avoided.

Light signals shall be complete, equipped with all their fittings and accessories and their entire control and interface equipment.

1.3.8.2. Basic Functions

The light aspects of the optical unit shall be as follows:

- “F0” for stop
- “F1” or “F2” for proceeding straight ahead or proceeding right respectively
- “A” for recording a routing request

1.3.9. Depot Management System

1.3.9.1. Brief Description

The Depot Management System supervises and regulates the traffic of vehicles inside the Depot in signalled areas. It informs the OCC operators on the status of the supervised equipment items in the field. It provides history and analytics for further processing through a

special application which cooperates with the Depot Management System. The application may be integrated in the main software or may be part of a third-party software interfaced with the main software of the application.

The system shall consist of the necessary number of PCs and servers with all their peripherals. A workstation with at least two (2) state-of-the-art liquid crystal displays of minimum dimensions of 21'' each.

The Contractor shall install a Depot Management System equipped with all its interfaces with the other systems. The system shall integrate the entire existing and new equipment of the Depot related to vehicle routing, display of the status of field equipment, connection with the entire Vehicle Identification System for existing and new parking places.

The Depot Management System shall be powered by the power distribution switchboard of the Management Building of the Tramway Operations Company. If necessary, the Contractor shall install a separate electrical sub-switchboard in a technical room to be suggested by the Service.

For the smooth operation of the OCC, the Depot Management System shall be equipped with small uninterruptible power supply units to be integrated in the area of the OCC.

1.3.9.2. Basic Functions

The Depot Management System operates the following basic functions without, however, being limited to them:

- Transmits routing orders to the Point Machine Control System.
- Receives and displays the field equipment operation status.
- Manages through the train identification system the optimum flow of shunts and movements inside the Depot.
- Records history data.
- Is interfaced with the Vehicle Identification System to display vehicle identifiers at the parking positions.
- Is interfaced with all systems for ensuring information of the OCC personnel.

1.3.10. Vehicle Routing Operation Local Panel

1.3.10.1. Brief Description

The Vehicle Routing Operation Local Panel ensures local operation of the routing commands for vehicles and oversees the corresponding control unit(s) of the Point Machine Control System.

The Contractor shall install one (1) local panel at the mast of the new light signal. The panel shall be equipped with illuminated buttons for movement options and a safety lock for unauthorized use.

The panel shall be equipped with all accessories and fittings and its entire control and interface equipment.

1.3.10.2. Basic Functions

The Vehicle Routing Operation Local Panel carries out the following functions without however being limited to them:

- Communication with the Point Machine Control System.
- Display of routing requests.

1.3.11. Parking Space Luminescent Display Panel

1.3.11.1. Brief Description

The Parking Space Luminescent Display Panel presents in numerical form the selected parking space where the vehicle reaches its final destination inside the new expansion.

The Contractor shall install one (1) luminescent panel displaying the parking spaces. It shall be mounted on the mast of the new light signal informing the driver on the final location where the vehicle will be routed. The panel shall have similar dimensions with the existing MS1 and MS2 panels of the existing light signals and shall display two (2) LED digits. It will be equipped with a support bracket fitted on the mounting mast and a visor ensuring visibility in sunlight.

The Parking Space Luminescent Display Panel shall operate via a circuit, which will set its brightness and be controlled by an outdoor light sensor. Its day/night operation shall reduce brightness down to a level, allowing for the pertinent indications to be visible and distinct under low-light conditions.

The circuit controlling switching shall be fitted with the appropriate settings, so that light increase/decrease for a short time period may not allow for instant switching. Instant switching not related to constant changes in the illuminance of the surrounding area must be avoided.

The panel will be complete with all its fittings and accessories and its entire control and interface equipment.

1.3.11.2. Basic Functions

The Parking Space Luminescent Display Panel shall be controlled by the Depot Management System.

Once vehicles are in front of the new light signal and the route of the vehicle is set, the panel shall display the number of the destination parking space.

1.3.12. Vehicle Identification System

1.3.12.1. Brief Description

The Vehicle Identification System shall ensure the identification of vehicles. Vehicles shall bear a unique identifier so that vehicles entering the parking space, allocated to them by the Depot Management System, are displayed on the OCC for traffic regulators to be advised accordingly.

The Contractor shall install one (1) Automatic Identification System with proven technology record, such as the Radio Frequency Identification (RFID) System.

The radio broadcasting equipment to be installed on the vehicles shall be mounted on the two vehicle ends. Some older trains are already equipped with transceivers identifying the vehicle at the stops of the network. The compatibility of these trains with the existing system must be checked. If there is no adjustment possibility, then the Contractor shall present a new approach for the implementation of the transceivers on the vehicles. Passive transceivers shall be supplied.

Readers shall be installed in close proximity to the parking spaces in a way which ensures clear identification of the vehicles per parking space. The Contractor shall submit a radio-coverage study presenting the directivity of the antennas and their location.

The Vehicle Identification System shall be fully equipped with all its accessories and fittings and its entire control and interface equipment. The Contractor shall equip the existing fleet (34 trains) and the fleet to be supplied (25 trains).

1.3.12.2. Basic Functions

The Vehicle Identification System performs the following basic functions without being limited to them:

- Communication of the base equipment (readers) with the vehicle transceivers for reception of the identifier's signal.
- Communication with the Depot Management System for displaying the vehicle identifiers.

1.3.13. Uninterruptible Power Supply System

1.3.13.1. Brief Description

The Uninterruptible Power Supply System shall be fed by the Low Voltage Distribution Panel inside the traction power substation. The system shall consist of one rectifier/charger and one inverter. It shall be equipped with a battery set, while in addition to the uninterruptible power supply branch (online configuration), it shall also be equipped with a bypass switch for automatic switching to the power supply network and one branch for manual bypass for maintenance reasons.

The Contractor shall calculate all protective and switching devices so as to ensure electrical isolation of the individual branches. The design shall ensure all necessary isolation transformers at the system's input and output. All integrated measurement instruments shall be digital. One (1) voltmeter, one (1) ammeter and one (1) frequency meter are required as a minimum.

The Uninterruptible Power Supply System shall be dimensioned so as to sufficiently power the systems of this Specification and the existing Signalling and Point Machine Control Systems with provision for future powering of two (2) additional point machine control units.

1.3.13.2. Basic Functions

- Uninterruptible Power Supply of the systems with an autonomy time of 10'.
- Operation and maintenance bypass branches.
- Voltage and current surveillance and alarm activation from the Depot Management System.
- Battery charging and surveillance.

1.3.14. Electrical Distribution Panel

1.3.14.1. Brief Description

The Electrical Distribution for the systems' consumption loads shall be powered by the Uninterruptible Power Supply System with regard to new consumption loads. The Panel shall be installed within the traction power substation technical room and adjacent to the existing power supply switchboard of the existing signalling installation. The protective and switching devices shall be rail components and properly sized, so as to cover the installed power supplied by the switchboard.

The existing distribution panel currently exclusively supplied by the power supply network shall be rewired at the output of the uninterruptible power supply.

1.3.14.2. Basic Functions

- Power supply of the field equipment and the systems in addition to the Depot Management System powered by a separate board.

1.4. OPERATIONAL REQUIREMENTS

1.4.1. Routing of Vehicles inside the Depot

1.4.1.1. General

The routing of the tramway vehicles inside the Depot following the execution of the works shall be carried out a follows:

When trains enter the Depot from the existing line, they shall move up to the new light signal upstream the entrance branch of the ladder turnouts of the new Depot expansion. At this point, the OCC shall route the vehicle through the Depot Management System.

If straight routing is set, then the driver, following the F1 signal aspect shall continue up to the existing light signal S1 and shall wait for a new routing. After this point, the operation shall follow the existing routing management.

If diverging routing is selected, then the driver shall follow the light signal aspect F2 and the train shall be routed as described in §1.4.1.2 below.

1.4.1.2. Entrance Routing at the New Depot Expansion

During diverging routing, the driver routes the vehicle at the final parking space allocated during train routing by the OCC or by the Vehicle Routing Operation Local Panel and follows

the aligned route on the point machines having as final destination the parking space signalled by the Parking Space Luminescent Display Panel .

1.4.1.3. Exit Routing from the New Depot Expansion

When vehicles exit the exit ladder turnout, the train driver shall route the train in line with the "Drive on-sight" rules up to the existing light signal S1 and shall wait for a new routing. After this point, the operation shall follow the existing routing management.

1.4.2. Operation during System Failure

In the framework of the Detailed Final Design, the Contractor shall submit all system failure scenarios and the anticipated redress duration, together with the description of the system's response or a combined response by both system and personnel.

If the Depot Management System cannot transmit routing orders, then the driver shall attempt routing, if foreseen by the operation procedure, through the local routing panel and with direct communication with the traffic regulators.

If the Vehicle Routing Operation Local Panel fails to set a route, then manual operation of the point machines is possible.

1.4.3. Routing during Project Construction

During project construction, vehicles shall enter the Depot through the existing point machines No. 5 and No. 6 (to be temporarily replaced) and shall run in reverse at the existing exit line of the depot up to the existing parking spaces or light signal S2 for routing inside the vehicle repair facility.

Entry movements shall not be signalled and shall be executed through a specified procedure. Exit routing shall apply as is; however, an additional procedure for regulating entry-exit shall be set.

1.5. EQUIPMENT TECHNICAL REQUIREMENTS

1.5.1. Equipment Cabinets and Panels

1.5.1.1. Location of Equipment Cabinets and Switchboards

The cabinets and switchboards to accommodate the equipment of the (sub-)systems and to be installed outdoors shall be properly located adjacent to the equipment they control or power. Equipment cabinets and switchboards to be installed indoors shall be properly located so as not to obstruct the use of the technical room.

Taking due account of the location-related limitations imposed by the existing facilities and equipment, the Contractor shall select and propose for use the appropriate location for the equipment cabinets based on the following criteria:

- Accessibility by the maintenance and troubleshooting groups in order to ensure sufficient space for accessing the cabinet and access around the cabinet, by calculating full and unobstructed opening of the cabinet doors.
- Availability of sufficient outdoor and indoor lighting.

- Visual contact with the field equipment that they control or power (outdoor cabinets).
- Operational limitations due to the cable length and/or wireless communication.
- They do not obstruct circulation at passage roads not intended for tramway vehicles and at the pedestrian walkways (outdoor cabinets).
- They do not limit visibility of any moving vehicle especially at crossings and they do not limit visibility of light signals and reflective signs (outdoor cabinets).

1.5.1.2. Placement and Installation of Equipment Cabinets and Switchboards

Outdoor equipment cabinets and switchboards shall be placed on a concrete foundation, embedded in the installation location. The concrete foundation shall be adequately high and its outer dimension shall ensure protection of the cabinet against collision and flooding. Cable ducts leading to the cabinet shall terminate on the upper side of the foundation and shall be embedded in it.

Cabinets and switchboards shall be properly installed on the foundation surface, so that there is no void between the upper side of the foundation and the bottom frame of the cabinet or switchboard, in order to exclude water inflow. The Contractor shall submit a structural design for cabinet support, which shall also include the appropriate width of the steel structure of the cabinet.

Indoor equipment cabinets and switchboards shall be founded on a steel base properly dimensioned and embedded on the location of installation. In case of raised technical floor, floor tiles shall be properly configured. Cable ducting towards the cabinet shall be ensured through the installation of grids.

In case of switchboards of smaller dimensions, wall-mounted installation with the respective cable routing trays is allowed.

Supporting and routing materials shall comply with the materials and accessories relevant requirements.

1.5.1.3. Construction Elements and Protection of Equipment Cabinets and Switchboards

Outdoor equipment cabinets and switchboards shall have an inclined upper part to prevent material and water retention.

They shall have as minimum an IP 53 rating against soil particles and water ingress in line with EN 60529 and an IK08 rating for protection against mechanical impact as per EN 62262.

Given that the above items shall be exposed to solar radiation during the greatest part of the day, they shall be equipped with fans for compressed air intake and louvers to exhaust the heat developed inside them taking due consideration of the worst case regional climatic data. Intake louvers shall be equipped with washable steel air filters.

Fans shall be activated through a two-level thermal sensor. Fan operation shall be ensured at the first level while at the second level a thermal alarm shall be activated which will be

transmitted to the OCC for on-time intervention of the maintenance personnel to reinstate an eventual fault of the fans or any other fault.

To prevent any sabotage to the cabinet and its equipment, cabinet doors shall have a safety lock to prevent unauthorised personnel access.

During cabinet door opening and in view of facilitating maintenance crews, the cabinet's interior lighting shall be activated through a limit switch, which shall be properly installed to ensure equipment illumination without obstructing access to other parts of the cabinet's interior. The lighting fixture shall operate with L.E.D. lighting technology and shall be easily accessible for repair or replacement.

1.5.1.4. Arrangement of Equipment Items inside Equipment Cabinets

The equipment placed inside cabinets shall be ergonomically designed and arranged per function. The equipment shall be structured in the best possible way with modules or switchboard rail materials.

The equipment through protection against unintentional contact shall separate locations due to dangerous voltage and current levels. These locations shall be properly labelled with electric shock risk warning signs.

The Contractor shall provide in the dimensioning of the inner usable space (and by extension of the outer dimensions), future extension and upgrading of the equipment by 20%.

The appropriate space shall be provided inside the cabinet to accommodate the drawings envelope.

1.5.2. Point Machines

1.5.2.1. Location of Point Machines

The location of the point machines shall be selected in line with the Technical Specifications of the Trackwork.

1.5.2.2. Foundation and Installation of Point Machines

Point Machines shall be founded and installed in line with the Trackwork Technical Specifications.

Point machines shall be interfaced with the control system through transverse routings to the corresponding structure of the cable routing system (as described in §1.5.8.1 "Cable routings below).

The interface between point machines and point indicators shall be ensured through transverse ducts connected directly with the equipment. The use of waterproof junction boxes with terminal strip is deemed necessary.

Supporting materials shall comply with the materials and accessories requirements.

1.5.2.3. Construction Elements and Protection of Point Machines

All types of point machines shall be able to operate being fully submerged in water without any impact on their safety whatsoever. Especially in terms of motorized point machines, the compartment of the motorized equipment and the electrical connections must be fully waterproof.

1.5.3. Point Indicators

1.5.3.1. Location of Point Indicators

Point indicators shall be installed adjacent to the junction where the location of the switch rails is signalled, so that they are noticed in due time by the driver when approaching the interchange track facing switch and at the right of the track in the sense of the vehicle's movement.

1.5.3.2. Foundation and Installation of Point Indicators

Visual display units shall be installed on a steel mast embedded adjacent to the track bed of the tramway at the appropriate height so that it is clearly into view by the tramway driver's driving position.

The Contractor shall submit a structural design for the support of the point indicators showing also the appropriate cross section of the mast and the embedment mechanical items. Moreover, he shall also submit a design for the passive safety of the overall construction by making also reference to the applicable standards.

The supporting system of the visual display units shall allow height-adjustment and alignment with sight direction.

Cable ducting shall terminate in the embedment base and shall allow access cable entry inside the mast.

The supporting material shall comply with the requirements of the Materials and Workmanship Specification of E/M systems.

1.5.3.3. Construction Elements and Protection of Visual Display Units

Visual Display units shall be equipped with the necessary visor appropriate for the outdoor ambient conditions (e.g. blur). The access hatch to the indoor visual display unit shall be secured.

The individual visual display units of the indicators shall be of L.E.D. technology shall have the appropriate cross-section, compatible with the existing project for uniformity reasons, an IP65 protection rate against the ingress of solids and water inflow in line with EN 60529 standard. The Contractor shall define the light performance of the visual display units (accompanied by the corresponding standards) per aspect (colour coding).

Each individual visual display unit shall be fault monitored by the system, so that it is turned off under a specific luminance threshold.

1.5.4. Vehicle Routing Operation Local Panel

1.5.4.1. Location of the Operating Panel

The operating panel shall be placed on the light signal metal pole below the optical unit, at a proper height, allowing unobstructed handling by operators.

1.5.4.2. Installation of the Operating Panel

When the pole is equipped with the local operating panel, then the entire structure is considered to be unified, while applicable shall be the technical requirements presented in §1.5.5.2 Foundation and Installation of Railway Light Signals below.

The supporting materials shall be in accordance with the requirements concerning materials and components.

1.5.4.3. Construction Items and Protection of the Operating Panel

The operating panel shall be secured with a locker to avoid non authorized handling of the point machine.

Cable routing shall be effected via the mounting pole. Interconnection with the Point Machine Control System shall be effected via transverse pipes routed directly to the equipment. Inside the panel there shall be a terminal strip for the termination of cables.

1.5.5. Railway light signals

1.5.5.1. Location of Railway Light Signals

Railway light signals shall be installed near the crossing indicating the permissible routing; thus, they shall be promptly perceived by the train driver when approaching the toe of the crossing switchpoint, on the right side of the rail, at the running direction of the train.

1.5.5.2. Foundation and Installation of Railway Light Signals

The optical units shall be installed on a metal pole embedded at the side of the track bed of the Tramway corridor, at an appropriate height, to be clearly visible from the driving position of the Tramway vehicle driver.

The Contractor shall submit a structural design for the light signals' support, indicating also the proper cross-section of the pole and the mechanical parts of the embedment. Moreover, the Contractor shall submit a design for the passive safety of the entire structure, making reference to the applicable standards. In particular, it is noted that any equipment structure mounted on the pole shall be addressed as a uniform structure, as to this paragraph.

The optical units supporting system shall enable the height-wise adjustment and the alignment with the view direction.

The cable routing pipes shall terminate at the base of the embedment and shall allow the cable to be placed inside the pole. The connection among the light signal and the point machine control system shall be effected via transverse cable pipes routed directly to the equipment. At the cable termination points there must be a terminal strip.

The supporting materials shall be in accordance with the requirements concerning materials and components.

1.5.5.3. Construction Items and Protection of Optical Units

The optical units shall be equipped with a proper visor, where deemed necessary, due to the outdoor environmental conditions (e.g. glare). The access hatch of the interior optical unit shall be secured to avoid non authorized access.

The individual optical units of the indicators shall be of LED technology, shall have the proper cross-section, shall be compatible with the existing Project for reasons of uniformity and their protection degree shall be IP 65 against solid particles and water inflow, in accordance with EN 60529. The Contractor shall present the performance of the optical units in terms of brightness (accompanied by the respective Standards) per aspect (colour aspect code).

Each individual optical unit shall be surveyed by the system against failure, so that each unit shuts down once the level of brightness imposes so.

1.5.6. Track Circuits and/or Mass Detectors (Train Detection System)

1.5.6.1. Location of Track Circuits and/or Mass Detectors

The train detection system equipment installed for the electrical interlocking of the motorized turnout, shall be placed within the area of the turnout, detecting the train at both positions of the turnout. The train detection system equipment utilized to track the location of the vehicle for the operation of the route controller shall be installed in the trackwork and in accordance with the Technical Specifications of the Trackwork System, so that it remains unaffected –in terms of operation- by interferences or other items that shall affect its proper and safe operation.

Should track circuits be used for sequence detection (detection of movement towards a specific direction), then the electric joint of the second sequence circuit shall be properly installed to avoid activation of any locking, should the train move backwards.

The system's field equipment boxes shall be installed near the detection point.

1.5.6.2. Foundation and Installation of Track Circuits and/or Mass Detectors

The system's field equipment boxes to be embedded should be accessible. If they are visible, they must be placed on a low pole or on a concreted base, adhering to the rules of foundation and installation of cabinets. The cables shall be routed through the pole or, if there is a base, the cable routing pipes towards the equipment box shall terminate at the top side of the base and shall be embedded therein.

The interconnection with the point machine control system shall be effected via transverse pipes routed directly to the equipment. Inside the equipment box there shall be a terminal strip for cable termination.

The electric joints of the track circuits shall be fixed on the track using special supports and the ends of the joints shall be fixed using special screws at specifically configured holes on the rail.

1.5.6.3. Construction Items of Track Circuits and/or Mass Detectors

The system's field equipment boxes protection degree shall be IP 55 or higher against solid particles and water inflow, in accordance with EN 60529, and IK 08 mechanical protection degree against impact in accordance with EN 62262.

1.5.7. Workstations, Screens, Peripheral Devices and OCC Equipment

1.5.7.1. Location of Equipment Items in the OCC

The OCC equipment shall be integrated into the existing fixtures and the offices already existing or to be provided by the Tramway Operation Company. The supply cable conduits and the structured cabling shall be included in the Contractor's scope.

1.5.7.2. Equipment Foundation and Installation in the OCC

The workstations shall be based on special fixtures added to the offices or on trolley bases. The screens shall be fixed using proper supporting items.

1.5.7.3. Construction Equipment Items in the OCC

The commercial equipment shall be made of good quality plastic with metal parts and its operation shall be uninterrupted, on a 24h basis, throughout the Project life cycle.

1.5.8. Cable routings and cablings for Cabinets, Switchboards and Equipment

1.5.8.1. Cable routings

The longitudinal cable routings shall run along the entire Tramway corridor track. At the locations where the longitudinal cable routings can use the Depot routing system, the latter system shall be selected always in accordance with the rules governing the routing of low voltage and power supply currents.

The cable routing of the turnouts' signalling and point machine control system shall use an exclusive routing via the aforementioned system. In the framework of the electromagnetic interferences' design, the Contractor has the obligation to present the minimum permissible distances from the power cable routings and how these are achieved.

As regards the direction of the transverse cable routings towards the field equipment, the routing cables shall have the appropriate cross-section, dimensioned by an extra 20% in case of any future routing related needs. They shall be embedded and properly protected within the trackbed and the pedestrian walkways at an appropriate depth to be defined by the Contractor in the Detailed Final Design.

Similarly, as regards routings in technical rooms, the appropriate metal tray systems shall be used either for under-floor routing or for wall-mounted routing or for ceiling routing. The metal tray systems shall be grouped depending on the use of cables, in terms of operation, routed within these trays.

Vertical cable routings are allowed to use a metal pipe in case there is one cable at the last part of the routing towards the equipment's point of termination. If the direction is changed, it is allowed to use a spiral type metal pipe.

It is evident that cable routings are subject to regulations related to cable sharing and cable distances that the Contractor must substantiate in his design documents. Splicing of cables and wires is in no way allowed in any type of routing. The network and data cables must be protected especially against mechanical strain. All cables shall be supported by outdoor ties at specific intervals.

The multi-strand signal cables must be dimensioned with auxiliary pairs of conductors by 20% of the useful pairs.

The transverse cable routings to and from the field equipment must be also finalized at the DFD phase.

1.5.8.2. Cabinet and Switchboard Wiring

Inside cabinets and switchboards, the cables shall be fixed on special supports and their wires shall terminate at terminal strips. Then, the wiring extending from the terminal strip to the equipment of the cabinet or the switchboard shall be placed in plastic channels for duct routing and sorting.

1.5.8.3. Cable and Wires Terminations

The cable terminations to terminal strips or points of connection of the equipment shall use proper terminals, depending on the cross-section of the wires. In case of special couplers, these must be locked against accidental disconnection.

Spare cable wires shall be terminated accordingly; this is the reason why the Contractor shall make a relevant provision as concerns the terminal strips.

1.5.9. Earthing Protection and Lightning Protection

1.5.9.1. Earthing Protection of Metal Parts

All metal parts of cabinets, switchboards and equipment boxes, as well as the metal poles must be connected to protective earthing to ensure the protection of personnel. The metal sheath of the cables shall be also grounded. The entire equipment earthing shall be connected to the existing protective earthing running in technical rooms and cable ducts and trays.

The Contractor shall submit the earthing design of the signaling and point control system at the DFD phase, specifying all restrictions related to the implementation and application of the specific solutions that he shall propose.

1.5.9.2. Overvoltage Protection and Lightning Protection

As regards the protection of equipment, the Contractor shall install lightning conductors and surge arrestors at the cable terminations to the system cabinets.

1.5.10. Signage of Equipment and Cabling

1.5.10.1. Signage Codification

At the DFD phase, the Contractor, in cooperation with the Service, shall finalize the signage codification concerning equipment and cabling (cables and wires). For reasons of uniformity, the signage should be similar to the signage of the existing project, where found and where possible.

In general, the signage shall refer to geographic data, operational data and numeric data.

1.5.10.2. Signage of Cabinets, Switchboards and Equipment Boxes

In accordance with the signage codification, the Contractor shall install on the cabinets, the switchboards and the equipment boxes the appropriate small sign bearing the appropriate signage for each equipment item.

1.5.10.3. Signage of Cables, Terminal Strips and Ducts

The cable signage shall refer to the fire behavior classification system and the numbering of each cable.

As regards the cable wires and the terminal strips, there must be numeric signage per group of pipes and terminal strips.

1.6. SYSTEMS INTERCONNECTION

1.6.1. General

As regards the interconnection of the sub-systems, the Contractor shall submit the documentation for each interconnection. For any systems other than the ones included in the scope of this specification, the Contractor shall submit the following coordination related documentation:

1.6.2. Interconnection of Point Machine – Trackwork

During the DFD phase, the Contractor shall submit coordination drawings for the interconnection between the point machines and the trackwork system.

1.6.3. Interconnection of the Vehicle Detection System – Trackwork

During the DFD phase, the Contractor shall submit coordination drawings for the interconnection of the track circuits and the mass detectors (Vehicle Position Detection System) with the trackwork system.

1.7. TESTING AND COMMISSIONING OF EQUIPMENT AND SYSTEMS

All tests of the signalling and point machine control system shall be carried out in accordance with Article “GS 0420 Testing and Commissioning” of the General Specifications.

Especially as regards the Point Machine Control System, the relevant tests shall include testing of the subject system with simulating inputs and outputs before the execution of completion tests using field equipment.

Especially as regards the Depot Management System, the relevant tests shall include the testing of the application software in a simulating environment before the execution of completion tests using interconnected equipment.

In general, the software tests must be accompanied by full documentation of the tested operations and, in case of revision of the application software version, changes must be submitted along with their documented traceability.

1.8. MATERIALS AND COMPONENTS RELATED REQUIREMENTS

All materials and components, including cables, being part of the equipment of the signalling and point machine control systems, must be service-proven and subject to the approval of the Service.

1.8.1. Cabinets, Switchboards, Equipment Boxes, Poles

Outdoor cabinets and equipment switchboards shall be 2mm-thick metallic structures, hot dip zinc plated, electrostatically painted with antioxidant paint of appropriate thickness. The paint color shall be decided upon at the DFD phase. Alternatively, aluminum alloy with anodization treatment can be applied.

Equipment or junction boxes to be used near the track shall be made of polycarbonate material of adequate strength for their intended use.

The poles to be used shall be metallic structures, hot dip zinc plated, electrostatically painted with antioxidant paint of appropriate thickness. The paint color shall be decided at the DFD phase.

In general, cabinets, switchboards, outdoor equipment boxes and poles must be corrosion-resistant due to oxidation/solar radiation and have a special coating for easy removal of any additional paint or adhesive substance.

1.8.2. Servers, Workstations and Electronic Equipment

The electronic equipment used by all systems shall be dimensioned and selected to operate in the appropriate environment within the environmental and temperature range specified by their manufacturers.

The P/Cs (Servers, Workstations and related items) shall be of industrial type and shall meet the specifications related to railway requirements. Apart from the workstations to be integrated into the Operations Centre items, all workstations and servers shall be installed in industrial modules and shall be protected inside cabinets or special frames.

1.8.3. Supporting materials

All supporting materials, such as screws, nuts, washers, connectors and various minor materials for mechanical fixing shall be in accordance with the metric system and shall be made of stainless steel. In case of polycarbonate equipment boxes, polycarbonate items are allowed to be used for their assembly, but not for their support.

In case of support of equipment subject to vibrations, the supporting materials shall be secured using respective components. If there is a need for vibration attenuation, the equipment support shall be ensured via proper gaskets or anti-vibration structures.

1.8.4. Trays and Pipes for Cable Routing

The metal trays and pipes to be used must be hot dip galvanized. A suitable coating must be foreseen at the cable outputs for the protection of the outdoor insulations.

1.8.5. Cables, Wires and Terminals

The cables to be used by the Contractor must be suitable for railway applications; signalling and point machine control cables in particular must be slow-burning and halogen-free, based on IEC 60332 and IEC 60754, or must conform with international and national standards.

Due to the conditions prevailing during routing and termination, the above must be corrosion-resistant due to dampness and have mechanical strength to avoid any failure thereof due to rodents.

Cable wires terminations should have suitable terminals, depending on their application, as well as heat-shrinkable protective rings, in case terminals do not provide this type of protection.

1.9. DIAGNOSTIC SYSTEMS AND DIAGNOSTICS CONTROL EQUIPMENT

The Contractor shall equip all automatic control systems with suitable diagnostic systems, so that in case of any accidents or errors, these are recorded bearing the appropriate time stamp synchronized for the entire network.

Thus, the diagnosis concerning the smooth operation and failures that occur shall be stored in means accessible only by authorized personnel and shall assist in addressing damage and targeted maintenance.

1.10. REQUIREMENTS FOR SPARE PARTS OF COMPONENTS AND SPECIAL TOOLS

1.10.1. Spare Parts Lists

The Contractor shall submit detailed spare parts lists classified per system and geographical region.

Each list shall include all structural and operational spare parts of the sub-system that is mentioned, with detailed description of the name of each spare part, the manufacturer, the product number and its quantity. In case there is more than one manufacturer, the details of at least two manufacturers shall be provided.

The Contractor shall deliver spare parts of the equipment items based on Mean Time Between Failures (MTBF) for a three (3) years period.

As regards the electronic equipment of the systems and the binding requirement mentioned in the previous paragraph, the following shall be provided, as a minimum:

- One (1) server and one (1) workstation of the Depot's Management System
- One (1) set of passive transceivers of the Vehicle Identification System for two (2) trains
- One (1) reader of the Vehicle Identification System
- Electronic cards / structural elements (1 processing unit – CPU, 1 access module, 1 exit module) of the system cabinets
- Cabinet feeders (at least 2)

As regards the field signalling equipment, the following shall be provided, as a minimum:

- One (1) motorized point machine
- One (1) manual trailable point machine
- One (1) track circuit and its accessories
- One (1) mass detector and its accessories
- One (1) light signal optical unit and its accessories
- One (1) point indicator

1.10.2. List of special tools

Special tools are specific tools used for any work related to installation, testing, measurement, maintenance and operation. The Contractor shall submit a list of special tools along with their characteristics and application.

The Contractor shall also provide a set of special tools (if any) for the equipment to be installed. The special bracket for the manual activation of the point machine mechanisms is also considered as special tool.

1.11. TRAINING OF TECHNICAL STAFF AND OCC PERSONNEL

Following the setting of the systems in operation and prior to the commencement of the trial run operation period, the Contractor shall undertake the training procedure and briefing of the technical staff about the systems presented in this specification, using his own means and human resources.

The training shall include the following:

- At least one (1) session for theoretical training on the various systems (architecture, technical characteristics, parameterisation, operation, maintenance, trouble-shooting).
- At least two (2) on site visits per basic equipment for practical training on the various systems (description of functionalities, data clarifications, operation, maintenance, trouble-shooting).
- At least two (2) sessions for practice on minor modifications and/or extensions of the software for parameterisation of control and/or for controlling additional input/output (I/O) points of the systems concerned.

- At least two (2) sessions for training the OCC personnel.

1.12. APPLICATION SOFTWARE AND OPERATIONAL SYSTEMS

As regards the operational systems and the commercial software, the Contractor shall ensure the necessary licenses by other manufacturers for at least fifteen (15) years, irrespective of the serial numbers of the spare parts.

As regards his systems' software, the Contractor shall sign an Escrow agreement with ATTIKO METRO S.A. as beneficiary, to ensure the software ownership in case the -relevant each time- manufacturer is unable to provide supporting services. It is evident that, during the lifecycle of the subject systems, the manufacturers of the installed software have granted their license for the entire life cycle of each system.