

SPI PROCESS nº 021.00000891/2024-87

INTERNATIONAL COMPETITION No. 02/2024

PPP LOTE ALTO TIETÊ

**EXHIBIT II.C – MANDATORY GUIDELINES AND PROJECTS FOR SIGNALING,
TELECOMMUNICATIONS AND ENERGY SYSTEMS**

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**PART I: SIGNALLING, TELECOMMUNICATIONS AND ENERGY SYSTEMS
VENTURES**

**PART II: ENERGY, SIGNALING AND TELECOMMUNICATIONS SYSTEMS
VENTURES**

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PART I: SIGNALLING, TELECOMMUNICATIONS AND ENERGY SYSTEMS VENTURES

1. GLOSSARY

- 1.1. The terms written in capital letters, acronyms and acronyms contained in this EXHIBIT shall be understood and interpreted in accordance with the respective meanings contained in EXHIBIT VII of the AGREEMENT.

2. OBJECTIVE

- 2.1. The purpose of this EXHIBIT II.C is to establish the guidelines and the mandatory technical and operational requirements for the implementation of the Signaling, Energy, Aerial Network and Telecommunications Systems, which will integrate the CONCESSION in order to fully provide an operational and safe transport of LINES 11, 12 and 13 and AIRPORT EXPRESS SERVICE.

3. MANDATORY GUIDELINES FOR SIGNALING, TELECOMMUNICATIONS AND ENERGY SYSTEM PROJECTS.

- 3.1. The guidelines defined as mandatory are intended for signaling, telecommunication and energy system projects.

- 3.1.1. The CONCESSIONAIRE shall carry out a running simulation with all SERVICES operating simultaneously to verify the existing and proposed signaling and traction energy systems in order to adapt the preparation of specifications and projects.

- 3.1.2. The CONCESSIONAIRE may prepare alternative proposals that will be CERTIFIED by the IMPLEMENTATION CERTIFIER, subsidizing the non-objection of ARTESP.

- 3.1.2.1. If the PARTIES do not agree with ARTESP's evaluation, subsidized by the IMPLEMENTATION CERTIFIER, regarding the projects presented by the CONCESSIONAIRE, the dispute may be submitted to the resolution of divergences under the terms of the divergence resolution mechanisms contained in CHAPTER XXIV of the AGREEMENT.
- 3.2. These mandatory guidelines include the VENTURES and investment actions under the responsibility of the CONCESSIONAIRE, including: reconstruction, expansion, renovation, relocation, modernization, implementation of infrastructure systems and equipment, preparation of technical specifications and projects, assembly, commissioning and testing, adjustments, receipt of equipment and, when applicable, licensing.
- 3.3. Regarding the systems, we highlight the following two:
- i. CMMS – "*Computerized Maintenance Management System*";
 - ii. SIGO – Integrated Operational Management System.
- 3.4. The CONCESSIONAIRE shall allow free and direct access, in real time and at any time, remotely or locally, to the databases of records and images, CMMS, SIGO or equivalent, real-time image monitoring systems, to the representatives appointed by ARTESP.
- 3.5. Table 01 lists the specific VENTURES related to signaling, telecommunication and energy, detailed in this EXHIBIT, and the OVERHEAD TRACTION NETWORK, detailed in EXHIBIT II.B. The identification of the PROJECTS followed as a rule, the use of 3 (three) capital letters, followed by 3 (three) sequential numbers, per PROJECT, having as an example: ENERGY - ENE 001.

3.6. This table refers to the identified VENTURES. It is incumbent upon the CONCESSIONAIRE to analyze and propose solutions that may, in turn, be located and quantified in a manner different from that indicated to meet the objectives of the CONCESSION, always in order to comply with the performance standards required for the provision of the SERVICE GRANTED, also observing EXHIBITES III.A and III.D.

Table 1: VENTURES – SIGNALING, TELECOMMUNICATIONS AND ENERGY

LOCAL	LINE	MILESTONE (KM)	SIGNAGE (SIN)	TELECOM (TEL)	ENERGY (ENE)
OPERATIONAL CONTROL CENTER					
Operational Control Center – CCO LINES 11 and 12	-		CCO 001		
Operational Control Center – CCO LINE 13	-		CCO 002		
EQUIPMENT ON THE TRAINS					
Installation of the on-board signalling system	-		SIN 001		
Installation of the monitoring system on the trains	-			TEL 070	
TRAFFIC ROUTES					
Barra Funda - Luz	11	04+691 a 0+000	SS 002	TEL 001	
Luz — Brás	11	0+000 a 2+240	SS 003	TEL 002	
Brás – SE Engenheiro Gualberto	11 and 12	2+240 a 8+500	SS 004	TEL 003	
SE Eng. Gualberto – Corinthians Itaquera	11	8+500 to 19+450	SS 005	TEL 004	
Tunel 3 - Guaianases	11	23+040 to 24+800	SIN 006	TEL 005	
Guaianases - Suzano	11	24+800 to 36+940	SIN 007	TEL 006	
Suzano - Estudantes	11	36+940 to 50+770	SIN 008	TEL 007	
Estudantes – Cezar de Souza	11	50+770 to 55+115	SIN 009	TEL 008	

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LOCAL	LINE	MILESTONE (KM)	SIGNAGE (SIN)	TELECOM (TEL)	ENERGY (ENE)
SE Engenheiro Gualberto – Engenheiro Goulart (km 12+800)	12	8+500 to 12+800	SIN 010	TEL 009	
Engenheiro Goulart – USP Leste	12	12+800 to 17+900	SIN 011	TEL 010	
USP Leste – Engenheiro Manoel Feio	12	17+900 to 33+150	SIN 012	TEL 011	
Engenheiro Manoel Feio – Calmon Viana	12	33+150 to 41+140	SIN 013	TEL 012	
Calmon Viana - Suzano	12	34+550 to 36+940	SIN 014	TEL 013	
Engenheiro Goulart – Guarulhos Airport	13	12+800 to 25+500	SIN 015	-	
Guarulhos - Bonsucesso Airport	13	25+500 to 35+600	SIN 016	TEL 014	
Engenheiro Goulart – Gabriela Mistral	13	7+300 to 12+800	SIN 017	TEL 015	
ENERGY SYSTEMS					
Replacement of the Calmon Viana substation	11	km 33+500			JAN 001
Replacement of the Sebastião Gualberto Substation	11	km 8+600			JAN 002
Repowering of the Don Bosco Substation	11	km 20+563			JAN 003
Repowering of the Guaianases Substation	11	km 24+018			JAN 004
Repowering of the Braz Cubas substation	11	Km 45+893			JAN 005
Replacement of the Ermelino Matarazzo Substation	12	km 20+100			JAN 006
Implementation of the São Miguel Paulista Substation	12	According to the CONCESSIONAIRE' s simulation			JAN 007
Repowering of the Eng. Manoel Feio Substation	12	km 32+800			JAN 008
Implementation of the Jardim São João substation	13	km 31+605			JAN 009
Implementation of the Presidente Dutra Substation	13	km 34+545			JAN 010

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LOCAL	LINE	MILESTONE (KM)	SIGNAGE (SIN)	TELECOM (TEL)	ENERGY (ENE)
STATIONS, PATIOS AND WALKWAYS					
Palmeiras-Barra Funda Station	11	03+686		TEL 016	
Bom Retiro Station	11	02+100		TEL 017	
Luz Maintenance Complex	11			TEL 055	
Luz Station	11	00+000		TEL 018	
Brás Station	11 and 12	02+243		TEL 019	
Novo Patio	11			TEL 056	
Eng. São Paulo Maintenance Complex	11, 12 and 13			TEL 057	
Test Path	11			TEL 058	
Tatuapé Station	11	06+579		TEL 020	
Penha Station	11			TEL 021	
Maintenance Base for Ballast and Sleepers	11			TEL 059	
Corinthians-Itaquera Station	11	18+174		TEL 022	
Don Bosco Station	11	20+563		TEL 023	
José Bonifácio Station	11	22+327		TEL 024	
Guaianases Parking Lanes	11			TEL 060	
Guaianases Station	11	24+018		TEL 025	
Lajeado Station	11	25+627		TEL 026	
Antônio Gianetti Neto Station	11	27+730		TEL 027	
Ferraz de Vasconcelos Station	11	30+073		TEL 028	
Poá Station	11	33+147		TEL 029	
Calmon Viana Station	11 and 12	34+360		TEL 030	
Suzano Station	11	37+059		PHONE 031	
Jundiapéba Station	11	42+398		TEL 032	
Rail Welding Yard	11			TEL 061	
Train Washer	11			TEL 062	

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LOCAL	LINE	MILESTONE (KM)	SIGNAGE (SIN)	TELECOM (TEL)	ENERGY (ENE)
Braz Cubas Station	11	45+893		TEL 033	
Mogi das Cruzes Station	11	49+158		TEL 034	
System Maintenance Base	11			TEL 063	
Estudantes Station	11	50+641		TEL 035	
Cezar de Souza Station	11	54+394		TEL 036	
Cezar de Souza Parking Routes	11			TEL 064	
Stretch between Palmeiras - Barra Funda station and Guaianases station	11			TEL 071	
Stretch between Guaianases station and Antônio Gianetti Neto station	11			TEL 072	
Stretch between Antônio Gianetti Neto station and Calmon Viana station	11			TEL 073	
Stretch between Calmon Viana station and Estudantes station	11			TEL 074	
USP Leste Station	12	18+068		TEL 037	
Comendador Ermelino Station	12	20+103		TEL 038	
Metallurgy and Turnout Maintenance Base	12			TEL 065	
São Miguel Paulista Station	12	24+483		TEL 039	
Jardim Helena-Vila Mara Station	12	27+000		TEL 040	
Itaim Paulista Station	12	28+952		TEL 041	
Itaim Paulista Parking Lanes	12			TEL 066	
Jardim Romano Station	12	30+996		TEL 042	
Eng. Manoel Feio Parking Yard	12			TEL 067	
Engenheiro Manoel Feio Station	12	32+800		TEL 043	
Itaquaquecetuba Station	12	35+301		TEL 044	
Aracaré Station	12	37+800		TEL 045	
Calmon Viana Maintenance Base	11 and 12			TEL 068	

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LOCAL	LINE	MILESTONE (KM)	SIGNAGE (SIN)	TELECOM (TEL)	ENERGY (ENE)
Stretch between Tatuapé station and USP Leste station	12			TEL 075	
Stretch between USP Leste station and Itaim Paulista station	12			TEL 076	
Stretch between Itaim Paulista station and Engenheiro Manoel Feio station	12			TEL 077	
Stretch between Engenheiro Manoel Feio station and Calmon Viana station	12			TEL 078	
Engenheiro Goulart Station	13	15+438		TEL 046	
Eng. Goulart Parking Lot	13			TEL 069	
Guarulhos-Cecap Station	13	22+600		TEL 047	
Guarulhos Airport Station	13	24+235		TEL 048	
Jardim dos Eucaliptos Station	13			TEL 049	
São João Station	13			TEL 050	
Presidente Dutra Station	13			TEL 051	
Bonsucesso Station	13			TEL 052	
Gabriela Mistral Station	13			TEL 053	
Cangaíba Station	13			TEL 054	
Technical rooms	11, 12 and 13			TEL 079	
Underpasses (155, 040 and 156)	11			TEL 080	
Underpasses (119 and 154)	12			TEL 081	

4. MANDATORY GUIDELINES FOR THE PREPARATION OF PROJECTS

4.1. The following mandatory basic premises must be adopted:

- i. The AIRPORT EXPRESS SERVICE must run the operational section between the Airport-Guarulhos stations (LINE 13) – Barra Funda and vice versa, considering the travel times defined in EXHIBIT III.A.
 - ii. The trains of LINES 11, 12 and 13 must meet the prerequisite of technical interoperability, sharing railway infrastructure with other railway lines operated by CPTM and other concessionaires, using 1,600mm gauge, 3,000Vdc power supply, and adequate signaling and telecommunication systems. These systems should make it possible to circumvent possible operational failures and enable prolonged maintenance on specific stretches.
 - iii. Implementation of a safe, interoperable and open signaling system, in the ETCS Level 2 standard, and that also allows the automated regulation of the operation of the trains, by a non-proprietary and interoperable ATO (Automatic Train Operation) system;
 - iv. The signaling system, by occupation, must activate the warning devices (audible or light) of the Level Crossings (PN), while they are not eliminated;
 - v. The operation of LINES 11, 12 and 13 will start with the existing TRAIN fleets, according to EXHIBIT II.F, which will be adapted with the on-board modules of the new signaling system, and other equipment.
- 4.2. Based on these premises, the new Signaling, Energy and Telecommunications systems should allow the safe movement of trains from all fleets, along any of the tracks, respecting, however, the differences and characteristics of specific operations of each fleet.
- 4.3. Due to the integration between the systems of LINES 11, 12 and 13 and the AIRPORT EXPRESS SERVICE, the mandatory guidelines established in this document consider that

the new Signaling and Telecommunications systems must be homogeneous and based on a single technological platform or technically compatible, even if through interface modules. Traffic Control Systems of LINES 11, 12 and 13 to be implemented by the CONCESSIONAIRE must observe the necessary interoperability and automatic regulation of the operation.

4.3.1. In order to comply with the provisions of the item above, it will be necessary to update the edge of the MRS locomotives that already circulate on the tracks that make up the network of LINES 11, 12 and 13, in the same way as in the EXISTING TRAINS, applicable only to locomotives that have not been updated by the other operators of the METRO-RAIL SYSTEM.

4.4. In order for the signaling system of LINES 11, 12 and 13 to meet the travel time established in EXHIBIT III.A, and other requirements foreseen, it is mandatory to implement a standardized, interoperable, open protocol signaling system without exclusive supply, ETCS Level 2, with SIL4 Integrity Limits, promoting:

- i. Interoperability guarantee;
- ii. Adaptability to various types of undercarriage;
- iii. Guarantee of continuous train-track communication - CCO;
- iv. Application of an open, standardized system that has several suppliers in the market.

4.4.1. The ETCS Level 2 system should:

- i. use a standardized radio communication system, observing the capacity, reliability and speed of continuous transmission in the railway network of LINES 11, 12 and 13, in a manner compatible with the maximum speed of the trains and the requirement of 3 (three) minutes between trains in the COMMERCIAL OPERATION. The interval between trains provided for in the project must be sufficient to ensure the maximum interval between trains and compliance with the performance indicators, under the terms of EXHIBIT III.A and III.D, meeting the required safety and reliability indices of the signaling system. The system must also provide for the implementation of ATO (*Automatic Train Operation*) functions for operational regulation of the LINES.
 - ii. adopt the TETRA (Terrestrial Trunked Radio) radio communication system or, preferably, the one provided for in ANATEL Act No. 915, of February 1, 2024, item 5.9, with channels 3 and 4 preferably authorized for use by railway and subway communications systems, in order to transmit data and operational commands through radiocommunications, meeting the levels of safety and reliability, dimensioned and able to integrate LINES 11, 12 and 13 and the AIRPORT EXPRESS SERVICE, especially observing EXHIBIT II.A, EXHIBIT II.B, EXHIBIT II.F, EXHIBIT III.A and EXHIBIT III.D.
- 4.5. The systems to be supplied must withstand the existing climatic conditions in the region. For the purpose of calculating and defining the characteristics of the equipment, external environments with a temperature range of 0° C to 45°C and a maximum relative humidity of 95% should be considered, with strong environmental pollution and acid rain. For equipment installed along the track, consider that the internal temperature may reach 80° C.
- 4.6. The mandatory guidelines for the preparation of projects related to the Energy System for LINES 11, 12 and 13, must consider, in addition to information on the energy demand in the stations, complexes, maintenance bases and parking yards, the use of the available fleet, Exhibit II.F, as well as the consumption necessary for the fulfillment of the OPERATIONAL PLAN.

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5. SIGNALING AND CONTROL SYSTEM (SSC)

5.1. MANDATORY GUIDELINES FOR THE SIGNALING AND CONTROL SYSTEM

- 5.1.1. The guidelines defined herein are mandatory for the SSC project, and the CONCESSIONAIRE, based on these guidelines, may define its own project, subject to the APPROVAL of the INDEPENDENT AUDITOR, who will support the non-objection of ARTESP. This item presents the description of the functional and operational requirements that the new Signaling and Traffic Control System must follow to ensure the operation with expected availability and safety.
- 5.1.2. The design of the new SSC must encompass the parallel operation and integration of the operational areas that use the systems currently implemented, in order to ensure the continuity of the operation throughout the implementation phase.
- 5.1.3. After the completion of the implementation and acceptance tests of the new signaling system, the old system may be deactivated, at the discretion of the CONCESSIONAIRE, observing the other EXHIBITES of the NOTICE.
 - 5.1.3.1. The tests must be carried out in the entire system, and sampling tests are not accepted. The old system will only be deactivated when the implemented systems are functioning and properly commissioned.
- 5.1.4. While the current SSC is not replaced by a new standard based on ETCS Level 2, the current SSC infrastructure, as well as all System infrastructures, will be made available to the CONCESSIONAIRE for its operational use in order to enable a replacement that does not affect the operation of the LINE.

- 5.1.5. The new SSC must be designed to control the fleet, not causing damage to operation and safety, keeping the trains under the defined average operating speed, in addition to preserving the stop times on the platforms and an interval between trains of 3 (three) minutes, the track plan and other PLANS under the responsibility of the CONCESSIONAIRE. For this, in addition to adequate hardware and software, this system must also make available on its on-board IHM, all the information necessary for the train operator to control the trip.
- 5.1.6. The System must be certified at SIL4 ("*Safety Integrity Level 4*") as defined in the IEC 61508 standard and reflected in the IEC62278/CENELEC50126 standards, making use of technology already proven in the market in similar systems.
- 5.1.7. The signaling system to be implemented by the CONCESSIONAIRE must not only meet the requirements considered for the ETCS Level 2 and SIL 4 system, but also allow the command and control of routes, as well as contemplate the possibilities of immediate and emergency cancellations, in addition to managing all maneuvers and route cycles necessary to meet operational needs, such as Auto Route, Auto Call, Auto Dispatch and Regulation.
- 5.1.8. The SSC must continuously monitor the integrity of all equipment on main tracks, stations and trains. Any non-compliance information must be sent to the CTCC (Centralized Traffic Control System), the Maintenance and Engineering Information Center (CIM) and the On-Board Controller (CB), as well as must be available at the Control Posts.
- 5.1.9. The system must allow a direct and efficient interface with the radio communication system, avoiding or eliminating the need for additional equipment or interface. All SSC functions must be available to the CTCC.

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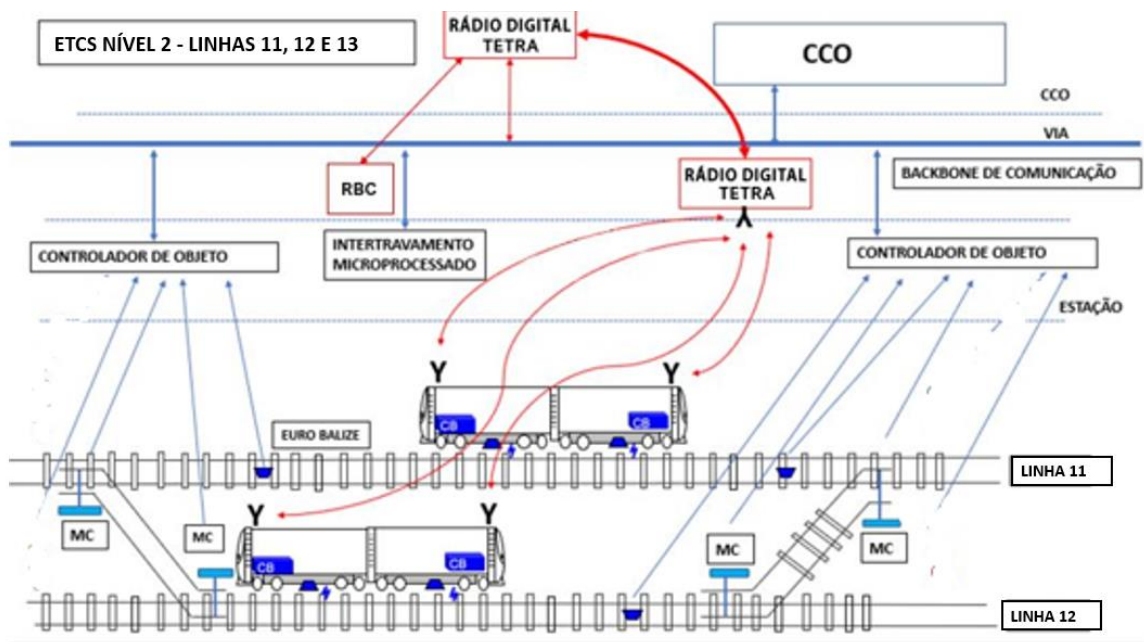
- 5.1.10. The specific Signaling System must include the means of digital communication between the onboard equipment, the track equipment and the CTCC belonging to the CCO, so that the whole set works in a uniform, safe and integrated manner.
- 5.1.11. The new signaling system must follow the basic principles of signaling and control for movement, tracking and detection of trains on the track, based on the following subsystems and equipment:
- i. Microprocessed Vital Interlocking – IVM with the ability to track trains on the tracks and yards, control of movements and control of turnouts of deviations;
 - ii. Equipment distributed along the track such as: beacons, occupancy loops, axle counters, signalmen, key machine, and others;
 - iii. On-board computer for vital processing of commands received via radio for the safe movement of trains and positioning transmission to the vital controller (IVM);
 - iv. Centralized Traffic Control System (CTCC) for managing the traffic of the LINE, proceeding to the identification and tracking of trains, generation of requests for movements to the fixed system, imposition of speed restrictions, regulation of the LINE, not related to the safety of the operation, but to the management and operational performance;
 - v. Communications of railway signaling data via land/train radio frequency, which must have coverage capacity along all sections of LINES 11, 12 and 13 and sufficient bandwidth to support the

transmission and reception of messages between trains, trackside safety control equipment (IVM) and the Centralized Traffic Control System (CTCC).

5.1.12. The System to be implemented does not use traffic lights on the main roads. The suppression of this installation is at the discretion of the CONCESSIONAIRE. Light signalmen should be deployed in yards where the manual operation of train movement takes place.

5.1.13. The following figure presents, in an illustrative way, a Signaling System based on ETCS Level 2, which has as requirements, in addition to allowing the operation with intervals between trains of 3 (three) minutes safely, the ease of superposition and coexistence with the existing system, facilitating its implementation:

Figure 1: ECTS LEVEL 2 EQUIPMENT SCHEME



Source: Adapted from ERTMS N2 illustration

Caption:

CCO – Operational Control Center

MC – Key Machine

CB – On-Board Computer

RBC – Radio Block Center

Microprocessed Vital Interlock – IVM

- 5.1.14. The system must receive status information from the IVM's, as well as send commands to them in order to perform the functions of control and automatic protection of the trains that circulate on the tracks. For IVM technologies, it is recommended, whenever possible, to favor standardized solutions of open and internationally recognized standards.
- 5.1.15. The IVM's must be designed using special software and hardware techniques that fully comply with the principles of operation in safe failure, as well as be equipped with components that guarantee high availability and reliability.
- 5.1.16. The IVM should provide interconnection for remote diagnosis from the CTCC and Local through its own interface, with software and diagnostic tools, part of the supply, with modularity and flexibility characteristics that allow its evolution and expansion.
- 5.1.17. The IVM, in addition to performing vital and non-vital functions, should also enable the exchange of information with the CTCC, PCL and with the adjacent IVM's.

5.1.18. Together with train positioning detection equipment, the IVM equipment must form an integrated system that allows the following functions to be performed at a minimum:

- i. Detection of the position of trains and track vehicles;
- ii. Interlocking for safety and route alignment;
- iii. Control of the aspects of the signalmen;
- iv. AMV drive key machine control;
- v. Interdiction of key machine;
- vi. Closure of stretch for maintenance;
- vii. Prohibition of blocking as an entry;
- viii. Prohibition of blocking as an exit;
- ix. Application for entry permit and cancellation of the application for entry permit;
- x. Entry authorization;

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- xi. Signaling of error messages and alarms in terminals with IHM;
- xii. Monitoring and permanent storage of event history on functional status, commands, routes and occupation situation of the regions covered, for at least 90 (ninety) days;
- xiii. Self-diagnosis routines that enable the detection and indication of any anomalies;
- xiv. Online monitoring of events and status of commands, routes and occupation situation of regions within its scope; and
- xv. To enable automated regulation of the SERVICES.

5.1.19. The IVM's may provide in the COMMERCIAL OPERATION PHASE the necessary interfaces with the equipment to be controlled by them in accordance with the EXECUTIVE PROJECTS.

Radio communications

5.1.20. The ETCS Level 2 Signaling System should use the TETRA radio system as a technology for data transmission, in order to meet all the technical, functional and operational needs demanded. This radio communication system must be of open protocol, non-proprietary and interoperable with the other lines of the railway system of the STATE OF SÃO PAULO, considering the terms of item 4.4.1, item (ii). It should be noted that the application of the ERTMS standard considers standardized frequencies not available in Brazil for railway signaling, and, in this case, there will be a need for adjustments and application of the standard as appropriate.

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- 5.1.21. The frequencies used must be authorized for use, and be funded and licensed by the CONCESSIONAIRE, in compliance with ANATEL's resolutions (preferably Act No. 915 of 02/01/2024 or another that may replace it) and may not be influenced or interfered with by any other voice communication between trains and CCO of LINES 11, 12 and 13, as well as the AIRPORT EXPRESS SERVICE, and other operators of the transport system and third-party critical communications, maintenance teams, as well as providing STO redundancy, at the discretion of the CONCESSIONAIRE.
- 5.1.22. If, during the CONCESSION period, ANATEL regulates new resolutions related to the frequency bands intended for the radiocommunication system that can be applied in accordance with the ERTMS standards, using 5G technology or higher, and the CONCESSIONAIRE chooses to update these systems, it must submit the proposal to ARTESP for analysis, aiming at its non-objection and the economic and financial rebalancing of the AGREEMENT.
- 5.1.23. Likewise, if ARTESP deems it necessary to update the radiocommunication systems due to 5G or other technology, as of the 8th year of the CONCESSION, for LINES 11, 12 and 13, the CONCESSIONAIRE must carry out the necessary actions, through the economic and financial rebalancing of the AGREEMENT.
- 5.1.24. The technological updates of the radiocommunication systems promoted by the CONCESSIONAIRE may not impact the guarantee of technical and functional interoperability of the sharing of railway infrastructure with the other lines of CPTM, other concessionaires and MRS vehicles.

Trackside equipment

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5.1.25. The equipment distributed along the road is basically the following:

- i. Key Machines for moving Turnouts – AMV's;
- ii. Positioning sensors for mobile needles and alligators of the turnouts;
- iii. Axle counters for detecting the passage of vehicles;
- iv. Track beacons and circuits, at the discretion of the CONCESSIONAIRE and when required by the signaling system.

5.1.26. For the LINES to be signaled, sufficient track equipment must be provided to allow the safe movement of trains at the specified times. This equipment must always be commanded and monitored remotely, without the need for local operators, except in case of contingency, in which the circulation will be commanded by other devices such as LCKs.

5.1.27. The initial integration of the new equipment with the existing equipment in the field and the CCO should be foreseen.

5.1.28. After APPROVAL of the new system by the INDEPENDENT AUDITOR and no objection by ARTESP, the old equipment will be decommissioned. This process must be conducted in such a way as not to cause interruption or degradation in the passenger and cargo transportation SERVICES.

On-Board Equipment – CB (On-Board Computer)

5.1.29. The CB must be integrated with the control systems of the ROLLING STOCK vehicles in order to ensure the possibility of preventing movement at speeds above those allowed in the stretch, perform automatic protections and, thus, preserve operational safety. It must also provide information and/or automatic operational controls (ATO), in order to allow the regulation of the intervals between trains (*Headway*) and/or punctuality (timetables) of the trips scheduled by the CTCC. The On-Board Equipment shall consist primarily of:

- i. One On-Board Computer Module – CB per cabin at the ends, to be installed in a specific electrical cabinet of the train, to process the ATP and ATO functions;
- ii. An IHM Module "Human Machine Interface" in the console of the trainsets' control cabins, for viewing operational and maintenance information, as well as for loading specific data from the undercarriage that may be required;
- iii. An antenna installed under the train platform, in each car at the end of the train, to enable the energization of the beacons installed on the track, and to receive information from these beacons or track circuits;
- iv. A tachometer, installed in each extreme car of the train, coupled to the axle of one of the wheel sets, whose purpose is to provide the real speed information of the train to the CB module. Each tachometer must have tacometric sensors in order to identify the direction of movement of the train, avoiding interference in the real positioning of the phenomena of slippage and sliding (*Slip & Skid*) of the wheels;
- v. An Event Recorder, installed in each cabin at the ends, in a specific electrical cabinet of the train, to record and store information on commands, speeds, location and events and failures occurring in the

equipment during a minimum period of 15 (fifteen) days of train operation, even if the train is shut down.

Track Signage

- 5.1.30. The specification of the signaling system and the project for the implementation of this system must be developed observing the geometric projects and characteristics of the tracks defined by the CONCESSIONAIRE, the modifications foreseen in the track bundle, the positioning of the turnouts, stations, detours, secondary roads, branches, yards, parking lots, CTCC – Centralized Traffic Control System and other elements with an impact on the circulation of the relevant trains to be considered, the performance conditions provided for in EXHIBIT III.A are guaranteed.

Considerations on the Implementation of Systems in the LINES

- 5.1.31. In the stretches equipped with the current signaling system, the implementation of the new system must be superimposed on the existing signaling system, that is, leaving the current signaling system working and providing for parallel operation, until the complete implementation occurs, APPROVAL by the INDEPENDENT AUDITOR and no objection by ARTESP. Only after this occurs can the old signaling system and its parts be decommissioned and suppressed. This should be done in such a way as not to harm the quality of passenger and cargo transport services.
- 5.1.32. The current Operational Control Center (CCO) will remain in the building attached to Brás Station, and the CCO infrastructure (supervision rooms and technical rooms) will be shared with the operation of lines 7, 10 and 14, according to EXHIBIT III.C. The sharing with Line 7 is temporary, considering that the TIC EIXO NORTE Concessionaire will build its own CCO, as set forth in the AGREEMENT and EXHIBITES.

5.1.33. The signaling system must be installed concomitantly with the installation of the modules embedded in the EXISTING TRAINS, following the following steps for its implementation:

- i. Installation of the new signaling system in all sections of LINES 11, 12 and 13, including expansions;
- ii. Installation of the new signaling system on board the EXISTING TRAINS.

Signaling and Traffic Control System

5.1.34. In this item, the criteria and requirements that must be observed in the development of the EXECUTIVE PROJECT of the signaling system are presented. These requirements aim to provide a modern, reliable, safe and interoperable system, observing the required operational characteristics of performance and automation. The Technical Requirements shall comply with technical parameters, and basic criteria of operation and safe failure, general criteria of safety and reliability, availability and safety:

5.1.35. Basic Requirements:

- i. Use ETCS Level 2 with ATO in the current state of the art, allowing continuous and bidirectional communication between trains/maintenance vehicles and fixed equipment along tracks, stations, parking lots and yard. The supply shall cover the entire system, including communication, micro-interlocking equipment and all equipment and parts of on-board and field equipment, including all interfaces with the equipment of the CCO;

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- ii. Perform the protection and automatic operation of the movement of trains on the main tracks, parking lanes and access roads of the yard, meeting the minimum *headway* of 180 s;
- iii. Determine the positioning and supervise the movement of maintenance vehicles, as well as their integrity on the main roads, parking lots and access roads of the yard;
- iv. The SSC must continuously address the integrity of all equipment on main tracks, stations and trains, and information on non-compliance must be sent to the CTCC, the Maintenance and Engineering Information Center (CIM) and the On-Board Controller (CB), as well as being available at the Control Posts;
- v. All SSC functions must be available to the CTCC;
- vi. The Signaling System shall use the TETRA radio system as a technology for data transmission, in order to meet all the technical, functional and operational needs demanded, considering the terms of item 4.4.1, item (ii) and item 5.1.20;
- vii. Have the capacity to ensure continuous and bidirectional communication with all trains simultaneously, along the tracks, parking lots and access tracks of the yard;
- viii. The design of the SSC should allow the incorporation of equipment and/or expand its functionalities, without the need to make structural changes to the system, that is, the SSC should allow full interoperability and connectivity with the systems associated with it;

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- ix. Be implemented in parallel and independently of the current signaling system without causing interference and impacts on safety, functionalities and operational performance currently practiced;
- x. Be designed in such a way that it can operate in parallel with the current signalling system until it is fully tested, validated, certified and released;
- xi. Be designed and developed to have a useful life of 30 years for electromechanical equipment and for electronic equipment;
- xii. The SSC must be designed with the guarantee of portability of its components, in order to enable updates and upgrades in case of obsolescence;
- xiii. Have resources that enable the continuity of the operation in cases of system degradation;
- xiv. The SSC must inform the CTCC of the actual technical and operational conditions of the train on the tracks, parking lots and access roads of the yard;
- xv. Be designed with modularity and interchangeability characteristics, allowing the insertion of modules without the need for equipment reconfiguration;
- xvi. Have resources to store and send all messages of abnormalities from the SSC system, to the Maintenance and Engineering Information

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Center (CIM) and to the Centralized Traffic Control System – CTCC, in order to enable predictive, corrective and preventive maintenance;

- xvii. The equipment must perform the functions of Traffic Control by the safe movement of the trains and auxiliary vehicles along the stretch under its domain, whether they are ROLLING STOCK of the CONCESSIONAIRE or other railway operators expressly authorized;
- xviii. Have operational reliability, availability and flexibility adequate to operational requirements (a minimum value of 99.998% with a maximum service time of 2 (two) hours must be considered;
- xix. Have a data communication infrastructure that provides reliability, availability and accuracy of the information transmitted and received;
- xx. Allow the automatic and safe restart of the modules that make up each system, including the field devices, thus providing agility and operational and maintenance gains for the System;
- xxi. Ensure the safety and specified automatisms (ATP + ATO) in the operation of each LINE, including the commitment to the AIRPORT EXPRESS SERVICE;
- xxii. Have immunity to electromagnetic interference and electrical protections against atmospheric discharges.

5.1.36. The signaling system must be designed using as a basic premise the operation in total obedience to the principle of Fail *Safe* or *Fault Tolerant* in all equipment in which there are techniques, methods, principles and operating processes

that guarantee the safety conditions of the system, whether in "*Hardware*" modules, "*Software*" or a combination of both. The safety functions within the functional architecture of the SSC are performed by the interlocking modules distributed in the technical rooms of the stations and along the track.

- 5.1.37. In the event of an equipment failure or human error, the system must continue to operate within the safety principle.
- 5.1.38. A human or equipment failure should result in the imposition of a more restrictive condition, that is, it should lead to the stop or reduction of speed of a train, or prevent the improper movement of turnouts.
- 5.1.39. The signaling system, together with the controls of stations, tracks and on board of the train, must allow the full operation of trains and auxiliary vehicles along the entire length of the main track and secondary or auxiliary tracks, yard and parking lots under its domain, with total safety, thus ensuring minimum compliance with the following General Safety Requirements-RGS:
 - i. RGS.1 – There may only be a route concession (both in the region of the main road and in the parking and yard lanes), under normal conditions of the signaling system, if there is no traffic established in the opposite direction to the exit block of this route, avoiding conflicts in the alignment of these routes;
 - ii. RGS.2 - If there is a prohibition of a blockage as an exit or entrance of a given route, by any operating IHM's (in Central or local mode), it must remain closed and there can be no route alignment that uses this blockade as an exit or entrance, respectively;

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- iii. RGS.3 – Route alignment can only be carried out within a given turnout region and in its vicinity, under normal conditions of operation of the System, if the safe distance between trains on the stretch of track belonging to the route is guaranteed;
- iv. RGS.4 – A lock may only be opened if all key machines involved in the route belonging to this lock are electrically and mechanically locked (with the turnout path fully completed), i.e. the needle tip(s) resting against the thrust rail and the power to the motor(s) removed, in states that clearly define a route provided for in the Interlock. For turnouts with long needles and/or with Mobile Alligators, confirmation of completed and positioned path provided by specific position sensors for these cases is also required;
- v. RGS.5 – There may only be cancellation of an aligned route by sequential vacancy of the track blocks belonging to the route (automatic cancellation by the train passage), or by cancellation by the IHM operator (in Central or Local mode);
- vi. RGS.6 – The cancellation of the route by the operator shall not be effective if the track section (Entry Block) belonging to the aligned route has already been occupied by the train;
- vii. RGS.7 – The cancellation of a given route by the operator shall only be effective after a sufficient timing to ensure the safe stop of the train before it reaches the entrance block of said route (this timing shall be at least 60 seconds). If the train is not at a distance from the route entry block that allows it to stop safely, the train will occupy the section of track belonging to the route and RGS No. 10 must be guaranteed;

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- viii. RGS.8 – In the cancellation of a route due to sequential vacancy, each track block shall only cease to be part of the route after it has been vacated by the train;
- ix. RGS.9 - A key machine can only be unlocked if it does not belong to any route and the safe track blocks in the key machine region are unoccupied. The secure road section of the key machine region is the one delimited by access blocks to the turnout region;
- x. RGS.10 – The logic of the Interlocking must guarantee a movement authorization, which provides a safe stopping distance, on the stretch of road that precedes an occupation or a closed blockade;
- xi. RGS.11 – In route alignment, the establishment of a movement authorization must comply with the established direction of traffic and the road conditions;
- xii. RGS.12 – In the section corresponding to the end of the track, there must be adequate signaling and the stop command to the trains must always be imposed by the Interlock;
- xiii. RGS.13 – There can only be a speed higher than 0 km/h for a train that travels a route already aligned under normal system conditions;
- xiv. RGS. 14 – When the Interlock receives a speed restriction command by any of the HMIs (Central or Local), it must impose the speed limit required by the IHM, in the entire stretch involved;

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- xv. RGS.15 – In the event of a blockade violation, a stop command to trains must be imposed on the stretch of track belonging to the invaded AMV region, with the immediate closure of all open blockades in this region;
- xvi. RGS.16 – There can only be a reversal of the direction of traffic if the blockade to which the train(s) will be headed is not being used as an exit from another route;
- xvii. RGS.17 – The implementation of maintenance mode in a turnout region can only occur if there is no route aligned in the region. Routes that are aligned must enter the cancellation process by time, if the approach section is busy;
- xviii. RGS.18 – Once the maintenance mode is effective, no route may be aligned and no key machine may be moved in the respective Interlocking region, except for the IHM that imposed the maintenance mode;
- xix. RGS.19 – The permanence of people and the movement of trains and vehicles within a region of turnouts under maintenance must be regulated by operational procedures;
- xx. RGS.20 – When the train is in manual operation, the safe stopping distance between two trains must be guaranteed by operational procedures;
- xxi. RGS.21 – There may only be route alignment in contiguous regions of turnouts, under normal system conditions, if the unoccupied block immediately after the route exit blockade is sufficiently extensive to allow the safe stop of the train before the next blockade;

- xxii. RGS.22 – The simulation of occupations on the road, either by the IHM of the Interlocking or by simulator devices added to it, may not in any way generate conditions that lead the System to potential conditions of "Insecurity";
- xxiii. RGS.23 – A signal referring to the blocking of the entry of a route can only present the yellow aspect if this route is aligned and released under normal conditions of system operation;
- xxiv. RGS.24 – An imposition of prohibition of exit or closure of entry of a blockade shall only be withdrawn by the IHM that originated it, including the mode of maintenance;
- xxv. RGS.25 – When a blockade is placed in Closed mode, the route that has been aligned by the opening of this blockade must enter the cancellation process by time, if there is occupation in the section approaching it;
- xxvi. RGS.26 – The Interlocking shall ensure the non-occurrence of loss of detection of occupation of a train in a certain stretch of track in which it is occupying;
- xxvii. RGS.27 – All communication of the vital signs of the modules that are part of the Interlock within a given domain and at its interfaces with adjacent Interlocks must be designed in a secure manner.

Reliability, Availability, and Security Requirements

- 5.1.40. The fixed equipment of the Signaling System must be designed to present a Global Functional Availability of at least 99.998%, with a maximum service time of 2 (two) hours.
- 5.1.41. To meet the specified parameters of availability required for the Signaling and Control System, redundancy resources may be used in all modules that are necessary, both in hardware and software.
- 5.1.42. In the availability calculations of each module, the "analysis of failure modes and their effects – FMEA" must be considered in accordance with the definitions of reliability, availability and defined environmental conditions.
- 5.1.43. In the calculations of intrinsic availability, critical and most relevant flaws should be highlighted. In the reliability calculations, all critical failures, major, minor and non-interfering, should be highlighted, considering the conditions of normal operation and degradation.
- 5.1.44. In the determination of the MTBF and the intrinsic availability of the constituent modules of the System, the calculations must be made and presented, according to the Mil-Std-756 standard in its latest version, using the *Parts Count Reliability Prediction Method* and the *Part Stress Analysis Method*"), described in Mil-Std-HdbK 217 in its latest version and, meeting the parameters specified in this document.

Level Crossing

- 5.1.45. All existing level crossings must be removed. Thus, during the work of its removal, the signaling system, if it is implemented first, must consider its control only for a while until the completion of the works. The signaling system,

by occupation, must activate the warning devices (audible or light) of the Level Crossings (PN), if any.

Key Machines

- 5.1.46. The Key Machines and connection bars must have full compatibility with the UIC and/or AREMA standard turnouts, with needle tip position detector(s) (and mobile alligators, if any) whose contacts will complete the associated interlocking, after detecting the complete movement of the respective turnout, as well as following the technical instructions and current standards, especially regarding the best degree of protection or equal to IP 55 (general) and class equal to or greater than IP 67 in regions subject to flooding and under exceptional conditions, as defined in the NBR 6146 standard.
- 5.1.47. A hand crank for manual operation shall be provided, combined with a device that interrupts the power supply to the motor operating circuit and the needle point positioning detection circuits, before the crank can be used for manual operation.
- 5.1.48. Key machines must have sufficient drive force to move the needles of the turnouts, in a safe way with adequate holding force to ensure their non-movement during the passage of trains.
- 5.1.49. The needle tip positioning detector device shall fail when its opening compromises safety in relation to the thrust rail and when the mechanical locking of the key machine has not been completed.

Technical Locations

- 5.1.50. Preferably, the Interlocking controls should be installed in the technical rooms of the stations, or in the construction of specific shelters along the LINE to accommodate the interlocking equipment of a given control domain.
- 5.1.51. The Luz and Engº São Paulo maintenance complexes and the parking lots distributed along the LINE must be mandatorily readjusted with the installation of signaling, among other readjustments, to meet the operational needs and maintenance services of LINES 11, 12 and 13.

Validation of Signaling System Reliability and Safety

- 5.1.52. Recognizing the responsibility for the operational safety that the signaling system has, it is mandatory that the implemented system has a safety report issued by an independent company and not affiliated with either the system manufacturer or the CONCESSIONAIRE, which has notorious specialization and that it is approved to carry out analysis in safety systems of the signaling system. The security analysis should encompass the hardware and software elements, especially those responsible for the functions of ensuring the security of the system and that have characteristics of "*Fail Safe*" – or "Fault Tolerant".
- 5.1.53. The Safety Analysis report must present the conclusions and recommendations on the safety conditions of the entire system, the severity of the hazards and probabilities of occurrence of unsafe failures in both directions of operation in a stretch considered bidirectional and in the direction of circulation in a unidirectional stretch (if any), as well as the conditions of acceptance
- 5.1.54. The analyses must be conducted in accordance with the functional requirements mentioned in item 5.2, safety standards and the analysis report must cite all the criteria used, identification of risks, identification of hazards, classification of risks and hazards and their probabilities of occurrence, detailing, among other analyses and considerations:

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- i. Identification of hazards and risks regarding the occurrence of failures in the operation and maintenance process:
 - a. Associated with the environment;
 - b. Interoperability;
 - c. The types of events or sequence of events that may cause accidents or dangerous situations, including component failures, errors in procedures and human error;
 - d. Prioritization of foreseeable hazards associated with the system, including hazards arising from:
 - Operation under normal conditions;
 - Operation in conditions of defect or failure;
 - Operation in emergency situations;
 - Misuse of the system;
 - System interfaces;
 - Functionality of the subsystem;

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- Issues related to operation and maintenance;
 - Human factors;
 - Characteristics of the environment;
 - Climatic conditions.
- ii. Critical Analysis of the Effects of Failure Modes – FMECA;
- iii. Analysis of Safety and Security Assurance Processes;
- iv. Estimation of the frequency of occurrence and the severity of each hazard;
- v. Recommendations for Mitigation of any critical points to Operational Safety;
- vi. Considerations and conclusions.

5.2. MANDATORY FUNCTIONAL REQUIREMENTS

- 5.2.1. The signaling system will be responsible for the execution of all functions considered vital (safety functions), which are directly related to the safe movement of passenger and freight trains and auxiliary vehicles along the track.

5.2.2. The station and track equipment together with the on-board equipment - CB of the trains must be responsible for *Automatic Train Protection (ATP)*, whose basic objectives are the following:

- i. Avoid opposing and/or conflicting movements;
- ii. Avoid retro-collision of trains moving in the same direction of traffic;
- iii. Avoid derailment caused by trains running at a speed higher than that allowed by the track layout;
- iv. Carry out the safe movement and protection of Lane Changing Devices - AMV's;
- v. Allow the movement of trains along the track by releasing safe speed profiles imposed by the Interlocking in accordance with the established traffic direction and the dynamic conditions of occupation of the sections.

Occupancy Detection

5.2.3. This safety function aims to detect the presence of trains and auxiliary vehicles at any point on the track, and must be performed with the use of beacon-type detector devices and axle counters. These devices shall be designed with Safe Fail characteristics.

Control of Signalmen's Aspects

- 5.2.4. Optical signaling exists to assist train drivers in turnout regions.
- 5.2.5. Regarding the implementation of the ETCS Level 2 System, these signalmen on the main roads will be installed at the discretion of the CONCESSIONAIRE, with the exception of yards and parking lanes where manual movements may occur with a speed limited to 25 km/h.
- 5.2.6. The signals, with LED lamps, can present only the following aspects, according to the dynamic conditions provided for in the PVS (Plan of Signalized Roads) and the Safety Requirements:
- i. Closed block: the signal must have a fixed red appearance;
 - ii. Open blocking on a free route: the signalman must have a fixed yellow appearance together with the fixed red.

Movement Authorization

- 5.2.7. This safety function will be responsible for the generation, selection and release of continuous speed profiles and movement authorizations on each section of track controlled by the respective signaling equipment.
- 5.2.8. To perform this functional requirement, the system must have the following basic safety information, which will be generated and supervised by the Interlocking (IVM):

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- i. Traffic Direction;
- ii. Aligned routes in the region;
- iii. Occupations ahead;
- iv. Civil Speed Limits;
- v. Temporary Speed Restrictions;
- vi. Interlocking Region Control Mode;
- vii. Prohibitions (routes and blockades).

Traffic Direction Control

- 5.2.9. The traffic direction control function must be based on the conditions present on the track and establish safe speed profiles that allow the direction of movement and the proximity between the trains traveling on the same track, preventing the occurrence of opposite and concurrent movements between two trains, for the same section of track between two consecutive interlocks, and allowing trains to follow each other in the same direction, safely.

Route Interlocking

- 5.2.10. This function should consist of the request, alignment and locking of routes in a safe way, with the correct execution of the command, movement and correspondence of the turnouts involved and opening of the desired lock through processing generated by the Interlocking.
- 5.2.11. The exit routes of Terminal Maneuvering Zones must be automatically aligned (Automatic Cycle) by the system from a dispatch command issued by the CCO or by the PCL HMIs (when the local control mode is selected).
- 5.2.12. The IVM must have hardware and software resources that enable the CCO to control the circulation of trains both in the normal and reverse directions of the operational tracks, always in a completely safe way.
- 5.2.13. The reversal of traffic to meet operational needs must be carried out in accordance with the General Safety Requirements - RGS's.

Route Alignment and Cancellation

- 5.2.14. The CCO will supervise and may automatically request the alignment and cancellation of routes along the entire road, including those referring to the maneuvering regions of each equipment of a given Interlock belonging to the Centralized Traffic Control Subsystem.
- 5.2.15. The Centralized Traffic Control System shall also enable, from the PCL, when the system is operating in the "Local Control Mode", the performance of at least the following functions:
 - i. Alignment or cancellation of Routes;

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- ii. Routes by Origin - Destination;
- iii. Direct Command Routes;
- iv. Approach routes;
- v. Prohibition of Blocking as an entry;
- vi. Prohibition of Blocking as a way out;
- vii. Direct Control over track elements;
- viii. Blocking Violation, at the discretion of the CONCESSIONAIRE;
- ix. Permanent Layout;
- x. Occupation Simulation;
- xi. Imposition and Withdrawal of Speed Restriction;
- xii. Reversal of Traffic Direction;
- xiii. Signaling of abnormal occurrences;

- xiv. Indication of power availability and blockages.

5.3. OPERATIONAL REQUIREMENTS

- 5.3.1. The Signaling and Control System must be designed in such a way as to allow the full operation of the movement of trains along the main, secondary or auxiliary tracks, yard tracks and parking lanes. The detection of the presence of trains must be carried out continuously in order to provide a high level of automatism of the operation activities and their regulation, without the need for constant interventions by the CCO operators.
- 5.3.2. The inherent conditions of the permanent track, such as: civil speed limits, curve radii, longitudinal slopes (ramps), superelevations, precise positions of the signaling equipment installed on the track, turnout regions, positions of the platforms with their extensions with expected train stop points, must be clearly defined in a Signalized Roads Plan – PVS and addressed by Specific Programs in the Traffic Control Subsystem, in order to enable the detection of continuous occupation of the train and its safe movement along the track.
- 5.3.3. The normal operating condition of the Signaling System will always be in "Central/Automatic" mode. An eventual stop of a train during the fulfillment of its operational mission along the route caused by interferences of the operational type or even occasional failure in any equipment that is part of the system, must have its automatic movement resumed and guaranteed, as soon as the interferences are eliminated and the safety conditions of the system are reestablished.

System Startup and Restart

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- 5.3.4. The initialization and re-installation of the Signaling and Control System in each controlled domain region must be automatic, simple, fast and safe, being carried out in less than 3 (three) minutes, with the verification of all traffic conditions, occupations, restrictions, communications and RGS's.
- 5.3.5. The initialization/restart must take into account the technical characteristics and operational requirements defined for each of the controlled systems.
- 5.3.6. In the initialization/reboot process, the following should be dealt with basically:
 - i. Control mode;
 - ii. The region of domain;
 - iii. The restrictions present in the system;
 - iv. The priorities of checkpoints (active room) in the CCO or PCL;
 - v. The operational facilities for Human-Machine Interaction;
 - vi. The exchange of status and diagnostic information between the functions of interdependent modules and equipment;
 - vii. The generation, synchronization and updating of timebases (both static and dynamic).

- 5.3.7. The boot/restart process should be initiated, executed, and completed in such a way that the system is always in a known and safe state.
- 5.3.8. The Signaling System shall be designed to meet the following basic operating requirements:
- i. Speed Limits;
 - ii. Compliance with intervals between trains and/or timetables;
 - iii. Safe Train Movement Control;
 - iv. Control of Lane Changes;
 - v. Control of the Direction of Movement;
 - vi. Modes of Operation and Control.

Speed Limits

- 5.3.9. The Signaling System, through the IVM's, must generate and command the continuous profiles of speeds and movement authorizations in every stretch of track under its domain, which must be permanently in accordance with the following Technical Design Requirements:
- i. General Safety Requirements;

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- ii. Civil speed limits established for each point of the controlled stretch;
- iii. Civil Speed Restrictions on the permanent road;
- iv. Traffic conditions present in the controlled section;
- v. Maximum operational speed defined for each service;
- vi. maximum speed restrictions on the track, adjustable and selectable per track and by track sections of a given controlled domain;
- vii. Dynamic and programmable movement authorizations automatically in accordance with the traffic and safety conditions present in front of the train.

Train Interval and Timetable Compliance

5.3.10. The new Signaling and Control System should ensure that the CCO is able to automatically manage the regulation and compliance with the operational *headway* of at least 3 (three) minutes for LINES 11, 12 and 13.

5.3.11. To obtain this *headway*, it is necessary to consider the stop time on the platforms of 30 seconds, average commercial speed compatible with the travel time, absence of interference (whether on the train, on the platforms, on the track or in the regions of "Terminal Maneuvering Zones"), regardless of the conditions of wheel-rail adhesion (dry or wet rails).

- 5.3.12. For the AIRPORT EXPRESS SERVICE, the system to be implemented must ensure compliance with a timetable of trips defined by the operational area, scheduled with the shortest interval between trains (*headway*) of 30 (thirty) minutes between trips for each direction, and without causing a decrease in speed at peak hours in order to meet the performance provided for in EXHIBIT III.A.

Control of Switches

- 5.3.13. Along the road, at predetermined points, there will be detour regions where Lane Changing Devices - AMV's standardized according to the ABNT NBR 16827 Standard will be installed.
- 5.3.14. In the turnouts, electric (or electro-hydraulic) switch machines and respective coupling layouts to the turnouts must be installed, as well as the position sensors of the needles and mobile alligators (if any), in order to ensure the release of trains and railway vehicles only when the turnouts are properly positioned and locked on the scheduled routes.
- 5.3.15. The command and correspondence controls of the turnouts must be carried out securely and comply with the RGS's.

Operation and Control Modes

- 5.3.16. The turnout regions must have the following control modes respecting the priority sequences:
- i. Central: controlled by the CTCC;

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- ii. Location: controlled by the PCL of the SSC;
- iii. Automatic: automatically controlled by SSC system;
- iv. Maintenance: controlled by the SSC's PCL or through the Maintenance portable HMIs.

5.3.17. The Central Control Mode has priority over the other modes, and the CTCC must allow requesting the passage to the Local, Maintenance or Automatic control mode;

5.3.18. The PCL can only request Local Control mode if the CTCC is in failure or a transfer authorized by the CTCC occurs, and the PCL must allow requesting the switch to Maintenance or Automatic control mode.

5.3.19. In the event of a failure of the CTCC in Central mode, the control mode must switch to Automatic mode, allowing the PCL to request Local or Maintenance mode.

5.3.20. Key Machines must have the following modes of operation:

- i. Remote: where the movement of the key machines is controlled by the IHM's of the CTCC or SSC;
- ii. Location: where the movement of the key machines is carried out by the crank on the body of the key machine;

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- iii. Automatic: where the movement of the key machines is carried out automatically by the SSC equipment.

5.3.21. The control modes for dispatching trains in shunting regions are as follows:

- i. Central: controlled by the CTCC;
- ii. Location: controlled by the PCL of the SSC;
- iii. Automatic: automatically controlled by SSC equipments.

5.3.22. The SSC shall allow parking lanes and access to the maintenance yard to be configurable through the Control Posts in the following ways:

- i. Operation: supervision and control of the entry and exit of trains from the yard carried out by the CTCC, in OBCTC mode (automatic dispatch and collection);
- ii. Maintenance: supervision and control of the entry and exit of trains from the yard carried out by the Local Control Post of the Yard;

5.3.23. In the event of degradation of the CTCC, the Local Control Post of the Yard must be able to control the modes of operation and maintenance of the said access roads to the yard.

Levels of System Degradation

- 5.3.24. The signaling system must be designed to automatically perform all functions related to the control of train movement and its regulation, in an integrated manner with the requisitions coming from the CTCC in an interactive way with the other Subsystems, meeting all the programs related to the SEAT AVAILABILITY PLAN, so that any eventuality that may alter the automatic operation of the trains and their performance must be circumvented by the System, maintaining the circulation of trains and auxiliary vehicles along the track in a safe manner.
- 5.3.25. The System shall be subordinated to the CTCC and PCL, according to the hierarchy to be defined in its architecture, in the functions that directly involve the parameters used in the control and regulation of the transport offer. For the other sectors without interference, the System must operate independently and automatically.

Dispatch and Collection of Trains

- 5.3.26. The CTCC, together with the SSC, must automatically dispatch and collect trains in parking lots, yards, as well as in the terminal maneuvering areas, in order to meet the Train Supply Schedule (POT) and removal of trains with breakdowns, as long as the operational and availability conditions allow.

6. STANDARDS, REGULATIONS AND LEGISLATION

- 6.1. The specifications for the stages of design, manufacture, assembly, installation, testing, as well as materials, equipment and the integration between hardware and software, shall be governed by the standards, in their most recent versions, according to the institutions listed in this EXHIBIT.

- 6.2. In the specifications for services, equipment and materials, the standards cited in the guideline of each equipment/system must be observed, in order to always consider its most recent edition. Whenever applicable, the ABNT standards - Brazilian Association of Technical Standards in force must be adopted.
- 6.3. In all topics related to telecommunications, the rules and resolutions to be obeyed must be those of ANATEL – National Telecommunications Agency. The frequencies used must be licensed and comply with the latest resolutions of ANATEL, and all equipment used that emits or receives radio frequency signals or that are part of its radiating system must be approved by ANATEL, even if the frequencies used do not require licensing.
- 6.4. In the topics in which these standards are omitted, international standards of recognized competence may be used, among which we cite those issued by the following organizations listed below:
- i. ABNT Standards – Brazilian Association of Technical Standards;
 - ii. Regulations IEEE/EIA/TIA – “Institute of Electrical and Electronic Engineers” / “Electronic Industries Association” / “Telecommunications Industry Association”;
 - iii. Regulations CENELEC – “European Committee for Electrotechnical Standardization”;
 - iv. Regulations IEC - “International Electrotechnical Commission”;
 - v. Regulations ISO - “International Standard Organization”;

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- vi. Regulations ITU – “International Telecommunication Union”;
- vii. Regulations MIL - “Military Standards”;
- viii. Regulatory Standards for Safety and Health at Work – Ministry of Labor – Ordinance No. 3214, of June 8, 1978;
- ix. NEMA standards;
- x. ANATEL Resolutions, highlighting:
 - a. Resolution 555 of 12/20/2010 - Approves the Regulation on Channeling and Conditions of Use of Radio Frequencies in the 225 MHz to 270 MHz Band;
 - b. Resolution 556 of 12/20/2010 - Approves the Regulation on Channeling and Conditions of Use of Radio Frequencies in the 360 MHz to 380 MHz Band;
 - c. Resolution 558 of 10/20/2010 - Approves the Regulation on Channeling and Conditions of Use of Radio Frequencies in the 450 MHz to 470 MHz Band;
 - d. Resolution 665 of 05/02/2016 - Assigns radio frequency bands and approves the Regulation on Channeling and Conditions of Use of the Radio Frequency Band from 380 MHz to 400 MHz;

- e. Resolution 674 of 02/13/2017 - Approves the Regulation on Channeling and Conditions of Use of Radio Frequencies in the 148 MHz to 174 MHz Band.

7. OPERATIONAL CONTROL CENTER - CCO

- 7.1. The Operational Control Center – CCO, located in the building attached to Brás Station, must adequately meet the operational needs of the SERVICES, housing LINES 11, 12 and 13 and coexisting with Lines 07 (the latter temporarily) and 10-Turquoise (including the MRS workstation) and 14.

- 7.1.1. The COEXISTENCE COMMITTEE shall establish rules for shared use, for the use of the CONCESSIONAIRE's employees, for the cafeteria and changing rooms/toilets, etc., observing the regulatory norm of the Ministry of Labor. In the event of lack of space, during the temporary stay of the employees of TIC TRENS S.A., the CONCESSIONAIRE shall rent, at its own expense, a container to accommodate the remaining provisions, in order to comply with the aforementioned rule, pursuant to EXHIBIT III.C.

- 7.2. The CCO will be composed of supervision and control equipment for the following functions, or subsystems:

- i. CTCC – Centralized Traffic Control System - Signaling and Control;
 - ii. SCE – Energy Control System - Electrical Power and Overhead Network;
 - iii. Auxiliary Subsystems – Low Voltage, Ventilation of Technical Rooms and Air Conditioning, Fire Detection and Fighting, Lighting, Pumps;

- iv. Passenger Subsystem – Escalator, Elevators; Locks;
 - v. Collection and Passenger Control Subsystem – SCAP;
 - vi. Security Subsystems – Surveillance and Supervision of Passenger Safety in the facilities and accesses to the system, at stations and during trips;
 - vii. Telecommunications Systems - STO, CCTV, sound, timing, radio communication.
- 7.3. The operational control of LINES 11, 12 and 13 shall be mirrored in a place to be defined, and shall perform at the request of ARTESP the function of supervision and monitoring of the systems, including the consultation of alarms and events, in real time, or in the historical record.
- 7.4. The new Control Center must be operating when the new Signaling system (ETCS Level 2) is entered and a migration plan must be made that enables the transition without prejudice to the operation.
- 7.5. The systems that are part of the CCO must be designed with a distributed and redundant *hot-standby* architecture, covering:
- i. Control Room: In this Room, the operational and supervisory consoles of the systems will be arranged in order to control the operations of the LINES. In the control room there will also be a *videowall* panel where it will be possible to view the movement and relative position of the trains operating on the tracks, an information board on the energization of the 3kVdc traction lines for train power (catenary), energy in the medium voltage power rings of 34.5 kVac and 4.4/13.8 kVac and energy and power supply of the primary High Voltage

substations. In this room will also be located a general panel and CCTV image monitors with the objective of Video Surveillance for supervision and determination of security and operational strategies to act in possible complications involving passengers within the facilities, accesses, stations and on trains during trips;

- ii. Server Room: In this room the IT equipment necessary for the operation should be located, including the Servers in redundant *Hot-Standby configuration*;
- iii. Communications with the equipment distributed on the LINES and trains: This communication connects the CCO's server equipment with the other Signaling and Telecommunications equipment. Two different technologies will be used for this communication: fiber optic network subsystem (STO) and radio communication. The normal way of operation of the *Hot-Standby architecture* is that one of the servers is in an online state (active) and the other in hot-standby (active standby);
- iv. Data Network: The data network must be configured so that the communication of the signaling control with the CCO supports a single failure in any of the elements. Therefore, it should be implemented through two switches connected in a ring and providing the proper redundancy;
- v. Crisis Room/Strategic Meetings.

7.6. The Control of the Operation and Monitoring of each LINE will be divided into subsystems, where each Operation and/or Supervision Station is controlled and monitored by IHM's – "Human Machine Interface" covering:

- i. Train Control;

- ii. Energy Control and Electrifications;
- iii. Monitoring and Control of Passenger Flow;
- iv. Telecommunications;
- v. Control and monitoring of Auxiliary and Low Voltage Equipment;
- vi. Maintenance Support.

CENTRALIZED TRAFFIC CONTROL SYSTEM - CTCC

- 7.7. The CTCC system monitors the operation of train traffic, including Yards and Parking Lots. The CTCC provides traffic information by displaying the location of the trains, the status of the routes and aspects of the signalmen (if any) both on the Mimic Panel of the control room and on terminals with CTCC HMIs.
- 7.8. Trains can also be controlled manually by the operator at the CTCC terminal of the CCO, through the route alignment command, the request to depart a train at the station and the request to stop a train at a certain station.
- 7.9. The CTCC system must also manage and execute the traffic regulation by *headway* (intervals between trains) and by timetables, which are used to control the supply of trains on LINES 11, 12, 13 and AIRPORT EXPRESS SERVICE, which will be measured by PERFORMANCE INDICATORS, according to EXHIBIT III.D, which must also be automatically generated by the CTCC.

POWER CONTROL SYSTEM – SCE

7.10. The SCE allows the monitoring and control of the equipment of the High Voltage, Medium Voltage, Low Voltage and Traction Power Supply System, covering the following subsystems:

- i. Primary Substations;
- ii. Rectifier Substations;
- iii. Auxiliary Substations.

7.11. The main controlled equipment is as follows:

- i. Breakers;
- ii. Disconnect switches (including overhead contact line disconnect switches);
- iii. Contactors.

7.12. In the CCO there must be a control terminal for the SCE that allows to command and monitor the status of the electrified LINES throughout the system, as well as to monitor and control the state of opening and closing of the Circuit Breakers, Disconnect Switches and other components subject to remote / remote maneuvers. The SCE must also present in its control terminals, for the monitoring of consumption and demand, the load of the input feeders (88 / 138 kVca), 34.5 kVac and 3 kVdc output) of the substations

and disconnecting cabins. On the Video Walls, the status of the catenaries must be shown together with the road.

AUXILIARY CONTROL SYSTEM

7.13. The Auxiliary Control System, which is part of the CMMS, should allow the monitoring and control of auxiliary equipment in the stations. The equipment controlled and/or monitored are:

- i. Low voltage;
- ii. Ventilation of Technical Rooms;
- iii. Air-Conditioned;
- iv. Fire Detection and Fighting;
- v. Lighting;
- vi. Bombs.

PASSENGER FLOW SYSTEM - SFP

7.14. The Passenger Flow System, which is part of the CMMS, should allow the monitoring and control of equipment in the stations related to the flow of passengers.

7.15. The equipment related to the flow of passengers controlled and/or monitored are:

- i. Escalators;
- ii. Elevators;
- iii. Locks;
- iv. Passenger counters at station exits.

Collection and Passenger Control Subsystem – SCAP

7.16. The Collection and Passenger Control System is responsible for Ticketing, collecting collection data and carrying out the treatment defined by the GRANTING AUTHORITY and ARTESP. This system is part of the CMMS.

Security Subsystem

7.17. The Security Subsystem is responsible for the Surveillance and Supervision of the Security of passengers in the facilities and accesses to the system, at the stations and during journeys;

Telecommunications Subsystem

7.18. The Subsystem responsible for the monitoring and Control of Telecommunications systems, which is part of the CMMS, covers:

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i. STO;

ii. CCTV;

Sound;

iii. Chronometry;

iv. Radio communications.

SCADA (Multiservice Platform)

7.19. SCADA is the Supervision and Data Acquisition System configured by a platform that will allow the visualization and control in real time of various electromechanical elements and equipment, integrated into a system or isolated, responsible for the supervision and control of the operational, energy, auxiliary, telecommunications and security systems, which must be connected and integrated to the CMMS and comply with the obligations required by EXHIBIT III.D.

7.20. It must be composed of software that works in a graphical environment, where operators can view a map of the facilities and identify each of the components of the system, with client-server architecture, which will be accessed through control posts located in the CCO as described in items 6 and 7.2 of this EXHIBIT and/or local supervision at the stations through SCLs or specific Systems, which will be interconnected to the CMMS and SIGO when relevant.

7.21. The devices and equipment to be covered by SCADA must be prepared to be remote-controlled and tele-supervised, and must be (if applicable) adapted to perform such functions.

7.22. Given the infeasibility of inserting control or supervision in all equipment while the SCADA is being implemented, as well as, as long as there is a need to adapt the equipment to support the supervision, control or communication of data, a non-operability procedure (equipment in operation without integration to the SCADA system) will be admitted, which must be presented by the CONCESSIONAIRE and APPROVED by the INDEPENDENT AUDITOR for subsequent non-objection by ARTESP, with a deadline for full implementation.

7.23. The minimum requirements for SCADA software will be:

- i. Supported operating systems: Windows, Linux, and Oracle Solaris;
- ii. Databases and image processing;
- iii. Redundancy of the Hot *Standby type system*, transparent to the user and without loss of information;
- iv. Modular and scalable system allowing orderly growth of the system;
- v. Storage of data in databases in parallel;
- vi. Security through encryption;

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- vii. Integration with the image capture and management system, among other systems;
- viii. Possibility of calendar and schedule of events;
- ix. Reports and Trends;
- x. Alarm system, meeting VDI/VDE 3699 and DIN 19235 recommendations regarding safety, reliable monitoring and sensitive equipment;
- xi. Obtain remote alarm information and alarm prioritization;
- xii. Graphical interface for status and control display devices;
- xiii. Multi-user platform;
- xiv. Access by username and password, with the hierarchy levels;
- xv. Possibility of alarm and system status management via Web-server;
- xvi. Remote maintenance;
- xvii. Ability to import and export data;

xviii. You should have the possibility of having different views of the facilities to manage and monitor the different types of facilities.

7.24. The signaling and control, telecommunications and energy systems and equipment mentioned in this EXHIBIT shall be supervised and controlled by SCADA shall be at a minimum:

- i. Lighting;
- ii. Elevators;
- iii. Escalators;
- iv. Nobreaks (UPS);
- v. Hydraulic pumps;
- vi. Fire Detection and Alarm System;
- vii. Fixed Telephone System;
- viii. Access Control System (SCA);
- ix. CFTV system;

- x. Road Monitoring System;
- xi. Public Address Systems, Variable Message Panels and Timing;
- xii. Aid Request System.

7.25. The CONCESSIONAIRE shall prepare the project, which shall be submitted for APPROVAL by the INDEPENDENT AUDITOR and not objection by ARTESP, under the terms of EXHIBIT II.E, and shall then implement the SCADA, with all the materials and equipment necessary for supervision and control of equipment installed in all stations, in the yards, in the CCO and in the substations and sectioning cabins.

7.26. The Supervision and Data Acquisition System (SCADA) configured by a platform should allow the visualization of several electromechanical elements and equipment, integrated into a system or isolated. It will be responsible for the supervision and control of the operational, energy, auxiliary, telecommunications and security systems, which must be connected and integrated to the CMMS and observe the obligations required in this EXHIBIT.

7.27. The SCADA system should allow the acquisition and processing of data in real time from multiple networks simultaneously, based on TCP/IP and UDP/IP, ensuring the operational performance of the system in view of the volume of data required.

7.28. The software should be totally object-oriented, have graphic libraries and symbols, allowing internal programming of both the visual part and the processing of data in real time.

7.29. It should allow protection of the developed libraries against use by unauthorized persons, through encryption by passwords, ensuring autonomy and security of the

developed programs, allowing direct access by the INDEPENDENT VERIFIER, ARTESP and others indicated by it.

DESIGN AND IMPLEMENTATION OF THE CENTRAL MANAGEMENT SYSTEM – CMMS (CMMS):

- 7.30. The CONCESSIONAIRE shall prepare the project and submit it for APPROVAL by the INDEPENDENT AUDITOR and subsequent non-objection by ARTESP, and implement the CMMS, with all the necessary materials and equipment.
- 7.31. The Central Management System (CMMS) should be implemented in the CCO and will be interconnected to the network of the telecommunications system, CTCC, SCE and SCADA of the stations, yards, substations and cabins, through the STO.
- 7.32. The CMMS will capture information from the CTCC, SCE and SCADA in real time on the status of each element of the supervised systems of the stations, the Yard, the CCO, the substations and other equipment through supervision consoles in the CCO, having its information made available to ARTESP, in real time.
- 7.33. The CMMS must enable both automatic and manual monitoring (opening and closing) of occurrences and failures for systems and equipment that present any anomaly in their operation. The system, based on this failure data, must generate reports that enable the calculation of the PERFORMANCE INDICATORS accessed remotely.
- 7.34. The devices, equipment and software that allow the automation of performance measurements must be implemented, maintained and funded by the CONCESSIONAIRE. Such equipment will be subject to prior approval by the INDEPENDENT VERIFIER, under the terms of EXHIBIT II.E. Prior to approval, the equipment/systems will receive approval consisting of reliability tests. Once the approval has been passed, the formal commissioning that conditions the framework for measurements of PERFORMANCE INDICATORS will be applied, under the terms of EXHIBIT III.D.

Mandatory Features for CMMS

7.35. For the implementation of the CMMS, the following activities and requirements must be observed:

- i. Planning of equipment maintenance, considering the environmental characteristics of the environment where they will be installed, in order to ensure the high availability of the system.
- ii. Document and maintain in the system the information about the entire maintenance history of each of the equipment of the systems, using the type, model and serial number of the equipment as an identifier. It includes the permanent record of all relevant information on maintenance, both preventive and corrective, carried out on each of its elements.

7.36. The basic features of the CMMS aimed at managing the maintenance of the systems are:

- i. Asset management: description and historical information of each asset with the ability to manage its hierarchical structure;
- ii. Analysis of failure trend/time between failures (MTBF), number of cycles between failures (MCBF);
- iii. Management and implementation of the Indicators provided for in EXHIBIT III.D;
- iv. Asset depreciation control (useful life);

v. Reports and Reports.

7.37. Implementation of the CMMS: The CMMS must be implemented and validated together with the systems and subsystems linked to the CMMS as described in this EXHIBIT, and made compatible with other obligations required in the other EXHIBITES. For systems and subsystems that are already in operation, the implementation of the CMMS must be carried out within 90 (ninety) days before the start of the COMMERCIAL OPERATION.

8. LOCAL CHECKPOINTS

SSC Local Control Post (PCL)

- 8.1. The PCL is part of the SSC and its purpose is the supervision and/or local operation of the Signaling System in a pre-defined area called the control domain. The LCKs must be installed in specific rooms in the master stations of each domain. The PCL interacts with the CTCC by obeying hierarchical rules and modes of control. The PCL equipment must use redundancy resources, in order to obtain the specified availability, with ease of maintenance, modularity, connectivity and expansion capacity.
- 8.2. The PCL must follow the mandatory guidelines for the signaling and control system, expressed in this EXHIBIT.

Local Power Control Post (LPCP)

- 8.3. The LPCP is part of the Power System and is intended for the supervision and/or local operation of the System in a substation and/or Disconnector Cabin when applicable. The LPCPs are part of the energy control systems incorporated in the Substations and

Sectioning Cabins. The LPCP interacts with the SCE obeying hierarchical rules and modes of control.

Local Control System (SCL)

- 8.4. The SCL is the system responsible for performing the functions of supervision and local control of telecommunications systems and, completely, of the low voltage, auxiliary, passenger and SCAP systems through equipment installed in all stations. The SCL equipment must use redundancy resources, in order to obtain the specified availability, with ease of maintenance, modularity, connectivity and expansion capacity.
- 8.5. The SCL, from specific graphic screens implemented in IHM's installed in the station SSOs and interconnected to the Electrical/Auxiliary/SCAP Control Posts in the CCO, will supervise and control the following systems:
- i. Low Voltage;
 - ii. Auxiliary Equipment;
 - iii. Collection and Passenger Control;
 - iv. Maintenance Support.

Functional Characteristics

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8.6. The SCL, when operating in Local Control mode and through specific graphic screens, will perform the supervision and control of the following equipment of the respective systems, and must be appropriate to the specific characteristics of each station:

8.6.1. Power Supply (Low Voltage):

- i. Primary Cab with 34.5 kV interior line input;
- ii. Diesel Generator Set;
- iii. Direct Current Distribution Board – DCDB;
- iv. Lighting Panels – LP's;
- v. Battery Charger Power Panel – PAC;
- vi. 220VAC/125VDC Battery Charger;
- vii. Static Inverter/Chave 125VDC/127VAC 60Hz;
- viii. Essential Panel – PESS;
- ix. Lock Power Panel – PAB.

8.6.2. Auxiliary Equipment:

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- i. Ticket Office Alarm or ATM violation;
- ii. Fire Alarm and Detection;
- iii. Escalators;
- iv. Elevators;
- v. Bombs.

8.6.3. SCAP:

- i. For each row of locks;
- ii. For each block.

8.6.4. Telecommunications:

- i. Closed Circuit Television – CCTV;
- ii. Station and Message Sound;
- iii. Chronometry;

- iv. Variable Message Panel (PVM).

Maintenance Support

- 8.7. The SCL must provide technical resources and operational facilities, providing extensive diagnosis of events and failures occurring in each equipment of the System for maintenance. This diagnosis must be made available locally in the SCL equipment in real time, with the Date/Time parameter, through registration on a high-capacity hard disk (with memorization of events and failures that occurred within a period of at least 1 (one) month).

Technical Requirements

- 8.8. The SCL should allow interface with the equipment controlled through specific IHM's, with graphic resources specially developed and made available in video monitors.
- 8.9. The SCL information available at HMIs must be, at least, of:
 - i. Graphic representation of the station's equipment and systems (Power Supply System, pumps, locking system (SCAP), escalators, elevators, fire detection system, with indication of detection loops in technical rooms, operating rooms, cable holds, galleries and others, CCTV, sound system, Diesel Generator, lighting circuits, Ticket Office Alarms, and VMS's), showing their operational status, commands issued and alarms occurred, in addition to the visualization of the layout of the station and its various levels;
 - ii. Information that allows the control, selection and visualization of the operational states of the equipment that is part of the CCTV Subsystem, sound

equipment, with transmission of pre-recorded and digitized messages and the electrical circuits of the Timing equipment with a screen representative of the station layout.

- 8.10. The operational status of the equipment that makes up the HMIs must always be represented on their graphic screens, as well as the mode of operation of the Subsystem/equipment.
- 8.11. There must be a specific graphic screen with the layout of the station, with the equipment that controls the circulation of users in the station, such as: escalators, elevators and locks, signaling the operational status of each one of them, with graphic representation through a typical architecture of interconnection communications of the SCL.
- 8.12. The SCL must have resources (hardware and software) that aim to automate functionalities - optimizing tasks and the number of interventions of the OHS operators - and the performance of multiple activities simultaneously, consequently, allowing the operation of the station and the station's equipment with greater flexibility, comfort, safety and efficiency.
- 8.13. The SCL equipment must use redundancy resources, in order to obtain the specified availability, with ease of maintenance, modularity, connectivity and expansion capacity.

Reliability Requirements

- 8.14. The systemic availability of the SCL shall be at least 99.998% and the average time for MTTR repair of the equipment shall not exceed two (2) hours.

8.15. In order for the specified availability to be met, redundancy resources of modules and equipment can be used in the SCL sizing.

9. TELECOMMUNICATIONS SYSTEMS

9.1. The Telecommunications System of LINES 11, 12 and 13 will have its design readjusted in order to fully comply with the specified operational requirements and will be implemented in order to provide a perfect integration with the equipment of Signaling, Electrical Power, Auxiliaries and Passenger Service.

9.2. Telecommunications systems comprise the following functionalities:

- i. Telephony;
- ii. Optical Data Transmission System Networks – STO;
- iii. Chronometry;
- iv. Closed Circuit Television - CCTV;
- v. Sound and Multimedia Information Panels;
- vi. Radio communications;
- vii. Access Control System - SCA;

viii. Data transmission by digital radio and Wifi network.

9.3. The stations of the stretch currently operational, in addition to the above systems, must have their complementary telecommunications systems adequate to the operational needs of the new services, namely:

i. Variable Message Panels – PVM;

ii. Local Control System – SCL;

iii. Collection and Passenger Control System – SCAP.

9.4. In addition to the requirements of standardization, maintainability and technological updates, the Systems must be adapted to the civil and structural reformulations that will be carried out in each of the stations. Therefore, it is necessary that the systems fit the renovations and remodeling that will be carried out, thus ensuring compliance with the functional, quantitative and aesthetic requirements of the proposals for reformulation of the stations.

9.5. In the expansions of LINES 11 (Students – Cezar de Souza), 12 (Calmon Viana – Suzano) and 13 (Airport-Guarulhos – Bonsucesso and Engº Goulart – Gabriela Mistral), the new or readapted stations must have the telecommunications systems mentioned above implemented, in the entire operational section.

9.6. The validators of the TRAVEL PASS will be provided and installed at the blocks by the GRANTING AUTHORITY. The infrastructure ("dry" channels and pipes) to allow the feeding and connection of these validators that must be provided by the CONCESSIONAIRE, as well as an area in the technical rooms of the stations for the installation of a server rack, also provided and installed by the GRANTING AUTHORITY.

- 9.7. In the case of the Optical Transmission Subsystem - STO, it must provide all the necessary communication channels for the interconnection of all systems and subsystems belonging to the CCO, the station systems, signaling system and traction power supply system along the LINE, as is currently done.

MANDATORY GUIDELINES FOR TELECOMMUNICATIONS SYSTEMS

- 9.8. The guidelines defined herein are mandatory for the design of telecommunications systems, and the CONCESSIONAIRE may define its own project, which must be submitted for APPROVAL by the INDEPENDENT AUDITOR and to ARTESP for non-objection.

SOUND SYSTEM

- 9.9. The main purpose of the Public Address System is to broadcast notices to USERS and employees of the stations, and as a secondary function, it is planned to broadcast background music.
- 9.10. Added to this system are the Variable Message Panels (PVMs), located in the platform regions that convey the same messages broadcast.
- 9.11. Through the PVM, the USERS who are in the region of the platforms must be informed of the destination of the train that will park next to it, presentation of alert messages, institutional notices and, in textual form, the digitized pre-recorded messages conveyed by the sound system, and the broadcasting of advertising messages in the PVMs is prohibited.

- 9.12. In each of the stations of the stretch, the sound system must enable all the necessary resources for the issuance of warnings (directly or through the MDPG – Pre-Recorded Digital Messages) and eventually background music.
- 9.13. The Public Address System must provide the CCO operator with all the necessary resources to issue warnings (directly or through the MDPG – Pre-Recorded Digital Messages) and eventually background music to the various stations.
- 9.14. From the CCO's Human-Machine Interface (IHM) it should be possible to manage all the programming of warnings that will be broadcast on the station, both in manual and automatic mode.
- 9.15. In manual mode, the CCO operator has the possibility to select the station, group of stations or all of them (general) to send one or more messages.
- 9.16. These messages can be sent by speaking directly into the microphone or using the database of previously recorded messages.

Functional Characteristics

- 9.17. The Public Address System must allow, from the CCO or from the station (when applicable), to perform the functions described below:
- i. Allow the operator, using the console microphone, to issue warnings to each station, sets of stations, or all stations simultaneously. The operator will be able to activate the electronic gong. There will be a signal to the operator when the system is cleared for issuing warnings;

- ii. Allow the operator to select scanned pre-recorded messages (MDPG) and command their sending to each station, sets of stations or all stations simultaneously. The operator must be able to monitor the selected message in advance and, during broadcasting, through the sonoflector monitor;
- iii. Allow operation employees to exchange digitized pre-recorded messages (MDPG) stored both in the CCO and in the stations, through the CCO equipment.

Technical Requirements

9.18. The Public Address Subsystem must meet the following general technical requirements:

- i. System intelligibility, which must be at least 90% (ninety percent) for all areas of the stations, the intelligibility assessment must be made, preferably by STI (*Speech Transmission Index*), according to IEC 60268-16 standard. The category of intelligibility to be achieved must be at least F (Exhibit G of the aforementioned standard);
- ii. Limits of Sound Areas should include all public areas (paid, unpaid and mezzanine), Technical Rooms and Operational Rooms;
- iii. Noise Levels operating in conditions of maximum power, without any type of sound incident on the microphone, the system shall not radiate any type of sound, noise or buzz at a level above 50 dBA, when switching the functions, the noise generated by these operations shall not exceed 60 dBA;

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- iv. Total Electroacoustic Distortion (DET) operating under maximum power conditions, the DET shall not exceed 5%, measured in any of the sonoflectors of the Subsystem;
- v. Sound Pressure Level (SPL) in the broadcast of warnings, the SPL must be at least 10 dB above the ambient noise level measured in any sound location of the station and in any range between 200 and 8,000 Hz, the SPL for the entire Subsystem must be limited to 105 dBA in any sound area of the station;
- vi. Linearity for a person walking along any sounded area, is not subject to SPL variations greater than 6 dB.

Reliability Requirements

9.19. The availability of the Sound System must be at least 99.998% with a maximum service time of 2 (two) hours.

Interface Requirements

9.20. Interface with the Architecture of the stations - the supports must be installed on roof slabs, columns, walls or false ceiling support structures, appropriate to the particular characteristics of each location.

TIMING SYSTEM

9.21. The Timing System shall consist of a Precision Time Center, to be installed at the CCO, which shall be referred to as the Main Time Center and will receive synchronization from the GPS (*Global Positioning System*), a system of American geostationary satellites. This center will synchronize Slave Clocks that will be installed in the CCO Operational Room and on the premises of the stations.

9.22. The Main Time Center will also provide synchronization for the Centralized Traffic Control System, for the Multichannel Recorder and for the CCTV (Video Recorders).

9.23. In each station there must be slave clocks distributed on the platforms, accesses and operational rooms, which will receive synchronization from the Main Time Center through the Optical Transmission System (STO), and these slave clocks can be integrated with the PVMs.

Functional Characteristics

9.24. The time centers will basically have the following functions:

- i. To emit synchronism to the station's slave clocks and to the various systems and user equipment through signals coded with time information (and not just synchronism pulses);
- ii. Provide electrical power for the time circuits, which power all the clocks in the system;
- iii. Allow GPS synchronism through an antenna;

- iv. Allow prior programming of at least 30 (thirty) days in advance, of corrections to the beginning and end of daylight saving time;
- v. Allow inhibition of synchronism signals for defective time circuits, without prejudice to the others;
- vi. Signal On-time Central (in the control unit itself);
- vii. Signal Failed Time Zone (in the control panel itself);
- viii. Inform, through a digital display, the time (hour, minute, second);
- ix. Test the time signals (in the form of self-diagnosis with signaling at the center itself);
- x. Test the power supply supplied to the time circuits (in the form of self-diagnosis with signaling in the control panel);
- xi. The power supply of the Clocks must have the possibility of individual circuit shutdown command.

Technical Requirements

9.25. The accuracy of the Secondary Time Centers must be greater than or equal to 10^{-6} (annual deviation better than ± 0.5 minute).

- 9.26. The Time Centers must send to the Slave Clocks and, to the other synchronized equipment and systems, pulse trains with the time information.
- 9.27. It must have a battery so that, in the absence of external power for at least 24 (twenty-four) hours, the time base remains unchanged and the previously made programs are memorized. Once the external power supply has been restored, the entire Timing Subsystem shall be automatically and fully operational again without any delay, loss of accuracy or function.
- 9.28. Time Plants must be protected against overvoltage, undervoltage, short circuit or opening of the power supply circuits and time information distribution circuits.
- 9.29. The Time Centers and Slave Clocks must be immune to electromagnetic interference generated by the various systems existing in the vicinity of the locations of their installations, such as: high voltage transformers, train inverters, luminaire ballasts, etc.
- 9.30. It is essential that the clocks have some visual resource that signals that the system is operational (such as 2 dots between digits, in the case of digital clocks) that flash during the time between one time update and another in order to characterize its operation.
- 9.31. The Slave Clocks must have protection against vandalism, overvoltage, undervoltage and short circuit of the electrical supply circuits and distribution circuits of the time information.
- 9.32. If the Slave Watches are subject to environmental inclement weather (rain, pollution), the Protection Index (IP) must be adopted at least, IP-66.

Reliability Requirements

- 9.33. The availability of the Timing System must be at least 99.998% with a maximum service time of 2 (two) hours.

Interface Requirements

- 9.34. Interface with the Architecture of the stations - the supports must be installed on roof slabs, columns, walls or false ceiling support structures, appropriate to the particular characteristics of each location.

OPTICAL TRANSMISSION SYSTEM – STO

- 9.35. The main objectives of the 10Gbps Gigabit Ethernet Optical Transmission System (STO) are to support the services of voice, data and image transmission systems for the perfect operation, maintenance and administration of the railway system, increase safety levels, speed up service in emergency situations, optimize operational performance and structure the means of communication, to allow a dynamic interaction between the various systems implemented in the CCO, stations, yards, substations, tracks and other locations of the LINES.
- 9.36. For these interactions, the design of the Optical Transmission System must provide for the appropriate hardware and software interfaces with the envisaged systems.
- 9.37. The Optical Transmission System (STO) must provide voice, data and image (video) transmission services to all user systems in the stations, CCO and Vias.
- 9.38. The following are considered STO user systems:

- i. Centralized Control;

- ii. Signaling and Control System;
- iii. Telecommunications System (Radio, Ticketing, Telephony, Timing, Sound and CCTV);
- iv. Traction Electrical Power System (Substations, Sectioning Cabins and Overhead Network).

9.39. The STO should meet the needs of user systems through a convergent data communication network and a network of optical cables. This network should interconnect the local networks of the stations and CCO, operating with a single data communication standard in its backbone and combining the various interfaces and segments of the access network, necessary to serve the STO user systems.

9.40. The optical cables connecting the stations and the CCO must have a dualized configuration for the essential systems transmitted by the STO.

9.41. The Optical Transmission System (STO) will basically consist of:

- i. Optical Cables;
- ii. General Distributors for Optical Cables (DO's);
- iii. General Distributors for Metallic Cables (DG's);
- iv. Multiplex Equipment;

- v. Interfaces and converters of the STO with the user systems;
- vi. STO Resource Manager: diagnostics, reconfiguration, re-routing, event reporting, etc.

9.42. This set of equipment will provide the interconnection of the CCO Technical Room with the Technical Rooms of the stations, where the user equipment is installed (control microcomputers, signaling equipment, telecommunications equipment, electrical supply equipment, etc.).

9.43. The same happens with the interconnection of the Technical Rooms of the stations with the equipment that uses the respective stations.

9.44. The CONCESSIONAIRE may request ARTESP to use or update the system's technology, incorporating network systems and 4G LTE (Long Term Evolution) or 5G NR (New Radio) technology, enhancing the connectivity of the assets. If ARTESP does not object, the CONCESSIONAIRE may request the economic and financial rebalancing of the AGREEMENT.

Functional Characteristics

9.45. The STO must be able to route packets between VLANs, in order to enable all the necessary communications between the various user systems.

9.46. In the event of partial or total shutdown of the convergent network and even with the de-energization of the equipment, the network should automatically return to its normal operation, after the system is restored, serving the user systems according to a logic of priorities.

- 9.47. In case of failures or abnormalities, in addition to informing the network manager, the system must provide alarms to the CCO or other systems.
- 9.48. The architecture of the STO must be such that a failure in one piece of equipment or simultaneous failures in two non-redundant equipment with each other, in communication with the other nodes of the network, should not compromise the communication between the equipment of the user systems in the same location or in different locations.
- 9.49. In the event of a total shutdown of two redundant communication equipment or *switches* in the same location, communication between the equipment in the other locations must not be compromised.
- 9.50. In each location, the STO must make available to each user system that requires redundant communication channels, standard Ethernet gates in independent switches.

Technical Requirements

- 9.51. The main technical requirements of the STO must meet the following characteristics:
- i. Backbone structure, aiming at high performance, high availability, with high-speed redundant communication (10Gbps / 25Gbps / 40Gbps);
 - ii. Redundancy considering double ring of fibers using the existing cable and the new fiber cable to be deployed;

- iii. Segregation of the L3 environment with the use of dynamic routing protocol between the Stations and CCO, to provide fast convergence or the solution that best suits the project;
- iv. Total segmentation using the Backbone and Distribution infrastructure;
- v. Definition of perimeter security in *firewall* between networks.

9.52. Switches and any equipment in the converged network must be designed to meet mission-critical applications, operating in aggressive environments, such as dust from the track, thermal variations, electrical and electromagnetic transients, and have the following characteristics described below, regardless of the technology used.

9.52.1. Implementation of the following protocols:

- i. IEEE802.3u: 100Base-TX *Fast Ethernet*;
- ii. IEEE 802.3ab: 1000Base-T *Gigabit Ethernet*;
- iii. IEEE802.3x: *Flow Control*;
- iv. IEEE802.1p: *Priority Queuing*;
- v. IEEE802.1q: VLAN;
- vi. IEEE 802.3x standard full duplex operation on all ports;

- vii. Scalability and modularity in order to allow the expansion of interfaces and gates (gates), with the simple addition of modules and reprogramming by the management functions;
- viii. Capacity to expand the gates that make up the backbone of the network, maintaining the amount of reserve and the topology of the original network;
- ix. Compliance with IEC 61850 and IEEE 1613 standards.

Reliability Requirements

9.53. The availability of the STO must be at least 99.998% with a maximum service time of 2 (two) hours.

Interface Requirements

9.54. The communication interfaces between equipment and systems must be designed in accordance with the Standards established by the Standards Institutes, and using one of the standards defined below:

- i. Fast-Ethernet according to IEEE-802.3 standard;
- ii. USB serial standard or according to IEEE-1394 standard (*firewire*);

RADIO COMMUNICATION SYSTEM

- 9.55. A complete Radio Communication System, especially for voice, should be implemented to enable the effective communication of data and voice between the various operational areas of the LINES of all the proposed SERVICES, including allowing the communication of the trains in operation of LINES 11, 12 and 13 and the AIRPORT EXPRESS SERVICE.
- 9.56. The radio communications system must have a redundant architecture to provide high operational reliability.
- 9.57. The system should allow the creation of multiple interdependent functional groups, for operation, maintenance, etc., as well as meet the needs of data transmission for the Signaling and Control System.
- 9.58. The licenses obtained from ANATEL in order to comply with LINES 11, 12 and 13, among other licenses and authorizations, will be incorporated into the REVERSIBLE ASSETS.

Technical Requirements

- 9.59. The communication networks must be directed to meet the various communication needs and must provide the mobile voice and data communication service to employees on LINHA's premises. All system services, as well as land-train communications services, will be implemented through a digital mobile communication platform, in accordance with ANATEL's Resolution.
- 9.60. The system is composed of Dispatch Consoles (IHM's) to be installed in the CCO, which communicate with the Base Radio Stations (ERB's) of the repeater sites in redundant configuration (1+1).

9.61. They must have a complete radiant system sized to offer radio frequency coverage on all tracks, thus allowing the CCO control posts to communicate with mobile radio stations (trains, track and road vehicles) and portable stations (transceivers used by train operators, track vehicle operators, operation, maintenance and safety agents) in the daily traffic and maintenance routines of LINE trains, operating 24 (twenty-four) hours a day, 7 (seven) days a week.

9.61.1. To define the height of the base station tower, the CONCESSIONAIRE must observe the current standards, whether of an urban nature, linked to ANATEL or ANAC, among others not indicated in item 5 of this EXHIBIT. Thus, the specifications for the stages of design, manufacture, assembly, installation, testing, as well as materials, equipment and the integration between "hardware" and "Software", must be governed by the applicable standards, in their latest revisions.

9.61.2. The repeater near the Jaraguá Station is for the use of the Radio Communication system, common to the other CPTM lines due to the current digital radio link (STO redundancy) and is not part of the CONCESSION AREA. For use, a rule of coexistence with CPTM and/or its successors must be established, observing the rules of coexistence in EXHIBIT III.C. If its use still remains necessary after the implementation by the CONCESSIONAIRE of the new Radio Communication system, the continuity of use must be justified before ARTESP, which will determine the reasons for the use.

9.61.3. The current radiocommunication system depends on a repeater station located at Rua Marambainha nº 37 in Guaianases-São Paulo, which should initially integrate the CONCESSION AREA. If it is not later necessary, due to the new radio system, indicated in item 9.64, the possession of this property must return to the GRANTING AUTHORITY. Such property needs territorial regularization by the CPTM.

9.62. In the control center, equipment/software for remote management of alarms available by the equipment that makes up the radio communication system must be made available.

9.63. The interconnection between the equipment that makes up the system must be done through an IP connection.

9.64. The Radio Communication System to be designed and supplied to LINHA shall:

- i. be regulated and approved by ANATEL or the regulatory body in force at the time of contracting.
- ii. provide voice recording equipment from all operational networks that are part of the system with remote access capability through IP network. The copy of the recording must be kept by the CONCESSIONAIRE for a minimum period of 60 (sixty) days.
- iii. have an emergency power supply system through UPS, source/charger/battery etc. com a minimum capacity of 4 (four) hours.

9.65. The CONCESSIONAIRE will use the current radiocommunication infrastructure until the end of the tenth year of the concession, and the implementation of the new system must occur at the beginning of the following year, without interruption of communications.

Operational Requirements

9.66. The Radio Communication System to be implemented for the voice/data communication of the LINE must allow at least the following functionalities:

- i. Traffic Network (TRAIN) - voice communication between the operator of the Control Center Traffic Console with the drivers, operators of the ground-track vehicles (track-mobil, aerial network maintenance vehicle, etc.);
- ii. Maintenance Network - voice communication between the operator of the Maintenance Console with the operators of the ground-track vehicles (track-mobil, aerial network maintenance vehicle, etc.), operation/maintenance agents equipped with portable transceivers, or fixed stations;
- iii. Safety Net - voice communication between the operator of the Safety Console located in the Control Center and security agents equipped with portable transceivers or fixed stations;
- iv. The Radio Communication System shall allow voice communication through mobile radios, located in vehicles, trains and HT's, along the entire length of the LINES, as well as provide signal coverage in all internal areas of stations, platforms and maintenance blocks and in external areas such as maneuvering yards.

9.67. The Radio Communication System should enable terminals to provide caller identification services.

9.68. The Portable Terminals and Mobile Radios of trains and vehicles must be able to emit audible and visual alarms when receiving calls and/or messages.

9.69. The Radio Communication System for voice and eventually data, must use a radiant system on the tracks that allows coverage of all areas of interest, without promoting or perceiving any interference from the signaling system, as well as the uniform distribution of the signal throughout the train route, with coverage that minimizes the installation of active equipment on the track and in its vicinity.

9.70. The Radio Communication System must enable all the functionalities specified for the Portable Terminals and Mobile Radios (installed in vehicles and/or trains), in:

- i. Internal areas of the stations;
- ii. Operational areas;
- iii. Technical rooms;
- iv. Way;
- v. Emergency exits considering the entire route to the external environment of the station area;
- vi. Internal areas of trains moving at any speed (with the estimated maximum speed of the train as an upper limit) on the main tracks, parking lots, transition zones, transfer zones and in the yards;
- vii. Internal areas of the courtyards;
- viii. Internal areas of the CCO.

ix. Bordering strip, both sides of the LINES, with a minimum coverage of 500m.

9.71. Railway stations along the LINES should be equipped with transceivers to provide communication with the CCO and station security officers.

9.72. The Radio Communication System must enable the functionalities specified for the HT's/TP's (operators, Trains and Special Vehicles) and the land-train communications with the on-board equipment throughout the train route on the main tracks, in the train parking lots, transition zones, transfer zones and in the yards, including inside the maintenance blocks.

9.73. The Radiocommunication System must provide for the possibility of direct and unidirectional communication between the CCO and the train hall, unilaterally, without the intervention of the driver, through an interface with the public address system on board the trains.

Performance Requirements

9.74. The Radiocommunication System must have an availability of at least 99.998% with a maximum service time of 2 (two) hours.

9.75. The sources of the equipment allocated to the base stations/repeaters must be redundant and configured for continuous operation and maintenance without the need for system downtime.

CCTV SYSTEM – CLOSED CIRCUIT TV

9.76. The CCTV system aims to allow the remote supervision of various locations of the stations, complexes and maintenance bases, yards, walkways, underpasses, running tracks and trains. Therefore, TV cameras properly installed in strategic locations allow the Operational Supervision Room (OHS) Operators at each station, Security Agents and CCO Operators, to view these locations.

Functional Requirements

9.77. For the region where the stations circulate, 100% of the operational and non-operational areas will be covered by the CONCESSIONAIRE.

9.78. The elevators of the stations must have coverage of 100% of their internal areas.

9.79. For the complexes and maintenance bases and yards, 100% of the operational and non-operational areas will be covered by the CONCESSIONAIRE.

9.80. For the right-of-way, along the raceway, 100% of the operational and non-operational areas will be covered by the CONCESSIONAIRE.

9.81. For the circulation region, walkways will be covered by each of the vertical accesses and underpasses.

9.82. For the region where the TRAINS circulate, there will be 100% coverage of the passenger lounge.

Technical Requirements

9.83. The CCTV System will consist of fixed and mobile cameras, internal and external, servers, *storage* and control center. The CCTV System must meet the LINE and be centralized in the CCO's Security Room. The main equipment of the system is listed below:

- i. Redundant Servers (1+1) in the CCO;
- ii. *Storage* for Image Processing and Storage;
- iii. Operational IHM;
- iv. Cameras:
 - a. Native IP color fixed cameras;
 - b. Native IP color mobile cameras;
 - c. Vandal-resistant protective housings or domes for cameras installed indoors and outdoors.
- v. Media converters (optical/Ethernet), only for cameras reached by optical cable;
- vi. Posts, brackets and accessories for installing outdoor cameras;
- vii. Software:

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- a. Management software for integrated control;
- b. Set of operational, application and system software (including manuals and licenses of use), to be used for recording images from IP cameras and remote management for configuration, viewing and retrieval of images recorded in the CCO, Complexes and Maintenance Bases, Parking Yards, Test Track, Running Way, Walkways, Underpasses and Stations.
- c. In places such as Complexes and Maintenance Bases, Parking Yards, Test Tracks, Running Tracks, Walkways, Underpasses, Substations, Cabins, Houses, Technical Rooms and Stations, software for intrusion detection must be coupled to the monitoring of cameras in order to prevent and combat acts of invasion and/or vandalism.

9.84. For the right-of-way, along the highway, the cameras must have sufficient range and resolution to meet the coverage indicated in the items 9.72 the 9.82 to be specified and implemented by the CONCESSIONAIRE, and the Management Software must allow access to ARTESP.

9.85. The CCTV system embedded in the trains and the CCTV system installed in the stations, complexes and maintenance bases, yards, walkways and underpasses must record images in 1080p, with DORI (Detect, Observe, Recognize, Identify) coverage in the standard EN-62676-4 system.

9.85.1. The images of the CCTV system (closed circuit TV) must be transmitted through the telecommunications system, without compromising the remote monitoring systems of the ROLLING STOCK and data and voice communications, in real time to the CCO, who may select them, at a resolution of 25 frames per second in NTSC standard, with CIF quality in quantization Q1. A digital system or equivalent may be accepted as long as it is proven to be used by other

passenger train operating companies. Digital systems whose TCP/IP network supports IEEE 802 series protocols will be accepted. The resolution should be 1,280x800 pixels at 30 fps, with an H.264 compression ratio. The system should allow the generation of reports using management software available on the market.

- 9.85.2. The transmission rate must be defined in a study, design and dimensioning under the responsibility of the CONCESSIONAIRE, in order to meet the quality and quantity of uninterrupted images (real time).
- 9.86. The systems at the Stations will be managed by the SCL, where applicable, and communication will take place entirely via STO. The commands and indications occurring in the system must be recorded.
- 9.87. CCTV must allow the viewing of images on any computer and on more than one terminal simultaneously, with authorized access to the telecommunications network in the LINHA's digital transmission system, always with an access password.
- 9.88. The fixed and mobile cameras of the Stations will then be distributed throughout the plant and will communicate with the local CCTV server via IP - *Internet Protocol network*.
- 9.89. The system as a whole will have the characteristic IP CCTV. The CCO will be able to communicate with each camera individually, through the SCL.
- 9.90. Communication between stations, substations, yard and CCO must be done through the STO.
- 9.91. The CCTV must have its time synchronized with the standard time generation system incorporated by the Timing System.

- 9.92. CCTV should allow integration with the SCADA system (SCL) by an IHM in all stations.
- 9.93. CCTV should allow camera images to be viewed through a central system, as well as recorded images that are using the same video surveillance system, allowing recordings and visualizations to be carried out centrally, locally or even a combination of these two options.
- 9.94. The structure of the CTV should have a single system concept, which allows it to be managed through a surveillance operation center that starts from a central site to other sites in different locations, bringing a hierarchical topology of scalability, allowing the complete administration and management of sites through a central site.
- 9.95. The system must allow integration with *Perimeter Defender* systems and with sound horns, installed at strategic points, especially in buildings along the road, in order to discourage acts of intrusion.
- 9.96. The system must have an automatic or manual tool for adjusting the sensitivity of detected movement, as well as allowing the configuration of exclusion zones in the image for a better performance of the camera, excluding objects that may cause unnecessary recordings from the area of interest.
- 9.97. It should allow the operator to create Bookmarks manually, which allow the insertion of information (comments) of the operator in images that will become important evidence within the system.
- 9.98. It must allow the use of automatic bookmarking, created by activating rules previously created in the system.

9.99. It should be easily identified in the recording through bookmark identification icon and have bookmark search option within the monitoring client software.

9.100. The storage system must guarantee, at a minimum, recording in local mode for thirty (30) days, redundantly and ninety (90) days in the BCC.

Reliability Requirements

9.101. The availability of CCTV must be at least 99.998% with a maximum service time of 2 (two) hours.

TELEPHONY

9.102. The basic purpose of the telephony subsystem is to enable fast, reliable, flexible, and good quality (intelligibility) internal and external communication.

9.103. The main needs of internal communication by Telephony are related to the following activities:

- i. Operationalization of the LINE;
- ii. System Maintenance;
- iii. Administration and Management.

9.104. These communications must be made possible internally to the station, between stations, and between these stations and the various locations that are located in the Yards and in the CCO. It must also enable external communications to the stations through connection with the public telephone network through trunks located in the station itself.

Functional Characteristics

9.105. To serve all locations, the following must be implemented in each location:

- i. G.703 standard interfaces;
- ii. Independent Ethernet standard connection ports that can be configured independently and with the ability to configure different IP addresses to operate in the same logical network;
- iii. Sufficient processing capacity to serve all IP fixed telephone devices and Intercoms, in addition to supporting all other functionalities assigned to the VoIP Suite;
- iv. VoIP Modular Platform (IP PBX), one for each station, with *redundant Storages (1+1) to perform digital voice recording at the CCO*;
- v. Control Posts for system management and control;
- vi. IP fixed telephone sets.

- 9.106. The Telephone System must enable internal and external voice communications with telephone operators and the public network. The Telephone System must operate using the technology called Voice over IP (VoIP), with SIP signaling protocol.
- 9.107. The Telephone System will consist of two VoIP sets installed in different locations. These assemblies will operate redundantly and with load balancing.
- 9.108. In each station, a modular VoIP platform (IP PBX) must be installed with the ability to operate in the event of a disconnection between the station and one or both VoIP sets, ensuring continuity of communication within the station.
- 9.109. The Telephone System must have the capacity to serve all physical terminals installed along the stations, substations, CCO and yards.
- 9.110. The VoIP sets to be installed must be interconnected, via STO, so that they share the trunks, so that:
- i. In the failure of a trunk, both sets use the others;
 - ii. If one of the trunks is at its maximum occupancy and the others have a reserve, the authenticated devices in the set that has its trunk at its maximum occupancy must make external calls through the other trunks;
 - iii. In the event of failure of one of the sets, the other must take over all the branches of the system and use the idle trunks;
 - iv. In the case where the same equipment has two or more network connections, the equipment or system itself must manage the switching of its connections,

ensuring the specified availability and the absence of addressing conflicts, even when the same logical address is used for redundancy purposes.

9.111. VoIP suites and their interconnected equipment must use the SIP signaling protocol.

Technical Requirements

9.112. The System must allow transfer and full transparency of call facilities between stations, substations, CCO and yards.

9.113. The System must allow communication between stations, substations, CCO and yard, from any terminal, without the occurrence of intermediate line tone.

9.114. The configuration of the Telephone System must have a minimum availability of 99.998% with a maximum service time of 2 (two) hours, in order to automatically preserve the continuity of the operation.

9.115. Recordings must be made in a non-proprietary digital format, that is, they must be made through open standards.

ACCESS CONTROL – SCA

9.116. The Access Control System - SCA will have as its principle the access control in the technical rooms of the stations, yards, CCO and substations.

9.117. The Access Control System must allow or deny access to defined areas, depending on the user's biometrics and the information contained in the database, including

authorizations for certain specific accesses. It must also meet the functional requirements for assigning access, defined user fields.

9.118. The system should make it possible to define the schedules to be established by the user. There shall be no limit on the number of time intervals within an hourly scale.

9.119. Any change in status detected by an Access Control Unit must be communicated to the operator on the SCL monitor of the stations and to the SGC. It must also have the resources to record and print such occurrences without the intervention of the operator.

9.120. The system will consist of the following components:

- i. Central Management Server;
- ii. Controller set;
- iii. Biometric readers;
- iv. Electric/Magnetic locks, door contacts, door locking/unlocking device, including power supply and emergency pushbutton;
- v. Door Opening Sensor;
- vi. Unlock button.

9.121. The SCA must be composed of hardware and software and other devices necessary for the management of the system, with the resource of user registration, definition of access levels, editors of access card layouts, definition of access times, forms for capturing / consulting data, digital photo, reports, as well as resources for capturing images of users.

9.122. The system should be centralized in the CCO.

Functional Requirements

9.123. The SCA shall have a Management Software/Database Server that will be installed on the CCO.

9.124. In small stations, the controllers of the SCA must be directly connected to the CCO. In larger stations they must be connected to the SCL.

9.125. The SCA should be integrated, through the Data Network and the STO, to the CCTV, Surveillance and Fire Detection and Alarm systems.

9.126. The SCA should have the following resources:

- i. Have a standard report library with an editor for customization, in market standard;
- ii. To be easy for the operator to locate the controlled areas, access parameters and information of access card holders;

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- iii. Schedule agenda by doors and areas;
- iv. Control the status of ports;
- v. Configure card access, with validity periods;
- vi. Enable digital outputs;
- vii. Limit access to system menu items, through passwords;
- viii. Issue management reports, which enable the monitoring of the operator's activities, the movement of the selected control cards and the transactions of the entire system;
- ix. Allow the operator to assign any combination of ports, for any user;
- x. Protect the historical data of the controller units in non-volatile memory and have the resources to send the data of the transactions that occurred during the interruption of communication with the central computer, as soon as communication between them is reestablished;
- xi. Have a server for daily data backup and that should be configured to take over the management of the entire access control system in case of failure on the main server without any impact on the operation of the equipment;

- xii. Have the capacity to operate the controllers offline in the event of a failure in communication with the servers for any reason, until communication with the servers is properly reestablished.

STATION WI-FI SYSTEM

- 9.127. The Wi-Fi System is intended to offer its user an information channel through a high-quality and high-performance Wi-Fi internet connection, at no cost to that audience.
- 9.128. The user will be able to use the Wi-Fi network available through pre-registration and will be able to make use of this service, for example, during the waiting time interval for boarding the trains.
- 9.129. The Wi-Fi System must provide wireless broadband network access to users at all stations, on the boarding and disembarking platforms, which presents, as main characteristics, flexibility, simplicity and mobility.
- 9.130. The communication infrastructure must use the resources of access points, with high performance and reliability, capable of supporting several state-of-the-art technologies regarding voice, data and images, supported by IP technology and prepared for the new demands that require the exchange of information in real time, such as access to e-mails, social networks, advertising and entertainment.
- 9.131. Wi-Fi must adjust the effective speed of the communication link, to serve the largest number of simultaneous users with at least 2 effective Mbps for download and upload.
- 9.132. Whenever the number of connected users, for a given station, reaches 90% of the capacity of the simultaneous connections provided for in the project, an increase in the

transmission capacity of the link must be foreseen so that it does not compromise the navigability of the Wi-Fi system in that station.

9.133. Telecommunications / IT equipment must meet all the standards established by ANATEL, including homologation, licenses, fees.

9.134. The installed networks must be able to guarantee the quality and stability of the signal to users, so that jitter and latencies conditions do not impair the user experience, minimally maintaining the levels established by ANATEL, being compatible with notebooks, cell phones, smartphones, tablets and other devices commonly used for internet access, within the minimum standards: IEEE 802.11a, 802.11b, 802.11g, 802.11n and 802.11ac.

Access Points – *Hot Spots*

9.135. The access points, according to their technical characteristics, must be distributed in such a way that they do not allow the concentration of people at a single point on the platform, and thus cause impediments to the flow of USERS in the station.

9.136. The installation of these access points should allow the widest possible range of USERS, according to their technical characteristics, aiming at greater efficiency by hot spots.

9.137. The stations have different contingents of USERS for each location, and in this way, the access points may have different characteristics depending on this contingent.

DOCUMENTATION FOR MAINTENANCE AND OPERATION

9.138. The CONCESSIONAIRE shall:

- i. Manage with the suppliers of the Signaling and Telecommunications Systems in order to receive the documentation related to the CDMS processes - Reliability, Availability, Maintainability and Security (or RAMS in the acronym in the English language), as established in the CENELEC EN 50126 standard;
- ii. To make available, for access by ARTESP, all software developed and related to the object of the CONCESSION.

9.139. The documents provided must be in Portuguese and the CONCESSIONAIRE must deliver a copy of all documentation in scanned files and recorded on media, to the representative appointed by ARTESP.

10. MANDATORY GUIDELINES FOR THE ENERGY SYSTEM

10.1. The guidelines defined herein are mandatory for the design of the energy system, and the CONCESSIONAIRE may define its own project. In the adoption of alternatives other than the mandatory ones, there will be a need for APPROVAL by the INDEPENDENT AUDITOR and non-objection by ARTESP.

Considerations in the Dimensioning of the Power System and OVERHEAD TRACTION NETWORK

10.2. With the extensions to be implemented in LINES 11, 12 and 13 and with the intensification of the operation of the services through the reduction of *the headway*, the Power System and the OVERHEAD TRACTION NETWORK should be readjusted and expanded to meet the increase in energy demand, and the smallest design *headway* for each LINE should be considered considering the defined train fleet.

Substations and Disconnecter Cabins

- 10.3. Substations and sectioning cabins, when essential for their implementation, must receive cubicles for power supply and remote and local energization control and track protections. For this, there should be the inclusion of circuits equipped with extra-fast circuit breakers, disconnect switches and cables. Such equipment shall be sized and located at the discretion of the CONCESSIONAIRE.
- 10.4. Disconnect switches must be for operation under load, provided with means for extinguishing arcs. They must be designed, built and tested, according to the standards EN 50123-4 and IEC 61992-4. These switches must be monopolar and located at the outlets to the overhead network.
- 10.5. Grounding meshes must be made in accordance with NBR 15751, NBR 15749 and IEC 62305 standards.
- 10.6. The remote command and monitoring of substations and cabins must be through a fiber optic data network from the Telecommunications system to the CCO. The data and commands shall be in accordance with EN 61850.
- 10.7. The disconnecter switches of the OVERHEAD TRACTION NETWORK must be connected to the energy remote control system and centralized in the CCO.
- 10.8. The substations and cabins must have a SCADA - *Supervisory Control and Data Acquisition* system connected to the fiber optic data network in order to allow commands and functional state monitoring by the CCO.
- 10.9. The location of substations and sectioning cabins must observe access for maintenance compatible with the availability of area, municipal projects and urban insertion.

- 10.10. The CONCESSIONAIRE shall provide for the registration or implementation of the water and sewage system in all cabin and substation buildings, performing the regularization of withdrawals and discharges, making the appropriate connections in the network of local concessionaires.
- 10.11. In the updating of substations by repowering, the state of the grounding loops must also be checked and, if necessary, reform the current grid or make a new grounding loop in addition to the existing ones, in accordance with the NBR 15751, NBR 15749 and IEC 62305 standards.
- 10.12. The repowering of substations should provide for the replacement of existing circuit breakers with new circuit breakers due to outdated technology or end of useful life. Likewise, the disconnecting cabins must have their extra-fast 3 kVdc circuit breakers replaced due to outdated technology and/or exhausted useful life.
- 10.13. For the replacement of existing substations, the CONCESSIONAIRE shall provide for the replacement of all components that are pertinent, due to outdated technology or end of useful life, as well as all the physical/civil rearrangement of its facilities, with the execution of all necessary works (civil, electrical, sanitation, compliance with the standards of the existing energy concessionaires, etc.).
- 10.14. The command and monitoring network of the substations must be adjusted (or new equipment installed) to use the fiber optic network communication of the new telecommunications system (STO) for the CCO, which in turn must be in line with the implementation of the SCADA, jointly forming the remotely controlled energy system. Data and control networks shall be in accordance with EN 61850.
- 10.15. They must have a SCADA - *Supervisory Control and Data Acquisition system* connected to the fiber optic data network, in order to allow commands and monitoring of functional status by the CCO.

- 10.16. Modular rectifier units must be able to be turned off individually, without the need to turn off the others, allowing the continuity of power, even in the event that one unit is out of service.
- 10.17. In order for the operation of the LINES in concession to occur, the entire Energy and Electrification System must be implemented, commissioned and made available in its entirety to supply each of the sections of the CONCESSION.
- 10.18. Thus, for the determination of the necessary power and quantities of Substations that will make up the Energy and Electrification system of the SERVICES, the fleet detailed in EXHIBIT II.F and the operational guidelines established in EXHIBIT III.A were taken into account.
- 10.19. The CONCESSIONAIRE shall prepare its projects, dimensioning and specifications, including repositioning and/or repowering of the substations with the appropriate remote control integrated with the CCO. The project must be submitted for APPROVAL by the INDEPENDENT AUDITOR, under the terms of EXHIBIT II.E and to ARTESP for subsequent non-objection.
- 10.20. It is the responsibility of the CONCESSIONAIRE to obtain all AVOBCs, including those related to buildings intended for the energy system.
- 10.21. In the maintenance and adequacy of the power systems, the Engenheiro São Paulo Substation shall maintain an independent power supply system, considering the Sebastião Gualberto Substation as a power source, or alternative to be evaluated by the CONCESSIONAIRE.

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10.22. The EXECUTIVE PROJECT will be detailed based on the BASIC PROJECT to be developed by the CONCESSIONAIRE, covering all systems, equipment contained therein and its buildings.

10.23. All information involving the electrical/electronic systems and equipment along the roads must be detailed and complemented, containing: sizing and routing of the interconnection cabling, dimensional drawings of frames/panels/equipment, their weights and reflections in the civil/structural/architectural part, ducts and junction and interface boxes for the passage of medium voltage power cables, cables for signaling system, telecommunications, lighting etc.

10.24. The EXECUTIVE PROJECT to be developed by the CONCESSIONAIRE must be in such a way that the resulting documentation allows a complete understanding for the implementation of the work with all the elements.

Interference

10.25. The interferences encountered during the implementation of the works must be detailed as to their need for relocation to the executive solution of the project and the agreement of the affected agency or concessionaire must be obtained.

PART II: SIGNALING, TELECOMMUNICATIONS AND ENERGY SYSTEMS VENTURES

The project items listed herein by the GRANTING AUTHORITY, as PROJECTS, are mandatory, and it is the responsibility of the CONCESSIONAIRE to ensure the preparation of the specifications, the BASIC PROJECT and the EXECUTIVE PROJECT.

I. DESCRIPTION OF THE SIGNALING VENTURES OF LINES 11, 12 AND 13

The PROJECTS related to signage must comply with the mandatory guidelines contained in items 6, 7 and 8 of PART I of this EXHIBIT.

1.1. VENTURE CCO 001 – OPERATIONAL CONTROL CENTER OF LINES 11 AND 12

The CCO of LINES 11 and 12 will correspond to the CCO Brás, currently in operation by CPTM, located next to Brás station.

The CCO must be adequate to receive and integrate its systems and equipment in order to allow the full operation of LINES 11 and 12 from modernizations and adaptation works based on the needs of the Systems and their guidelines established in item 7 on PART I from this EXHIBIT.

The CONCESSIONAIRE shall carry out the necessary modernizations as a result of the implementation of the signaling and control, telecommunications and energy systems, as well as shall implement a system for monitoring the traffic of the LINES (only mirroring the operations of LINES 11 and 12) that shall be implemented in a location (or locations) to be defined by ARTESP.

The commissioning of this PROJECT (Modernization of the CCO) will take place observing all the technical, functional and operational requirements foreseen, linked to the Signaling, Telecommunications and Energy systems, including labor standards, such as NR 24.

This PROJECT must necessarily, in its execution, articulate the implementations and other obligations of the CCO 002 PROJECT.

1.2. VENTURE CCO 002 – OPERATIONAL CONTROL CENTER OF LINE 13

The CCO of LINE 13 will correspond to the CCO Brás, currently in operation by CPTM, located next to Brás station.

The CCO must be adequate to receive and integrate its systems and equipment in order to allow the full operation of LINE 13 and the AIRPORT EXPRESS SERVICE from modernizations and adaptation works based on the needs of the Systems and their guidelines established in item 7 on PART I from this EXHIBIT.

The CONCESSIONAIRE shall carry out the necessary modernizations in the CCO as a result of the extension of LINE 13 to Bonsucesso, with the implementation of signaling and control, telecommunications and energy systems, as well as shall implement a system for monitoring the traffic of the LINES (only mirroring the operations of LINE 13 and the AIRPORT EXPRESS SERVICE that shall be implemented in a location to be defined by ARTESP.

The commissioning of this PROJECT (Modernization of the CCO) will take place observing all the technical, functional and operational requirements foreseen, linked to the Signaling, Telecommunications and Energy systems, including labor standards, such as NR 24.

This PROJECT must necessarily, in its execution, articulate the implementations and other obligations of the VENTURE CCO 001.

1.3. VENTURE SIN 001 - INSTALLATION OF THE ON-BOARD SIGNALING SYSTEM

The CONCESSIONAIRE shall install 214 (two hundred and fourteen) pieces of equipment of the on-board signaling system, that is, 2 (two) pieces of equipment per train of the patrimonial fleet, compatible with the ETCS N2 signaling system, allowing the interoperability of the trains on the three LINES in operation.

The CONCESSIONAIRE shall also provide 6 (six) MRS locomotives with an on-board signaling system, compatible with the ETCS system, allowing shared operation and interoperability in the Engº Gualberto – Engº Manoel Feio section (LINE 12) and in the section between Estudantes – César de Souza (LINE 11).

1.4. VENTURE SS 002, SS 003, SS 004, SS 005, SS 006, SS 007, SS 008, SS 009, SS 010, SS 011, SS 012, SS 013, SS 014, SS 015, SS 016 AND SS 017 – SIGNALING SYSTEMS OF 11, 12 AND 13

The CONCESSIONAIRE shall implement and commission the signaling system along the existing stretches and expansions (in accordance with the SSC guidelines contained in item 6 of part I) in the ETCS N2 standard, connecting all stations, complexes and maintenance bases, yards and circulation routes, as well as connecting, deploying and commissioning the local control posts (PCL) at the stations where they are needed.

2. DESCRIPTION OF THE TELECOMMUNICATIONS VENTURES OF LINES 11, 12 AND 13

VENTURES related to telecommunications must comply with the mandatory guidelines contained in item 9 on PART I from this EXHIBIT.

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2.1. VENTURES TEL 001, TEL 002, TEL 003, TEL 004, TEL 005, TEL 006, TEL 007, TEL 008, TEL 009, TEL 010, TEL 011, TEL 012, TEL 013, TEL 014 AND TEL 015 – TELECOMMUNICATIONS SYSTEMS ON LINES 11, 12 AND 13

The CONCESSIONAIRE shall implement and commission the telecommunications systems, with emphasis on CCTV, in order to carry out monitoring along the circulation routes in the level and underground sections, covering 100% of the operational areas.

The systems must be interconnected to the CCO or to the local systems of the stations, contemplating the operational strategy of the CONCESSIONAIRE, ensuring monitoring through cameras and software for intrusion detection in order to prevent and combat acts of invasion and/or vandalism.

2.2. VENTURES TEL 016, TEL 017, TEL 018, TEL 019, TEL 020, TEL 021, TEL 022, TEL 023, TEL 024, TEL 025, TEL 026, TEL 027, TEL 028, TEL 029, TEL 030, TEL 031, TEL 032, TEL 033, TEL 034, TEL 035, TEL 036, TEL 037, TEL 038, TEL 039, TEL 040, TEL 041, TEL 042, TEL 043, TEL 044, TEL 045, TEL 046, TEL 047, TEL 048, TEL 049, TEL 050, TEL 051, TEL 052, TEL 053 AND TEL 054 – TELECOMMUNICATIONS SYSTEMS AT LINE 11, 12 AND 13 STATIONS

The CONCESSIONAIRE shall implement and commission the telecommunications systems in all existing and planned stations, with emphasis on the telephony systems, STO, timing, CCTV, Sound and Multimedia Information Panels, radiocommunications, SCA data transmission by digital radio, public wi-fi network, PVM, SCL and SCAP.

Regarding the Optical Transmission System - STO, it should be structured as an optical fiber system and should provide all the communication channels necessary for interconnection of the CCO to the station systems, listed above, to the defined signaling system and to the traction power supply system along the LINE, Substations and Sectioning Cabins.

Due to the obsolescence of telecommunications systems, every 15 years these systems will

have to be upgraded/replaced. For the STRO, the update/replacement should also occur every 15 years for the LINES.

2.3. VENTURES TEL 055 TO TEL 069 – TELECOMMUNICATIONS SYSTEMS IN THE COMPLEXES, MAINTENANCE BASES AND YARDS OF LINES 11, 12 AND 13

The CONCESSIONAIRE shall implement and commission the telecommunications systems, with emphasis on CCTV, in order to carry out monitoring along the operational areas of the complexes, maintenance bases and yards, covering 100% of the operational areas.

The systems must be interconnected to the CCO, in accordance with the operational strategy of the CONCESSIONAIRE, ensuring monitoring through the software cameras for intrusion detection in order to prevent and combat acts of invasion and/or vandalism.

2.4. VENTURE TEL 070– MONITORING SYSTEMS (CCTV) ON TRAINS

The CONCESSIONAIRE shall install 107 (one hundred and seven) pieces of equipment of the CCTV system embedded in the trains that make up the CONCESSION's patrimonial fleet, according to the guidelines of the item 9, ensuring 100% monitoring of the passenger lounge.

2.5. VENTURE TEL 071 AND TEL 078– TELECOMMUNICATIONS SYSTEMS ON THE WALKWAYS OF LINES 11, 12 AND 13

The CONCESSIONAIRE shall implement and commission the telecommunications systems, with emphasis on CCTV, in order to monitor the walkways under the responsibility of the CONCESSIONAIRE, which are provided for in EXHIBIT II.A, covering 100% of the areas intended for pedestrian crossings.

The systems must be interconnected to the CCO or to the local systems of the stations, contemplating the operational strategy of the CONCESSIONAIRE, ensuring monitoring through cameras and software for intrusion detection in order to prevent and combat acts of invasion and/or vandalism.

2.6. VENTURE TEL 079– TELECOMMUNICATIONS SYSTEMS IN THE TECHNICAL ROOMS OF LINES 11, 12 AND 13

The CONCESSIONAIRE shall implement and commission an intrusion detection system in the technical rooms, located along the circulation routes of LINES 11, 12 and 13, according to the mandatory guidelines presented in item 9, and especially the items related to the monitoring system (CCTV).

2.7. VENTURE TEL 080 AND TEL 081– TELECOMMUNICATIONS SYSTEMS AT THE UNDERPASSES ON LINES 11 AND 12

The CONCESSIONAIRE shall implement and commission a monitoring system (CCTV) at underpasses 155, 040 and 156 of LINE 11, and underpasses 119 and 154 of LINE 12, in accordance with the mandatory guidelines presented in item 9, whose location of the passages is listed in EXHIBIT II.A.

DESCRIPTION OF THE ENERGY VENTURES OF LINES 11, 12 AND 13

VENTURES related to energy must comply with the mandatory guidelines contained in item 10 of this EXHIBIT.

2.8. ENE 001 VENTURE - REPLACEMENT OF THE CALMON VIANA SUBSTATION

The electricity from the Calmon Viana Substation is supplied by the energy concessionaire EDP

Brasil at the voltage level of 88/138 kVca. For this substation, the CONCESSIONAIRE shall provide for the replacement of the equipment that composes it, as well as the construction of a new substation, based on the BASIC AND EXECUTIVE PROJECT to be prepared by the CONCESSIONAIRE, maintaining at least the installed powers, in both direct current and alternating current circuits, or increasing them in accordance with the study to be carried out by the CONCESSIONAIRE based on the new operating conditions. Note that this substation feeds direct current (3kVdc) to LINES 11 and 12, and alternating current (34.5kVca) to the Guaianases substation, in turn interconnected with the Patriarca substation.

2.9. ENE 002 VENTURE – REPLACEMENT OF THE SEBASTIÃO GUALBERTO SUBSTATION

The electricity at the Sebastião Gualberto Substation is supplied by the energy concessionaire ENEL Brasil at the voltage level of 88 kVca. For this substation, the CONCESSIONAIRE shall provide for the replacement of all the equipment that composes it, as well as the construction of a new substation, in the same location, based on the BASIC PROJECT and the EXECUTIVE PROJECT to be prepared by the CONCESSIONAIRE, maintaining at least the installed powers, in both direct current and alternating current circuits, or increasing them according to the gear simulation to be carried out by the CONCESSIONAIRE based on the new operating conditions. Note that this substation feeds direct current (3kVdc) to LINES 11 and 12.

2.10. ENE 003 VENTURE - REPOWERING OF THE DOM BOSCO SUBSTATION

For the Dom Bosco substation, the CONCESSIONAIRE shall provide for the inclusion of a new 4MW rectifier group, expanding the installed powers, in both direct current and alternating current circuits, or increasing them according to the running simulation to be carried out by the CONCESSIONAIRE based on the new operating conditions.

2.11. ENE 004 VENTURE - REPOWERING OF THE GUAIANASES SUBSTATION

For the Guaianases substation, the CONCESSIONAIRE shall provide for the inclusion of a new 4MW rectifier group, expanding the installed powers, in both direct current and alternating current circuits, or increasing them according to the running simulation to be carried out by the CONCESSIONAIRE based on the new operating conditions.

2.12. ENE 005 VENTURE - REPOWERING OF THE BRAZ CUBAS SUBSTATION

For the Braz Cubas substation, the CONCESSIONAIRE shall provide for the inclusion of a new 3MW rectifier group, expanding the installed powers, in both direct current and alternating current circuits, or increasing them according to the running simulation to be carried out by the CONCESSIONAIRE based on the new operating conditions.

2.13. ENE 006 VENTURE – REPLACEMENT OF THE ERMELINO MATARAZZO SUBSTATION

The electricity at the Ermelino Matarazzo Substation is supplied by the energy concessionaire ENEL Brasil at the voltage level of 88 kVca. For this substation, the CONCESSIONAIRE shall provide for the replacement of all the equipment that composes it, as well as the construction of a new substation, based on the BASIC AND EXECUTIVE PROJECT to be prepared by the CONCESSIONAIRE, maintaining at least the installed powers, in both direct current and alternating current circuits, or increasing them according to the running simulation to be carried out by the CONCESSIONAIRE based on the new operating conditions.

2.14. ENE 007 VENTURE - REPOWERING OF THE ENG MANOEL FEIO SUBSTATION

For the Engenheiro Manoel Feio substation, the CONCESSIONAIRE shall provide for the inclusion of a new 4MW rectifier group, expanding the installed powers, in both direct current and alternating current circuits, or increasing them according to the running simulation to be carried out by the CONCESSIONAIRE based on the new operating conditions.

2.15. ENE 008 VENTURE – NEW SÃO MIGUEL PAULISTA SUBSTATION

A new Rectifier Substation, with an area planned for its implementation near the São Miguel Paulista station of LINE 12 preferably, will serve for the CONCESSION's energy system to reinforce the 3 kVdc grid power supply capacity of the LINE 12 trains. This new substation should be powered at high voltage 88/138kVca, and provide power of 12MW through three sets of 4MW rectifiers. The implementation of the CPB (Consumer Power Branch) at high voltage may imply expropriations, eventual resettlements and environmental compensations at the expense of the CONCESSIONAIRE, giving rise to the economic and financial rebalancing of the AGREEMENT.

The definition of the exact location for implementation in the indicated stretch will be at the discretion of the CONCESSIONAIRE, however, within the CONCESSION AREA, ensuring its functionality integrated with the traction energy network.

2.16. ENE 009 VENTURE – NEW SÃO JOÃO SUBSTATION

This PROJECT involves the implementation of a substation fed in 88/138kVac, through CPB (Consumer Power Supply), which should feed the medium voltage circuit in 34.5kVac and other auxiliary circuits (AC and DC), also having two rectifier sets of 4MW to feed the aerial network in 3kVdc, responsible for feeding the trains, in a location close to the future São João station, it is the responsibility of the CONCESSIONAIRE to evaluate its exact location next to the future CONCESSION AREA. The CONCESSIONAIRE shall through its simulation of the gear to be carried out, confirm the powers of the rectifier sets mentioned herein, considering their operational aspects.

At the discretion of the CONCESSIONAIRE, the 88/138kVac power supply with CPB power supply in this substation may be reviewed, and it may be implemented next to the ENE 007 PROJECT and transforming the power supply input of the new São João substation into 34.5 kVca.

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2.17. ENE 010 VENTURE – NEW PRESIDENTE DUTRA SUBSTATION

This PROJECT involves the implementation of a 34.5kVac powered substation that should have two sets of 4MW rectifiers to feed the 3kVdc overhead network, responsible for feeding the trains, in a location close to the future Presidente Dutra station, and the CONCESSIONAIRE is responsible for evaluating its exact location next to the future CONCESSION AREA. At the discretion of the CONCESSIONAIRE, the power supply may be revised at 34.5kVca, which can be implemented next to the ENE 006 PROJECT and transforming the power supply inlet of the new Presidente Dutra substation into 88/138kVca, with power from CPB.