«ЛОКОМОТИВ»
АКЦИОНЕРЛІК ҚОҒАМЫ

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№ Исх/393-ш
19.01.2016 ж.

**По месту требования**

АО «Локомотив», дочернее предприятие АО «НК «Қазақстан темір жолы», является крупнейшим владельцем и оператором тягового подвижного состава Республики Казахстан.

В рамках программы обновления тягового подвижного состава, начиная с 2013 года АО «Локомотив» осуществляет закупку и эксплуатацию грузовых магистральных двухсекционных грузовых электровозов KZ8A производства ТОО «Электровоз құрастыру зауыты» (Электровозосборочный завод). Всего до 2020 года запланировано приобретение 200 единиц локомотивов KZ8A. На сегодняшний день в инвентарном парке предприятия работает 31 единица электровозов KZ8A.

Эксплуатация электровозов KZ8A существенно повысила эффективность использования парка локомотивов. На пологом профиле данный электровоз позволяет водить составы весом до 9000 тонн, что дает возможность использовать меньшее количество локомотивов для перевозки большего объема грузов. В настоящее время нами применяются две секции KZ8A для поездов массой 7 000 тонн на тех участках, где ранее использовались трехсекционные сплотки электровозов серии ВЛ80.

Благодаря повышенной эффективности тяговой системы и использованию двигателей асинхронного типа общей мощностью 8800 кВт, при эксплуатации KZ8A, удельный расход электроэнергии снизился на 17-20%, при этом на 10-12% вырос коэффициент готовности локомотивного парка.

Значительно снижены затраты на техническое обслуживание электровозов, тогда как сроки межремонтных пробегов увеличились в 2-3 раза.

На электровозе имеется система климат-контроля, оборудование для хранения и приготовления пищи, санузел, эффективная компьютеризированная система управления, что создает комфортные условия труда для локомотивной бригады.

В целом, по результатам эксплуатации в течение 2013-2015 г.г. электровоз KZ8A производства ТОО «Электровоз құрастыру зауыты» зарекомендовал себя, как обладающий высокой надежностью, мощностью, экономичностью и отличными тяговыми и эксплуатационными характеристиками.

**Президент** **М.Шакенов**

**014423**

30

**BUREAU VERITAS**
**Certification**

# ТОО «Электровоз құрастыру зауыты»

ул. А 184, д. 10, г. Астана, район Алматы, 010012, Казахстан

*Bureau Veritas Certification Holding SAS – UK Branch настоящим подтверждает, что Система Менеджмента данной организации проверена и отвечает требованиям стандартов на систему менеджмента, указанных ниже*

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# ISO 9001:2008

*Область сертификации*

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**Сборка и сервисное обслуживание электровозов переменного тока.**

Дата начала сертификационного цикла: **16 октября 2015**

При условии результативного функционирования Системы Менеджмента организации этот сертификат действителен до: **15 сентября 2018**

Дата первичной сертификации: 16 октября 2015

**Сертификат No. UA227968** Версия 0, Дата ревизии: **16 октября 2015**

*Подписано от имени BVCH SAS UK Branch*

UKAS MANAGEMENT SYSTEMS

008

*Адрес органа по сертификации: 66 Prescot Street, London, E1 8HG*
*Региональный офис: 5-й этаж, ул. Симона Петлюры, 28, г. Киев, 01032, Украина*

Информация относительно области сертификации и применимости требований системы менеджмента может быть получена от сертифицированной организации.
Для проверки срока действия этого сертификата обращайтесь по тел.: **+380 44 354 16 00.**



3 1

**BUREAU VERITAS**
**Certification**

# LLP «Electrovoz kurastyru zauyty»

h. 10, A 184 Str., Astana city, Almaty region, 010012, Kazakhstan

*Bureau Veritas Certification Holding SAS – UK Branch certify that the Management System of the above organisation has been audited and found to be in accordance with the requirements of the management system standards detailed below*

## ISO 9001:2008

*Scope of certification*

**Assembly and maintenance of AC electric locomotives.**

Certification cycle start date: **16 October 2015**

Subject to the continued satisfactory operation of the organisation's Management System, this certificate expires on: **15 September 2018**

Original certification date: 16 October 2015

**Certificate No. UA227968** Version 0, Revision date: **16 October 2015**

*Signed on behalf of BVCH SAS UK Branch*

UKAS MANAGEMENT SYSTEMS

008

*Certification body address: 66 Prescot Street, London, E1 8HG*
*Local office: 5th floor, 28, Simon Petlyura St., Kyiv, 01032, UKRAINE*

Further clarifications regarding the scope of this certificate and the applicability of the management system requirements may be obtained by consulting the organisation. To check this certificate validity please call: **+380 44 354 16 00.**



32

# Georgian PRIMA G08A 2x(BoBo) Locomotives

## TECHNICAL SPECIFICATION

## Clause by Clause analysis

| Client / Customer: | Alstom: | Revision: |
|---|---|---|
| JSC Georgian Railway | BAD0003822591 | A0 |

| ALSTOM | | | |
|---|---|---|---|
| Fonction / Function | Nom / Name | Date | Visa |
| Ecrit par / Written by : | F. BRUNET | 16/02/02 | |
| Contrôlé par / Checked by : | | | |
| Approuvé par / Approved by : | L. BERA | 16/02/02 | |

| # | Requirements | Compliance Level | Tenderer's Comments |
|---|---|---|---|
| 1 | NAME AND APPLICATION AREA :<br>Mainline DC freight locomotive is designed to provide traction for freight trains on 1520 mm gauge Georgian railways electrified by 3 kVDC. The locomotive is designed for operation at the head end, in middle and at the end of train on existing and reconstructed railways with maximum permitted speed of 120 km/hr and on conventional rail lines with established movement speed.<br><br>Development should be guided by requirements of regulatory and technical documentation as per Appendix. | Full compliance | Our proposal fully comply with this requirement.<br>Nevertheless, note that it do not include any remote control system. There shall have one driver per locomotive in remote multiple units operation. However, in case the locomotive are one next to the other, only one driver can drive this multiple units assembly. |
| 2 | TECHNICAL AND ECONOMIC REQUIREMENTS | - | |
| 2.1 | Application feasibility study should be performed for the locomotive taking into account application of new parts, units and equipment including calculation of life cycle cost.<br>Reduction of the life cycle cost in comparison with existing locomotives by 20-30%. | Non Compliance | We were not able to perform such analysis as there was not complete input data. For instance, were missing : cost of one ton of dry sand for locomotive, sand consumption estimate, accurate track profile with slopes, speed limitation and turnaround stations, .... |
| 2.2 | The main economic effect should be achieved by applying innovational technical solutions in the locomotive design that ensure power saving, reduction of maintenance and repair costs and improvement of environmental safety. | Full compliance | Our proposal is at the best state of art of locomotive business. It ensures high efficiency leading to, as low as possible, energy consumption and high reliability rate leading to low corrective maintenance costs. The whole ensuring high cost efficiency. |
| 3 | BASIC TECHNICAL REQUIREMENTS | - | |
| 3.1 | General requirements | - | |
| 3.1.1. | The locomotive should be manufactured in accordance with technical documentation issued, agreed and approved in accordance with established procedure and should meet requirements of regulatory documents provided in Appendix. | Full compliance | Please note that required normative referential is now replaced by TR CU. Opportunity to comply with TR CU will have to be discussed at later stage. |
| 3.1.2 | The locomotive should be two-sectional, eight axle, dual cabin. It should be provided with four bogies with wheel arrangement 2x(2o - 2o). All axles of the locomotive should be powered with axial suspension of traction motors and traction motor rolling bearings. It possible to use 2nd class traction drive with axial traction gearbox. | Partial Compliance | Requirement to be clarified at later stage. |
| 3.1.3. | Locomotive should be equipped with regenerative and rheostatic braking systems. | Full compliance | |
| 3.1.4. | It is necessary to provide coupling, connection capability from two locomotive and synchronous control from any cabin using control circuits. All technical parameters and characteristics in these requirements are specified for a single 8-axle locomotive unless the operation of two 8-axle locomotive or three 4-axle sections is specified for multiple unit system (MU). | Full compliance | Noted. However, we have sized the input inductors as if EMC requirement would have to be applied on a (BoBo+BoBo)*2 assembly. Would this be a too conservative approach, we would be able to improve our budgetary estimate. |
| 3.1.5 | It is necessary to develop such equipment layout in the locomotive body that ensure central passage between cabins. | Full compliance | We provide wide central corridor to ease performing pf maintenance tasks (ca. 750 mm width). |
| 3.1.6. | The length of locomotive between automatic coupling device axes should not be greater than 35.1 m. | Full compliance | The length of the locomotive is 35m |
| 3.1.7. | Design speed of locomotive should be not less than 120 km/h. The design of the locomotive should provide for possibility of single travelling during tests on non-worn wheels at speed by 10% higher than design speed. Maximum operational speed will not be greater than 120 km/h. | Full compliance | |
| 3.1.8 | Service weight of the locomotive with loaded with 0.67 of full sand capacity should not less than 184 and not greater than 200 t. Nominal static load of wheel set axis on rails of the fully equipped locomotive should not be less than 226 kN and not greater than 245 kN. | Full compliance | |
| 3.1.9 | Locomotive and its equipment should have climatic category U (moderate climate) and category of location 1, 2, 3 as per GOST 15150. The following conditions should be met:<br>■ locomotive and equipment installed outside the body should have climatic category U1, the range of operating ambient air temperature should be minus 40 oC - plus 50 oC;<br>■ equipment installed in the body should have climatic category U2, the upper value of the operating ambient air temperature should be plus 60 oC;<br>■ equipment installed in the cabin c should have climatic category U3, the upper value of the operating ambient air temperature should be plus 60 oC;<br>■ the high value of the relative air humidity at 27 oC should be 90%.<br>■ Maximum altitude above sea level is 1300 m.<br>Locomotive and its equipment can have category UkhL.<br>The equipment of category U1, U2 should be designed to resist frosting and its subsequent melting. | Full compliance | |
| 3.1.10 | The equipment of locomotive should be designed for operation under the impact of mechanical external factor with respect to vibration and impact loads specified by groups M25, M26, M27 as per GOST17.516.1. | Partial Compliance | Basically used for traction motor, motor fan and few HV components. Otherwise acc. to IEC 61373. |
| 3.1.11 | All metal parts of the locomotive except internal parts of closed welded structures and tanks, internal surfaces of pipes, internal surfaces of pneumatic apparatuses, friction surfaces, surfaces of resistor tapes, holders with fixed connection with tapes and specified by GOST 9219, should be protected from corrosion by paint, polymer or metal corrosion-protection coatings. Internal surface of pipes of pneumatic systems should be chemically treated by etching with subsequent passivation. All wooden parts should be treated by wood preservatives and antipyrenes. | Full compliance | |
| 3.1.12 | Locomotive should be painted in accordance with GOST 22896. Color scheme should comply with GOST 12.2.056 with supplement "Album of colored reference and enamels for exterior and interior of locomotives" (1985). | Full compliance | According to Technical assignment, we made the following change in requirement : replace the words "Color design shall comply with GOST 12.2.056 with an addition under the Album of color standards and enamels for exterior and interior design of locomotives (1985)" with the words "color design of electric locomotive shall be agreed with the customer". |
| 3.1.13 | The design of locomotive as required by the customer should provide a capability of its maintenance without operator's assistant in accordance with requirements of GOST 12.2.056 and TsRB-756. | Full compliance | |
| 3.1.14 | Locomotive should meet Certification Requirements NB ZhT TsT 04. | Full compliance | Our proposal complies with this requirement. Nevertheless, this certification referential has been replaced by Technical Regulations for Custom Union. Choice of certification referentil will have to be discussed at later stage. |
| 3.1.15. | Main technical parameters of locomotives and sections of locomotives should meet Table 3.1. | Full compliance | |
| Table 3.1 | Main technical parameters of locomotive + note | Full compliance | |
| 3.1.16 | Locomotive traction values specified in Table 3.1 should be implemented with wheel tread diameter from 1250 to 1210 mm with nominal voltage on current collector. | Full compliance | |

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| 3.1.17 | Maximum brake force of regenerative and rheostat braking of a single locomotive or two synchronously controlled locomotives should not exceed 500 kN for extrusion conditions as per NB ZH TsT 04. | Full compliance | |
| 3.1.18 | Required duration of the period of the maximum traction force corresponds to the time of heating of traction motors to from completely cooled condition to maximum allowable value of the rise of winding temperature. Thermal properties of the other equipment of the locomotive should meet this condition. | Full compliance | |
| 3.1.19. | The said power and speed of the locomotive should be retained when voltage on current collector drops to 2.7 kV. When voltage on current collector drops below said values the power of locomotive drops. | Full compliance | The power can drop following the requirement given at §5.5.4 |
| 3.1.20 | Maximum operating speed should be maintained with fully worn out wheelset treads with minimum voltage on current collector. | Full compliance | |
| 3.1.21. | Continuous (one hour) power of traction motors of the locomotive s is defined based on results of technical and economic studies for specific areas of operation of locomotives for improvement of their energy efficiency. It is also possible to refine the gear ratio of traction gearbox or locomotives designed for operation in areas with prevailing mountainous or plain track profile. | Full compliance | |
| 3.1.22 | Locomotive is designed for operation with locomotive crew consisting of operator and assistant operator. Possibility for single operator to control the locomotive should be provided. At the same time the respective requirements of GOST 12.2.056 an TsRB-756 should be met. | Full compliance | |
| 3.2 | Availability and Life Cycle Cost | - | |
| 3.2.1. | Locomotive should have high level of reliability and technical availability which determine the life cycle costs and impact the reliability of operation of transport system of the Customer. | Full compliance | |
| 3.2.2 | Locomotive should maintain high technical and economic performance defined by these Technical Requirements at the Customer operational sites. The following characteristics have high priority for the Customer:<br>- minimum costs during life cycle (maintenance, scheduled and unscheduled repairs, power, operational and repair personnel);<br>- balanced application of simple, proven designs and new technologies;<br>- High level of safety;<br>- High level of reliability of equipment;<br>- Minimum maintenance requirements and high repairability;<br>- Suitability of equipment for operation and maintenance in winter conditions;<br>- minimum environmental impact;<br>- good working conditions or locomotive crew, operational and repair personnel. | Full compliance | |
| 3.2.3 | Locomotive should maintain its characteristics during service life. | Full compliance | |
| 3.2.4 | Manufacturer jointly with Developer should ensure delivery of technical availability and life cycle cost parameters. For this reason during the project implementation it is necessary to apply the such strategy of work in all spheres which is aimed at consistent advance of the design of the locomotive for ensuring the defined parameters. | Full compliance | |
| 3.2.5 | Technical and economic parameters of locomotive should be based on calculations. All activities for implementation of availability and life cycle cost parameters should be documented. | Full compliance | |
| 3.2.6 | Results of calculations should confirm defined parameters of technical availability and efficiency of replacement of currently operated locomotives of the Customer. | Full compliance | We are ready to perform calculation about efficiency of the locomotive but we would need additional input data to provide a proper assessment. |
| 3.2.7 | Selection of the base locomotive (replaced series) during technical and economic calculations is agreed with the Customer. | Full compliance | |
| 3.2.8 | The locomotive should be provided with a onboard diagnostics system that together with stationary diagnostics equipment and set of operational documentation ensures required level of technical availability. | Full compliance | |
| 3.3 | Main Calculation Parameters | - | |
| 3.3.1 | Parameters of travelling on continuous welded rails of two-section, four-section and six-section locomotives for with design ascend of 29, 24, 18‰ and design speed of 25, 50 km/h. | Full compliance | |
| 3.2.3. | Traction calculations are performed in accordance with "Rules of Traction Calculations for Train Operation". | Full compliance | |
| 3.3.3 | For calculation the traction factor (ratio of traction force or electrical braking force to static axle load) should not exceed design coefficient of friction. It is recommended to use the following equation for calculation of design coefficient of friction for traction mode:<br>$\psi_k = 0{,}316 + \frac{4{,}6}{50 + 6i} - 0{,}0006i$<br>For calculation of electrical braking the design friction coefficient is assumed as 0.8 of the design friction coefficient of traction mode.<br>Developer should provide for a higher design friction coefficient in the design of the locomotive if it does not result in the increase of the cost of locomotive. However, normative traction and braking parameters during tests should be defined with the specified friction coefficients. | Full compliance | |
| 3.3.4 | Design voltage on current collector of locomotive in traction mode should be assumed as equal to 3000 V and should be assumed as -3300 V in regenerative braking mode. | Full compliance | |
| 3.3.5. | Calculations are made for average worn wheels with average tread diameter of 1210 mm. In the design it is necessary to take into account the average operational difference of diameters of wheelsets. | Full compliance | |
| 3.3.6 | Developer should provide design characteristics of the locomotive (with nominal and minimum voltage on current collector) reduced to the tread of both new and averagely worn wheels:<br>■ traction characteristics with indication of points or continuous design modes;<br>■ braking characteristics for regenerative and rheostat braking;<br>■ characteristics of resistance to movement on straight horizontal track. | Full compliance | |
| 3.4 | General Design Requirements<br>Locomotive is subject to mandatory certification of compliance with requirements of NB ZhT TsT 04-1998 Safety Norms in Rail Transport. Electric locomotives. Certification Requirements". All accessories subject to mandatory certification in accordance with list of railway products subject to mandatory certification approved by the Board of Railway Transport of Commonwealth Participant States, Latvia, Lithuania, Estonia and Georgia should be certified in System of Certification on the Federal Railway Transport. | Full compliance | |
| 4 | OPERATIONAL REQUIREMENTS | - | |
| 4.1 | Operation | - | |
| 4.1.1 | Locomotive is designed for operation in the Customer's railway. | Full compliance | |
| 4.1.2. | Locomotive crew consists of operator and assistant operator or one operator when locomotive is operated by one person. Locomotive crew controls the trains from operator's cabin when travelling along the route complying with rules and norms of traffic safety in accordance with applicable regulatory documents. | Full compliance | |

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| 4.1.3 | Locomotive should be design to operate with average daily run of up to 900 km with length of operation area of 2000-2500 km and length of locomotive crew operation area of 400 km. | Full compliance | |
| 4.2 | Operating Modes | - | |
| 4.2.1 | Operational and repair documentation should provide description of all functional conditions of locomotive, possible functional conditions of equipment and systems, procedures of transition from one functional condition to the other condition including description of required actions of the personnel (locomotive crew, repair, servicing personnel, locomotive crew of auxiliary locomotive). | Full compliance | We will deliver operating manual which covers listed topics. |
| 4.2.2. | All required actions of operator and automatic tests of functionality of equipment and devices ensuring safety of movement for one locomotive and for two coupled locomotives should be performed from one (any) operator's cabin. Required information about tests should be provided to operator.<br>As an option during automatic testing of functionality of equipment and devices ensuring safety of operation of locomotives the information about scheduled maintenance and routine repairs of locomotive should be recorded. | Full compliance | |
| 4.2.3 | It is necessary to provide optional capability for automatic control of the locomotive movement. In the automatic mode the locomotive should move on the trajectory with optimum power. The operator should be able to switch to manual train control at any time. | Full compliance | |
| 4.2.4 | The locomotive control system should be provided with shunting mode that limits speed at 3 km/h when locomotive approaches trains for prevention of accidents. | Full compliance | |
| 4.2.5 | During maintenance and repair the repair personnel should be able to perform scheduled maintenance, inspections and equipment adjustment concurrently. For accessing the archive of diagnostics messages the locomotive should be provided with capability to switch on the control system, view archived data in the operator's cabin or using additional process equipment. | Full compliance | Our train control and monitoring system features a log memory for that purpose. |
| 4.2.6 | Prolonged parking in the operational condition is performed outdoors on specially designated depot tracks with no personnel staying inside the locomotive. In case of prolonged outdoor parking in case of negative ambient air temperature it is possible to apply equipment service heating. | Full compliance | |
| 4.2.7 | Service heating circuits can be powered both from overhead lines and from three phase 380 V external power source. | Full compliance | |
| 4.2.8 | Locomotive equipment should be arranged so that to provide capability to partial switch with maintained general functionality of the locomotive with possible functional limitations. All switching of electric circuits whenever possible should be performed from operator cabin without stopping the train. | Full compliance | |
| 4.2.9 | Operator should be provided with information about fault with recommendations for response actions and imposed operational and functional limitations. | Full compliance | |
| 4.2.10. | Control system should perform continuous monitoring of functionality of equipment of locomotive and should prevent dangerous situations (possible overheating of equipment, incorrect switching, shutdown of safety devices, etc.). | Full compliance | |
| 4.2.11. | When overhead line power is shut off the equipment (powered from battery) ensuring safety of locomotive, locomotive crew life support equipment (internal lighting, sound signals, clearance signals, train radio, toilet, parking brake) should operate for at least 1 hour. After recovery of overhead line power supply the locomotive should start and resume movement without help of auxiliary locomotive. | Full compliance | |
| 4.2.12 | In case of derailing of wheelsets or in case of any flat spots on wheelsets with depth over 2 mm it is necessary to provide capability for partial lifting of the locomotive using cranes or jacks attached to special points and for transporting the locomotive with partially stuck wheelset using transportation trolley. | Full compliance | Necessary equipment to proceed to partial lifting are part of our supply. Note that we did not plan to supply any transportation trolley. |
| 4.2.13 | Towing of non-operational locomotive should be possible without any preparation work (for example, shut down of traction motors, tying the current collectors, closing of air intakes, etc.) to home depot over the distance of at least 1000 km with maximum speed at least 90 km/h. | Full compliance | No preparation work is required for locomotive towing. |
| 4.2.14 | The operational documentation should provide requirements and limitations for storage and prolonged parking with indication of required additional appliances, procedure of preservation and depreservation of equipment of the locomotive. | Full compliance | |
| 5 | OPERATIONAL INFRASTRUCTURE COMPATIBILITY REQUIREMENTS | - | |
| 5.1 | General requirements | - | |
| 5.1.1. | Technical solutions and design of locomotive should minimize the risk of dangerous situations. Locomotive should be safe in all described operating condition subject to compliance with established maintenance and repair procedure. | Full compliance | |
| 5.1.2. | Failures in the locomotive should not result in the incompatibility with infrastructure and dangerous situations. | Full compliance | |
| 5.2 | Track Infrastructure | - | |
| 5.2.1. | Locomotive should be designed for operation on track superstructures with rails R65 (GOST 8161-75) and crushed rock ballast (GOST 7392-85) with the following travelling speeds: | Full compliance | |
| 5.2.1.1 | Tangent sections - 120 km/h; | Full compliance | |
| 5.2.1.2 | Curved tracks with radiuses where at speed 120 km/h the non-dampened acceleration of 0,7 $m/s^2$ - 120 km/h is not exceeded; | Full compliance | |
| 5.2.1.3 | In curved sections with radiuses where the maximum speed is limited by non-dampened acceleration with maximum elevation of outer rail of 150 mm with speeds corresponding to non-dampened acceleration of 0.7 $m/sec^2$; | Full compliance | |
| 5.2.1.4 | On switches of type R65 grade 1/11 on side track -40 km/h. | Full compliance | |
| 5.2.2. | On other types of tracks and switches the acceptable speed of locomotives is established by calculations using results of tests. | Full compliance | |
| 5.2.3. | Lifespan of tire is defined based on supervised operation depending on locomotive operation area. | Full compliance | |
| 5.3 | Rolling Stock Dimensions | - | |
| 5.3.1. | Outer dimensions of the locomotive should meet requirements of size 1-T GOST 9238 with lower contour as shown on drawing 11b. | Full compliance | |
| 5.4 | Aerodynamics | - | |
| 5.4.1. | For reduction of aerodynamic impact on the infrastructure facilities and rolling stock located close to the passing locomotive it is recommended to design streamline operator's cabin without extending the length of the locomotive. | Full compliance | |
| 5.4.2. | Compacted and even layer of crushed rock between ties that does not elevate above the tie upper surface should not be blown and raised by air stream produced by locomotive travelling at the speed that exceed the design speed by 10%. | Full compliance | |
| 5.5 | Power Supply System | - | |
| 5.5.1 | Locomotive is designed for operation in the direct current traction power supply with 2.2-4.0 kV voltage in overhead wire that uses rails as conductor of reverse traction current. | Full compliance | |
| 5.5.2 | Regenerative braking is applied in the locomotive operation areas, the received regeneration energy is limited by maximum voltage on current collector of 3850-4000 V. | Full compliance | |
| 5.5.3. | The locomotive in all modes unless otherwise is expressly specified should be operated with one lifted current collector (if design of the locomotive uses 4 current collector two current collectors should be lifted, one on each section). | Full compliance | In operation, one current collector will be lifted per doube section locomotive. |

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| 5.5.4. | Maximum input current of one locomotive (per one current collector) in single hour mode should not exceed 3200 A. | Full compliance | |
| 5.5.5. | The locomotive should be operational in the forced power supply operating modes. | Full compliance | |
| | Forced mode of traction power supply system is possible in case of temporary (including sudden) shut down of some components of power supply system: one or several power transmission lines powering traction substation, traction substation, line devices, sections of electric traction network.<br>In the forced mode the size and speed of trains can be limited, main parameters characterising operation of the traction power supply system (electric loads, power losses, voltage, etc.) can change, the respective values of the normal mode can be exceeded but not beyond the maximum allowable values. Traction power can decrease when locomotive operates in the forced mode. | Full compliance | |
| 5.5.6 | Stepwise increase or decrease of power voltage on locomotive current collector between maximum and minimum continuous values is possible within 0.02 sec. | Full compliance | |
| 5.5.7 | One-time switching overvoltages up to 10 kV and duration of up to 8 ms are possible determined by the characteristics of overvoltage limiters in the power supply devices. | Full compliance | |
| 5.5.8. | One-time external lightning overvoltage with amplitude of up to 35 kV are possible determined by strength of insulation of overhead line and one-time lightning overvoltage limited by characteristics of limiters of overvoltage at the level specified in item 5.5.7 | Full compliance | |
| 5.5.9 | The components and parts of locomotives should not be destroyed in case of short-circuit in the overhead system or in respective high voltage circuits of rolling stock with stabilised current of 30 kA and duration of up to 0.1 sec. | Full compliance | |
| 5.5.10 | When power supply from traction substation is shut the circuit breaker of locomotive should should turn off within time not greater than 3 sec. | Full compliance | |
| 5.5.11 | Enabling of circuit breaker of locomotive provided with input filters in the normal mode should not result in any noncontrollable transient processes and resulting shutoff of circuit breakers or electronic current protection of traction substation. | Full compliance | |
| 5.5.12 | Locomotive should not produce any unacceptable dynamic impact on the standard overhead catenary used on Customer's railways at the movement speed of up to 120 km/h. | Full compliance | |
| 5.5.13 | In normal conditions (without precipitation and icing) when locomotive travels at design speed and with maximum input current the duration of sparking in the point of contact of current collector elements and overhead line should not exceed 3% of the measurement time. | Full compliance | |
| 5.6 | Traffic Safety Systems | - | |
| 5.6.1 | Locomotive should be provided with Safe Locomotive Integrated Complex (SLIC) that should include:<br>■ Continuous automatic cab signaling;<br>■ Automatic brake control system;<br>■ Telemechanic dead-man's vigilance system. | Full compliance | We propose to use KLUB-u system associated with TSKBM for driver vigilance monitoring system. |
| 5.6.2 | Travelling parameters should be saved on the electronic information storage media. | Full compliance | Our storage system record travel parameters. The list of those parameters should be agreed during development phase. |
| 5.6.3. | GPS system should be used or locomotive positioning. | Full compliance | |
| 6 | MECHANICAL REQUIREMENTS | - | |
| 6.1 | General requirements | - | |
| 6.1.1 | Mechanical part of locomotive consists of the following parts:<br>■ two sections of body;<br>■ four two-axis boogies;<br>■ spring suspension;<br>■ connections;<br>■ traction drive type;<br>■ traction gear box;<br>■ draw and buffing gear. | Full compliance | Our locomotive is fitted with SA3 type coupler. |
| 6.1.2 | Mechanical part of locomotive should ensure operation both on non-continuous and continuous welded rails with the following characteristics:<br>■ rail type..... R65;<br>■ ballast..... crushed stone;<br>■ number of ties per 1 km of track..... 1840;<br>■ minimum radius of curves passed by one section..... m125.<br>■ Condition of tracks not below rating "satisfactory" according to norms of "Technical instructions for decoding of records of track measurement cars, evaluation of deviations from norms of maintenance of tracks, train safety measures when they are revealed".<br>It is possible to operate the locomotive on the track with worse rating with appropriate limitation of speed. The acceptable speed of travelling on tracks with R50 rails should be at least 70 km/h, at least 25 km/h on switches of rails R50 grade 1/11 to side track.<br>Mechanical part and locomotive generally should be designed for operation on the tracks meeting the requirements | Full compliance | |
| 6.1.3. | Locomotive should not cause unacceptabe stresses in track components with characteristics as per item 5.2 or interruption of its stability during movement with design speed on tangent track section and with maximum governed speed (with non-dampened acceleration 0.7 m/sec$^2$) on curved sections with radius of 500 m and more and during travelling to side track on switches R65 1/11 with speed up to 40 km/h; on switches R50 grade 1/11 at least 25 km/h. In modes the frame force should not exceed 40% of axle load. | Full compliance | |
| 6.1.4. | The components of mechanical part should meet conditions of sufficient fatigue and static strength and resistance under the most adverse combination of acting forces:<br>■ from static weight load;<br>■ loads produce during movement on tangent and curved sections of different radius with critical speed and under wind pressure on the body sidewalls of 490 Pa (50 kgf/m);<br>■ tension and compression with force of 2500 kN applied along the longitudinal axis of body to automatic coupling device;<br>■ forces produced when body with full set of equipment is lifted by four jacks or lifting crane;<br>■ forces produced during lowering of the wheelset;<br>■ forced produced during lifting of body at one end;<br>■ forces produced during lifting of a derailed bogey. | Full compliance | Those load cases are subject to calculation analysis which will be properly reported to the customer by writing. |
| 6.1.5 | Traction and braking force should be transferred from bogeys to body by inclined rods. | Full compliance | Our solution features one rod per bogie. |
| 6.1.6 | The locomotive should be equipped with automatic coupling device standardized with automatic coupling device of freight cars with high energy capacity cushioning device located on the body frame. The suspension of the body of the automatic coupling device should be elastic. The design of the frame of the body should ensure replacement of the automatic coupling device and cushioning device without removal of the bogey. | Full compliance | |

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| 6.1.7 | Automatic coupling device should be designed for compression force of 2500 kN and extension force of 1500 kN. | Full compliance | |
| 6.1.8 | Disengagement of the automatic coupling devices should be performed by single person without entering between two locomotives or between locomotive and car. | Full compliance | |
| 6.1.9 | Sand should be supplied underneath each bogey. The sanding nozzles should be located in the body or outside under the body of the locomotive. The design of sanding nozzles should ensure adjustment of the nozzles within the range of 0.8-1.2 kg/min and should keep water way and it is necessary to provide the possibility for emptying the bins of the sanders. Sand should be delivered through flexible hoses. Settling of sand in hoses and leakage of sand from sanders is not acceptable. Total capacity of sanders should be at least 1000 l per locomotive. | Full compliance | Sand refilling by the top of the locomotive |
| 6.1.10 | Critical parts and components should be subjected to nondestructive testing by magnetic or ultrasonic defect inspection in accordance with GOST 14782 and GOST 21105 in the scope specified on the drawings. | Full compliance | |
| 6.1.11. | Parts which in case of any fault can drop on the track and affect the safety of traffic should have protective devices designed for maximum load but not less than twofold weight of the protected component. | Full compliance | |
| 6.1.12. | The locomotive should be provided with places for storage of two re-railing ramps and twenty four stop blocks. | Full compliance | |
| 6.1.13 | The design of mechanical part should ensure passage of two coupled locomotives of S-shaped curve with radius of 170 m without straight insert. | Full compliance | |
| 6.1.14 | Safety margin with respect to yield point from static loads and single impacts on automatic coupling device should be in its components at least 1.1, in bogey and links of bogey with body it should be at least 1.2. The components of structure should not lose their stability and should not have permanent deformations. | Full compliance | |
| 6.1.15 | The design of undercarriage and used materials should ensure rated values of impact of the locomotive on the track with maximum allowable wear in entire range of speeds during operation between overhauls. | Full compliance | |
| 6.1.16 | The locomotive should be equipped with wheel flange lubrication system The design of lubrication system should keep lubricant away from brake shoes, brake disks (if available) and from surface of wheels on the taping line. | Full compliance | Our solution is based on lubrication stick, avoiding greasing of non relevant area. |
| 6.2 | Locomotive Weight Distribution<br>The wheel weight distribution of locomotive should meet requirements provided in Table 6.1. | Full compliance | |
| Table 6.1. | Locomotive weight distribution | Full compliance | |
| 6.3 | Bogey | - | |
| 6.3.1 | Bogeys should be two-axle, non-pedestal with radial installation of wheelsets when passing curved tracks. The bogey should have a welded frame. To remove welding stresses the bogey frames should be thermally treated. | Full compliance | |
| 6.3.2 | In terms of strength the frames of the bogies should meet "Norms of calculation and evaluation of the strength of load-bearing elements, dynamic properties and impacts on the track of undercarriage of locomotives of 1500 mm gauge rail roads of the Ministry of Railways of Russia". | Full compliance | |
| 6.3.3 | The finished frames of bogies before painting should be shot blasted. | Full compliance | |
| 6.3.4 | It should be ensured that wheels can be removed without lifting of the body. | Full compliance | We understand this requirement as "wheel" being replaced by "wheelset" in the text. |
| 6.3.5 | Maximum movement of bogie relative to the body frame in the vertical and transverse directions should be limited by stops. | Full compliance | |
| 6.3.6 | Spring suspension should be two-staged with overall static deflection at least 130 mm and separated damping system of each stage. The design of the spring suspension should provided for possibility of adjustment of the wheel weight distribution. | Full compliance | |
| 6.3.7 | The springs of spring suspension should meet requirements of GOST 1452. | Full compliance | |
| 6.3.8 | The hinge joints of spring suspension and brake lever mechanism should ensure operation without replacement between routine repairs in the scope of TR-3 of the locomotive. | Full compliance | |
| 6.3.9 | The design of the bogey should ensure possibility of transportation of the locomotive in case of sticking of one wheelset using transport trolley driven under the stuck wheelset with partial disassembly of the lever mechanism. | Full compliance | |
| 6.3.10 | Traction drive | - | |
| 6.3.10.1 | Traction drive should be design with support and axle mounting of traction motors, traction motor support rolling bearings and gearbox designed for application of traction motors with maximum rotor speed of 3000 rpm. | Full compliance | At maximum operational speed of the locomotive and considering worn wheel, the rotational frequency of the traction motor is 2888 rpm. |
| 6.3.10.2 | The gears should have tooth surface strengthened by case-hardening. The hardness of teeth surface should be at least 60 HRC. | Full compliance | |
| 6.3.10.3 | The distance between the casing of the gear and rail head with new tires should be at least 120 mm. | Full compliance | |
| 6.3.10.4 | The lubrication of the drive components (gear trains and bearings of traction motor and gearbox) can be both separated and integrated. In case of application of the integrated lubrication system the forced delivery of lubricant to bearings with filtration is recommended. | Full compliance | |
| 6.3.10.5 | In case of separated lubrication the sealing of chambers with grease lubricant should prevent its washing out by transmission lubricant. | Full compliance | |
| 6.3.10.6 | The design of the seals of the bearings should prevent possibility watering and contamination of the lubricant during operation. The leakage of the lubricant is not acceptable. | Full compliance | We propose to reuse our service proven solution, giving full satisfaction to our customers. |
| 6.3.10.7 | The flexible elements and connecting sleeves of the traction drives should ensure their operation without replacement and damage between the routine repairs in the scope of TR-3. | Full compliance | |
| 6.4 | Wheelset | - | |
| 6.4.1. | The wheelsets should be composed in accordance with agreed drawings, GOST 11018 with checking of the press fitting of the axle against the agreed samples of press fitting charts. | Full compliance | |
| 6.4.2. | The main parameters of the wheelset:<br>■.....Nominal thickness of tire..... 90 mm;<br>■.....Minimum thickness of the tire in operation..... 45 mm;<br>■.....Nominal distance between internal edges of the tire..... 1440 mm. | Non Compliance | Our wheelset design is fully compliant with GOST requirements and is already certified, according Georgian Railways required referential, on 2ES5 and KZ8A locomotives. Note that, for this wheel design, the thickness is 80 mm at nominal value and 35 mm as minimum value in operation. Those design parameters are applied on our wheel since years and have shown full customer satisfaction, that is why we propose to offer them to you. Would this be an issue for you, we would find relevant solution to face it and ensure your complete satisfaction. |

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| 6.4.3. | On new locomotive the difference of tape line diameter of the wheels of the locomotive should not exceed 0.5 mm. In operating conditions the maximum acceptable difference of locomotive wheel diameter is 10 mm, the maximum difference of diameters of wheels of wheelsets of one bogey is 6.5 mm. | Full compliance | |
| 6.4.4. | Wheelsets should have current collectors on the face end of the axle. | Full compliance | |
| 6.4.5. | The journal boxes with bearings should transfer longitudinal and lateral forces on the bogey frame via non-wear flexible couplings. The design is determined during their designing. The designed endurance of journal box bearings should be at least 3 mln. km. | Full compliance | |
| 6.4.6. | Oil removal channels should be provide for pressing out of the wheels. | Full compliance | |
| 6.4.7. | Wheelsets with fixed gear wheel should be dynamically balanced in accordance with GOST 11018. | Full compliance | |
| 6.4.8. | The axle of the wheelset should be subjected to ultrasonic inspection and magnetic defect inspection. | Full compliance | |
| 6.4.9. | The surfaces of the necks of the wheelset axle, pre-axle, axle and middle parts and fillets of transition from one parts of the axle to other parts should be strengthened. | Full compliance | |
| 6.4.10. | The wheelsets should meet technical requirements NB ZHT TST 063. | Full compliance | |
| 6.4.11. | Design lifespan (endurance) of bearings should meet requirements of NB ZHT TST 04. | Full compliance | |
| 6.4.12. | The design of the bogeys should include built-in testing systems and systems for measurement of temperature of journal bearings. | Full compliance | |
| 6.4.13. | Temperature of the tested parts should be continuously recorded and information should be saved in the memory unit. Information is displayed automatically on the operator's panel when temperature exceeds allowable (preset) values. Information about excessive temperature should be saved in non-volatile memory and should be accessible for repair and servicing personnel. | Full compliance | This monitoring is applied on wheel axle boxes. |
| 6.4.14. | The design of the undercarriage of the locomotive should provide for the possibility of travelling of the locomotive with the following size of the slid flat on the wheel tape line:<br>■ up to 1 mm – without limitations;<br>■ from 1 to 2 mm – with limitation of speed of 15 km/h;<br>■ from 2 to 4 mm – with limitation of speed of 10 km/h. | Full compliance | |
| 6.5 | Body | - | |
| 6.5.1. | The body should have rail-car bearing structure and should allow for its lifting with all equipment using four jacks or lifting crane and it also should allow for lifting the body from one end in case of derailing of the locomotive (in case of positioning of derailed bogey on the rails). The body should be lifted by special fittings. The frame of the body should not have permanent deformations. | Full compliance | |
| 6.5.2. | In terms of the strength the body should meet "Norms of calculation and evaluation of the strength of load-bearing elements, dynamic properties and impacts on the track of undercarriage of locomotives of 1500 mm gauge rail roads of the Ministry of Railways of Russia". The front part of the control panels below window opening should have reinforcing boom for protection of the service personnel in case of collision of the locomotive with foreign objects. The front part of the body should be provided with cushioning device with energy capacity of at least 750 kJ. The cabin in the area of this boom without dangerous deformations should resist impact of the load of up to 290 kN equally distributed along the width of the front part of the cabin. | Full compliance | |
| 6.5.3. | The body should be linked in vertical and lateral directions with bogies by elastic and dampening elements. | Full compliance | |
| 6.5.4. | The battery should be installed under the body in its middle part and should ensure easy access for maintenance. | Full compliance | |
| 6.5.5. | Track cleaners should installed on the front parts of the locomotive. The track cleaners should be designed for minimum force of 150 kN with windows for free air flow. The caps of the track cleaners should have adjustable height relative to the rails depending on the wear of tires. The track cleaners should provide for possibility of installation of metal brushes for cleaning of the track in the zone of passage of bodies of traction gearboxes. | Full compliance | |
| 6.5.6. | The roof of locomotive should be provided with removable covers of doors for installation and removal of equipment in the body, self-closing doors for sand filling and decks for walking on the roof. | Full compliance | The roof of the locomotive is fully removable (except on top of driving cab area). The roof cover is split in three parts independantly removable. |
| 6.5.7. | One floodlight on the longitudinal axis of symmetry of locomotive and two two-color buffer lamps should be installed on the front walls. The design of the floodlight should provide for the possibility of replacement of lamps (LED modules) and adjustment of the direction of the light beam from the cabin. | Partial Compliance | Our Floodlight is based on Xenon technology |
| 6.5.8. | Caps and gutters should provided to run water off the roof and keep it away from the air intake grills, side windows of the cabin, entrance doors and their railing. | Full compliance | |
| 6.5.9. | The design of the body should prevent ingress of dust, snow and water through ventilation devices, seals of doors and roof hatches and through other channels in the quantities that interrupt normal operation of the locomotive. Recommended positive pressure of air in the body is within the range of 2-12 mm of water in all modes. | Full compliance | |
| 6.5.10. | Locomotive should be provided with 4 outer doors for entrance and exit. The outer doors should be provided on both sides of the body and should have such design that ensures their opening and unlocking from the platform or from the first step of the entrance ladder. The doors should also have locks holding them in the opened position. | Full compliance | |
| 6.5.11. | The locomotive should be provided with tyfons and whistles. | Full compliance | |
| 6.5.12. | Antennas should be installed on the roof of the locomotive (decimeter, meter and hectometer band). Free pads with minimum size of 1m2 should be provided for installation of decimeter and meter band antennas. No screening objects and equipment should be located near the antennas. | Full compliance | Our commitment is to install antennas in such a way that Voice/data transmission is achieved at highest quality level |
| 6.6 | Dynamic properties, strength | - | |
| 6.6.1. | Dynamic properties of locomotive should meet requirements provided in Table 6.2. | Full compliance | |
| 6.6.2. | The strength parameters should meet requirements specified in Table 6.3. | Full compliance | |
| 6.6.3. | The dynamic and strength characteristics are measured during acceptance testing in accordance with "Norms of calculation and evaluation of the strength of load-bearing elements, dynamic properties and impacts on the track of undercarriage of locomotives of 1500 mm gauge rail roads of the Ministry of Railways of Russia". | Full compliance | |
| Table 6.2 | Dynamic properties of the locomotive | Full compliance | |
| Table 6.3 | Strength | Full compliance | |
| 7 | BRAKING EQUIPMENT REQUIREMENTS | - | |
| 7.1 | General Requirements | - | |

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| 7.1.1. | Locomotive should be provided with the following type of brakes<br>According to the method of realization of the braking force:<br>■ Friction shoe brake;<br>■ Electrodynamic brake.<br>According to control type:<br>■ Automatic pneumatic brake;<br>■ Auxiliary direct-acting locomotive brake;<br>■ Parking brake. | Full compliance | |
| 7.1.2. | Length of braking of single travelling locomotive on horizontal straight track from the speed of 100 km/h should not be greater than 800 m in case of emergency braking by pneumatic brake. | Full compliance | |
| 7.1.3. | The manual or automatic parking brake of the locomotive should held it on the slope with inclination of not less than 30 0/000 with handle force of 343 N and coefficient of friction between the wheel and rail at least 0.25. | Full compliance | |
| 7.1.4. | The braking system of the bogey should be designed with dual application of braking shoes. | Non Compliance | Our braking system feature one braking pad per wheel. Nevertheless, it fully complies with performance requirements set by Georgian Railways. |
| 7.1.5. | The design of the braking unit should ensure locking of the braking shoe and even wear of the braking shoes and it also should prevent possibility of slipping of the shoes from the tire surface to the outer edge. It should prevent any contact between braking shoes and tires of the wheelsets when brake is released, the design should provide for the possibility of adjustment of the brake lever mechanism and replacement of the brake shoes on the tracks without inspection pit. | Full compliance | |
| 7.1.6. | Braking should not cause abnormal wear and damage of the tires of wheelset by brake shoes. | Full compliance | |
| 7.1.7. | Pneumatic braking equipment should be applied in accordance with technical specifications. | Full compliance | |
| 7.1.8. | Locomotive should be provided with the following equipment:<br>■ Air distributor of the freight type;<br>■ Emergency braking system designed in accordance with GOST 12.2.056;<br>■ Operator's brake valve with remote control;<br>■ Valve of auxiliary direct-acting brake;<br>■ Brake locking device that ensure correct actuation and disabling of the braking system and forced braking of the locomotive when control cabins changes and that also prevent any impact on the braking system from inactive cabin;<br>■ System for disabling traction mode in case of pneumatic braking;<br>■ device for releasing locomotive brakes when automatic brakes of the train are actuated;<br>■ brake release alarm system for each bogey;<br>■ Two compressors with total capacity of at least 5.0 m3 /min with maximum operating pressure of 0.92 MPa (9 kgf/cm2);<br>■ Auxiliary compressor for raising the current collector;<br>■ At least 3 main serially connected air tanks for each section with total capacity at least 1000 l per section;<br>■ Spare tank with capacity of at least 150 l for raising the current collector;<br>■ System of automatic braking for locomotives operating in multiple unit system in case of their automatic uncoupling or sections or breakage or automatic disengagement of inter-locomotive and inter-sectional air hoses. | Full compliance | |
| 7.1.9. | The leakage of compressed air from the pneumatic system should not exceed the limits set by instruction TsT-533. | Full compliance | |
| 7.1.10. | The locomotive should have stack (unit) assembly of pneumatic equipment. | Full compliance | |
| 7.1.11. | The accuracy class of pressure gauges should be at least 1.5 with scale division value not greater than 0.02 MPa (0.2 kgf/cm2), except pressure gauges of the tank of current collector or tank of air circuit breaker that can have accuracy of 2.5. | Full compliance | |
| 7.2 | Compressed Air Supply System | - | |
| 7.2.1. | The locomotive should be provided with two compressor units. | Full compliance | |
| 7.2.2. | Each compressor unit includes compressed air filtering and drying unit. | Full compliance | |
| 7.2.3. | Each compressor unit should include system for controlling and diagnostics compatible with locomotive control system. | Full compliance | |
| 7.2.4. | It is necessary to provide for possibility of short-time shut off of the air drying units for testing of the density of braking network of the train and for permanent shutoff in case of a failure. | Full compliance | |
| 7.2.5. | Compressed air supplied to braking system after compressed air filtering and drying unit should correspond to class 4 of contamination of the compressed air as per GOST 17433. | Full compliance | |
| 7.2.6. | The limit pressures in the main tanks in after automatic restarting of compressors and their shutoff by regulator should be 0.75 – 0.9 (±0.02) MPa (7.5 – 9.0 (±0,2) kgf/cm$^2$). | Full compliance | |
| 7.2.7. | The consumption of air for auxiliary needs of the air drying unit should be 15% of the amount of dried and filtered air. | Full compliance | |
| 7.2.8. | It is necessary to provide for possibility of compressor shut off in case of its failure and possibility of manual actuation of the compressor uinit from the operator's panel. | Full compliance | |
| 7.2.9. | Compressors should start in winter time under minimum ambient air temperature. | Full compliance | |
| 7.2.10. | Locomotive should be provided with devices for remote blowing of main tanks with electric heating and moisture collectors on pressure main upstream of end valves from both ends of the locomotive. | Full compliance | |
| 7.2.11. | Cabins should be sound and vibration insulated during operation of compressors and other pneumatic equipment. | Full compliance | |
| 7.3 | Mechanical Braking System | - | |
| 7.3.1. | The locomotive should employ wheel-by-wheel braking using one brake cylinder per wheel. | Full compliance | |
| 7.3.2. | Braking cylinders should be provided with automatic regulator of extension of rod ensuring automatic control of clearance between wheels and brake shoes as they wear. | Full compliance | |
| 7.3.3. | The design of the braking system should ensure locking of the braking shoe and even wear of the braking shoes and it also should prevent possibility of slipping of the shoes from the tire surface to the outer edge. It should prevent any contact between braking shoes and tires of the wheelsets when brake is released, the design should provide for the possibility of adjustment of the brake lever mechanism and replacement of the brake shoes on the tracks without inspection pit. | Full compliance | |
| 7.3.4. | Wear resistant bushings should be inserted in the hinge joints of braking lever system. | Full compliance | |
| 8 | ELECTRIC EQUIPMENT REQUIREMENTS | - | |
| 8.1 | General requirements | - | |
| 8.1.1. | Electric equipment of locomotives should ensure reliable operation under the combined climatic factors and mechanical impacts. | Full compliance | |
| 8.1.2. | Electrical equipment ensuring safety of movement and starting of locomotives should ensure normal functioning at minimum temperature of minus 45°C. At temperature below minus 25 °C starting of locomotive with preliminary heating is acceptable. | Full compliance | According to technical assignment, we consider a minimum temperature of minus 40°C |

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| 8.1.3. | All components of the electrical equipment should retain their characteristics after long-term storage at minimum temperature of minus 50 °C. Separate units, equipment, components can be removed with subsequent storage in the premises with temperature not below minus 25 °C. | Full compliance | According to technical assignment, we consider a minimum temperature of minus 40°C |
| 8.1.4. | Electrical equipment of category U1, U2 should function with nominal voltage without breakdown or breakover in case of frosting with subsequent melting. | Full compliance | |
| 8.1.5. | Boxes (cabinets) electrical equipment located outside the locomotive should be protected from the ingress of foreign objects, dust, rain, snow and moisture and should have enclosure protection class at least IP65 as per GOST 14254 (EN 60529). | Full compliance | |
| 8.1.6. | Boxes (cabinets) with electrical equipment installed in the bodies should have protection rating at least IP21 as per GOST 14254 (EN 60529). | Full compliance | |
| 8.1.7. | Electrical equipment should have required thermal margin. During design and continuous modes of operation of the locomotive the acceptable heating temperature of the components should not be exceeded. | Full compliance | |
| 8.1.8. | Mechanical strength of the shells of the underframe equipment should be designed to resist the impact of the foreign objects during movement at design speed. Power equipment installed in the underframe space outside the boxes should resist the impact of components of the ballast layer during movement of the train at design speed or it should be provided with protection elements. | Full compliance | |
| 8.1.9. | The electrical equipment should function under the impact of external electromagnetic fields. | Full compliance | |
| 8.1.10. | Locomotive should be provided with noise suppression devices. The interference field strength of the locomotive should not exceed the levels specified in GOST P 55176.3.1 , GOST 16842. | Full compliance | |
| 8.1.11. | For protection of the power electrical equipment in the electrical braking mode it is necessary to provide quick-action switching device in the circuit of the traction motors or power conversion unit and electronic system that impacts the power converter. | Full compliance | |
| 8.1.12. | Spectral components of the traction current in the operating bands of the locomotive signaling system and devices of rail signaling circuits on DC lines should not exceed values specified in Table 8.1. | Full compliance | Values are not overpassed, even considering two locomotives (four sections) of our design working together. |
| 8.1.13. | With respect to electromagnetic compatibility the locomotives should meet requirements of GOST P 55176.3.1. | Full compliance | |
| Table 8.1 | Normative values of parameters of traction current ensuring electromagnetic compatibility of electric rolling stock with rail circuits and automatic locomotive signaling system devices | Full compliance | |
| 8.1.14. | A possibility should be provided for driving the locomotive in the depot using traction motors and converters while the converters are powered by low voltage alternating current through special under frame sockets. | Full compliance | Possibility with 380Vac socket |
| 8.1.15. | Diagnostics should be possible when any traction motor is powered from depot system. | Full compliance | |
| 8.1.16. | Devices should be provided that ensure discharging of the capacitors within the time of not more than 30 sec after removal of voltage. | Full compliance | |
| 8.1.17. | Electric equipment of the locomotive should have the following operating modes:<br>■ Acceleration and movement at define speed;<br>■ Change of movement direction;<br>■ Electrodynamic braking using regenerative or rheostat brake;<br>■ Adjustment of traction and braking force | Full compliance | |
| 8.1.18. | Electrical equipment should consist of the following main functional systems:<br>■ Traction power equipment;<br>■ Auxiliary power equipment;<br>■ Traction and auxiliary equipment control and protection systems. | Full compliance | |
| 8.1.19. | Electric installation requirements | - | |
| 8.1.19.1. | Electric installation should be performed in accordance with OST 16.0.801.066, GOST 12.2.056. | Full compliance | |
| 8.1.19.2. | According to fire safety requirements the installation and applied non-flammable and not easily combustible materials should meet GOST 12.1.004, GOST 12.1.044, TsT-6. | Partial Compliance | Mainly, according to European standard |
| 8.1.19.3. | The air insulation distance, insulation distance on surface of insulation, surface of wiring, cables and buses should be selected for maximum operating voltage in this circuits in accordance with Operational Code for Electrical Installations. | Full compliance | |
| 8.1.19.4. | The cross-section area of wires and buses should be chosen based on current loads taking into account modes (including emergency modes) of operation of electrical equipment, acceptable drop of voltage, method of installation. | Full compliance | |
| 8.1.19.5. | Distance from conductive parts to meshed protective enclosures inside the body should not be less than the distances specified in GOST 12.2.056. | Full compliance | |
| 8.1.19.6. | Non-attached section of the wire should absorb vibrations of the power equipment including power equipment mounted on shock-absobers. | Full compliance | |
| 8.1.19.7. | Extension of the wires and cables is not acceptable. | Full compliance | |
| 8.1.19.8. | Wires should be connected using terminals, contact clips and connectors. | Full compliance | |
| 8.1.19.9. | Buses, wires and their attachments should be designed for dynamic forced produced in case of short circuits in the electric circuits. | Full compliance | |
| 8.1.19.10. | The current—carrying conductor of wires and cables should have flexibility of at least group 5 as per GOST 22483. It is possible to use hook-up wire with cross section of at least 2.5 $mm^2$ with current-carrying conductor with flexibility of at least class 3. | Full compliance | |
| 8.1.19.11. | In flexible electric connections the sections of cords, wires and cables moving during operation if it can cause mechanical damage should be additionally protected by corrugated hoses, heat-shrinkable or non-shrinkable insulation tubes, protective spirals or by other methods. In certain cases it possible to use fabric hoses as a protection. Cleat insulators and brackets on moving eyes of the wires should be provided with holes. Each of such holes should be designed for attachment of at least 2 wires. | Full compliance | |
| 8.1.19.12. | Wires, cords, cables extending outside through the floor or walls of the locomotive should be sealed to keep dust, snow and water away. | Full compliance | |
| 8.1.19.13. | Back up wire accounting for at least 3% of the total number of connected wires should be provided in control circuits between terminal strips, units, panels, plug connector, etc. | Full compliance | |
| 8.1.20. | Protection of electric circuits of locomotive should prevent damage of the equipment in case of emergency situations: short circuits, overvoltage, insulation breakdown. | Full compliance | |
| 8.1.21. | Power equipment of the locomotive which is electrically linked with the current collector and which is not protected by quick-action circuit breaker should resist electrodynamic and thermal impact of 30 kA short-circuit through current during 0.1 sec. | Full compliance | |
| 8.2 | Traction Electrical Equipment | - | |
| 8.2.1. | Traction electrical equipment includes high voltage devices designed for controlling the traction and braking of the train. | Full compliance | |
| 8.2.2. | Functional parameters of traction electric equipment. | - | |

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| 8.2.2.1. | The locomotives should be provided with the following traction modes of operation of the electrical equipment:<br>■ Shunting mode with speed limitation at 3 km/h;<br>■ Semi-automatic starting mode with speed from 0 to 120 km/h;<br>■ Startup mode to defined movement speed with defined traction force and intensity limited by thermal capacity of traction motors and cohesion conditions and movement at permanent speed. Specific speed values are set by the operator;<br>■ Mode of speed reduction with defined intensity (run down or electrical braking); | Full compliance | |
| 8.2.2.2. | The locomotives should be provided with the following braking modes of operation of the electrical equipment:<br>■ Electrical braking with intensity limited by the thermal capacity of traction motors and cohesion conditions from maximum speed to critical speed value defined by braking calculations and results of tests;<br>■ Automatic switching of traction electric drive to electrodynamic braking (regenerative and rheostat) mode;<br>■ Maintaining of the defined braking force until defined speed is reached with subsequent automatic maintaining of the speed;<br>■ Adjustment of the defined braking and speed force;<br>■ Combined braking by electrodynamic brake on the locomotive and pneumatic brake on rail cars;<br>■ Automatic replacement of the electrodynamic brake by friction brake in case of the failure or low efficiency of the electrodynamic brake;<br>■ It is necessary to provide for automatic replacement of the electrodynamic regenerative braking by rheostat braking if the voltage in the DC overhead system exceeds 3.85-4.0 kV due to absence of power loads on this section and automatic repeated actuation of the regenerative mode when voltage in the overhead system drops below 3.85-4.0 kV. | Full compliance | |
| 8.2.3. | In case of the failure of the part of the electric equipment the locomotive should function in the emergency mode with possibility of actuation of the backup scheme from the operator's cabin. The power loss in the traction and braking modes should be minimized. | Full compliance | |
| 8.2.4. | Special devices should be provided for protection from the following factors:<br>■ Short circuits in any part of the electric diagram (including line-to-line short circuit and short circuit to frame);<br>■ External short circuits in the regenerative braking mode,<br>■ Overload currents in the traction drive circuits;<br>■ Impact of the external overvoltage;<br>■ Unacceptable high heating of electrical equipment components;<br>■ Short-time increase of the voltage in the overhead system above the established level;<br>■ Spinning (in case of excessive slippage of wheels of over 4%) and wheelset slip. | Full compliance | |
| 8.2.5. | Traction electrical equipment should consist of the following main functional units:<br>■ Electrical equipment connected to overhead system and reverse rail circuit (current collectors, switching and protection equipment, noise filters, cable and busduct lines, etc.);<br>■ Converters powering traction motors;<br>■ Traction motors;<br>■ Protection of high voltage equipment. | Full compliance | |
| 8.2.6. | Energy parameters | - | |
| 8.2.6.1. | Efficiency ratio of the locomotive in the continuous mode should be at least 86% taking into account the auxiliary loads with nominal voltage on the current collector, switched off compressors, air conditioners and other devices maintaining comfortable working conditions for the locomotive crew. | Full compliance | |
| 8.2.7. | Current should be returned to rails via special grounding devices on the axle of the wheelset for prevention of the damage of the journal bearings. | Full compliance | |
| 8.2.8. | Current collectors | - | |
| 8.2.8.1. | Locomotive should be provided with at least two current collectors. Their design should meet requirements of Instruction TsT-TsE-844 and current load requirements.<br>Current collectors should be designed for the following speed and current:<br>■ Speed of 120 km/h;<br>■ Maximum current of 3200 A; | Full compliance | |
| 8.2.8.2. | Collector components should be made from metal ceramics, graphite or copper and graphite composition. | Full compliance | |
| 8.2.8.3. | The lifespan of current collector materials should be at least 40,000 km. | Full compliance | |
| 8.2.8.4. | Current collectors should be functional in the icing conditions. | Full compliance | |
| 8.2.8.5. | Current collector should be functional under the impact of 30 kA short circuit current during 0.1 sec. | Full compliance | |
| 8.2.8.6. | Current collectors should be made from corrosion resistant material and should preserve corrosion resistance under the impact of detergents (fresh water up to 60 °C, caustic soda, synthetic and other detergents). | Full compliance | |
| 8.2.8.7. | Detachment of the current collector from overhead wire is not acceptable after the first contact when it is raised. The moving parts of the current collector should not hit the fixed parts when current collector is lowered when train moves at designed speed. | Full compliance | |
| 8.2.8.8. | Current collector should resist acceleration of 50 $m/s^2$ with retained functionality of all parts of current collector. | Full compliance | |
| 8.2.8.9. | Lateral stiffness of the current collector should be at least 17 N/mm. | Full compliance | |
| 8.2.8.10. | Support insulators of the current collector should be made from polymer or from porcelain. | Full compliance | |
| 8.2.8.11. | In case of the movement at the speed exceeding the design speed by 10% the lowered current collector should not be raised by air counterflow. | Full compliance | |
| 8.2.8.12. | Parameters of static characteristic of current collector should meet table 8.2. | Full compliance | |
| Table 8.2 | Static characteristic of current collector | Full compliance | |
| 8.2.9. | Protective and switching equipment | - | |
| 8.2.9.1. | Switching high voltage equipment conductively coupled with overhead wire or traction converters should meet requirements of GOST 9219. | Full compliance | |
| 8.2.9.2. | Locomotive should be provided with quick-action circuit breakers for protection from short-circuit currents and overloads. | Full compliance | |
| 8.2.9.3. | Minimum switching capacity of circuit breakers should be 30 kA with inductance of the short circuit line 5..15 mHenry. | Full compliance | |

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| 8.2.9.4. | Quick – action circuit breaker should be non-polarized and should be sufficiently quick for selective (without actuation of the protective circuit breakers of the traction substation) shutting down of the short circuit current when locomotive is at the end of inter-substation power supply zone of the overhead system. | Full compliance | |
| 8.2.9.5. | Power supply circuit breakers should be actuated when locomotive circuit breaker is switched on in the normal operation mode. | Full compliance | |
| 8.2.9.6. | Overvoltage limiters should be provided for protection of the power equipment of the locomotive from lightning and external switching overvoltage. | Full compliance | |
| 8.2.9.7. | The level of remaining voltage in the devices of overvoltage limits should be 8.0...9.0 kV. | Full compliance | |
| 8.2.9.8. | Overvoltage limiters for 3kV DC system should repeatedly resist up to 2500 A current pulses with energy of 150 kJ. | Full compliance | |
| 8.2.9.9. | Overvoltage limiters should limit the level of switching overvoltage generated by the locomotive and supplied to overhead line at the level specified in item 5.5.8. | Full compliance | |
| 8.2.10. | Traction converter | - | |
| 8.2.10.1. | Traction converters should meet conditions of GOST 9219, GOST 24607.<br>Traction converters meeting EN 61287 can be used. | Full compliance | |
| 8.2.10.2. | Liquid cooling system can be used for cooling of power elements of the traction converter. Components of the cooling system, cooling fluid and filters should not be chemically aggressive and should be environmentally safe. Applied fluid and materials should be agreed with the Customer. Replacement of semiconductor devices should not require drainage of cooling fluid and disassembly of the cooling system. Cooling fluid should not freeze at the temperature minus 40°C. | Full compliance | |
| 8.2.10.3. | Replacement of semiconductor devices should not require drainage of cooling fluid and disassembly of the cooling system. | Full compliance | |
| 8.2.10.4. | All components of converters should ensure functionality of the systems of the locomotive under the ambient air temperature specified in section 3. | Full compliance | |
| 8.3 | Auxiliary system | - | |
| 8.3.1. | Asynchronous three-phase electric motors with square-cage rotor with nominal voltage of 380 V and frequency 50 Hz should be used to drive auxiliary mechanisms (fans, braking compressors and convertor cooling system). | Full compliance | |
| 8.3.2. | Electric motors of auxiliary mechanisms and other auxiliary loads should be powered from auxiliary static convertors of voltage, frequency and number of phases. The operation of static auxiliary converters in any operating modes of traction electric drive should not violate the requirements for harmonic composition (pulsing) of traction current of locomotive provided in Section 8. | Full compliance | |
| 8.3.3. | Static auxiliary converters should ensure the following values of the output nominal voltage:<br>■ 380 V AC three phase with frequency 50 Hz;<br>■ 220 V AC single phase with frequency 50 Hz;<br>■ 110 VDC.<br>The tolerance for variation of the output voltage and frequency of each channel of auxiliary converter should be aligned with respective tolerances for power supply voltage of the equipment connected to respective channels. The following should be taken into account | Full compliance | |
| 8.3.4. | Motors of cooling liquid pumps of power converters, motors of brake compressors should be powered from auxiliary converters with stabilized frequency and voltage. | Full compliance | |
| 8.3.5. | Power, quantity and scheme of connections of auxiliary converters should be selected so that to preserve functionality of all traction motors of locomotive in case of the failure of single auxiliary converter. | Full compliance | |
| 8.3.6. | Control circuits should be powered by stabilized DC voltage 110 V ± 5% from special static converter with pulsing of supply voltage not greater than 1% of the amplitude. If supply voltage disappears including the passage of neutral inserts the control circuits and protection device power supply should be automatically switched from static converter to battery. Gaps of supply voltage are not acceptable in this case. | Full compliance | |
| 8.3.7. | The battery should be recharged by stabilized direct current with deviation of ±5%. | Full compliance | |
| 8.3.8. | A separate power supply unit should be provided for microprocessor systems. | Full compliance | |
| 8.3.9. | It should be possible to power the auxiliary system of the locomotive from depot 3-phase power supply using special sockets bypassing auxiliary converters. | Full compliance | |
| 8.4 | Electrical Machines | - | |
| 8.4.1. | Traction electric motors should meet requirements of GOST 2582. Motors can be produced in accordance with EN60349-2. Class of insulation of winding of power electric machines should be not less than N. | Full compliance | |
| 8.4.2. | AC brushless electric motors can be used as traction motors. Traction electric machines should be brushless and should not require scheduled maintenance in the intervals between routine repairs of locomotives. It is recommended to apply asynchronous traction motors with square cage rotor. | Full compliance | Schedule maintenance of electric machine will be performed during routine repairs of locomotives. |
| 8.4.3. | Thermal properties of traction motors should ensure realization of the traction force and electric braking with the most adverse combination of the difference of diameters of tires of the wheelsets (3 of wheelsets have maximum diameter, 1 wheelset has minimum diameter in the range specified in these Technical Requirements) without violation of motor winding temperature increase limits specified in GOST 2582. | Full compliance | |
| 8.4.4. | Traction motors should be provided with forced air ventilation. Air coming in the cooling system should be filtered. The locomotive should be provided with multicyclone filters or centrifugal mechanical separators with continuous removal of dust, moisture and snow. The dust filtering coefficient with nominal flow rate of air with specific dust surface 2800 $cm^2/g$ should be not less than 75 %. The system of filtering of the air should keep snow and moisture away from electric machines. | Full compliance | |
| 8.4.5. | Bearings of traction motors should run without replacement at least 600,000 km of the locomotive travelling distance. The design of the bearings and their seals should ensure preservation of the lubricants n the bearing chambers, should prevent its contamination. The timing of filling and replacement of lubricants should be defined based on results of pilot operation of the locomotive. | Full compliance | |
| 8.4.6. | It is necessary to prevent ingress of lubricant inside the traction motors and electric motors of auxiliary mechanisms through labyrinth seals of the bearings and from gearbox into TED bearings. | Full compliance | |
| 8.5 | Equipment Diagnostics | - | |
| 8.5.1. | The design of the main parts of the electrical equipment should provide a possibility for evaluation of the current condition and correctness of functioning using built-in or external diagnostics equipment. | Full compliance | |
| 8.5.2. | The diagnostics of the devices of the electrical equipment should provide the following functions:<br>■ Identification of excessive parameters of operation of electrical equipment;<br>■ Recording of unacceptable and dangerous events and saving of electrical processes in non-volatile memory for subsequent analysis of emergency situations by repair personnel and identification of their causes;<br>■ Transmission of information to locomotive control system. | Full compliance | |

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| 8.5.3. | ■ Traction and auxiliary converters;<br>■ Quick action switch;<br>■ Switching devices;<br>■ Batteries and charging devices. | Full compliance | |
| 9 | LOCOMOTIVE CONTROL SYSTEM REQUIREMENTS | - | |
| 9.1 | General requirements | - | |
| 9.1.1. | All functions of locomotive control system requiring logical sequence such as controlling current collectors, quick action circuit breaker, contactors of auxiliary drive, traction and auxiliary converters and other devices should be performed by an integrated microprocessor computing and control system (hereinafter – integrated system) using commands received from the panel and from operator's controller taking into account signals received from sensors provided for by the locomotive circuit. | Full compliance | |
| 9.1.2. | Integrated system should control all systems of the locomotive (traction and auxiliary drives, control circuit devices, protection, traffic safety, automatic train operation, diagnostics of main equipment and self-diagnostics). Possibility should be provided for testing of the locomotive system, its parts and control system in the parking area before departure of the train. In case of any faults the lifting of the current collectors, actuation of the quick action circuit breakers should be forbidden. | Full compliance | |
| 9.1.3. | The locomotive should be provided with the capability of actuation of the quick-action circuit breaker, lifting of the current collector after prolonged parking at ambient air temperature below -25°C. | Full compliance | |
| 9.1.4. | Integrated control and safety system should consist of multicontour hierarchically structured subsystems. Functions implemented by the system should be integrated and should be performed in the single process of train operation. | Full compliance | We will instal KLUB-U as safety system |
| 9.1.5. | Locomotive control and traffic safety system should be based on microprocessors. All subsystems should interact with each other without conflicts exchanging information required for performance of these functions. | Full compliance | |
| 9.1.6. | Integrated traffic safety and control system should consist of the following subsystems ensuring main train control and monitoring functions listed in the hierarchy lowering order:<br>■ Safety subsystem of locomotive receiving information about train situation and controlling the speed of the train (hereinafter - safety and speed control system);<br>■ Subsystem of safe automatic speed control in the target braking mode (hereinafter – braking control system) operating based on safety principles;<br>■ Operation and traction drive control subsystem;<br>■ Auxiliary equipment control subsystem. | Full compliance | |
| 9.1.7. | The following subsystems provide information support, monitor and record results of operation of the above subsystems and equipment:<br>■ Subsystem of diagnostics and monitoring of technical condition of equipment of rolling stock and maintenance of rail track (hereinafter - diagnostics subsystem);<br>■ Operator's information support subsystem;<br>■ Locomotive subsystem for receiving information from relevant services about train situation and change of train operation conditions (hereinafter - information receiving subsystem);<br>■ Subsystem for information support of operation of all systems and equipment of single locomotive or two locomotives (communication network);<br>■ Subsystem for recording information about characteristics of train, performance of equipment in the electronic memory and transmission of information by radio channels to relevant services (recording subsystem);<br>■ Common astronomical time subsystem. | Full compliance | |
| 9.1.8. | Subsystems listed in items 9.1.6 can be functionally and structurally linked with each other and integrated into the subsystems listed in items 9.1.5. | Full compliance | |
| 9.1.9. | All subsystems should be synchronized with astronomical time set using satellite navigation system. In case of the absence of satellite navigation signals it is necessary to define master clock processor unit. | Full compliance | |
| 9.1.10. | Control and traffic safety system should be open for expansion of functions. It should provide possibility of integration with separate new devices, parts and components. | Full compliance | |
| 9.1.11 | Backup and redundancy system should be provided taking into account minimum set of functions (to free the section between stations in case of majority of failures) and economic efficiency over entire life cycle. | Full compliance | |
| 9.1.12 | Integrated control system should ensure automatic energy optimum driving of the train between stations and at the stations (hereinafter - automatic operation) taking into account all speed limitations definition of trajectory with accuracy up to 3 km/h and fulfilment of the movement schedule with accuracy of up to ±60 sec and in case of schedule slippage identification of track sections for regaining the speed and bringing the train in conformance with schedule taking into account minimization of power consumption, required accuracy of driving at permitted speed taking into account limitations and train length. | Partial Compliance | Minimization of power consumption is not done by the Automatic driving system (not used energy counter) |
| 9.1.13 | When the line is provided with operational schedule setting devices the system ensures its fulfilment. It is necessary to ensure minimization of the losses of kinetic energy through timely selection of traction shutoff moment and required stage of service braking ensuring realization of adaptive program of movement trajectory. | Full compliance | |
| 9.1.14 | The functions of automated operation of the train and traffic safety assurance should be mutually integrated and implemented in mutual integration of the optimum and safe operation of the train in the real time as part of the common microprocessor control complex. | Full compliance | |
| 9.1.15. | Braking control subsystem (in case of availability of track generators) should prevent any overspeeding both in the automatic and manual train operation modes which can disturb the safety of traffic by using electrodynamic, electropneumatic and pneumatic braking with maximum allowance for overspeeding of 2 km/h. Entire range of defined movement trajectories is adapted to the track profile, train weight and real braking forces realized by selection of the stages of service braking. | Full compliance | |
| 9.1.16 | If the station is provided with specialized equipment the integrated system should allow departure from the station only when the locomotive receives command by digital radio channel or by rail circuits from station operator confirming permission for departure of the train. | Non Compliance | We need to better understand your requirement and the way you would like to achieve it in order to be able to propose a solution fitting to your needs. At the moment we are missing some input data. |

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| 9.1.17 | Braking control subsystem should control the speed of the train defined by the automatic operation subsystem preventing overspeeding by service braking. | Full compliance | |
| 9.1.18. | Safety and speed control subsystem meeting the safety requirements should receive information about vacancy of block sections ahead and station tracks from floor mounted devices of automatic cab signalling system, digital radio channel and to use the data of electronic data bases of the section. In accordance with the received signals it should define the maximum allowable speed and to control the braking system. | Full compliance | |
| 9.1.19 | Safety and speed control subsystem should ensure transmission of speed control function to braking control subsystem. | Full compliance | |
| 9.1.20. | In case of the failure of the braking control subsystem the safety and speed control subsystem should stop the train before restrictive signal or by emergency braking with accuracy not worse than 50 m. | Full compliance | |
| 9.1.21 | Interaction of automatic train operation subsystem, braking control subsystem, safety and speed control subsystem should be ensured via dedicated specialized system bus ensuring that these subsystems use common input information including information for definition of the precise coordinate of target stopping of the train when entering the station and definition of the length and profile of block stations, allowable speed on ahead section when leaving the station, etc. | Full compliance | |
| 9.1.22 | The design of units of control system should ensure safety of service personnel in accordance with GOST 12.2.056. | Full compliance | |
| 9.1.23. | Control and traffic safety system of the locomotive should ensure reliable operation under the combined impact of climate and mechanical factors. | Full compliance | |
| 9.1.24. | The protection of enclosures of units from water and foreign objects should be not below IP50 as per GOST 14254. | Full compliance | |
| 9.1.25. | Control system units should be designed for operation in the ambient temperature range from minus 50 C to plus 50°C. | Full compliance | According to technical assignment, we consider a minimum temperature of minus 40°C |
| 9.1.26. | Certain elements can be heated at low temperatures when locomotive is started. It is necessary to provide for safety measures, fire safety measures, possibility of prevention of the discharge of battery. | Full compliance | |
| 9.1.27. | The equipment of control and safety system should be immune to electromagnetic interference in accordance with applicable standards. It should have appropriate protection from external sources of electromagnetic radiation and it should meet the limits of electromagnetic exposure of people. | Full compliance | |
| 9.1.28. | All units should perform continuous self-testing. | Partial Compliance | Self testing is performed by all functions which are critical for locomotive performance in operation. |
| 9.1.29. | Under additional agreement a service portable testing and stationary equipment should be developed and supplied to the depot to perform testing and diagnostics of separate modules, units and parts of locomotive with capability to save information on external electronic media, to perform re-configuring of control system of entire locomotive, to perform testing of the system software taking into account change of program data. | Full compliance | This would be provided under separate and additional agreement. |
| 9.1.30. | Control system should enable operator to turn off remotely faulty traction motors of the locomotive from the panel. | Full compliance | |
| 9.2 | Safety and speed control subsystem | - | |
| 9.2.1. | The subsystem should provide the following capabilities:<br>■ Receiving from track information devices of signals of continuous automatic cab signaling and integrated continuous automatic cab signaling, information about vacancy of ahead section;<br>■ Defining of acceptable speed depending on the colored light signals and train situation, electronic data base of section, continuous comparison of these data with actual situation and application of braking in case of overspeeding;<br>■ Measurement of actual speed and current time, automatic train positioning including positioning using satellite navigation equipment;<br>■ Prevention of unauthorized non-stop passing of colored lights with restrictive signals in the track sections equipped with continuous automatic cab signaling;<br>■ Monitoring of actuation and deactivation of safety devices;<br>■ Assurance of unambiguity of light and sound information received by the operator;<br>■ Recording of data about operating modes of the rolling stock, information from track devices and digital radio channel, actions of the operator during at least 16 hours and saving these data in protected information storage device with possibility of subsequent decoding preventing the locomotive crews from any correction of the said data. | Partial Compliance | Our solution is KLUB-U with TSKBM and Autopilot from USAVP |
| 9.2.2. | To ensure functioning of the system the locomotive should be provided with the following equipment:<br>■ Receiver coilds of continuous automatic cab signaling;<br>■ Electropneumatic autostop valve;<br>■ Unit for controlling unauthorized deactivation of the autostop;<br>■ Compressed air pressure sensors and speed sensors;<br>■ Satellite navigation antennas and digital radio channel antennas;<br>■ Transceiver of digital radio channel;<br>■ Duplex filter. | Full compliance | |
| 9.2.3. | Safety system should be based on the application of the unified interface, it should be open for expansion of functions through addition of new units without modification of the structure of the system in general. | Full compliance | |
| 9.2.4. | Interface gateway units should be used as interfaces of the safety subsystem with other subsystems. | Full compliance | |
| 9.3 | Braking Control Subsystem | - | |
| 9.3.1. | Braking control subsystem is designed to control the operating speed to ensure traffic safety through automatic train brake control. | Full compliance | |
| 9.3.2. | The subsystem should provide the following capabilities:<br>■ Automatic control of train automatic brakes for prevention of unauthorized passing of restrictive signals and overspeeding;<br>■ Prevention of unacceptable excessive longitudinal forces and accelerations in the train. | Full compliance | |

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| 9.3.3. | Subsystem should perform the following functions:<br>■ Automatic evaluation of efficiency of brakes and diameter of tires based on non-slipping wheelset for accurate measurement of the speede and travelled distance to ensure precise stopping at the station ±5 m and ±15 m at the section between stations;<br>■ Train braking taking into account profile of track section, real efficiency of brakes in the train and realization of multiple braking curves with different braking coefficients depending on the real conditions;<br>■ Receiving of information about the incoming route and station itinerary, speed along the route and route length, coordinates of target stopping, applicable speed limitations and vacancy of the section between stations;<br>■ Measurement of actual speed and automatic train positioning;<br>■ Evaluation of allowable speed depending on the signals and train situation;<br>■ Generation of control response for application of emergency braking if actual speed exceeds allowable speed;<br>■ Prevention of unauthorized non-stop passing of colored lights with restrictive signals in the track sections equipped with continuous automatic cab signaling devices; | Partial Compliance | Our solution is KLUB-U with TSKBM and Autopilot from USAVP. |
| 9.3.4. | It is necessary to provide for a possibility of testing and recording of functionality of braking system when train is parked (before trip). | Full compliance | |
| 9.4 | Automatic train operation subsystem | - | |
| 9.4.1. | Automatic train operation subsystem should provide the following capabilities:<br>■ Automatic control of operation of single locomotive or two locomotives based on multiple unit system;<br>■ Delivery to operator of all required information for train operation; | Full compliance | |
| 9.4.2. | Subsystem should support operation in the automatic mode, operator advise giver mode, manual control mode. In the manual control mode and operator advise giver mode the train is controlled by an operator, in automatic train operation mode the train is controlled automatically and operator is provided with full information about operating modes of the equipment of locomotive(s). | Full compliance | |
| 9.4.3. | In automatic train operation mode the subsystem should provide the following capabilities:<br>■ Calculation and automatic handling of the train along defined trajectory with accuracy of up to 3 km/h allowing for fulfillment of a schedule with accuracy of up to ±60 sec with minimization of the traction power consumption;<br>■ Control of acceleration, maintaining of the defined speed and electrical (electropneumatic and electrodynamic) braking when train moves n the calculated trajectory;<br>■ Making up delays taking into account real traffic condition and characteristics of the section and train;<br>■ Selection of sections to make the time with minimization of the power consumption;<br>■ Notification of the operator about operation in the automatic mode;<br>■ Monitoring of technical condition and operating modes of the traction, braking and auxiliary equipment and transmission of alarm messages for operator about dangerous fault and operation modes of the equipment (list to be agreed with the customer);<br>■ Detection and notification of the operator about unacceptable longitudinal, lateral and vertical acceleration related to violations in the maintenance of the rolling stock and track.<br>In automatic operation and operator advisory mode the subsystem should ensure lowering of the speed without involvement of the operator. | Full compliance | |
| 9.4.4. | In operator advisory mode the subsystem should provide the following capabilities:<br>■ Calculation and displaying for the operator of the trajectory of movement with accuracy of up to 3 km/h allowing for fulfullment of the schedule with accuracy of ±60 sec with minimum power consumption;<br>■ Notification of the driver about operation in the operator advisory mode;<br>■ Monitoring of technical condition and operating modes of the traction, braking and auxiliary equipment and transmission of alarm messages for operator about dangerous fault and operation modes of the equipment;<br>■ Detection and notification of the operator about unacceptable longitudinal, lateral and vertical acceleration related to violations in the maintenance of the tracks;<br>■ Continuous recording of information from all subsystems to single wearable cartridge of automatic train operation subsystem. | Partial Compliance | Our solution is KLUB-U with TSKBM and Autopilot from USAVP. |
| 9.4.5. | Calculation of the speed in the track function should be performed assuming the condition of fulfillment of the traffic schedule taking into account signals of automatic locking, information from track devices upon arrival to the station, characteristics of the track section contained in the data base of integrated system including profile and allowed speed and temporary speed limitation data promptly transmitted to the locomotive. The information agreed with the technology of receiving and processing of information accepted in automatic operation systems should used as input information for automatic train operation system characterizing the properties of the train, characteristics of the movement section and schedule. | Full compliance | |
| 9.4.6. | The response time of the systems and equipment of locomotive to the control commands of the operator or automatic operation subsystem should be not more than 0.5 sec for commands related to traffic safety and not more than 1 sec for other commands. | Full compliance | |
| 9.4.7. | In automatic train operation mode the operator should be able to promptly correct train operation parameters automatically selected by the system, namely, to select the mode of fulfillment of the schedule in case of delay, to set acceleration in case of starting up and braking, to immediately limit the speed or to turn on braking mode. | Full compliance | |
| 9.5 | Operation and Traction Drive Subsystem | - | |
| 9.5.1. | The subsystem in control mode should generate control commands for the following functions:<br>■ Interlocking of movement control commands from inactive operator cabins;<br>■ Change of direction;<br>■ Adjustment of the traction and braking force by handling the traction drive;<br>■ Electrodynamic braking using regenerative or rheostat brake including:<br>■ Braking to defined speed with defined value of the braking force;<br>■ Automatic replacement of electrodynamic brake by electropneumatic brake (pneumatic) brake in case of the failure or low efficiency of electrodynamic brake;<br>■ In the mode of joint electrodynamic braking of locomotive with electropneumatic (pneumatic) braking of train cars. | Full compliance | |
| 9.5.2. | Subsystem should ensure protection from overloads in the operation of the equipment as well as from the slipping and spinning. | Full compliance | |

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| 9.5.3. | The response time of the systems and equipment of locomotive to the control commands of the operator or automatic operation subsystem should be not more than 0.5 sec for commands related to traffic safety and not more than 1 sec for other commands. | Full compliance | |
| 9.5.4. | Control system should perform the following functions for controlling the traction equipment:<br>■ Collection of information about condition of this equipment, receiving of commands from control panel transmitted using control equipment;<br>■ Generation of appropriate commands for equipment control units using communication network;<br>■ transmission of information about operation of the system and condition of the locomotive to control panel;<br>■ Checking of acceptability of train control actions of the operator (i.e. unacceptable conditions of the system should be controlled or locked by the control system), etc. | Full compliance | |
| 9.5.5. | Controls should be designed taking into account the impact of control signals from control equipment on the operation safety taking into account the frequency of application, convenience of usage, algorithms of work of the operator, etc. | Full compliance | |
| 9.5.6. | The commands from the controls after processing are output in the form of control inputs to communication bus. The control algorithms are realized directly in the control units of the respective equipment. | Full compliance | |
| 9.6 | Auxiliary Equipment Control Subsystem | - | |
| 9.6.1. | Subsystem should perform the following functions for controlling auxiliary equipment:<br>■ Collection of information about condition of this equipment, receiving of auxiliary machine and auxiliary circuit control commands from control panel transmitted using control equipment;<br>■ Generation of appropriate commands for equipment control units using communication network;<br>■ transmission of information about operation of the control system and condition of the locomotive to control panel; | Full compliance | |
| 9.6.2. | System should receive and process information about conformance of the operating modes of the auxiliary equipment defined by traction or other auxiliary equipment in accordance with operation protocols. | Full compliance | |
| 9.6.3. | Commands from control equipment are transmitted to central processor for subsequent processing and output of control inputs to communication bus. The control algorithms are realized directly in the control units of the respective equipment. | Full compliance | |
| 9.7 | Diagnostics Subsystem | - | |
| 9.7.1. | Diagnostics should be implemented in three modes: Before departure, in transit and in depot conditions. | Full compliance | |
| 9.7.2. | Diagnostics in transit should support the following capabilities:<br>■ Monitoring of the condition and parameters of the train equipment (mechanical, electrical, pneumatic) including self-testing of control system;<br>■ Timely notification of the operator about accidents and near miss incidents;<br>■ Determination of the cause of deviation of controlled conditions and parameters with delivery of recommendations for maintaining the functionality of the train and its safe operation;<br>■ Identification of incorrect actions of the operator with generation of appropriate messages;<br>■ Mode of recording and storage of main monitored parameters for subsequent analysis. | Full compliance | |
| 9.7.3. | Locomotive should be provided with integrated non-volatile memory unit which should save the parameters limiting the operation of the locomotive. These parameters should be continuously taking into account during operation. The data should be accessible for repair personnel for evaluation of the scope of repair when locomotive enters the depot. | Full compliance | |
| 9.7.4. | List of monitored conditions (respective codes) should be developed for each type of equipment. These conditions are identified in case of failures and faults of the equipment. The following information should be specified for them:<br>■ Signature of failure, fault, i.e. the readings of the instruments and equipment based on which the conclusion is made that certain failure occurred;<br>■ System response in case of this event, recommendations for operator in case of this event;<br>■ Recommendations for repair personnel. | Full compliance | |
| 9.7.5. | A certain event priority should correspond to each error code. The information is provided to the operator and measures are taken in accordance with these priorities. | Full compliance | |
| 9.7.6. | In case of the failure of locomotive equipment it is necessary to provide program measures for operation of the locomotive systems in emergency mode with automatic actuation of the backup systems. | Full compliance | |
| 9.7.7. | Reliability of 95 % of diagnostics information should be ensured. | Full compliance | |
| 9.7.8. | It is necessary to provide possibility for transmission of the results of diagnostics to respective services. | Full compliance | |
| 9.7.9. | If diagnostics is performed in depot conditions, during scheduled inspection and repair the units and parts as well as all units of control system (including backup sets) should be tested using set of tests and service programs both before repair and after repair and it should be possible to work jointly with depot's stationary diagnostics equipment. | Full compliance | |
| 9.7.10. | For recording of the information it should be possible to record the data on the removable cartridge of the automatic train operation subsystem. Additionally, the data should be recorded in non-volatile memory modules of safety and speed control and braking control subsystems. | Full compliance | |
| 9.7.11. | Diagnostics equipment of the locomotive should detect unacceptable longitudinal, vertical and horizontal accelerations in transit, their recording with correlation to location on the electronic media. | Non Compliance | This function is not included in our proposal. Would this be unaccetable for Georgian Railways, we would discuss to understand Georgian Railway's need and propose the best technical solution. |
| 9.8 | Operator Information Support Subsystem | - | |
| 9.8.1. | Information for the operator should be provided in the visual and sound form. Information should be visualized by application of graphic colored information panels (displays). Sound information should be provided in the form of voice messages (voice synthesizers) and sound signals. In certain cases it is possible to use point light indicators installed both in the operator's cabin and in high voltage chamber. | Partial Compliance | Our reference solution do not include Voice synthetizer but only sound generator. |
| 9.8.2. | Graphic multicolor displays used as information panels should be provide with function of adjustment of the brightness depending on the ambient light level which will ensure visibility of displayed information both at night and at day time under solar illumination. | Full compliance | |
| 9.8.3. | Information related to safety should be duplicated by application of indication units that meet high safety and reliability requirements. The keyboard for inputting critical commands also should be designed taking into account high safety and reliability requirements. | Full compliance | |

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| 9.8.4. | Information should be provide in three forms:<br>■ Main set of parameters characterizing the current condition of the train (standard mode);<br>■ Information provided upon demand of the operator;<br>■ Additional information automatically displayed in case of non-standard and emergency situations. | Full compliance | |
| 9.8.5. | Information support should provide the operator with required data about fulfillment of all main functions by control system. The subsystem should be able to provide the following information:<br>■ Estimated and actual trajectory, speed - track function;<br>■ Maximum allowable speed;<br>■ Signals of continuous automatic cab signaling;<br>■ Condition of equipment and train systems;<br>■ Hazardous faults or limit modes of operation of equipment of the locomotive. | Full compliance | |
| 9.8.6. | For information support of the repair services of depot it is possible to use displays of the operator cabin with on-demand display of information from diagnostic systems and it is also possible to use portable testing equipment. It is possible to provide local control systems with service display equipment. | Full compliance | |
| 9.8.7. | Only such display equipment and controls are installed on the control panel which are required for direct control during movement. | Full compliance | |
| 9.8.8. | Controls should be installed on the panel taking into account standard control algorithm in the easy and maximum reach capability zones depending on their operational significance and frequency of usage. | Full compliance | |
| 9.8.9. | The information equipment and controls should be integrated into the functional groups on the control panels. Main information devices should be provided on the control panels. They should be arranged taking into account their functional and operational significance, convenience of use, accessibility and visibility. | Full compliance | |
| 9.8.10. | Information panel should arranged perpendicularly to the direction of the glance of operator to the signal devices (it should be provided with protective cap) to prevent parallax and mirror reflection in the front windows. | Full compliance | |
| 9.8.11. | Operational control information panel provided in the operator's optimum visibility zone should include module of visualization of information for operator. Visualization module should consist of single graphic display and block of critical operation safety information with keyboard for entering critical commands. | Full compliance | |
| 9.8.12. | Controls should be installed on the panel taking into account standard control algorithm in the easy and maximum reach capability zones depending on their operational significance and frequency of usage. | Full compliance | |
| 9.9 | Communication Network | - | TCMS Backbone protocol is on CIP |
| 9.9.1. | Communication network should link separate components of the locomotive and train, it should transmit information and control signals for implementation of adjustment, control and diagnostics processes. | Full compliance | |
| 9.9.2. | Communication network should provide the following capabilities:<br>■ Interaction between equipment of the locomotive;<br>■ Exchange of information with train. | Full compliance | |
| 9.9.3. | Communication network should have common hierarchic structure that allows for debugging, startup, servicing, configuration, monitoring and control of the network. | Full compliance | |
| 9.9.4. | It is necessary to provide for self-diagnostics of the communication network before and during the trip, the system should recognize and ignore error data in case of any failure at all levels of transmission of information, operating protocols of buses in case of faults in all elements of the network, protocols of transmission of information with different safety status should be agreed. No failure should not result in hazardous irrecoverable consequences. In case of any unsatisfactory results of self-diagnostics related to both main and backup sets and unit messages should be generated for locomotive crew, a record should be made in the diagnostics memory and then submitted to the depot. | Partial Compliance | This requirement shall be detailed and discuss together to fully understand it. However, Alstom commitment is to design technical solution leading to required availability level of the locomotive. This is achived combining sub-system reliability and redundancy. |
| 9.9.5. | If any error or failure is found in the system the communication network should be capable to continue functioning with specified possible set of functions and safety limitations but subject to shutting off of the redundant element or entire part of the system that causes the error. | Full compliance | It is our design development approach. Modular architecture in order to be able to shut off sub system indivuadally and witout affaicting the remaining all sub systems |
| 9.9.6. | The design of inter-car electrical and pneumatic connections, hardware and software of the system should be unified and should provide for linking the locomotives based on multiple unit system. | Full compliance | |
| 9.10 | Recording Subsystem | - | |
| 9.10.1. | Information recording system should be provided with the following information recording contours:<br>■ Recording of safety system information;<br>■ Recording of diagnostics information;<br>■ Recording of parameters of control system and intrasystem backup.<br>Parameters of the operation of the train on the traffic route should be recorded in the non-volatile memory | Full compliance | Recording of safety system information is achieved by RPV system which is proposed with Radio (Voice recorder). Parameters to record shall beagreed at early stage of development of the locomotive. |
| 9.10.2. | It is necessary to ensure storage and accessibility of recorded data in non-volatile memory during at least 16 hours. The data should be available for analysis from the control panel for copying on the diagnostics portable computer. | Full compliance | |
| 9.10.3. | System should provide recommended actions for operational and repair personnel for each diagnostics message. | Full compliance | |
| 9.11 | Software of Integrated System | - | |
| 9.11.1. | Software (SW) should implement all control and safety tasks. | Full compliance | |
| 9.11.2. | Diagnostics system should record all cases of interruption of functionality of the system for subsequent analysis of the causes of freezing for subsequent prevention. | Full compliance | |
| 9.11.3. | Software should use a modular approach and clear representation of functional composition, information streams, Interfaces for exchanging information between modules, structure of data, sequence of execution of commands and limitations and assumptions related to information and designing. Each software module should easily readable, clear and testable. Interfaces used during development of the software and separate modules should be standard and should be agreed with the Customer. Uniquely identified programming languages should be used for the software. | Full compliance | |
| 9.11.4. | System software should include the following programs:<br>■ For diagnostics of system equipment failures;<br>■ For identification of errors in communication channels;<br>■ For testing with running system of standard applied software modules. | Full compliance | |

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| 9.11.5. | In case of the detection of the error or failure the locomotive control and safety system should continue to operate subject to shut down of number of components. The specific technical specifications for development of the software should provide possible functions in case of degradation of the system. | Full compliance | In case of failure of sub system of the locomotive, the remainning subsystem continue to operate and the locomotive can encounter performance limitation depending of the type and depth of the failure. |
| 9.11.6. | Software is delivered to the customer with installation and operation instructions. | Full compliance | Executable file is provided |
| 9.11.7. | Software testing is performed during acceptance of locomotive control and safety systems. | Full compliance | |
| 10 | COMMUNICATION EQUIPMENT REQUIREMENTS | - | |
| 10.1 | locomotive should be equipped with 2, 160, MHz radios. | Full compliance | |
| 10.2 | Radio communication control panels for operator and assistant should be installed in each locomotive cabin. Radios should be installed in both sections of two-section locomotives. | Full compliance | |
| 10.3 | Antennas for each of the operating bands of radio communication 2, 160 MHz should be installed on the roof of the locomotive | Full compliance | Radio RVS-01 foresseen |
| 10.4 | The locomotive should be equipped with radio communication equipment in accordance with requirements of regulatory document "Rules and Norms of Equipping Mainline and Shunting Locomotives, Electrical and Diesel Trains by Radio Communication and Noise Suppression Equipment." TsSh/4783. | Full compliance | |
| 10.5 | The antennas should be installed on the roof of locomotive so that to ensure intrasystem electromagnetic compatibility (EMC) of radio communication equipment; EMC of radio communication equipment and radio equipment of railway automation system data transmission channel. | Full compliance | |
| 10.6 | The antennas of radio equipment should function under operating temperature from minus 45°C to plus 50°C. | Full compliance | |
| 10.7 | The acceptable actual value of psophometric current in the range of 300-3400 Hz from single locomotive should not be greater than 2 A. | Full compliance | |
| 10.8 | All locomotive control and monitoring devices that transmit data from locomotive should be integrated at the hardware and software level for sharing the radio channel. | Full compliance | |
| 10.9 | Radio stations installed on the locomotive should be powered from battery with voltage rating 110 V. | Full compliance | |
| 10.10 | Data transmission radio stations should be powered from specialized power sources of control and monitoring systems. | Full compliance | |
| 10.11 | Radio stations can be powered by onboard systems of mobile facilities with nominal voltage of 110 V instability of ±20 %, pulsation factor not greater than 3 %, voltage surge not greater than 725 V with duration up to 40 ms and voltage loss time not greater than 10 ms. If pulsation in the onboard systems exceeds the said values the smoothing filters are installed in the mobile facility. | Full compliance | |
| 10.12 | The power supply units of radio stations are connected to 110 V onboard systems using two-wire system directly at the terminals of the battery (or switchboard) to prevent any supply wire leakage of current consumed by the control equipment in operating and switching modes. | Full compliance | |
| 10.13 | All fire and security alarm equipment installed on the locomotive and diagnostics equipment of the locomotive should ensure interfacing with radio equipment for transmission of information via radio channel. When locomotive is staged it is necessary to ensure transmission of information from fire (security and fire) alarm by radio channel to the depot operator. | Partial Compliance | Intefacing with radio is not included in our platform solution. Thus, we have to investigate further to define a solution fulfilling your needs. At the moment, this feature is not part of our technical proposal. |
| 10.14 | In terms of climate and mechanical requirements the radio station (including control panel) should meet group V5 of the second category of severity as per GOST 16019-2001 with the following values of the mechanical and climatic factors:<br>■ Relative humidity 93% at temperature 25°C;<br>■ Sinusoidal vibration at frequency range of 10-100 Hz (with acceleration amplitude 4g);<br>■ Low operating temperature minus 40°C; | Full compliance | |
| 11 | VENTILATION SYSTEM REQUIREMENTS | - | |
| 11.1 | Natural and forced ventilation should be provided. In summer mode with nominal capacity of fans the temperature in the gangways of the body should not exceed the temperature outside the body by more than 15°C. Positive pressure in the body should be 2-12 mm of water column at all modes of rotation of fans. | Full compliance | |
| 11.2 | Effective cleaning of air from dust, rain water and snow without application of contact action seasonal filters should be used in ventilation systems of traction motors and other electrical equipment whose winding and electrical insulation directly contact with cooling air. | Full compliance | |
| 11.3 | Intake shutters should be located in the upper part of the body. The air stream exhausted from ventilation systems should be not directed to the elements of the track superstructure. | Full compliance | |
| 12 | INTERNAL AND EXTERNAL EQUIPMENT REQUIREMENTS | - | |
| 12.1 | General requirements | - | |
| 12.1.1. | Operator's cabin should meet requirements of GOST 12.2.056 (with respect to labor safety requirements) and should provide optimum working conditions for the locomotive crew. | Full compliance | |
| 12.1.2. | The observability from the operator cabin should meet requirements of GOST 12.2.056. The upper edge of the windshield glass should be at the height of at least 1835 mm from the cabin floor level. | Full compliance | |
| 12.1.3. | The cabin should be arranged so that to ensure maximum observability of the track, floor signals, overhead system. Optimum visibility of external train situation and emergency signals during operation of the operator in the sitting and standing position should be ensured without degradation of the visibility conditions. | Full compliance | |
| 12.1.4. | Front windows of the operator cabin should be made from high-strength electrically heated glass meeting the requirements of GOST 12.2.056. | Full compliance | |
| 12.1.5. | The observability from the side windows of operator cabin should meet requirements of GOST 12.2.056. | Full compliance | |
| 12.1.6. | Impact resistance of windshield should meet requirements of GOST 12.2.056, UIC 651. | Full compliance | |
| 12.1.7. | Sanitary and household support should take into account requirements of standard GOST 12.2.056. | Full compliance | |
| 12.1.8. | The microclimate system of the cabin should include the following equipment:<br>■ Air conditioning system that performs the functions of cooling, heating and ventilation;<br>■ Warm air supply device for heating the feet of the operator and assistant operator. | Full compliance | |
| 12.1.9. | Design of the exterior lighting of the locomotive should meet the requirements of GOST 12.2.056, GOST 24179. | Full compliance | |
| 12.1.10. | Signs and labels should be provided on the locomotive in accordance with Railroad Operating Rules as agreed with the customer. | Full compliance | |
| 12.2 | Operator Cabin | - | |
| 12.2.1. | The design of operator cabin should ensure safety of locomotive crews, safe and efficient control of movement, shunting on the tracks maintaining the visibility conditions, preparation of functional systems for operation, convenient and safe access to all instruments and devices during train control, maintenance and repair, free movement in the cabin, working in the most comfortable working postures. | Full compliance | |
| 12.2.2. | At the night time the exit area should be provided with external lighting at least 2 lux at the ground level. | Full compliance | |
| 12.2.3. | The cabin should be separated from other premises by fire retardant partition wall with fire endurance at least 0.5 h. The design of the door and door frame in the fire retarding partition wall should have the same fire endurance as the partition itself. | Full compliance | |

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| 12.2.4. | The dimensions of the cabin are set as per GOST 12.2.056. Internal dimensions of the cabin, window opening, main dimensions of the height of the panel and chair should be set for creation of optimum conditions for control in the sitting and standing position for persons who are 165-190 cm tall. The cabin should be provided with seats for operator and assistant operator and folding seat for instructor operator. | Full compliance | |
| 12.2.5. | The folding seat for instructor operator should be positioned so that not hinder the work of the operator and assistant operator. The size of the seat and place of installation should ensure possibility of observation of the work of the operator in the comfortable seated position. | Full compliance | |
| 12.2.6. | Overall design of the internal space of the cabin and its equipment should create minimum number of protruding corners and edges which can threaten the safety of operator or assistant. | Full compliance | |
| 12.2.7. | In narrow areas for prevention of the possible impact all edges should be rounded and lined by soft material (elements of passive protection). | Full compliance | |
| 12.2.8. | Materials that can be destroyed by fragments should not be used for covering the walls of the cabin and structural elements. | Full compliance | |
| 12.2.9. | The floors of the cabin and service platform should be arranged at the same level and should be flat over entire are to ensure save movement. | Full compliance | |
| 12.2.10. | Internal space of the cabin should be easily cleanable. | Full compliance | |
| 12.2.11. | The locomotive should be controlled by operator in the free seated or standing posture. The operator seat should be located to the right from the longitudinal axis of the cabin and seat of assistant operator should be provided on the left form the longitudinal axis of the cabin. The seat of the assistant operator should be arranged at the same level with the operator seat. | Full compliance | |
| 12.2.12. | The operator cabin should be provided with emergency exit using side window openings in accordance with requirements of TsT-6. To exit the emergency door the latter one should be provided with rope ladder or by lanyard. | Full compliance | |
| 12.2.13. | Organization of the workplaces for controlling the locomotive. | Full compliance | |
| 12.2.13.1. | Control panel and seat should be functionally linked with each other with respect to assurance of rational seating of the operators who are from 165 to 190 cm tall. | Full compliance | |
| 12.2.13.2. | Main controls and information visualization equipment should be arranged in the most convenient zone for manipulation and observation. Multifunctional instruments are recommended for reduction of the number of information elements and controls. Holder for storage of the forms of operational and service information should be provided in the center of the control panel. | Full compliance | |
| 12.2.13.3. | Functional link of the panel and seat implies necessity of creation of large and wide bay for legs. The time for emergency escape from the operator's workplace should not exceed 3 sec. | Full compliance | |
| 12.2.13.4. | The seats should not enhance the vibration and amplitude of shocks at the ends of the rails to the seat. The seat should be rigidly attached with movement mechanism on the floor. | Full compliance | |
| 12.2.13.5. | The seat should have soft upholstery from resistant, air - proof, easy to clean material. | Full compliance | |
| 12.2.13.6. | The seat during operation should not damage the panel. 12.2.14. Lighting equipment. | Full compliance | |
| 12.2.14.1. | The level of artificial light in the operator cabin should meet OST 32.120. | Full compliance | |
| 12.2.14.2. | The following types of lighting should be provided in the operator cabin:<br>■ Working lighting providing illumination at the level of panel from 20 lux to 60 lux with possibility of adjustment of the light up to 10% of the maximum light designed for 110 V voltage;<br>■ Emergency lighting providing 2-9 lx illumination at the level of the panel | Full compliance | |
| 12.2.14.3. | Local lighting systems should be provided in the operator cabin:<br>■ for illumination of the train schedule at the operator workplace, panels with operational controls, desk of operator assistant ensuring illumination of at least 10 lx with smooth adjustment to 1 lx;<br>■ for illumination of the scales of instrumentation of the panel ensuring brightness of the scales with white field from 2 cd/m2 to 5 cd/m2 with smooth adjustment to not greater than 0.6 cd/m2. | Full compliance | |
| 12.2.14.4. | Operational and emergency lighting of the cabin should comprise light sources powered by 110 VDC current. The cabin should be provided with sockets for portable lamps. | Full compliance | |
| 12.3 | Machine Compartment (inside area) | - | |
| 12.3.1. | The internal structures and their dimensions, dimensions of nominal passages should be designed in accordance with GOST 12.2.056. | Full compliance | |
| 12.3.2. | The floors of the cabin and service platform should be arranged at the same level and should be flat over entire are to ensure save movement. | Full compliance | |
| 12.4 | External Equipment | - | |
| 12.4.1. | Signaling lamps on the front walls of the head car should have white and red color and should be arranged both on the right and the left side at the height of 1500...1700 mm from the rail head level with distance between them not less than 1300 mm. Two-colored (red and white light) single casing tail lamp can be designed. | Full compliance | |
| 12.4.2. | The possibility should be provided for separated switching on of the signaling lamps. | Full compliance | |
| 12.4.3. | Signaling lamps should be protected from such climate factors as freezing and internal condensation of moisture. | Full compliance | |
| 12.4.4. | Floodlight should be installed on the front part of the cabin for illumination of the track and overhead wire. The axial lighting force of the floodlight should be within the range of $(6.4\div9.6)\cdot10^5$ cd, angle of dispersion from the axis within the range of 0.1 of axial lighting force in vertical and horizontal planes not less than 3°. The switching scheme of the floodlight should ensure possibility of switching the mode "bright light" with axial force within the range of $(6.4\div9.6)\cdot10^5$ cd and "dim light" mode that produces light with force within the range of $(0.7\div1.2)\cdot10^5$ cd over the distance of 20 m from the floodlight. | Full compliance | |
| 12.4.5. | Glass that resists collision with birds should be used in the floodlight. | Full compliance | |
| 12.4.6. | The floodlight should provide easy access for adjustment in the vertical and horizontal planes and for lamp (LED module) replacement from the cabin. | Partial Compliance | Xenon technologie |
| 12.4.7. | Locomotives should be provided with pneumatic sound signal devices (whistle and tyfon) using compressed air with characteristics complying with GOST 28466 and GOST 12.2.056. The tyfon and whistle should be controlled by buttons installed on the control panel at the workplace of the operator and assistant operator and pedal linked with direct action pneumatic valve. | Full compliance | |
| 12.4.8. | Tyfons under the pressure of supplied air of 0.8 MPa should produce sound signal with main tone frequency of 360...380 Hz and sound level of 120 ± 5 dB over the distance of 5 m from the locomotive. | Full compliance | |
| 12.4.9. | Whistles under the pressure of supplied air of 0.8 MPa should produce sound signal with main tone frequency of 600...700 Hz and sound level of 105 dB over the distance of 5 m from the locomotive. | Full compliance | |
| 12.4.10. | Track cleaner. | - | |
| 12.4.10.1. | The frontal part of the cabin should be provided with track cleaner with minimum force of 150 kN (application of uniform distributed load). | Full compliance | |
| 12.4.10.2. | It should be possible to install metal brushes on the track cleaner for cleaning the track in the zone of passage of traction gear boxes. | Full compliance | |
| 12.4.11. | Red-orange fluorescent paint strip with total area of at least 1.2 $m^2$ should be provided on the front part of the cabin. | Full compliance | |
| 12.5 | Windows and doors | - | |
| 12.5.1. | Specific electric heating power should be at least 0.1 W/$cm^2$. | Full compliance | |

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| 12.5.2. | Additionally, the windscreen windows can be additionally heated by warm air from fans of heating or conditioning system. | Full compliance | |
| 12.5.3. | Automatic temperature regulators should be used for protection from possible overheating of the windows. The design of the windows and climate control equipment should ensure absence of condensate on the windshield and side windows. | Full compliance | |
| 12.5.4. | One side window of the operator cabin should open on each side, the windows should have multilayer or reinforced glass. | Full compliance | |
| 12.5.5. | The glass in the side windows of the operator cabin should have electrically heated area required to ensure visibility through the rear vision mirrors. Automatic temperature regulators should be used for protection from possible overheating of the glass. | Full compliance | |
| 12.5.6. | The closing device of the side window should tightly keep it in the closed position at all speeds of the locomotive and in case of interference of other trains. | Full compliance | |
| 12.5.7. | Windshields should be provided with wipers and washers. | Full compliance | |
| 12.5.8. | Sun screens (shutters) with possibility of securing their position at any level relative to height of the window should be provided inside the operator cabin. | Full compliance | |
| 12.5.9. | Front and side windows should keep moisture, snow and dust away from the operator cabin. Testing should be performed by sprinkling. | Full compliance | |
| 12.5.10. | The glass of the windows of the cabin of the locomotive should not distort the perception of the color of the signals adopted for color signaling in the rail road transport as per GOST 24179.<br>The transmission coefficient of the glass in visible spectrum should be at least 70 %.<br>Transparent light-–protective blue strip (molding) is possible in the upper part of the windshield and side windows with insignificant decrease of light transmission coefficient. | Full compliance | |
| 12.5.11. | Outer doors should open inside. They should be provided with locks for manual locking from the outside, open position locks. The design of the outer doors should ensure their opening from the platform or from the first step of the entrance ladder. | Full compliance | |
| 12.5.12. | The design of the locomotive should provide for possibility of entry of the locomotive crew through outer doors from high, low platforms and from earthwork. | Full compliance | |
| 12.5.13. | A device should be provided to prevent unauthorized opening of the doors. | Full compliance | |
| 12.5.14. | Impact resistance of windshield should meet requirements of GOST 12.2.056. | Full compliance | |
| 12.6 | Microclimate Control Systems | - | |
| 12.6.1. | The coolant of air conditioners should be ozone safe and should have fire and sanitary and hygienic certificates. | Full compliance | |
| 12.6.2. | Cabin microclimate system should be controlled from operator's panel. | Full compliance | |
| 12.6.3. | Operator cabin temperature sensors should be arranged so that ensure automatic maintaining of the microclimate parameters within defined limits | Full compliance | |
| 12.6.4. | Temperature of heated surfaces (arm rests, panels) in the cabins should not be greater than 45°C. | Full compliance | |
| 12.6.5. | It is necessary to provide protection from overheating and short circuits to the frame of electrical heating elements of the air heater of heating system. | Full compliance | |
| 12.6.6. | Heat transmission coefficient of enclosures (average) the cabin should not be greater than 1.5 – 1.7 W/m·K. Tightness coefficient (temperature) of the cabin should not be greater than 0.055 1/°C·h. | Full compliance | We ensure 1.7 W/m.K |
| 12.7 | Sanitary and household conditions | - | |
| 12.7.1. | Environmentally safe wash sink and toilet should be installed in the body. | Full compliance | We instal one cabinet with toilet and wash sink per locomotive. |
| 12.7.2. | The locomotive should be provided with the following facilities:<br>■ Cabinet for outwear (minimum height 1200 mm, width 450-500 mm, depth 250-400 mm) and for hand luggage of the locomotive crew with minimum size of 500x400x300;<br>■ Closet for first aid kit with medicines;<br>■ Refrigerator for food and drinks;<br>■ Microwave oven<br>■ Two ash trays<br>■ Section or place for storage of the set of electrical protection equipment;<br>■ Section or place for storage of locomotive crew PPE;<br>■ Section or place for storage of two fire extinguishers - one 6 liter powder fire extinguisher and one CO2 fire extinguisher for electrical equipment with operation rules;<br>■ Place for storage of brake shoes (manufactured as per TU-32-01124323-72-94). | Full compliance | |
| 12.8 | Signs and Marking of Equipment | - | |
| 12.8.1. | All equipment of the locomotive should be provided with nameplates or marking and stamps specified in documentation. | Full compliance | |
| 12.8.2. | Equipment should be provided with designation corresponding to its position designation in the wiring diagrams and pneumatic schemes. Fuses in addition to diagram designation should have marking indicating type and rating current of the fuse. | Full compliance | |
| 12.8.3. | Indications, technical marks and signs should be provided on the sides of the locomotive. | Full compliance | |
| 12.8.4. | Marking of electrical items should meet GOST 18620. | Full compliance | |
| 13 | HEALTH, SAFETY AND EVIRONMENT REQUIREMENTS | - | |
| 13.1 | General requirements | - | |
| 13.1.1. | Safety of locomotive crew should be ensured in all modes of operation of locomotive:<br>■ by all systems (parts, devices, etc.) of locomotive in accordance with their function including:<br>■ by onboard control systems;<br>■ Control, diagnostics and recording systems controlling condition and operation of the equipment and operator;<br>■ Reliable design of the locomotive, its systems and parts ensuring rated safety margin;<br>■ Injury-safe design of the operator cabin and service rooms;<br>■ Application of environmentally safe and fireproof materials and chemical substances in the design of the locomotive and its systems;<br>■ Special safety devices of the locomotive:<br>■ Impact energy absorbing devices;<br>■ Fire detection and fighting equipment;<br>■ Devices for evacuation of the locomotive crew, service personnel and by other appropriate organizational and technical measures. | Full compliance | |
| 13.1.2. | The locomotive should be provided with measures for protection from unauthorized actions and errors of the locomotive crew, service personnel that can result in an accident. | Full compliance | |
| 13.2 | Fire Protection | - | |

| | | | |
|---|---|---|---|
| 13.2.1. | Fire safety should be ensured by fire prevention systems, alarm and fire fighting system. Required level of safety should be maintained in accordance with GOST 12.1.004. | Full compliance | High voltage cubicle and high voltage area inside the locomotive are fitted with fire detection and extinction system. Fire detection system is based on signal sent by two electrical wires enabling electrical contact together after their insulation protection has melted. Extinction system is based on aerosol spraid. This spraid aerosol contains, weakens and finally stops the fire. |
| 13.2.1.1. | Non-flammable and not easily combustible materials with parameters specified in GOST 12.1.044 should be used in the design of the locomotive. They should have fire safety certificate and sanitary and epidemiological conclusion. | Partial Compliance | Fire protection is at the heart of our concerns. We propose GOST agreed materials or material defined according European standards material. In both cases, personal protection is ensured at best level. |
| 13.2.1.2. | The operator cabin should be separated from machine compartment by fire partition with fire endurance not less than 0.5 hour. The design of the door and door frame in the fire retarding partition wall should have the same fire endurance as the partition itself. | Full compliance | |
| 13.2.1.3. | The operator cabin should be provided with emergency exit using side window openings. To exit the emergency door the latter one should be provided with rope ladder or by lanyard. | Full compliance | |
| 13.2.2. | Electrical equipment requirements | - | |
| 13.2.2.1. | Electrical equipment should be designed for possible mechanical, electrical and thermal loads. | Full compliance | |
| 13.2.2.2. | Low voltage (up to 1000 V) DC equipment in the normal mode should have two-wire system, it should be isolated from the frame of the locomotive and should be provided with insulation resistance reduction alarm; | Full compliance | |
| 13.2.2.3. | The temperature on the surface of covers of electric heaters (heat supply) should not exceed + 60°C. Temperature on the surface of all elements of the electrical equipment and protective surfaces should have such values that prevent possibility of ignition of adjacent elements and structures. | Full compliance | |
| 13.2.2.4. | Traction motors should be provided with sensors controlling the temperature of heating of wiring and cables. Their temperature should not exceed 200°C. | Non Compliance | Non-compliant : we did not have temperature sensor ( the temperature is estimated by calculation ) |
| 13.2.3. | Fire alarm | - | |
| 13.2.3.1. | Fire alarm system should ensure guaranteed detection of the overheating and fire, alarming (optical and acoustic), display of information on the operator panel or control panel of the fire fighting system. Acoustic and optical alarm should be provided in both cabins. Fire alarm should consist of the following components: Fire detectors responding to heat/smoke and fire control and indicating device. | Full compliance | |
| 13.2.3.2. | In case of actuation of the fire alarm the signal is supplied to the operator panel ("Fire", "Fault") and for shutting the air conditioning system. | Full compliance | |
| 13.2.3.3. | Operator of the locomotive is notified after actuation of the fire detector using light and sound signal duplicated on the display of operator panel with indication of the fire location. In case of the failure of fire alarm system the detailed message about location of the fault is displayed in the operator cabin. Information about fire can be transmitted from emergency communication stations. If locomotive is staged the signal should be transmitted to depot operator by radio channel. | Full compliance | |
| 13.2.3.4. | Fire fighting should be automatic. Nonflammable gas should be used as fire extinguishing agent. | Full compliance | |
| 13.2.3.5. | Fire fighting system should support remote and automatic actuation. | Full compliance | |
| 13.2.3.6. | Fire extinguishing agent should be supplied to all fire hazardous sections of the locomotive. | Full compliance | |
| 13.2.3.7. | In case of detection of fire in the second locomotive (after actuation of the fire alarm) the system should perform fire fighting in the automatic mode. | Full compliance | |
| 13.2.3.8. | Locomotives are provided with manual fire extinguishers in accordance with Norms of equipping of the facilities and rolling stock of the Federal rail road transport by primary fire fighting equipment. | Full compliance | |
| 13.3 | Sanitary and hygienic requirements | - | |
| 13.3.1. | The design of locomotive should ensure protection of locomotive crew and service personnel from harmful and hazardous operational factors as per GOST 12.0.003. | Full compliance | |
| 13.3.2. | Control cabin microclimate | - | |
| 13.3.2.1. | The microclimate system of the cabin should include the following equipment:<br>■ Air conditioning system that performs the functions of cooling, heating and ventilation;<br>■ Warm air supply device for heating the feet of the operator and assistant operator. | Full compliance | |
| 13.3.2.2. | Air temperature in the cabin should be maintained automatically with accuracy of ±2°C with possibility of manual adjustment by ±2°C. | Full compliance | |
| 13.3.2.3. | Cabin microclimate parameters should meet requirements listed in Table 13.1. | Full compliance | |
| Table 13.1 | Cabin microclimate parameters | Full compliance | |
| 13.3.3. | Noise and vibration protection | - | |
| 13.3.3.1. | Sound level and sound pressure in operator cabin during movement of the locomotive at any speed up to maximum one and with running auxiliary equipment should not exceed values specified in table. | Full compliance | |
| 13.3.3.2. | Maximum allowable level of sound and sound pressure in cabin of locomotive is provided in table 13.2. | Full compliance | |
| Table 13.2 | Maximum allowable sound pressure | Full compliance | |
| 13.3.3.3. | Infrasonic sound levels in the operator cabin during movement of the locomotive at up to maximum speed should not exceed values specified in table 13.3. | Full compliance | |
| Table 13.3 | Infrasonic sound levels in operator cabin | Full compliance | |
| 13.3.3.4. | Vibration acceleration in cabin at the workplaces of the locomotive crew (seats) during movement of the locomotive at up to maximum speed should not exceed values of SP 2.5.1336., | Full compliance | |
| 13.3.4. | Electromagnetic radiation levels in the cabin should meet requirement of SP 2.5.1336. | Full compliance | |
| 13.3.5. | Air environment condition | - | |
| 13.3.5.1. | Maximum allowable concentrations of contaminating substances in the cabin air should not exceed concentrations as per GN 2.1.6.1338. The condition of the air is evaluated based on the concentration of carbon dioxide ($CO_2$) and products of destruction of the polymer materials in the normal conditions (with air temperature in the cabin from plus 20 to plus 40°C.).<br>The outer and recirculation air should be filtered using filters with degree of purification at least 95%. | Full compliance | |
| 13.3.6. | The level of artificial light in the operator cabin should meet OST 32.120. | Full compliance | |
| 13.4 | Health and Safety | - | |
| 13.4.1. | Safety marks in accordance with requirements of GOST 12.2.056 should be applied on the locomotive. | Full compliance | |
| 13.4.2. | Devices for locking the control buttons on the operator panel and switch of direction of the movement of the locomotive should be provided in the locomotive. | Full compliance | |
| 13.4.3 | The apparatuses, devices and equipment of the locomotive should be designed in accordance with requirements of the health and safety standards system for protection of the locomotive crew, service personnel from the impact of harmful and hazardous factors. | Full compliance | |
| 13.4.4. | Technical and organizational measures and equipment should be provided for emergency and recovery work in the of locomotive accident. | Full compliance | |

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|---|---|---|---|
| 13.4.5. | Energy absorbing devices.<br>Energy absorbing of the car in case of emergency collision should be ensured by the following design elements:<br>■ Cushioning device of the automatic coupling device;<br>■ Sacrificial area whose deformation does not affect the living space of the cabin. | Full compliance | |
| 13.4.6. | The design of the locomotive should ensure convenient and safe access of the service personnel to serviced units and devices. | Full compliance | |
| 13.4.7. | Doors, covers and dampers closing the access to separate structural elements or devices should be provided with simple and reliable quick-action locks. | Full compliance | |
| 13.4.8. | To prevent exposure of service personnel to electric shock the doors of high voltage chambers should be provided with locks that ensure safe servicing of the single locomotive and two locomotives operating as multiple unit system. | Full compliance | |
| 13.4.9. | High voltage grounding conductor with manual actuator enabled when high voltage chambers are unlocked should be used for grounding of the roof equipment. Grounding conductor with manual actuator should be used for grounding of power capacitors. Without grounding of the roof equipment and power capacitors the entrance into the high voltage chamber should be locked. One grounding conductor can be used if it combined the functions of grounding conductor of the roof equipment and grounding conductor of the power capacitors. | Full compliance | |
| 13.4.10. | To prevent exposure of the service personnel to voltage when locomotive is powered from depot mains a socket should be provided for supplying power to the coil of the contactor of the depot mains. | Full compliance | |
| 13.4.11. | To ensure correct actuation of the braking system when control tower changes a braking lock device should be provided. | Full compliance | |
| 13.4.12. | Locomotive should be started when the following conditions are met:<br>1) brake locking device of this control tower is on;<br>2) switches of the operator panel are unlocked;<br>3) reverse handle of the operator controller is set in one of the working positions. | Full compliance | |
| 13.4.13. | The locomotive should be provided with train emergency stopping devices ensuring actuation of emergency braking with simultaneous actuation of the typhoon and supply of sand under the odd wheelsets in the travel direction and stopping of sanding when speed is less than 10 km/h. | Full compliance | |
| 13.4.14. | The locomotive should be equipped with:<br>■ One grounding rod for grounding of the overhead wire;<br>■ Dielectric mats and gloves. | Full compliance | |
| 13.5 | Environment Safety and Disposal | Full compliance | |
| 13.5.1. | The level of external noise when locomotive travels at speed equal to 2/3 of the design speed should not exceed 84 dBA – on continuous welded rails and 87 dBA on jointed tracks. | Full compliance | External noise at a speed of 80 kph is lower than 84 dBA on a continuous welded rail and 87 dBA on a jointed track at the 25 m distance from the center line of a track and at the height of 1,6 m above top of rail. |
| 13.5.2. | Facing, decoration and other materials should used in locomotive should prevent accumulation of dirt and allow for easy cleaning and hygienic treatment. | Full compliance | |
| 14 | RELIABILITY AND AVAILABILITY REQUIREMENTS | - | |
| 14.1 | General requirements | - | |
| 14.1.1 | The technical condition of the equipment of locomotive that is related to operation safety and current maintenance of this equipment should be organized and performed in such manner so that the locomotive is operated in standard mode and under such conditions which are specified in the operation requirements. | Full compliance | |
| 14.1.2 | The design of the critical equipment of the locomotive including undercarriage, electrical equipment, braking system and control system should be realized so that in case of partial failure or fault the train will be able to continue to move without damage of the equipment which should retain complete functionality. | Full compliance | |
| 14.1.3 | All faults which can be repaired during scheduled entry of the locomotive in the depot or maintenance centers are considered as failures of the third type and are not statistically recorded. Any downtime of the rolling stock for repair of faults with maximum duration of up to 60 minutes in addition to maintenance normative time established by the rail road is considered as the scheduled entry of the locomotive into the depot or maintenance centers. | Full compliance | |
| 14.1.4 | When the locomotive is operated by the Customer the faults and repair time is not recorded in the following cases:<br>- Contingent faults caused by the other faults; - faults caused by the external factors;<br>- Faults caused by violation of the operational manual, maintenance and repair manual requirements by service personnel; - single faults the cause of which is not identified;<br>- Faults caused by factors eliminated during retrofitting. | Full compliance | |
| 14.1.5 | In case of the signatures of the faults of the second and third type at the same time the fault is qualified only based on one type of faults. Specific type of failure is determined based on results of investigation. | Full compliance | |
| 14.1.6 | The signature of the fault of the second type is failure of the locomotive that resulted in the delay of the train between the stations at least on one of the tracks or stations above the time defined by the established operation schedule by one hour and more. | Full compliance | |
| 14.1.7 | The signature of the fault of the third type is fault of the locomotive resulting in the downtime of the locomotive in the depot or in the bay of the maintenance center for repair of the fault of over 60 min from the established time limit for scheduled maintenance. | Full compliance | |
| 14.1.8 | The reliability of locomotive in case of full maintenance (service) servicing by Manufacturer or organization authorized by the Manufacturer should be characterized by the following parameters:<br>- Mean time between failures of the second type - maximum 3.0 events per 1 mln. km;<br>- Mean time between failures of the third type - maximum 16 events per 1 mln. km. | Full compliance | |

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| 14.1.9 | Coefficient of availability (internal availability) is defined as the probability of the fact the locomotive will be operational at any time except scheduled period during which it is not used in accordance with designed purpose – scheduled maintenance and repairs, reserve, standby, waiting for operation or repair, transfer, etc. (OST 32.46-95).<br>Operational time of the locomotive is determined by equation<br>ТРС=ТФ - ТОТ<br>Where:<br>Трс – total operational time of the locomotive in the considered period of operation;<br>ТФ - locomotive working time fund;<br>Тот – total time during which the locomotive is not operational due to unscheduled repairs caused by failures of defined types through the Manufacturer's fault in the considered period of operation without taking into account the time of transfer of the locomotive, downtime waiting for repair and components of maintenance and repair downtime attributable to organizational delays not depending on the Manufacturer.<br>Internal availability coefficient is calculated using the following equation:<br>Кит = Трс/(Трс+Тот)<br>In case of the compliance with requirements specified in locomotive operational manual the availability coefficient (internal availability) of locomotive should be not less than 0.96. | Full compliance | |
| 14.1.10 | Availability coefficient in accordance with OST 32.46 is defined as the ratio of expected value of total time of locomotive in the operational condition within certain period of operation to expected value of total time of locomotive in the operation condition and downtime caused by maintenance and repair within the same period.<br>Operational time of the locomotive is determined by equation:<br>ТРС=ТФ - ТПЛ<br>Where:<br>ТРС - – total operational time of the locomotive in the considered period of operation;<br>ТФ - locomotive working time fund;<br>ТПЛ - total time during which the locomotive is not operational due to scheduled and preventive maintenance and repairs in the considered period of operation without taking into account time of transfer of the locomotive, downtime waiting for repair and components of maintenance and repair downtime attributable to organizational delays not depending on the Manufacturer.<br>Availability coefficient is calculated using the following equation:<br>Кгт=Трс / Трс+Тпл<br>In case of the compliance with requirements specified in locomotive operational manual the availability coefficient of locomotive should be not less than 0.95. | Full compliance | |
| 14.2 | Maintainability. | - | |
| 14.2.1 | General design layout and arrangement of equipment of locomotive should ensure quick localization of faults and their repair. The design of all structural elements should ensure easy access, suitability for replacement without removal of neighbour (adjacent) components and convenience of evacuation of equipment that requires repair and delivery of repaired equipment. Components subject to frequent maintenance should be replaceable without removal of entire part. Replacement of components with low failure probability should be performed without preliminary disassembly. | Full compliance | |
| 14.2.2 | All structural elements (mechanical, electrical, pneumatic and other systems) should be designed with maximum application of the modular principle. The arrangement of these modules on the locomotive, the design of their attachment and connection with electrical cable and air ducts should ensure possibility of maximum fast speed of replacement of all modules. Modules with weight exceeding 20 kg should be provided with fittings for strapping using lifting mechanisms. Devices embedded into the module that required repair or maintenance should be easily accessible and replaceable. | Full compliance | |
| 14.2.3 | All low voltage protection devices (for example, fuses, circuit breakers) and information and testing error memory connectors should be arranged in the low voltage cabinets above the floor level with easy access. | Full compliance | |
| 14.2.4 | The convenience of the inspection of the undercarriage of locomotive and its equipment should be ensured. | Full compliance | |
| 14.2.5 | The possibility should be provided for connection of the supply line of the depot with compressed air to locomotive, connection of external power supply. | Full compliance | |
| 14.2.6 | Doors, covers and dampers closing the access to separate structural elements or devices should be provided with simple and reliable quick-action locks. The access to high voltage elements should be limited by special locks. | Full compliance | |
| 14.2.7 | The lists of scheduled work (operations) to be performed during maintenance and repair of each type, lists of structural members exposed to wear with indication of discarding parameters of structural members and number of lubrication points as well as the frequency of lubrication and consumption rate should be provided in Operational Manual. | Full compliance | |
| 15. | MAINTENANCE AND ROUTINE REPAIR | - | |
| 15.1 | General requirements | - | |
| 15.1.1 | Frequency of repairs of locomotive and its assembly units should correspond to the travelled distance specified in Table 15.1. | Full compliance | |
| Table 15.1 | Frequency of maintenance and repairs | Full compliance | |
| 15.1.2 | Based on results of test operation the frequency and scope of maintenance and repairs recommended by the Developer should be updated (by Developer jointly with Customer) depending on actual operating condition, monitoring of condition and repair of locomotives. | Full compliance | |
| 15.1.3 | In case of compliance with the system of regular maintenance and routine repairs in accordance with Table 15.1, the locomotive should retain its characteristics during entire service life until it is written down. Service life of locomotive is at least 40 years from the date of commissioning (without prolonged staging in preserved condition) or 8,000,000 km or run depending on what is earlier. | Full compliance | |
| 16. | TECHNICAL DOCUMENTATION REQUIREMENTS :<br>Requirements for Technical Documentation delivered with locomotive are to be agreed at the stage of signing of the Supply Contract (Agreement). | - | |
| 16.1 | General requirements | - | |
| | Operational documentation should provide lists of instruments for measurement and monitoring parameters of locomotive and its systems and respective metrological support sections. | Full compliance | |
| | When locomotives are delivered it is necessary to provide equipment and methodologies for calibration of instruments provided by the design and additional electronic and diagnostics equipment. | Full compliance | |
| 16.2 | Supply Package | - | |
| 16.2.1 | Developer provides the following technical and validation documentation:<br>- Software documentation – 2 recorded copies;<br>- Operational documentation (GOST 2.601) - 2 set for each locomotive;<br>- Documentation for equipment and appliances for maintenance and repair.<br>- Acceptance and operational testing methodology agreed with the customer. | Full compliance | |

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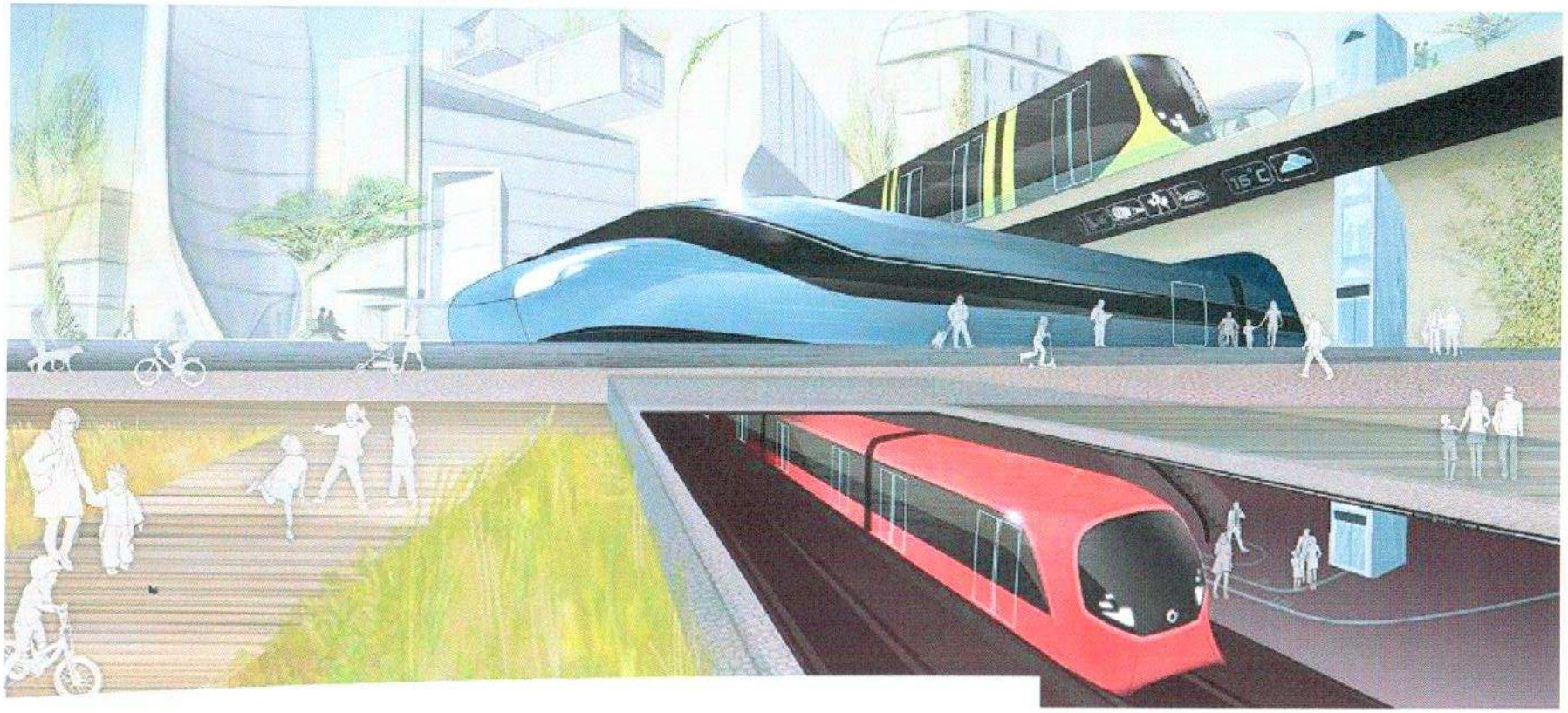
| 16.2.2 | Developer in case of designing and development of a new locomotive additionally should provide the following technical documentation and validation documents:<br>- Calculation confirming selected technical concepts – in two copies;<br>- Reports of bench and preliminary factory tests of locomotive and its components – 2 copies;<br>- Reports of standard tests;<br>- Design documentation (GOST 2.004) – 2 recorded copies;<br>- Chimmology map (with breakdown of chemical composition); | Full compliance | |
| 16.3 | Forms of documents | - | |
| 16.3.1 | All documentation should be provided in paper form in the specified number of copies and in the electronic form for application in the automated computer systems for documentation storage. Paper format - for text documents A4, for drawings - A0-A4. Electronic format for text documents and schematic design - Microsoft Word (version 10 or later) or Adobe Acrobat (version 5 or later), for drawings - Autocad (version 12 or later) and Adobe Acrobat. | Full compliance | |
| 16.3.2 | All documents should have a unique digital identifier. Appropriate indices should be provided enable search for required information in the documents. | Full compliance | |
| 16.2.4 | All supplied electronic documentation should not have protection from copying. | Full compliance | |
| 17 | STAGES AND PHASES OF DEVELOPMENT ACCEPTANCE PROCEDURE (pertains to newly designed locomotive) | - | |
| 17.1 | Development of locomotive should be performed in accordance with GOST R 15.201, OST 32.181 (application of EN 50126 is also recommended) and should comprise the following stages:<br>- development of terms of reference;<br>- Development of schematic design (technical offer);<br>- Development of technical design;<br>- Development of sample components and their type and acceptance testing;<br>- Developed of detailed design (design documentation);<br>- Fabrication of pilot locomotive;<br>- Training of repair and operational personnel at the stage of installation of equipment;<br>- Preliminary testing including supervised test run of 5000 km;<br>- Development of draft technical specifications, repair and operational documentation;<br>- Acceptance and certification testing;<br>- Operational testing. | Partial Compliance | Development process is based on Alstom internal procedures (IRIS "International Railway Industry Standard" certified) |
| 17.2 | Performance and acceptance of the stages of designing work should meet requirements of GOST 15.201, OST 32.181. | Full compliance | |
| 17.3 | Developer should provide the Customer upon its request the calculation, reports, protocols of tests and other documentation confirming fulfillment of defined requirements at all stages of designing and development of the locomotive. Customer and its authorized representative are entitled to participate in all types of tests and to monitor the justification of the accepted technical concepts. | Full compliance | |
| 17.4 | Locomotive should have Certificate of Conformity and Sanitary and Epidemiological Conclusion. Certificate of Conformity of the form established by single safety norms should be issued by an authority listed in the Register of organizations recognized by the Railroad Transport Board of the participants of the Commonwealth certified for evaluation of the conformance of the railroad products. | Full compliance | |
| 17.5 | Locomotive should meet all requirements of NB ZhT TsT 04-98. Certification testing is performed in accordance with standard methods. | Full compliance | |
| 17.6 | Full scope of certification testing is determined by the list of parts and equipment subject to mandatory certification. Developer and Manufacturer of the locomotive and its accessories should ensure that Customer or its authorized representative can check the progress of work, control the quality of the product and compliance with manufacturing technology at all stages of production, testing or components and entire locomotive. | Full compliance | |



*Concevoir la fluidité

Georgian Freight E-Locomotive

February 2016

# PRIMA GO8A "1520" 3 kV 2x(BoBo)

## Overall presentation

**BAD0003824441_A0**

ALSTOM

*Designing fluidity*

# CIS Locomotives program

| | FREIGHT | PASSENGER |
|---|---|---|
| | BoBo - BoBo | BoBo |
| KAZAKHSTAN |  **KZ8A**<br>▪ Customer: KTZ (Kazakh Railways)<br>▪ Quantity: 200 locomotives<br>▪ Assembly : 25 in France / 175 in Kazakhstan (EKZ)<br>▪ in operation |  **KZ4AT**<br>▪ Customer: KTZ (Kazakh Railways)<br>▪ Quantity: 95 locomotives<br>▪ Assembly : 20 in France / 75 in Kazakhstan (EKZ)<br>▪ in operation |
| AZERBAIJAN |  **AZ8A**<br>▪ Customer: ADY (Azerbaijan Railways)<br>▪ Quantity: 40 locomotives<br>▪ Assembly : in Kazakhstan (EKZ)<br>▪ Commercial service: about mid 2017 |  **AZ4A**<br>**OPPORTUNITY:**<br>▪ Customer: ADY (Azerbaijan Railways)<br>▪ Quantity: 10 locomotives |

# Гамма электровозов СНГ

| | ГРУЗОВОЙ | ПАССАЖИРСКИЙ |
|---|---|---|
| | **BoBo – BoBo (8-ОСНЫЙ)** | **BoBo (4-ОСНЫЙ )** |
| КАЗАХСТАН |  **KZ8A**<br>▪ Заказчик: КТЖ (Казахстанские железные дороги)<br>▪ Количество: 200 электровозов<br>▪ Сборка: 25 во Франции / 175 в Казахстане (ЭКЗ)<br>▪ в эксплуатации |  **KZ4AT**<br>▪ Заказчик: КТЖ (Казахстанские железные дороги)<br>▪ Количество: 95 электровозов<br>▪ Сборка: 20 во Франции / 75 в Казахстане (ЭКЗ)<br>▪ в эксплуатации |
| АЗЕРБАЙДЖАН |  **AZ8A**<br>▪ Заказчик: АЖД (Азербайджанские Железные Дороги)<br>▪ Количество: 50 электровозов<br>▪ Сборка: в Казахстане (ЭКЗ)<br>▪ Коммерческая эксплуатация: приблизит. середина 2017 г. |  **AZ4A**<br>**ПОТЕНЦИАЛЬНАЯ ВОЗМОЖНОСТЬ:**<br>▪ Заказчик: АЖД (Азербайджанские Железные Дороги)<br>▪ Количество: 10 электровозов |

# Agenda / Содержание

- Locomotive overview / Общий обзор электровоза
- Locomotive Gauge / Габарит электровоза
- Locomotive fitting elements / Монтажные элементы электровоза
- Locomotive cab arrangement / Компоновка кабины электровоза
- Carbody and passive safety / Кузов и пассивная безопасность
- Locomotive coupler / Автосцепка электровоза
- Bogie / Тележка
- Electrical traction and braking performances / Характеристики электротяги / торможения





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# Agenda / Содержание

- Electrical concept / Концепция электрооборудования
- Travelling across the borders / Пересечение границ государств
- Adaptation to climatic conditions / Адаптация к климатическим условиям
- Safety / signalling devices / Безопасность / Система сигнализации
- Locomotive Control System !/ Система Управления Локомотивом
- Design for Serviceability / Maintainability / Ремонтопригодность и удобство обслуживания
- Options / Варианты





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# Locomotive presentation

## Overall

| | |
|---|---|
| Architecture | 2x(BoBo) |
| Steel made carbody with flat shaped side walls | |
| Inductance tank fitted under carbody | |
| Automatic coupler | |
| Air intake on the roof sides | |

## Bogie

| | |
|---|---|
| Min. curve radius | 125 m (up to 10 km/h)<br>250 m (on line) |
| Bogie wheel base | 2600 mm |
| New wheel diameter | 1250 mm |
| Worn wheel diameter | 1150 mm |
| Traction motor | Nose suspended |

## Technical characteristics

| | |
|---|---|
| Rail gauge | 1520 mm |
| Catenary | 3 kV |
| Loading gauge | GOST 9238-83 1-T |
| Total length | 2 x 17 500 mm |
| Distance between pivot | 8 500 mm |
| Overall height | 5 290 mm |
| Weight | 2 x 100 t |
| Temperature range | -40°C / + 40°C |





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# Презентация локомотива

**Основные технические характеристики**

Осевая формула 2x(BoBo)

Стальной кузов с плоскими боковыми стенками.

Блок дросселей установлен под кузов.

Автосцепка.

Воздухозаборник по бокам крыши.

**Тележка**

| | |
|---|---|
| Мин радиус кривой | 125 м (до 10 км/ч)<br>250 м (на линии) |
| Колесная база тележки | 2600 мм |
| Новый диметр колеса | 1250 мм |
| Диаметр износа колеса | 1150 мм |
| Тяговый двигатель | носовая подвеска |

**Технические характеристики**

| | |
|---|---|
| Ширина колеи | 1520 мм |
| Контактная сеть | 3 кВт |
| Габарит | ГОСТ 9238-83 1-Т |
| Полная длина | 2 x 17 500 мм |
| Расстояние между осями | 8 500 мм |
| Полная высота | 5 290 мм |
| Вес | 2 x 100 t |
| Диапазон рабочих температур | -40°C / + 40°C |





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