

1 Introduction

1.1 Purpose

"The scope of this document is to define the requirements and performances for the Front Coupler (FC)/ Automatic Coupler (AC) and Semi-Permanent Coupler (SPB) for AS300.

The Supplier will answer with a Clause by Clause (CbC) to the list putting in evidence the differences and any technical/ cost impact derived from the respect of these additional/ new requirements.

Any non-compliance shall be assessed on a 'case by case' basis.

Supplier is responsible to obtain homologation and certification for the scope of supply represented by this document."

This document is a Technical Product Specification (TPS) Version 1

1.2 Definitions, acronyms, and abbreviations

"AT Alstom Transport

BOM Bill Of Material

BSL Baseline

CI Configuration Item

CM Corrective Maintenance

CMP Configuration Management Plan

Config Configuration

CONQ Cost Of Non Quality

CR Change Request

DIN Deutsches Institut für Normung

DR Design Review

EBOM Engineering BOM

ECP Engineering Change Proposal

FAI First Article Inspection

FEI First Equipment Installation

HL Hazard Log

IP Ingress Protection

IPC Illustrated Parts Catalogue

LCA Life Cycle Assessment

LCC Life Cycle Cost

LRU Line Replaceable Unit

FMECA Failure Mode Effects and Criticality Analysis

FPMH Failures Per Million Hours

"

"FTA Fault Tree Analysis

Mgmt Management

MSDS Material Safety Data Sheet

NA Not Applicable

OMP Obsolescence Management Plan
PBOM Production BOM
PHA Preliminary Hazard Analysis+C83
PIC Person In Charge (of a specific activity/task/responsibility)
PM Preventive Maintenance
PRM Persons with Reduced Mobility
QR Code Quick Response Code
RAMS Reliability Availability Maintainability Safety
REACH Registration, Evaluation and Authorisation of Chemicals
RNC Rapporto di Non Conformità
RS Rolling Stock
RSC Rolling Stock & Components
SAF Supplier Alteration Form
SCMP Software Configuration Management Plan
SIL Safety Integrity Level
SMHA Systems and Maintenance Hazard analysis
SPL Spare Parts List
SPQD Supplier Product Quality Development
SQAP Software Quality Assurance Plan
SRIL Safety Related Items List
STL Special Tools List
TBC To Be Confirmed <PIC>
TBDL To Be Defined Later
TSI Technical Specification for Interoperability
UIC Union Internationale des Chemins de fer or international union of railways
VPLM Virtual Product Lifecycle Management"

1.3 References

1.3.1 Applicable directives/laws

TSI Loc&Pass: 2020

1.3.2 Applicable standards

EN 45545-2:2013+A1:2015.: Railway applications - Fire protection on railway vehicles - Part 2: Requirements for fire behaviour of materials and components

1.3.3 Applicable Alstom Documents

"DTRF150900 "General Engineering Conditions with Supplier"

NOTA: CbC to DTRF is not in the scope of this document but central agreement between supplier and AT"

1.3.4 Other stakeholder references

2 Overall description

"Name of platform: Pendolino

PROJECT: AS300

Operation country: Italy

First Delivery / Delivery rate: July 2025

Production rate (cars /month): 2

Delivery location: SAV

Number of trains (basic): 12

Number of trains (option): 8"

2.1 Scope of supply

Front/ Automatic Coupler: According to configuration

Front cover: N.A.

Intermediate/ Semi-Permanent Bar coupler: According to configuration

2.2 Sub-System variants and options

System shall be compliant to TSI Loc&Pass: 2023 like option (preferred)

2.3 Mission and Route Profiles

"Average annual journey per rolling stock [km]: 630.000

Useful life train [years]: 30

Maximum commercial service for day [hours]: 20"

Interoperability component (in term of the European TSI): Yes

2.4 Operational Information

Number of trainsets / MU: 2

Railway track width: 1435 mm

Maximum travelling speed: 300 km/h (+10%)

Service brake available deceleration (dry):

Max requirement deceleration (100 % EB = TSI):

Minimum requirement deceleration:

Emergency brake equivalent deceleration:

Average acceleration in service:

2.5 Climatic Condition

The train shall meet the requirements without affecting the integrity and operation of the train for snow, ice and hail defined by SR EN 50125-1.

"All forms in which snow may fall shall be taken into consideration, including their effects when trains are parked.

The maximum hail diameter is deemed to be 15 mm."

"Temperature range:

In accordance with the §4.3 EN 50125-1

Class T3 (-25°C to + 45°C)"

"Relative humidity:

According to EN 50125, the following external humidity levels shall be assumed:

- yearly average: ≤ 75 % relative humidity;
- on 30 days in the year continuously: between 75 % and 95 % relative humidity;
- on the other days occasionally: between 95 % and 100 % relative humidity;
- maximum absolute humidity: 30 g/m³ occurring in tunnels."

"Rain:

In accordance with the §4.6 EN 50125-1

Maximum 6 mm/minute"

"Solar radiation:

In accordance with the §4.9 EN 50125-1: Class R2"

"Altitude range:

In accordance with the §4.2 EN 50125-1

Class A1 (up to 1400m)"

"Wind:

In accordance with the §4.5.1 EN 50125-1"

"Snow and hail:

In accordance with the §4.7 EN 50125-1

Snow level above iron level: Class S1

Maximum hail grain diameter of 15 mm"

"Ice:

In accordo con il §4.8 EN 50125-1"

"Surrounding air:

In accordance with the §4.5.2 EN 50125-1"

"Lightning:

In accordance to the §4.10 EN 50125-1"

"Large animals on rails:

In accordance with the §4.12 EN 50125-1"

"Pollution:

In accordance with the §4.11 EN 50125-1"

2.6 Train Characteristics

2.6.1 Train configuration

"7 cars configuration

1 Front coupler

2 Articulation

3 Intermediate coupler - Semi Permanent Coupler"

2.6.2 Mass of coaches

The Mass Distribution Analysis was performed according to the load conditions defined by EN 15663 2017+A1-2018 in accordance with the TSI LOC&PAS in force.

Reference AXD1003232755_AS300-Italo_Mass_Analysis_Results_R00_31-10-2023

The weight of train to be considered, for both trains, for energy absorption calculation/simulation shall be as 426279 kg in Working Load (MVD) (only with staff) and 467799 kg in Normal Load (MND) (also with all passengers seating with luggage each one (80 kg/person with luggage included))

3 To ensure Sub-System Capabilities

3.1 Front Coupler

The front coupler is the coupler located at the front of the train on each of its end vehicles that enables the push/ pull operation in multiple configuration of train sets and rail vehicles to couple automatically at low speed without manual assistance and results in a rigid, slack free and fully latched connection.

The uncoupling of the mechanism head is accomplished either remotely from driver's cab or at the coupler itself using manual release. Once the rail vehicles have moved apart, the couplers are automatically reset and ready to be coupled again

The automatic coupler shall made up of:

Coupler head with mechanical coupling and uncoupling devices

"An absorption energy device

"

"One pneumatically controlled uncoupling device (including hose interface)

"

"A mechanical device for axis centring

"

A device to hold the automatic coupler on the horizontal and to adjust the coupling height

The electrical and pneumatic linking system

Manual uncoupling control

One pneumatic coupler for brake pipe (including hose interface)

One pneumatic coupler for main pipe (including hose interface)

One automatic electrical coupler fitted above the mechanical coupling head

"All electrical links

- Electrical Head

- Contact Pins

- Plug Interface

- Connectors"

The coupling device shall ensure the continuity of the main and brake pipes between units during normal commercial service

In the event of accidental breakage of the coupling, the braking of trainset shall be automatically guaranteed by exhaust of the brake pipe circuit.

The coupler shall be able to operate normally with regard to the flow of air and control if the air dryer has broken down or is not working. In the same conditions, it shall be able to withstand impurities propagated in the pneumatic circuit by oil used by the compressors

For the colouring of the ducts, the following convention shall be observed: red for general, yellow for main.

Units and end coupling-systems shall be designed so that staff is not exposed to undue risk during coupling and uncoupling, or rescue operations, as requested in TSI LOC PAS clause 4.2.2.2.5.

A manual coupling system shall be provided, based on the UIC type (as described in clauses 4.2.2.2.3, of the TSI LocPas, and 5.3.2 (not applicable), of the TSI LocPas).

3.1.1 Allocated Weight

Allocated weight (all included): ≤ 620 kg

3.1.2 Pivoting Angles

Horizontal: $\text{Min} \pm 19.4^\circ$

Vertical: $\text{Min} \pm 9.6^\circ$

Rotation around coupler axis: $\text{Min} \pm 3^\circ$

Minimum curve radius when traveling: 150 m

Minimum curve radius in production site and depot: 100 m

Maximum slope: 40 ‰

Maximum lateral acceleration: 1 m/s^2

Maximum railway cant: 6°

3.1.3 Allocated Volume

Allocated Volume Reference: AXD1003231123

3.1.4 Mechanical resistance

Yield stress in traction/ draft: 1000 kN

Yield stress in compression/ buff: 1500 kN

3.1.5 Coupler head

"Automatic coupling operation

UIC Type 10"

Uncoupling device in normal mode: Automatic

EN 16019: 2014

3.1.6 Electrical head

Presence: Yes

Position: Top mounted

Type of drive: Pneumatic

Tightness (in all service condition, in all rescue and emergency condition and in according to "Climatic condition"): At least IP55 (coupled)/ IP54 (uncoupled)

Number of pin/ sleeve contacts: 2x101 contacts (101 male and 101 female contacts)

Type of contact: To be proposed by the supplier

Number of plug: 4

Number of network connectors (100 Mb): 1x1 Ethernet (ETH) connectors

"Number of network connectors (1Gbit):2x2 ETH connectors 1Gbps

"

"

"

Type of ETH connectors: To be proposed by the supplier

Supply of cabling and connectors to carbody

Contact replacement: It shall be possible to modify or replace all the contacts from the front without having to open the connector and without obstructing one another

"Voltage and current:

Nominal voltage: 24Vdc,

Minimum current: 10mA,

Maximum current : 2A

Minimum voltage : < 10 Vdc"

"Heating and protection:

The electric head shall be fitted in order to protect people from electrical shocks and pins sleeve from the water and dirty ingress. To avoid moisture accumulation inside the electric head an heating device shall be provided; the supplier shall define the switch on temperature!"

"The electrical head of the automatic coupler shall allow the implementation of the following principle scheme (Low Voltage 24 V DC), to detect the presence of another unit electrically coupled.

In particular, the coupler shall realize the indicated electrical bridge between female pins X and Y in the scheme, to guarantee readback of coupled unit presence by the other unit."

"

"

3.1.7 Pneumatic

Uncouple Pipe (UP)

Main reservoir pipe (MRP)

Brake pipe (BP)

Uncouple Pipe (UP): ISO8434-1 – L12 (M18x1,5) interface

Pipe socket for BP and MRP: ISO8434-1 – L28 (M36x2) interface

3.1.8 Energy absorption devices

3.1.8.1 Reversible Energy absorption

Maximum stroke draft: 5 mm

Maximum stroke buff: supplier shall propose the minimum value, ≤ 100 mm, according to coupling simulation scenario and safety tolerance from non reversible energy absorption

Full stroke indicator

Maximum dynamic force with tolerance: According to coupling simulations

3.1.8.2 Non Reversible Energy absorption

Deformation tube

Position: Rear mounted

"Stroke : 1400 mm

To be proposed by supplier"

Initiation indicator

Minimum energy absorption : According to coupling simulations

Nominal dynamic force (buff/ draft): 1500/1000 kN

Maximum Dynamic force: According to coupling simulations

Spherical Rubber Anchor with deformation tube : To be proposed by supplier

3.1.9 Draft Gear

Height adjustment device

Centring device

3.1.10 Protection

"Heatings and special protection: To be proposed by the supplier

See § 3.1.6 (S30-01.RSTPS 107)"

"Earthing

See § 5.2"

"Earthing between Coupler and Carbodyshell

2 threaded holes on welded grounding studs"

"Earthing between Coupler and Carbodyshell

2xM12 threaded holes"

"Earthing connections

The grounding connection zone shall be not painted and treated with high conductive and low oxidation finishing in compliancy with the metallic surface used."

"Earthing between Coupler and Carbodyshell (in scope of supply)

At least 1 link of 100mm² minimum, identified with a green/yellow shrinkable label on each extremity"

"Earthing between Earthing between Coupler and Carbodyshell (in scope of supply)

2 links of 50mm² minimum, identified with a green/yellow shrinkable label on each extremity"

Location of coupler / rail level: The possibility of coupling the vehicle with the driving - crashing – hook towing system shall be at 1025 +15mm/ -5mm from the rail upper level (RUL)

Automatic centering device: Mechanical

Automatic centering deactivation system: No

Vertical support

3.1.11 Coupling Simulations

"The coupling allows connections of type:

- mechanical (motor transmission) with mechanical head;
- electrical (transmission of monitoring and control signals) with electric head;
- pneumatical (continuity of the main and supply air lines) with pneumatic connections."

"In the scenario, the type of connection:

- between two trainsets with the same AC is mechanical, pneumatical and electrical coupling,
- between two trainsets with the AC Type 10 is mechanical and pneumatical coupling,
- between loco and trainset is mechanical and pneumatical coupling."

The result of the coupling is a rigid and locked connection between two trainsets without any speed limitation or between trainset and rescue vehicle with speed limitation to 100km/h

The coupling shall accomplish at low speed (maximum 5km/h, nominal 2km/h) without manual assistance and in safety condition

Uncoupling shall accomplish by activating the automatic coupler uncoupling mechanism, either manually or by remote uncoupling

3.1.12 Outputs

Force-stroke curve for each reversible absorption device

Maximum force at each interface

Energy absorbed at each interface

Maximum stroke at each interface

Maximum acceleration/ deceleration at each interface

Maximum jerk at each interface

Maximum displacement for each coaches

Coupling simulation between trains

"Coupling simulation between loco (80000kg) and train for this track conditions:

-Straight

-Slope

For slope condition graph that correlates:

In X - The limit mass of the rescue trainsets beyond which the locomotive and the train (rescued and braked released) is sliding down from the hill,

In Y - Slope of hill expressed in % or in angular degrees"

"Loco G2000

Coupler compliant to EN 15566"

"

"

3.2 Semi-Permanent Coupler

The intermediate coupler is the semi-permanent coupler between two rail vehicles that enables the push/ pull operation of the intermediate cars of train sets

The intermediate coupler is composed by two semi-permanent couplers

Inner couplings between the different vehicles (fully supported by their own wheels) of a unit shall incorporate a system capable of withstanding the forces due to the intended operating conditions.

3.2.1 Allocated Weight

Allocated weight: ≤ 520 kg

3.2.2 To respect Dimensions

Distance flange to flange: refer to the allocated volume (§3.2.4) 3167 mm

Interpivot distance: refer to the allocated volume (§3.2.4) 2887 mm

Semi Permanent Coupler must consist of two symmetric halves

Semi Permanent Coupler shall have identical mechanical interface to the carbody

Link between parts: Socket joints with guide cone

Maximum number of disassembly and reassembly operations: 6 time/ year

3.2.3 Pivoting Angles

Horizontal: $\text{Min} \pm 18.5^\circ$

Vertical: $\text{Min} \pm 7.5^\circ$

Roll: $\text{Min} \pm 3^\circ$

3.2.4 Allocated Volume

Allocated Volume Reference: AXD1003242463

3.2.5 Mechanical resistance

Yield stress in traction/ draft: 1000 kN

Yield stress in compression/ buff: 1500 kN

Maximum compression strength: 1800kN

3.2.6 Electrical

Earthing

"Earthing between both half semi-permanent couplers (in scope of supply)

At least 1 link of 100mm² minimum, identified with a green/yellow shrinkable label on each extremity"

"Earthing between both half semi-permanent couplers (in scope of supply)

2 links of 50mm² minimum, identified with a green/yellow shrinkable label on each extremity"

"Earthing between Coupler and Carbodyshell

2 threaded holes on welded grounding studs"

"Earthing between Coupler and Carbodyshell

2xM12 threaded holes"

"Earthing connections

The grounding connection zone shall be not painted and treated with high conductive and low oxidation finishing in compliancy with the metallic surface used."

Cable support

3.2.7 Support for Gangway

Support for gangway

Gangway mass loaded: 550 Kg (TBC)

3.2.8 Energy absorption devices

3.2.8.1 Reversible Energy absorption

Energy absorption level: According to bumping simulations

Maximum stroke: supplier shall propose the minimum value, ≤ 20 mm, according to coupling simulation scenario

"Maximum Dynamic force: 800 kN

To be proposed by supplier"

3.2.9 Non Reversible Energy absorption

Type: Collapsible element

"StrokeForce:

1 level

Stroke: 200 mm

Force 1300 kN

2 level

Stroke: 600 mm

Force 1800 kN

Transition 50mm

To be proposed by supplier"

Total stroke (reversible + Non Reversible Energy) in full crash scenario shall be 950mm

"Total energy absorption: $\geq 1050 - 5\%$ kJ

To be proposed by supplier"

"Deformation force: $1500 \pm 112,5$ kN

To be proposed by supplier"

3.2.10 Draft Gear

Temporary Vertical support

4 To respect Interfaces with Train and other Systems

4.1 To respect Dimensions

Distance from mating face to pivot (mm): 1840 mm

Distance from pivot to mounting face (mm): 140 mm

Distance from mounting face to mating face: 1980 mm

Distance from mating face to first cabine element (mm): 352,199 mm

Distance from mating face to crash absorber retract (1/3 C.A. lenght) (mm): 1804.154 mm

Distance available behind the coupler (mm): 2811.998 mm

Head car geometry

4.2 To respect Mechanical interfaces

4.2.1 Front Coupler Interface

Mounting interface measures: $\leq 450 \times \leq 400$ mm

Hole pattern: $4 * M30, \leq 420 \times \leq 220$ mm

Diameter of the hole on the carbody shell where to insert the deformation tube is 300 mm

Complete coupler stroke, including reversible, irreversible and release / shear-off stroke, to the end of the deformation stroke up to the force level of $F = 0$ kN shall be 1704 mm

4.2.2 Semi-Permanent Coupler Interface

"Mechanical interface of the Semi-Permanent Coupler

"

Hole pattern: Refer to allocated volume (§3.2.4) $4 * \varnothing 32, < 500 \times < 335$ mm

Mounting Interface: $< 600 \times < 335$ mm

5 Transverse Requirements

5.1 To respect Aerodynamics, Gauge and Infrastructure Constraints

5.2 To respect Electrical Rules

The supplier shall deliver the internal and inteface wiring diagrams with all the required components (wires, connectors, terminal boards, terminals, relays, mechanical parts and characteristics of protections if present) and all the interface connections (pin positions, connector names). The

schematics shall be designed in compliance to EN61082 and the symbols shall be compliant with IEC 81346, IEC 60617, IEC 61082, IEC 61355-1. Each device shall be named and its function shall be explained.

"The following Alstom norms have to be applied for electrical design:

DTR0000282507 - PPL Protection equipments

DTR0000268707 - PPL Cables

DTR0000281179 - PPL Terminals-Clip-End piece

DTR0000254610 - PPL connectors

DTR0000282508 - PPL Relays / Contactors

DTR0000275236 - PPL Wiring accessories and Conduits

DTR0000263907 - PPL Cable Gland

DTR0000282509 - PPL Terminal blocks

DTR0000282502 - PPL Commutators and push button

DTR0000281698 - PPL Heat shrinkable

DTR0000282493 - PPL Attaching system

DTR0000507917 - PPL Grounding"

The supplier shall deliver an architecture schematic that allows AT to understand all the functions and the interfaces of the system (internal and external), including internal protections. Each device shall be named, the size and the function shall be explained.

The complete list of electrical interfaces belonging to a sub-system must be agreed with Alstom and shared using the EIS template (ENG-RSC-EN-CR-GDL-0005). Each modification of the electrical interfaces must be communicated to AT by the evolution of the aforementioned file.

5.2.1 Low Voltage Power System

"The low-voltage power system consists in a low-voltage battery, a low-voltage power supply (LVPS) distribution line and battery charger with associated circuitry.

Each equipment operating from the low-voltage power supply system shall function in accord with IEC / EN 60077-1 and if the equipment is an electronic device in accord with the EN50155 following the limits imposed by the following table:"

5.2.2 Circuit protection

"Supplier shall design its sub-system providing all the necessary protections against short circuits, overheating and human direct contact according to CEI EN 50153, including those that can occur on the output interfaces (e.g. output interfaces to electrical motors).

Alstom electrical system is designed to protect only the wires that are connected to the train electrical power distribution system."

All sub-assemblies have to be connected to ground for earthing protection in accord with EN50153.

To connect an equipment to the carbody ground, it is possible to use some cables or metallic braids. Braids are preferred to cables. Ref to RS Engineering Instruction "Safety Grounding Management Guide" AXD1000613588.

"Cable Protection: The exposed cables, meaning the cables mounted outdoor, shall be protected against:

- Atmospheric elements as UV ray, Salt Spray, Snow, Ice etc..

- Aggressive chemist elements as cleaning product, fuel, oil etc..

- Mechanical aspect as: stone impacts (for under-frame cables), branches impacts, relative movement between different part of the train where the cables are mounted (example bogie/body-shell connections and inter-car jumper connections).

In any case the design of cable routing and fixation have to take in account that the installation has to guarantee cable protection.

Design of cables duct and conduit shall also take into account that sharp edges and metallic sharp parts shall not damage the cable insulation and sealings."

Each cable used for grounding connection shall be in green/yellow color or identifiable by a yellow/green marking (according to EN50343).

The grounding connection zone shall be not painted and treated with high conductive and low oxidation finishing in compliancy with the metallic surface used.

All sub-assemblies installed in exposed zones like roof, underframe, external bodyshell areas shall be connected to a safety bonding cabling system redundant (two times) including catenary fall protection for all the lines under which the train will run (25kVac, 3kVdc, 15kVac).

5.2.3 Wiring Norms

Wiring shall be compliant with EN 50343 - Railway applications - Rolling stock - Rules for installation of cabling

"LV cables shall comply with following standards:

EN 50306 - Railway rolling stock cables having special fire performance - Thin wall

EN 50264 - Railway rolling stock power and control cables having special fire performance

EN 50200 - Method of test for resistance to fire of unprotected small cables for use in emergency circuits

EN 50382 - Railway rolling stock high temperature power cables having special fire performance"

5.2.4 Wire and Cable

Cable cross section calculation shall be done according to the applicable rules of standard EN 50343

Cables installation : The cable installation, routing, fixation and bundling shall be designed according to standard EN 50343. Moreover all the routing rules shown in the following tables shall be respected:

"Each cable and wire must be identified by dedicate cables marker sleeve.

In the marker sleeve labels, cable numbers identification must be written (by means special printing tool) according to the electrical wiring schemes.

The markers to be used have to be chosen according to AT PPL Heat shrinkable. The marker sleeve must be halogen free and the quality of identification is compliant to EN 50343 sections 7,6 and appendix H and MIL-M81531.

Furthermore each cable marker sleeve have to printed in both sides (see example below)."

All cable marking shall be placed in the same reading direction.

Cable marking is done on a marker sleeve and shall not be done on the cable itself. Erasable inks are forbidden. Hand-written cable markers are forbidden.

All the cables shall be compliant to EN 45545-2 Risk level HL2 (table 2, sub-table E).

5.2.5 Wiring Connections

The accessibility of all electrical equipment including cabling shall be in accordance with EN 50153 Railway applications - Rolling Stock - Protective provisions relating to electrical hazards.

Every circuit shall be suitably protected against short circuits and overload conditions to satisfy EN50343

"All sub-assemblies electrical interfaces have to be connected via an appropriate single class connector for signals up to 500V.

For higher voltages shall be used screwed isolators or terminal blocks. HV connectors shall be used only following AT approval."

Bending radii shall be designed according to EN50343 or cable and conduits datasheets.

Bending radii of cables/conduits and cables/conduits/sealings protection from sharp edges shall be respected during all the storage, production and delivery phases.

Cable ducts inside the equipment shall use no more than 80% of their capacity. Conduits inside the equipment shall use no more than 60% of their capacity, according to EN50343.

When the cable shielding continuity is required at train level to meet EMC requirements for a specific function, the shield connection shall to be implemented also inside the sub-system equipments to ensure the full function.

"Dielectric test between the various equipotential areas and between the latter and the ground shall be dimensioned for testing voltage values according to EN 61439-1, EN 50343. When a class is under test, the circuit of the other classes shall be connected together and earthed, as described in EN50343.

Electronics circuits

Test voltage: 500 Vac

Time: 60 s \pm 5s

LV circuits

Test voltage: 750 Vac

Time: 60 s \pm 5s

MV circuits

Test voltage: 2500 Vac

Time: 60 s \pm 5s

HV rated voltage circuits

Test voltage: 8100 Vac

Time: 60 s \pm 5s

It is reminded, as mentioned in EN 61439-1, if Dielectric rigidity test is repeated voltage test is reduced by 20% of original voltage."

"Electrical insulation test resistance shall be checked by subjecting the complete harness cabling or the complete system device cabling to the following voltage values according to the provisions set forth in EN61439-1, EN50343:

Test voltage:

500 Vdc (for all circuits)

Time: 60s

The insulation resistance of each device and the system as a whole shall be:

- 5 M ohm for circuits having a rated voltage equal to or greater than 300 V d.c. or 100 V a.c.

- 1 M ohm for circuits having a rated voltage less than 300 V d.c. or 100 V a.c."

The wiring have to be checked point to point with an automatic system

"Ethernet lines shall be tested in order to avoid bad Ethernet performance on the whole Train line.

Testing of line shall respect ISO/IEC 11801:2002

-ISO 11801 mode Channel Classe Ea (500 Mhz);

-ISO 11801 mode Channel Classe Fa (1000 Mhz).

Device to be used is a Ethernet cable Analyzer (i.e DTX – 1800 (DTX-5000) Ethernet Analyzer Fluke Manufacturer).

Wiring map, Line Loss and Near End Cross Talk (NEXT) parameters have to be verified. Following result is required:

- Correct Pin-Out of Cabling

- Insertion Loss @100 MHz < 22 dB

Near End Cross Talk @100 MHz > 29dB"

"The test shall be performed following the sequence below:

1. Insulation Resistance Test

2. Dielectric Rigidity Test

3. Insulation Resistance Test

(Resistance value have to be within 10% tolerance compared to 1st insulation resistance test.)

4. Point to Point Automatic Test

5. Ethernet Line Test

All the afore-mentioned tests, in addition to the automatic testing of the cables, shall be documented in specific test reports which must necessarily accompany the delivery of each sub-system to Alstom. Moreover, the documentation shall be filled by the sub-system manufacturer and, if necessary, shall be made available to AT over a time period of five years of the delivery of the sub-system."

5.2.6 Electrical Devices and Hardware

"All the equipment (electronic, electrical, electro-pneumatic, etc.), and its connections, shall be characterised, according to its position, by a degree of dust and water tightness (IP index) according to EN 60529.

- Equipment outside the train: at least IP66"

The subsystem components (connectors, terminal boards, circuit breakers, fuses, etc...) shall comply to EN 45545-2 Risk level HL2 R22 for interiors applications and R23 for external application.

All removable parts or parts that have to be accessed during train's life (relays / terminals / contactors...) must be accessible and removable

5.2.7 Connectors Requirements

"Each equipment connectors shall be identified by a label with the electrical name.

The connector electrical name shall be consistent with the the sub-system documentation (electrical schemes, EIS, technical descriptions...)"

"Refinish surface treatment of contacts : Connector contacts shall have gold plate treatment surface according to characteristics of signals (kind of signal, class, intensity...) to ensure good transmission through those contacts.

- Silver plated contacts could be used for MV and LV (110VDC) high current loads $I > 1,5A$

- Gold plated contacts could be used for all signals from 0,02A to 1,5A.

- Gold plated contacts shall be used for all signals under 0,02A"

The position of electrical interfaces shall be agreed with AT according to the allocated volume.

"All the connector shall be chosen by AT connector PPL.

Non-PPL interfaces shall be agreed with AT TE office, for example if the equipment or sub-system is standard and significant saving is possible."

Connectors accessibility : A sufficient clearance must be provided for all the connectors in order to guarantee easy accessibility. (Connection / Disconnection)

Connector grounding: the connectors that cannot guarantee double insulation shall have their metallic parts connected to ground if used for voltage rate band higher of Band I on DC Circuits and Band II on AC circuits (according to EN 50153). Alternative connectors solution have to agreed between Alstom and Supplier.

"Connectors coding system : Using connectors to connect electrical equipment, coding pins with coupling guides shall always be provided when the two connectors (male/female) have no inserts with coding for anti-reversal constraints.

Coding pins system are also required when several identical connectors (same size, same number of pins, same zone etc..) have to be fitted to the same apparatus/equipment"

In order to prevent shock hazards, socket connectors and/or socket (female) terminals shall be used as subsystem side interfaces when power is flowing from the equipment to train side. Vice-versa if the power is flowing from train side to equipment plug connectors and terminal shall be used.

The cable entry of the connector housing shall have metric thread. The size of the entry shall be defined according to the numbers and the size of cables used in the connector. AT have to agree and validate the entry size of each connector.

"Connectors – Degree of protection : the minimum degree of IP protection (protection against the penetration of solid and liquid particles) required of the connectors as a function of their intended application and voltage is as defined below according to IEC60529:

- Inside the vehicle: \geq IP20 applicable for LV zone Electrical cubicle
- Inside the vehicle: \geq IP40 applicable for MV zone Electrical cubicle
- outside the vehicle: IP66 except Electrical Coupler that should be equal or more than IP55 according to Electrical head specification

Inside of the vehicle or a cubicle, if a particular case needed lower IP level, it shall be validated with design engineering."

To ensure the pre-wiring of the AT harnesses and comply to EMC requirements each sub-system equipment connector must belong to a single EMC class. Exceptions could be evaluated by AT TE office for modular connectors which satisfies the aforementioned requirement.

"Fork end" lugs are forbidden. Connector with "Soldered Contacts" are forbidden in train side harnesses and cubicles.

Interface connectors or terminal boards shall use no more than 80% of their capacity of connection points. That means 20% of spare connection points with a minimum of n.1 spare contact point depending on the global numbers. (Example: for connections with 10 points where 8 used, two points must be spare; in case of 3 points one must be spare)

5.3 To resist to Fire, to limit Smoke propagations & to respect International / Local Regulations

"The materials, components and cables used must be certified by fireproofing certificates in according with the EN45545-2 (version 2020). Only hardly inflammable materials are chosen. In case of fire, the material properties shall only allow a slow fire spreading or not even this. According the EN 45545-2 (version 2020) HL2 is the hazard level requested.

The UNIFE Template shall be used for components which consist of different combustible materials (which need an individual fire protection certificate). The template is an official document for listing the EN 45545-2 (version 2020) fire protection certificates for combustible materials. This template must be filled out for concerned components.

In case the certificate according to EN 45545-2:2020 lead to additional cost versus the one related to EN 45545-2:2015, the supplier shall notify it to Alstom in the Clause by Clause, and a decision about the reference standard to be adopted will be taken, case by case.

"

"The supplier shall be in charge to keep the EN45545-2 F&S Certificate updated according with TSI LOC&PAS in force for the project - section 4.2.10.2.1 (3), by providing the necessary renewals until last train delivery.

In order to ensure constant product characteristics and manufacturing process, it is required that:

— the certificate to prove compliance of a material with the standard, which shall be issued immediately after testing of this material, shall be reviewed every 5 years,

— in case there is no change in the product characteristics and manufacturing process, and no change in the requirements (TSI), it is not required to perform new testing of this material; the certificate needs only to be updated regarding its date of issue."

5.4 To respect Train Integrity (TAIL/ NO TAIL) function

"SIL4 system called ERTMS Train Integrity

The train integrity monitoring is a function within the ERTMS system. With absolute positioning of trains, it would be possible to reduce the separation of the trains down to the distance to complete stop, plus length of the train, plus a safety margin"

"In the frame of ERTMS Roll-out in Italy, all the trains will be upgraded with a signalling system which is compliant to ETCS Baseline 3 Release 2 (i.e. B3R2).

Such ETCS B3R2 (with High Density function) introduces a new functionality called "train integrity", that requires the train to report to the signalling system its integrity (from end to end).

In order to identify which are the ends (head and tail) of the train, it is required to acquire the status of the mechanical coupling of the AC.

Such status shall be acquired by the signalling system with the maximum safety integrity level (SIL4). The signalling system will then know which are the ends of the train (AC mech coupling status = uncoupled).

Then, the train integrity status will be sent to the Trackside system which then knows the status for each train running on the network."

"The train integrity function, for automatic coupler system, is composed by

- 1x4 ethernet lines 100Mb added
- get the coupled and uncoupled train information available at train level mechanically and pneumatically"

Train integrity is not a function that detects the integrity of the multiple configuration; does not detect whether two coupled automatic couplers or automatic couplers coupled with on-site mounted rescue coupler are intact but the objective is to define whether a cab (with its automatic coupler) is TAIL or if the cab is not TAIL

"The Train Integrity must be SIL4 at train level.

The failure rate of the AC parts (switches) is part of the calculation of the Fault Tree Analysis (FTA) at the level train and, since the objective is to obtain SIL4 of the train integrity at the level, the SIL of the switches shall be lower than SIL4."

5.4.1 Microswitches Requirements

"Space for new 2 microswitches

S1.2 (coupled)

S3 (decoupled)"

Robust constructed and suitable for use on rolling stock

"Supplier shall provide of the MTBF value of the microswitch

The supplier has to provide MTBF/ FR of the component then the calculation of the level of SIL of the entire circuit of the Train Integrity on which is inserted the part of the AC is up to AT"

"Provide the following data: Tolerable Hazard Rate (THR)

"

"For SIL 4 classification, THR is the target value.

To confirm this value, perform the following steps.

1st Step:

Calculation of failure rate per million hours (fpmh)

According to IEC 62061 / ISO 13849-1

(using mission profile and the normal B10 value).

2nd Step:

Perform reliability analysis = FMECA (RAM-System-FMECA)

Analysis of the influences on the coupled and uncoupled signal.

3rd Step:

Fault tree analysis (FTA)

The FTA calculation will give the THR value which has to be reached according to SIL 4 criteria

"

"Space for the new signal cables inside the cables from EBOX to the vehicle

"

Space for the new contact inside the interface connector to the vehicle for the new signal cables

Contacts with a range > 2 times the current on the circuit

"Microswitches shall be

"

"

"

"Maximum current (intended as maximum current without gluing of the contacts)

"

"Comply with the following requirements of reinforced insulation of EN 50124-1 (Through the open contacts, between coil and contacts, between contact and contact, between contacts and support):

"

"Microswitches with IP \geq 65

Characteristics (between contact and contact, between open contacts and between contacts and coil):

Minimum air distance $> 1,5\text{mm}$

"

"Microswitches with IP \geq 65

Characteristics (between contact and contact, between open contacts and between contacts and coil):

Minimum surface distance $> 3,0\text{mm}$ "

"Microswitches with IP \geq 65

Characteristics (between contact and contact, between open contacts and between contacts and coil):

Dielectric strength $> 1,2\text{kV @}50\text{Hz}$ "

"Microswitches with IP $<$ 65

Characteristics (between contact and contact, between open contacts and between contacts and coil):

Minimum air distance $> 5,5\text{mm}$ "

"Microswitches with IP $<$ 65

Characteristics (between contact and contact, between open contacts and between contacts and coil):

Minimum surface distance $> 8,0\text{mm}$ "

"Microswitches with IP $<$ 65

Characteristics (between contact and contact, between open contacts and between contacts and coil):

Dielectric strength $> 1,2\text{kV @}50\text{Hz}$ "

"Considering and referring to the EN60947-5-1 at paragraph K.5.4.1 "Actuator travel and operating force", supplier shall provide the next information

- a. the minimum direct opening travel;
- b. the minimum force required to achieve direct opening action of all break contacts;
- c. the maximum travel including travel beyond the minimum travel position (i.e. including overtravel);
- d. for limit switches only the maximum speed of actuation;
- e. for limit switches only the maximum frequency of actuation"

Supplier shall provide EN60947-5-1 (2017) certification conformity

Supplier shall provide maintenance task (periodicity 6 months)

Information above is mandatory to detect malfunction on limit switch S1.2 and S3

5.4.2 Terminal Box

"Terminal box with IP \geq 65

Characteristics (between terminal and terminal):

Minimum air distance $> 1,5\text{mm}$ "

"Terminal box with IP \geq 65

Characteristics (between terminal and terminal):

Minimum surface distance $> 3,0\text{mm}$ "

"Terminal box with IP \geq 65

Characteristics (between terminal and terminal):

Dielectric strength $> 1,12\text{kV @}50\text{Hz}$ "

"Terminal box with IP $<$ 65

Characteristics (between terminal and terminal):

Minimum air distance $> 5,5\text{mm}$ "

"Terminal box with IP $<$ 65

Characteristics (between terminal and terminal):

Minimum surface distance $> 8,0\text{mm}$ "

"Terminal box with IP $<$ 65

Characteristics (between terminal and terminal):

Dielectric strength $> 1,2\text{kV @}50\text{Hz}$ "

5.4.3 Connectors

"Connectors with IP \geq 65

Characteristics (between contact and contact):

Minimum air distance $> 1,5\text{mm}$ "

"Connectors with IP \geq 65

Characteristics (between contact and contact):

Minimum surface distance $> 3,0\text{mm}$ "

"Connectors with IP \geq 65

Characteristics (between contact and contact):

Dielectric strength $> 1,2\text{kV @}50\text{Hz}$ "

"Connectors with IP $<$ 65

Characteristics (between contact and contact):

Minimum air distance $> 5,5\text{mm}$ "

"Connectors with IP $<$ 65

Characteristics (between contact and contact):

Minimum surface distance $> 8,0\text{mm}$ "

"Connectors with IP $<$ 65

Characteristics (between contact and contact):

Dielectric strength > 1,2kV @50Hz"

Connector shall robust and suitable for use on rolling stock.

"Connector shall be locked

"

Connector shall be fitted with coding pin and with appropriate labelling to avoid incorrect connections

Comply with EN 50306-2

5.4.4 Cables/cabling

Dielectric strength > 1,2 kV @50Hz

Protection against excessive physical damage

Protection against electricity-conducting foreign bodies

5.5 To respect TCMS HW

"The automatic coupler shall provide an electrical interface to signal the status of ""mechanically coupled"" to the TCMS HW logic. The Low Voltage (24 V DC compatible) electrical interface of each Coupler Mechanical Sensor shall include:

- 1 contact for TCMS acquisition; contact shall be normally open, closed when the mechanically coupling is achieved;
- 1 contact for TCMS acquisition; contact shall be normally open, open when the mechanically coupling is achieved."

"

"

5.6 To respect environment and climatic adaptation

"The equipments (Doors, pantograph, bogie, coupler, ...) shall be fonctionnal with [3] mm maximum thickness of ice.

The equipments exposed to Ice height of [30] mm cannot be fonctionnal and require a de-icing maintenance operation.

"

"For a non-painted part mounted at "" Exterior area (Ext)"" zone, permanently exposed to humid conditions, salt spray test requirements are:

-> [960] Hrs for a part Never replaced.

-> [600] Hrs for a part Mid-life replaced.

-> [480] Hrs for a part Periodically replaced.

-> [48] Hrs for electronical and electrical equipments (EEE) as per Test [Ka] according to EN 60068-2-11:[2021] and EN 50155:[2021]: covers, cubicle, boxes or any envelop protecting the EEE, are not concerned by this requirement and shall considered as single metallic parts painted or not.w

-> Chemical passivation required for austenitic stainless steel.

-> Painting for martensitic and ferritic stainless steel.

"

"In humid or wet zones, the assemblies of different metals shall comply with Standard potential difference between metals \leq [300] mV according to IEC 62995 annex J [2018] or to MIL-STD-171F table 1 [2011].

In case of coupling potential $>$ [300] mV, it shall be demonstrated that the galvanic corrosion is avoided (additional protection,...).

Stainless Steel (eg: AISI 304L/316/316L etc.) should not be directly interfaced with Carbon steel, Aluminum or Zinc-coated materials in wet zones without a corrosion risk analysis and ALSTOM review.

"

"For a painted metallic part mounted at ""Exterior area (Ext)"" zone, permanently exposed to humid conditions, the salt spray test requirements are:

-> [960] Hrs for a part Never replaced.

-> [600] Hrs for a part Mid-life replaced.

-> [480] Hrs for a part Periodically replaced.

"

Equipments shall comply to cleaning procedures and products identified in DTRF150262, elsewhere the The list of cleaning products must be provided to Alstom and tested if necessary as per DTRF 150262:[Rev.C]

"The equipment mounted outside shall comply with at least :

. IP[65] for enclosures and electrical connectors

. IP[20] for ventilated open area

according to EN 60529:[2019].

Note : ventilated zones (forced or natural convection) like motor fan.

Otherwise shall be demonstrated full functionality of the equipment related to the watertightness performance in accordance to its reference norm."

5.7 To respect Electromagnetic Compatibility

"Applicable to:

- External interfaces of subsystems from external supplier (e.g. connectors, earthing).

Cables shall be classified into 3 categories according to EN 50343 and into the following sub-classes :

Note: for DC only trains, the DC bus cables (including 2F filter) shall be always classified into A.2 sub-class. The A.5 sub-class shall be only dedicated, if applicable, to heating lines.

"

"Applicable to:

- External interfaces of subsystems from external supplier (e.g. connectors, earthing).

Cable of different classes shall never be mixed in the same wiring harness, connector or cable tray. Cable harnesses and sub-system interfaces of different classes shall be separated. The separation distance shall depend on the type of classes:

Classes A and B : 0.1 m

Classes A and C : 0.2 m

Classes B and C: 0.2 m

These requirements shall be respected as much as possible according to the available space. If not, the EMC Engineer shall validate the cables routing.

These requirements shall be respected as much as possible according to the available space.

Note 1: These separation distances take into account the fact that cables of class C are shielded, and that power and battery referenced cables are not shielded.

Note 2: When a separation distance cannot be respected (in a cable tray for instance), a complementary metallic screening shall be installed (e.g. different compartments in the cable tray).

Note 3: The upper surface of installed cables shall be at least 10 mm below the top of the barrier.

Note 4: Cables of a same sub-class shall be grouped together in a same harness. No separation distance is required between these sub-class harnesses (except for class A).

Note 5: In some cases, space restriction requires the use of only one connector for several conductor classes. Within the connector, the segregation of pins shall be performed.

"

"

"

"Applicable to:

- External interfaces of subsystems from external supplier (e.g. connectors, earthing).

Within Class A, HV cables (sub-class A.1 & A.2) shall be separated from all the other sub-classes (A.3 to A.9) by a minimum distance of separation: 10cm. The electrical interfaces of subsystems shall allow this separation.

Note: Class A.2 cables can be routed with A.3 cables as they are not used simultaneously."

"Applicable to:

- External interfaces of subsystems from external supplier (e.g. connectors, earthing).

The Sub-system shall have the earth terminal on the equipment to enable train level grounding management."

5.8 To respect Eco-Design

"The Coupling Equipment shall comply with :

Recyclability rate (mass/mass) according to [ISO 22628] $\geq 95\%$

Recovery rate (mass/mass) according to [ISO 22628] $\geq 95\%$

MoP [The external suppliers shall fill and release the Recyclability & Recoverability Calculation Template]

Reference:

ISO 22628/2002 - Road Vehicles - Recyclability and recoverability - Calculation Method

UNI-LCA-001.00 - Recyclability and Recoverability Calculation Method Railway Rolling Stock

UN CPC 495 - ROLLING STOCK - Product Category Rules"

"The supplier shall apply the requirements mentioned in ENG-STD-003[vG].

If necessary, derogation shall be requested in accordance with rules stated in ENG-STD-003[vG] and according to template ECO-FRM-001[vA]."

The external supplier shall commit to conformity according to ENG-FRM-001[vF] on hazardous substances.

The internal supplier shall commit to conformity according to ENG-FRM-005[vC] on hazardous substances

"The supplier shall provide last applicable version of Safety Data Sheet (SDS) for mixture contained in the supplied scope, as well as for mixture intended for use during operation or maintenance.

The SDS shall be available in English languages [and/or any other contractual language] and shall meet the requirements of GHS.

The Safety Data Sheets shall be updated and resubmitted for review and approval prior to any design changes."

The European Economic Area (EEA) supplier shall provide SCIP notification number from SCIP database for supplies sold on the EEA in the ENG-FRM-001[vF] declaration.

"The supplier shall declare the Bill of Material and the related weight, material, quantities, fixation and environmental data by filling the Material record and recyclability potential ENG-RSC-EN-XS-FRM-0004[vD.1] . Detail shall be done at Shop Replaceable Unit level.

"

The subsystem shall include at least 25% in mass of recycled content (secondary raw materials). The supplier shall indicate the percentage in mass of recycled content in the Material record and recyclability potential Template ENG-RSC-EN-XS-FRM-0004[vD.1] and provide associated certificates or Environmental Product Declaration if existing.

5.9 To respect Reliability

In order to demonstrate compliance to reliability targets, the Supplier shall provide dedicated Fault Tree Analyses (also source file shall be provided) performed with Isograph Reliability Workbench 11.0 Tool

"The Supplier/PU in order to perform reliability analysis shall use the following Alstom template "AS300_Supplier_RAMs analysis"".

NOTE: any other Supplier/PU internal template can be acceptable if all the requested informations are included."

The supplier shall comply with DTRF 150802 "Generic Reliability Specification for supplied sub-systems

"[Reliability towards coupling/uncoupling function]

The failure rate associated to "Impossible coupling/uncoupling due to mechanical, pneumatic or electrical failures OR Spontaneous uncoupling leading to undesired stop (T3)" shall be less than: 1 FPMH"

"[Reliability towards coupling/uncoupling function]

The failure rate associated to "Coupling signal disruption OR Loss of automatic uncoupling requiring a manual action (T2)" shall be less than: 0,5 FPMH"

"Mission profile of AS300

Avreage Yearly mileage: 630.000 km

Maximum speed: 300 km/h

Lifetime: 30 years

Max daily powered up time: 24 h

Maximum Commercial service per day: 20 h

Average Yearly use: 350 days."

5.10 To respect Safety

The coupler assembly shall be capable to withstand buff or draft loads for the condition specified in TPS.

"The Supplier's safety documentation shall include also a list of Safety Critical components, as defined by TSI LOC & PASS in force for the project (rif. §4.2.12.1 clause 4) during maintenance (TSI LOC & PASS in force for the project rif. §4.2.12.3) and during operations (TSI LOC & PASS in force for the project rif. §4.2.12.4).

Note 1: according to EU Directive 2016/798 Article 3(12), a Serious Accident means any train collision or derailment of train resulting in the death of at least one person or serious injuries to five or more persons or extensive damage to rolling stock, the infrastructure or the environment, and any other accident with the same consequences which has an obvious impact on railway safety regulation or the management of safety: ""extensive damage"" means damage that can be immediately assessed by the investigating body to cost at least EUR 2 million in total."

The supplier shall comply with DTRF 150801 "Generic Safety Specification for supplied sub-systemes"

5.11 To respect Integrated Service Readiness

"For the purpose of this document the following abbreviations apply:

-AMM: Adjustable Maintenance Module

-CBM: Condition Based Maintenance

-LRU: Line Replaceable Unit

- MCMH: Mean Corrective Man Hours
- MPMH: Mean Preventive Man Hours
- MTTR: Mean Time to Repair
- Max TTR : Maximun Time to Repair
- OMS: On board Maintenance server
- PHM: Prognostics & Health Management
- SRU: Shop Replaceable Unit
- TSS: Train Sub System"

"Line Replaceable Unit (LRU) :

The following definition is derived from MIL-STD-1390D- Appendix B] A LRU is a sub-assembly or single part installed in an item of equipment or system (e g: a vehicle) which is replaceable in an operational environment. (By operational environment, we mean at the maintenance depot safe for exceptional circumstances). A LRU may be a printed circuit board, an electronic module; a wheel set assembly, a pantograph, etc. Maintenance personnel undertake this repair by replacement.

A LRU should normally be capable of removal without dismounting adjacent LRUs.

Shop Replaceable Unit (SRU) :

Shop Replaceable Unit is a subset of a LRU (examples: a relay of a turntable or a block, a chart of an electronic drawer, the rotor of an engine...) whose maintenance or exchange is carried out in workshop on LRU already deposited of the train. The exchange of a SRU is carried out to give in operating condition the LRU failing. A SRU can be repairable or Non Repairable called SNRU"

"Definition of Maintenance Levels :

Maintenance level 1 : Includes all the works that do not require any tool or control equipment. It can be done by staffs without technical training. Level 1 activity includes cleaning, visual checking, lamps exchange, etc.

Maintenance level 2 : Includes actions that require simple procedures and/or simple to use support equipment. The safety checking handled by qualified technician, exchange of simple components such as lighting equipment, handled by non-qualified staffs, belongs to this level.

Maintenance level 3 : Includes operations that require complex procedures or complex to use support equipment. Major inspection consists in measure and test, exchange of some components and general checking. These tasks also include parts exchange, both for small parts and for parts needing heavy lifting device. This maintenance level includes only part exchange.

Maintenance level 4 : Includes operations that require the use of a specific technique, technology or specific support equipment. Level four concerns all the overhaul works. Components Exchange Overhaul (from less than 1 day to 20 days) consists of exchange and repairs of components, depending on the reliability of components. It is done every year to 15 years or more according to the expected lifetime duration of each component. This task necessitates repair shops in order to realize standard exchange of each component.

Maintenance level 5 : Operations that require know-how based on particular techniques, technologies and process or support equipment. All the modifications aimed at upgrading the availability of the equipment or components are included in this level. It can be achieved in contractor light repair workshop, overhaul workshop, or at sub-contractors premises."

Automatic Coupler, Semipermanent coupler, Emergency adapter failure rate shall not be greater than 0,14 FPMK including all failures at train level (inherent reliability)

Semipermanent coupler failure rate shall not be greater than 0,033 FPMK including all failures at train level (inherent reliability)

Each maintenance task shall be designed in order to have a minimum +10% of tolerance for each maintenance periodicity

Rubber part shall have an average life of 12 years of operation time

There will be no preventive maintenance activity with frequency less than 50.000 km.

"As general requirement there will be no overhaul activity with frequency less than 1.500.000 km or 48 months, whatever happens first.

Particularities will be described in further requirements."

Automatic coupler - Mechanical head measurements: 12 months

Automatic coupler - Overhaul: not less than 10 years

Semi-permanent coupler - General check: 3 months

Semi-permanent coupler - Overhaul: not less than 10 years

Automatic Coupler (including semipermanent coupler, Emergency adapter, Adapter) LCC shall not be greater than 0,0020 euros/km for period 0-2 Years at train level

Automatic Coupler (including semipermanent coupler, Emergency adapter, Adapter) system LCC shall not be greater than 0,0065 euros/km for period 0-30 Years at train level

Semipermanent coupler system LCC shall not be greater than 0,0008 euros/km for period 0-2 Years at train level

Semipermanent coupler system LCC shall not be greater than 0,0035 euros/km for period 0-30 Years at train level

"In the LCC and MDJF the Supplier have to insert the maximum value of interval achievable.

The maintenance plan extracted by the LCC will have the following schedule:

1° Preventive visit - [50 000] km

2° Preventive visit - [100 000] km

3° and further preventive visit – multiple of the immediately previous interval (e.g. 150.000, 200.000, etc.)

-

1° Overhaul - [1.500.000] km

2° Overhaul - [3 000 000] km

3° and further Overhaul – multiple of the immediately previous interval (e.g. 4.500.000, 6.000.000)

"

Any maintenance activity not strictly necessary for safety or functionality of the system should not be foreseen

"As per TSI 2020, the design reasoning and process (calculation, RAMS analysis, Safety analysis, Norms, etc.) shall be indicated for each task of preventive maintenance, thus answering to these questions: ""Why is this task necessary? What is its goal?"" , ""Why this maintenance frequency?""

As required by TSI, the maintenance design justification shall be provided, containing:

1) Precedents, principles and methods used to design the maintenance of the unit.

2) Utilisation profile: Limits of the normal use of the unit (e.g. km/month, climatic limits, authorised types of loads etc.).

3) Relevant data used to design the maintenance and origin of this data (return of experience).

4) Tests, investigations and calculations carried out to design the maintenance."

Components selection (and relevant maintenance strategy and plan) shall be based on Reliability and Safety analysis and not only on historical data

"In case of bolt connections:

- galvanic corrosion shall be absolutely avoided (e.g. through contact between steel and aluminium elements)

- deviation of bolt sizes per system shall be kept at the lowest level

- torqued bolts shall be marked following ALSTOM specification"

"

Materials shall be chosen avoiding rust and corrosion for the whole life of the Trainset"

Pipes, cables and flexibles shall be fixed in such a way to avoid rubbing with other parts of the train (especially metallic ones). In particular, areas as bogie, inter-car, roof, etc. have to be protected with specific protection (metallic mesh, rubber reinforcement, etc.)

Design of LRU components with significant failure rate, impacting on failure of the whole system, and requiring frequent maintenance (up to once per year) shall be particularly careful.

"Automatic coupler - AC shall be equipped with:

- a mechanical sensor triggering an alarm in case of intervention (compression in case of crash, even light one)

- an automatic system for mechanical self-centering, in case of lateral movements"

"Semi-permanent coupler - SPC shall be equipped with:

- a mechanical sensor in case of intervention (compression in case of crash, even light one)"

Components requiring longer than 4 hours to be removed and reinstalled are critical. In case of longer times, design should be reviewed to achieve the 4 hours timespan.

Automatic coupler - Check and greasing: 6 months

5.12 To respect Rolling Stock System - Equipment and Tool

Automatic coupler must provide a specific interface for the installation of flag supports and lamp. Interfaces shall be optimized for the installation of brackets GL00000667219 and GL00000667220 without interference between brackets and equipment associated to the automatic coupler. Brackets indicated can be fixed by butterfly screws M8 Alstom code DTR0009184761. The installation of brackets and screws has to be guaranteed.

5.13 To Respect Vibration Constraints

All pneumatic, electrical and electronic equipment/components equipment to be fitted on to railway vehicles shall comply with IEC 61373:[2010].

5.14 To Respect Paint

"Colour of paint

The colour of paint will be "844 grey" or Ral 7016"

5.15 To Respect Special Process

5.15.1 Torque Tightening

5.15.1.1 Alstom References

The supplier or the manufacturer need to be demonstrate the compliance to DTRF150212: Criticality for assemblies and parts

5.15.2 Wiring

5.15.2.1 Alstom References

The supplier or the manufacturer must be compliant to the DTRF 150621-1 & DTRF 150621-2.

5.15.3 Bonding

5.15.3.1 Alstom References

The supplier or the manufacturer need to be demonstrate the compliance to DTRF 150223: Design of glued assemblies

The supplier or the manufacturer need to be demonstrate the compliance to DTRF 150620: Industrialization of Glued Assemblies

The supplier or the manufacturer need to be demonstrate the Adhesive Bonding Joints classification (H, M, L) following the Info of the DTRF150223 and DTRF150620

The supplier or the manufacturer need to create for each joints the List of requirements of an Adhesive Bonding Joint

5.15.3.2 General requirements

No Silicon Adhesive

No PUR Adhesive

Acrylic and methacrylic Adhesive shall be Low Odor

5.15.4 Riveting

5.15.4.1 Alstom References

The supplier or the manufacturer need to be demonstrate the compliance to DTRF 150218_RIVETED ASSEMBLIES OR LOCK BOLT

The supplier or the manufacturer need to be demonstrate the compliance to DTRF150228_Purchasing Specification for Rivets used in structures

The supplier or the manufacturer need to be demonstrate the compliance to DTRF150219: Assembly requirements for rivets and lock bolts

5.15.5 Welding

5.15.5.1 Scope

The supplier or the manufacturer need to be qualified follow EN15085 and EN3834

5.15.5.2 Alstom References

The supplier or the manufacturer need to be demonstrate the compliance to DTRF150215: Welding Condition for Purchased or sub-Contracted mechanically welded parts

The supplier or the manufacturer need to be demonstrate the compliance to DTRF150221: Main Welding Terms at AT Transport SA

5.15.6 Painting and Adhesive Filming

5.15.6.1 Alstom References

5.15.6.2 Painted parts

The standard DTRF 150602: Standard paints for carbody and painted parts need to be applied in case of the painting system is not compliant to DTRF150611

5.15.6.3 Adhesive Film

The supplier or manufacturer need to be compliant to DTRF 150607: Adhesive films - Preparation and application in case of Adhesive films or Labels applications

5.15.6.4 General requirements

"the dimension shall be indicated on the drawing to correctly mount of the fitting components referring to the tolerance chain.

"

The paint products used need to be 100% Water based Painting (% COV of the product ready to use $\leq 10\%$)

For the integrations where the loss of the tightening torque has to be addressed, the surfaces of parts and equipment at screwed, bolted and riveted interfaces shall be painted according to the instructions provided by EI 150210-2 rev D.

Purchased and not purchased painted parts shall be painted according to document Technical Painting Specification AXD1003198766- Preparation and painting Carbody and relevant components.

The adhesive films shall be applied on the external side of the CBS according to document Technical Filming Specification AXD1003198877

The internal area and the external flat area of the CSlot need to be not painted ASP 00

In general, all external inscriptions shall have adequate resistance to detergents and commercial products used for graffiti removal.

The trainset and its components shall not be damaged or suffer from any consequence resulting from washing operation detergents. It's strongly recommended to use cleaning agents with PH in the range from 5 to 9.

6 Documentation Requirements

6.1 Requested documents for tender

Technical description with functional description

Coupling/ Impact simulation

3D model (different positions, if relevant)

General dimensions 2D drawing including "Principle working diagram" and tolerances

To be filled and reported on 2D drawing

Interface plan (if not specified by AT)

"Validation Plan

- Front Coupler + Electrical Head

- SemiPermanent Bar"

Languages of documents: English