IRS Rolling Stock vs. Power Supply

Reference: IRS.72.1 Application Date: 19/05/2011

Version: 02



**CHENNAI METRO RAIL LIMITED**

Reference: IRS.72.1

Version: 02

Objective

This Interface Requirement Specification defines the requirements to be agreed between the Rolling stock contractor (ARE-01) i.e. ALSTOM and the Power and OHE contractor (AEP-01) i.e. SIEMENS.

This is not a final document. It will become final after the development phase of both contractors.

Application Scope

All interaction between Power Supply/Catenary and Rolling Stock.

Responsibilities

ALSTOM is the leader of the interface and as such is responsible for this document.

Signatures

|  |  |  |  |  |
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Contents

[Section 1 – Design Stage 4](#_Toc293618116)

[1.1 General description of the rolling stock 4](#_Toc293618117)

[1.2 RS maximum power supply requirements 4](#_Toc293618118)

[1.2.1 Four car trainset 4](#_Toc293618119)

[1.2.2 Six car trainset 5](#_Toc293618120)

[1.2.3 Power factor 5](#_Toc293618121)

[1.2.4 Vacuum circuit breaker and roof-mounted elements 5](#_Toc293618122)

[1.3 RS Harmonic Levels 5](#_Toc293618123)

[1.4 Train characteristic curves 7](#_Toc293618124)

[1.4.1 Four-car trainset 7](#_Toc293618125)

[1.4.2 Six-car trainset 7](#_Toc293618126)

[1.4.3 Train Resistance Diagram 7](#_Toc293618127)

[1.5 General car arrangement including pantograph positions 7](#_Toc293618128)

[1.6 Grounding schema of RS 7](#_Toc293618129)

[1.7 Power maximum allowable harmonic limitations 8](#_Toc293618130)

[1.8 Pantograph in dynamic mode 8](#_Toc293618131)

[1.9 Pantograph drawings 8](#_Toc293618132)

[1.10 Carbon Strip characteristics 9](#_Toc293618133)

[1.11 Gradient of OHE 10](#_Toc293618134)

[1.12 Neutral section characteristics 10](#_Toc293618135)

[1.13 Warning board and visual indication of neutral section 10](#_Toc293618136)

[Section 2 – Construction/Installation Stage 11](#_Toc293618137)

[Section 3 – Test & Commissioning Stage 11](#_Toc293618138)

[Section 4 – Maintenance Stage 11](#_Toc293618139)

Figures

[Figure 1 – Harmonic distribution for 4-car and 6-car trainsets 6](#_Toc293618140)

[Figure 2 – Grounding schema 8](#_Toc293618141)

Tables

[Table 1 – Characteristics of the Vacuum Circuit Breaker 5](#_Toc293618142)

[Table 2 – Harmonic limits frequency distribution 7](#_Toc293618143)

Appendix

[A – Definitions and References 12](#_Toc293618144)

[A–1 Definitions & Abbreviations 12](#_Toc293618145)

[A–2 Reference Documents 12](#_Toc293618146)

[B – Control Sheet 13](#_Toc293618147)

1. Design Stage
   1. General description of the rolling stock

Chennai trainset has a fixed configuration of 4 cars (DMC-TC-TC-DMC) where the extremity cars are motorised *(all motorised axles)* and the intermediate are trailer cars. Potentially, Chennai trainset can evolve to a 6-car configuration adding intermediate motor and trailer cars.

The following data shall be considered as design inputs for the rail system:

Total length of the 4-car trainset: 84,4 meters (coupler to coupler).

Total length of the 6-car trainset (estimation): 128,1 meters (coupler to coupler)

Length of the DMC car: 22,35 meters.

Length of the TC car: 21,85 meters.

Maximum weight in AW4 (4-car unit, 8 pas/m2): 256 Tons.

Maximum weight in AW4 (6-car unit, 8 pas/m2): 384 Tons.

Tare weight (VOM) for 4-car unit: 173 Tons

Tare weight (VOM) for 6-car unit (estimation): 260 Tons.

Rotational mass is estimated at 10% of tare mass (VOM).

Maximum speed: 80 km/h

Maximum acceleration: 0,82 m/s2 (Max. Tractive effort)

Maximum deceleration: 1,0m/s2 (Electrodynamic Brake)

Maximum deceleration: 1,3m/s2 (Emergency Brake)

Jerk will be limited at 0,7m/s3 except in emergency brake.

* 1. RS maximum power supply requirements

Rated power at transformer level: 1040kW (3 x 1040kW with a 6-car trainset). Maximum power per transformer can reach 1398kVA in traction.

A constant consumption of 290kW for auxiliary power supply shall be considered for a 4-car trainset (equivalent consumption for a 6-car trainset will be 150%), already included in the maximum rated power of the transformer.

* + 1. Four car trainset

Calculation has been done considering line voltage at 22.5 kV in traction and in braking. As the output of the calculation is active power at pantograph level, the same calculation can be used also for voltage > 22.5 kV.



Maximum voltage when in regenerative braking will not exceed 27.5kV (at train level).

Alstom confirms that the maximum power in regenerative braking is higher than the maximum power in traction mode.

Traction and braking train characteristics are included in the following excel file:



The simulation is based on information provided in the Rolling Stock contract for the line profile. Should there be any modification / alteration to the line profile by CMRL the above document will need to be updated.

* + 1. Six car trainset

First estimate for six-car configuration is to increase the power consumption by a factor of 1.5, as the two additional cars are one motor and one trailer from the existing four-car configuration.

* + 1. Power factor

For dimensioning a power factor of 98% should be taken into account.

Transformer efficiency = 92%

Traction efficiency (PMCF + Inverter + Gearbox + Traction motor) = 90%

Traction motor efficiency: 93%

Gearbox efficiency: 97%

* + 1. Vacuum circuit breaker and roof-mounted elements

|  |  |
| --- | --- |
| Technology: | Vacuum switch technology |
| Standard: | IEC 60077-4 |
| Nominal rated voltage: | 25 kV |
| Maximum voltage: | 30 kV |
| System frequency: | 50 Hz |
| Rated current: | 1000 A (at 25°C) |
| Short circuit power: | 400MVA for 1s over the whole operating voltage range. |
| Environmental constraints: | according to IEC 60077-2 par 8.2.1 |
| Line surges | In accordance with IEC 60 850 |
| Dielectric strength between poles | 75 kV rms / 1mn / 50Hz (wet & dry) |
| Dielectric strength between input and earth | 75 kV rms / 1mn / 50Hz (wet & dry) |
| Shock wave 1.2/50 μs between poles | 170 kV (contacts open with one of them connected to the earth) |
| Shock wave 1.2/50 μs between input and earth | 125 kV(closed contacts) |

Table 1 – Characteristics of the Vacuum Circuit Breaker

* 1. RS Harmonic Levels

Harmonic distribution will be the same for four-car and six-car units.

|  |
| --- |
|  |
| Figure 1 – Harmonic distribution for 4-car and 6-car trainsets |

The above harmonic spectrum has been calculated in steady state. Therefore, it can be exceeded during transient (slip/slide, line overvoltages etc.). The proposed spectrum could change due to the effect of voltage distortion in the industrial network.

|  |  |
| --- | --- |
| Hz | A rms |
| 50 | 185,7258 |
| 150 | 20 |
| 250 | 12 |
| 350 | 8 |
| 450 | 5 |
| 1049 | 1 |
| 1050 | 10 |
| 1750 | 10 |
| 1751 | 1 |
| 2049 | 1 |
| 2050 | 3 |
| 2600 | 3 |
| 4000 | 3 |
| 5000 | 3 |
| 6500 | 3 |
| 7000 | 3 |
| 7001 | 1 |
| 20000 | 1 |

Table 2 – Harmonic limits frequency distribution

* 1. Train characteristic curves
     1. Four-car trainset

See document [R2].

* + 1. Six-car trainset

To be completed by ALSTOM.

* + 1. Train Resistance Diagram

According to train characteristics (provisional), the Davis formula will be:

F (N) = 3689,3 + 35,204 x V + 0,655 x V² (Being V in km/h)

* 1. General car arrangement including pantograph positions

See document [R4].

* 1. Grounding schema of RS

Grounding schema will be as follows:

|  |
| --- |
|  |

Figure 2 – Grounding schema

* 1. Power maximum allowable harmonic limitations

To be completed by SIEMENS.

* 1. Pantograph in dynamic mode

*Provisional data: Gauge at pantograph level to be clarified.*

Catenary zig zag when circulating in tunnel shall be limited to 200mm with a catenary height between 4318 to 5000mm.

Catenary zig zag when circulating in open areas shall be limited to 250mm in any condition of catenary height and curve, to avoid surpassing the clearance line.

Catenary height in any condition shall not be higher than 5000mm.

* 1. Pantograph drawings

See document [R5].

* 1. Carbon Strip characteristics

Hardness of Cu-ETP of contact wire 120-125 HB (Brinell-hardness).

Reference force diagram (measurement of a similar pantograph) will be the following:

|  |
| --- |
|  |

Characteristics of the carbon strip collector head will be the following:

|  |
| --- |
|  |

* 1. Gradient of OHE

Gradient of contact wire shall be governed by relevant standard of EN 50119.

* 1. Neutral section characteristics

To be completed by SIEMENS.

* 1. Warning board and visual indication of neutral section

To be completed by SIEMENS.

1. Construction/Installation Stage

N/A

1. Test & Commissioning Stage

To be completed.

1. Maintenance Stage

N/A

1. Definitions and References
   1. Definitions & Abbreviations

xxxxxxxxxxxx:

* xx xxxx
  + 1. xxxxxxxxxxxx

xxxxxxxxxxxx:

* xx xxxx
  1. Reference Documents

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| ID | Name | Description | Version | Subcontractor |
| [R0] | RS-PS&OHE\_ARE01-AEP01-MOM-0001\_02Mar2011 | Minutes of meeting for first interface meeting. | 01 | ALSTOM |
| [R1] | Ref. CMRL 10000280  Ref. ALSTOM 2865DT | Electrical Traction & Brake Dimensioning | 00 | ALSTOM |
| [R2] | Ref. CMRL 10000100  Ref. ALSTOM 2861DT | Electrical Traction & Brake | 00 | ALSTOM |
| [R3] | Mail of Mr.Jan Bernard Bosse | Comments about catenary stiffness and gradient of contact wire. | 28/03/11 | SIEMENS |
| [R4] | SPPA001.00.005 | General view of rolling stock | 00 | ALSTOM |
| [R5] | L100757-0101-PO | LX 1800 PANTOGRAPH | Rev.4 | ALSTOM |
| [R6] | TD 100757 A | Technical description of LX 1800 PANTOGRAPH | Rev.B | ALSTOM |

1. Control Sheet

|  |  |  |  |
| --- | --- | --- | --- |
| Ver | Date | Revision description (changes marked in yellow) | Author |
| 00 | 16/03/11 | First issue. | R.Aragonès |
| 01 | 26/03/11 | Changes on 1.9 and 1.10 according to[R3].  Changes on 1.4, 1.8 and 1.9 according to [R4], [R5], [R6].  Changes to 1.7 according to gauge calculation.  Changes to 1.5 to add grounding schema. | R.Aragonès |
| 02 | 19/05/11 | Increased minimum ceiling for harmonic current to 1A due to return of experience, at section 1.2. Recalculated harmonic current at low frequency. Added additional comments.  Added 1.1.4 VCB information.  Added 1.1; General description of the RS.  Added max. rated power of the transformer and auxiliary power at 1.2.  Added comment at 1.2.1 about the difference between regenerative and traction power values.  Added comment at 1.8 about provisionality of the data for zigzag and max. height of catenary. | R.Aragonès |