SIEMENS

Industry – Mobility

Anexo Técnico
DESCRIPCIÓN TÉCNICA DE LOS TRENES PROPUESTOS

Cotización no vinculante:
Sondeo de Mercado para la Provisión del Material Rodante para la Línea 12 Tláhuac-Mixcoac

TRA1/2278/C2678/GMF/DRD del 23 de noviembre de 2009

Sistema de Transporte Colectivo

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Mexico D.F Line 12

Train Concept

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1 Introduction

This document provides a technical description of the Siemens Rolling Stock Platform proposed for Metro Mexico D. F. Line 12.

Please note that the equipment descriptions herein may refer to equipment of specific suppliers. As the final selection of the suppliers is not yet finalised, equipment of other suppliers offering comparable performance in accordance with the requirements of this platform may be used.

Siemens reserves the right to implement changes from the solutions described in this document.

1.1 Structure of this Document

The structure of this document is based on the European standard EN 15380 " Railway applications - Designation systematic for Railway vehicles -Part 2: Product groups".

Code of Assembly	Designation of the Assembly
A [1)]	General Topics – related to more than one assembly
B	Vehicle Body
C	Vehicle Outfitting
D	Interior Appointments
E	Running Gear
F	Power System, Drive Unit
G	Control Apparatus for Train Operations
H	Auxiliary operating Equipment
J	Monitoring and Safety Equipment
K	Lighting
L	Air-conditioning
M	Ancillary Operating Equipment
N	Doors, Entrances
P	Information Facilities
Q	Pneumatic / Hydraulic Equipment

Code of Assembly	Designation of the Assembly
R	Brake System
S	Vehicle Linkage Devices
T	Support Systems, Enclosures
U	Electrical Wiring

[1)] Letter A is predetermined by IEC 61346-2:2000 and not explicitly mentioned in DIN 25002-2

Table 1 Overview of the Principal Product Assemblies

1.2 Applicable Standards

Standards used are based on a list of standards used by Siemens Mobility for execution of metro projects. Principles used as a base for the selection of Siemens list of standards for metro projects world-wide covering engineering, manufacturing and commissioning.

- Standards are specifically and conclusively for the application and the used production technology. If possible "standard families" for railway vehicles should be used.
- Future safety/validity, standards which will be replaced by EN standards within reasonable time, are only specified as an alternative
- Internationality, avoidance of exclusive prescribing of national standards
- Proven and accepted for comparable applications

Priorities to be followed:

- Priority 1: Standards relevant for acceptance
- Priority 2: Valid EN standards
- Priority 3: Valid ISO, IEC and UIC standards
- Priority 4: prEN standards
- Priority 5: National standards, if standards above are inapplicable or partial valid only.

Adaptations according to local regulations and customer requirements are made on a case by case basis.

2 RA Vehicle Complete

2.1 System Overview

The design is based on the following concepts:

The trains are electrically powered passenger trains supplied from pantographs mounted on the roof of motor cars. Number of pantographs will be defined based on final parameters.

The train is preferably an eight-car train, which consists of

- Mc cars Motor cars with cab
- M-cars, M1-cars Motor cars
- T1-cars Trailer cars

The primary structure of the aluminium car body shell will be a totally integrated design suitable to serve in mass transit service and have a design life of more than 30 years.

Air spring suspended bogies of proven type are provided to ensure high comfort and reliability up to operating speed of 80 km/h.

For easy coupling and uncoupling the trains will be equipped with semi-automatic couplers at the cab ends providing mechanical and pneumatic automatic coupling and electrical coupling by jumper cables. The other car ends are equipped with semi-permanent couplers. All couplers may incorporate energy absorption devices as an option.

Gangways are connecting the saloon areas of adjacent cars and provide a maximum clear view through the train combined with capacity for standing passengers as well as improved passenger security.

Electrically operated passenger doors, four per car side, allow for easy passenger flow. Each door provides a clear opening of approx. 1400 mm. Door type is preferably outside sliding plug type, outside sliding type may be offered as an alternative.

Cab side doors will allow easy access to the driver's cab.

The saloon interior is practically identical for all car types. It includes 48 seats per car for each type of car. Longitudinally arranged seats allow for high transport capacity combined with sufficient seating capacity for low load periods.

Longitudinally arranged ceiling lights provide an appropriate lighting level for normal as well as for emergency conditions.

Passenger information is provided via an audio public address system and passenger information displays.

Each car is equipped with ventilation units providing fresh air to the saloon.

One driver's cab is incorporated into each Mc-car.

The train will be able to be operated by a single driver without any further assistance.

Particular emphasis is taken in the design with respect to the following features:

- Provision of a high comfort level for passengers and drivers.
- Reduction of life cycle costs.
- Easy maintenance.
- Highest reliability and availability.
- Provision of high levels of safety and security for passengers and drivers.
- Easy entrance and safe journey also for disabled passengers.
- Destination indicator (interior and exterior).
- Car body construction of aluminium.

2.2 Basic Technical Conditions

2.2.1 Environmental Conditions

The proposed trains will be designed to operate reliably and safely under the local climate conditions. as summarized in Table 2.

Meteorological temperature	-6...+40 °C
Relative humidity	75-90 %
Max. wind speed	115 km/h

Altitude above sea level	2240 m
Impurity in the air	Sand, acid rain, dust, carbon, copper, ozone, sulphide, sulphur dioxide

Table 2 Environmental Conditions

All equipment mounted in the vehicle will be designed to perform in a satisfactory manner in the environment in which it is installed and to withstand the specified effects of strong wind, high temperature, high humidity, vibration, noise and pollution by detergent.

2.2.2 Line Conditions

2.2.2.1 (intentionally left blank)

2.2.2.2 Line Parameter

The criteria summarized in Table 3 are usually taken into account for the design of the trains but may vary slightly due to the regarded project.

Track gauge		1435 mm (-2 mm, +6 mm)
Minimum radius of vertical curve		1500 m
Minimum radius of plain curve		
	Main line	150 m
	Depot line	70 m
Max. gradient		
	Main line	40 ‰
	Connecting lines, access lines	40 ‰
Max. super elevation of outside track		150 mm

Table 3 Line Parameter

Specific Kinematic Envelopes of the vehicles are based on specific line data as confirmed by the specific Customer and based on specific vehicle data as given by the Seller and are subject to mutual agreement between Customer and Seller.

2.3 Power Supply Criteria

The criteria summarized in Table 4 are taken into account for the design of the offered train (in accordance with IEC 60850 and GB/T 7928-2003).

Power supply mode		Overhead catenary
Power supply voltage		DC 1500 V
Power supply voltage variation range		DC 1000...1800 V
Height from catenary to top of rail		
	Minimum	4185 mm
	Maximum	5382 mm

Table 4 Power Supply Criteria

2.4 Train Configuration

The train consists of two motor cars with cab (Mc-car), four driving motor cars (M, M1) and two trailer cars (T1). The motorization rate of this train consist is 75 %.

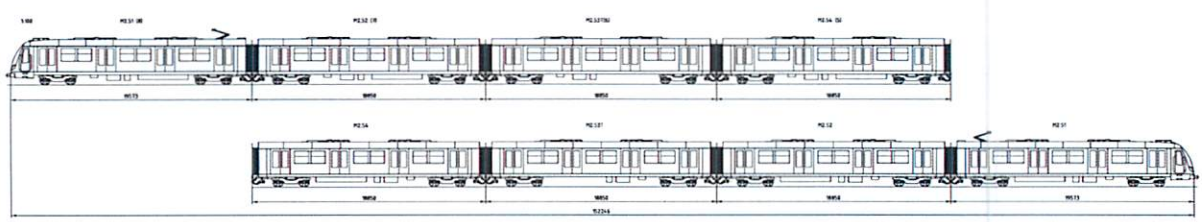

Figure 1 Train Configuration Eight-Car Train (typica)

2.4.1.1 Overview of Distribution of Main Equipment

The typical distribution of main equipment in the eight-car train is summarised in Table 5.

Equipment	Mc	M1	T1	M	M	T1	M1	Mc
Cab	1							1
Heating ventilation system	1	1	1	1	1	1	1	1
Traction motor	4	4		4	4		4	4
Auxiliary inverter with battery charger		1	1			1	1	
Traction inverter	1	1		1	1		1	1
Battery		1	1			1	1	
Air compressor	1							1
Brake module	1	1	1	1	1	1	1	1
Brake resistor	1	1		1	1		1	1
High voltage / low voltage box	1	1	1	1	1	1	1	1

Table 5 Distribution of Main Equipment in Eight-Car Train (typical)

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2.5 Main Dimensions

Dimensions given below are indicative and may vary slightly during design.

Length over coupler face of Mc-car	max. 19843 mm
Length over coupler face of M-car, M1-car, T1-car	approx. 18850 mm
Length over coupler face eight-car train	max. 152786 mm
Width overall (max.)	max. 2825 mm (outside sliding doors) 2712 mm (sliding plug doors)
Overall height above TOR	3620 mm roof including exhausters 4085 mm panto dropped down
Height of floor above rail level (nominal at AW0)	max 1150 mm
Height of ceiling above TOF	approx. 2100 mm
Clear width of passenger doors when open	approx. 1400 mm
Clear width of gangway	approx.1400 mm
Clear height of gangway	min. 1900 mm
Bogie centre distance	max. 12600 mm
Height of centre line of coupler above TOR	830 mm
Wheel diameter when new	850 mm
Wheel diameter when fully worn	770 mm

Table 6 Main Dimensions (indicative)

2.6 Passenger Capacity

Passenger capacities are calculated taking into account the number of seats, available standing areas and the number of passengers to be considered per square meter. Calculation is based on EN 15 663 Railway applications – definition of vehicle reference masses. Figures reflect current status and may vary during progress of design.

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Load Condition	Description	Passengers per Car		Passengers per Train
		Mc	M, M1, T1	Eight-Car Train
EL S (all seats occupied)	Seated Load	42	44	348
EL 4 (all seats occupied+4 P/m²)	Normal Payload	141	150	1182
EL 6 (all seats occupied+6 P/m²)	Crush load	191	203	1602
EL 8 (all seats occupied+8 P/m²)	Overload	241	256	2019
EL 10 (all seats occupied+10 P/m²)	Structural Load	291	309	2437

Table 7 Passenger Capacity (current status)

2.7 Vehicle Weight Predictions

Please note: Vehicle weight prediction reflects the current status of design and may vary during detailed design; passenger weight is 70 kg.

2.7.1 Weights

Load Condition	Description	Weight per Car [t]				Train Weight [t]
		Mc	M	M1	T1	Eight-Car Train
EL E	Tare Load	31,8	29,5	30,7	26,0	236
EL 4	Normal Payload	41,7	40,0	41,2	36,5	318,8
EL 6	Crush load	45,2	43,7	44,9	40,2	348,0
EL 8	Overload	48,7	47,4	48,6	43,9	377,2
EL 10	Structural Load	52,2	51,1	52,3	47,6	406,4

Table 8 Weight Estimation (current status)

2.7.2 Axle Load, Wheel Load and Imbalance

The average car axle load (including EL E unbalanced weight) shall be not more than 13,5 t.

Under EL E load condition of car, weight distribution shall comply to IEC 61133 standard. The following requirements of IEC 61133 clause 5.3.6 are applicable to the vehicle:

- Measured load on the line of the wheels on one side does not differ by more than ±4 % from the average of the measured loads on both lines of wheels.
- For a given axle, the measured load per wheel does not differ by more than ±4 % from the average load per wheel on this axle.

2.8 Train Performance

2.8.1 Assumptions

All performance characteristics are based on the following assumptions:

- Average line voltage:
  - Driving DC 1500 V
  - Braking DC 1800 V
- Wheel diameter is taken as half worn.

2.8.2 Propulsion Performance

All rates specified herein are net rates on clean, dry, well-maintained tangent track.

The operation area of the traction system is DC 1000…1800 V. Driving performance will be reduced if the line voltage drops below DC 1500 V.

2.8.3 Electro-Dynamic Braking Performance

All rates specified herein are net rates on clean, dry, well-maintained tangent track.

The electro-dynamic brake is used in service braking mode. For the service brake the electro-dynamic brake is favoured in use. If the load of the train increases, the pneumatic brake will assist the electro-dynamic brake and provides the rest of the required deceleration.

Braking performance is achieved under all conditions of line receptivity up to 100 % (maximum regenerative brake) and includes intermediate degrees of partial receptivity. The regenerative braking schemes will optimise the utilisation of the available line receptivity for braking. Below the line voltage of DC 1700 V the traction system will be disconnected from the line and the electric braking is rheostatic using the brake resistor.

The commanded brake rate will be achieved at any loading up to and including a train loading of EL 6.

Table 9 shows the electric braking performance.

	Eight-Car Train
Max. deceleration rate up to EL 6	≥ 1.0 m/s²
Jerk limit	0.75 m/s³
Blending speed	4...8 km/h

Table 9 Electric Braking Performance (typical)

2.8.4 Pneumatic Braking Performance

All rates specified herein are net rates on clean, dry, well-maintained tangent track and without the assistance of electric braking. All rates are time-average values measured including response time until standstill. The response time comprises the dead time and the brake force build-up time (time until 90 % of the commanded brake cylinder pressure have been achieved). The full command brake rate for emergency braking will be achieved with no assistance from electric brake, for any load from AW0 to AW3 inclusive. The brake values given are load compensated. The service brake is durable for continuous service usage. The emergency brake can handle up to three consecutive start/stop sequences.

Table 10 shows the pneumatic braking performance.

	Eight-Car Train
Service brake rate (with jerk limitation)	1.0 m/s²
Jerk limit (adjustable)	0.75 m/s³
Emergency brake rate (the emergency brake will apply instantaneously without jerk limit restriction)	≥ 1.3 m/s²

Table 10 Pneumatic Braking Performance

2.8.5 Parking Brake Performance

The parking brake force holds a train loaded to EL 8 on a 40 ‰ gradient, with any degree of wheel wear and the most unfavourable tolerances for the equipment for an indefinite time.

2.9 Fire Safety

2.9.1 General

In recognition of the importance of fire safety of the vehicle and the special nature of fire aspects for underground trains fire safety compliance will form an integral part of the design of the vehicle to ensure that all aspects of the specified standard have been fulfilled.

2.9.2 Operating Conditions

In this respect it is important to distinguish and to clarify which measures have to be taken by the supplier/manufacturer of the vehicles and which have to be taken by the operator (infrastructure, processes, etc.).

The fire safety description is based on assumptions as follows:

It is assumed that the fire risk is influenced to a great extent by operation on underground lines and distances between stops on underground tracks of up to 2000 m.

It is assumed that the tunnel is in accordance with DIN 5510 equipped with all safety relevant equipment including side walkways.

It is assumed that the train is in operation with a driver (no automatic train operation).

2.9.3 Level of Protection and Basic Standard

According to the assumed operation conditions the offered vehicle design will meet the requirements of DIN 5510 “Preventive fire protection in railway vehicles”, fire protection level 3.

2.9.4 Management of Fire Safety

Fire safety compliance will be an integral part of the design review procedures, design briefs etc. ensuring that all aspects of the specified standard have been fulfilled. This philosophy extends to the control of sub-contractors. Procurement specifications will include fire safety requirements, including test schedules and verification of compliance, provision of test certificates (where applicable), samples etc. Throughout the design process the developing vehicle design will be reviewed to ensure that the requirements for fire safety are being met. This is achieved through internal design reviews; again, this extends to sub-contract design/engineering reviews.

2.9.5 Material Requirements

2.9.5.1 Fire Prevention Requirements

The vehicle (materials, components, systems) will fully meet the requirements of standard DIN 5510 fire protection level 3. The test certificates for these materials will be submitted. The performance and the requirements will be listed within the fire safety table.

2.9.5.2 Material Restrictions

Material containing high halogen content, such as PVC and CFC (Chlorofluorocarbons, CFCs) are not allowed to use.

Materials known to decrease their fire safety properties because of aging and/or cleaning are prohibited to use.

Material containing Polychlorinated Biphenyls (PCBs), Chromates, Cadmium, Cyanide, Asbestos are not allowed to be used.

Specific exceptions may only apply in technically necessary cases were it may be possible, providing a case is put forward to Siemens and agreed by both parties.

2.9.6 Fire Resistance Requirements

Fire barriers are separating elements that resist the passage of flame and/or heat and/or effluents for a period of time under specified conditions. Fire barriers shall be provided as follows using CEN/TS 45545-3 as a guideline:

- Underframe structure: Requirement E15
- High power electrical cabinets (underframe and interior): Requirement E15
- Cab partition walls: Requirement E10

2.9.7 Vehicle Design

The vehicle design will follow the preventive fire protection vehicles design safety requirements according to DIN 5510-4 and standard fire safety aspects.

2.9.8 Electrical Equipment

The requirements according to EN 50343 and to DIN 5510 will be met for all electrical equipment (cable, electrical cabinets, electrical circuits).

2.9.9 Additional Measures

2.9.9.1 Public Address and Emergency Communication

Public address (PA) will be possible from the operating driver's cab and control centre room to all passengers.

2.9.9.2 Emergency Egress and Access Device (EED and EAD)

At least two exterior passenger side doors per car side accessible from the passenger saloon will be equipped with EED and EAD. The location of these emergency exits will be indicated to passengers, staff and rescue services by appropriate signs and will be self-explaining to the passenger.

The EED will be designed so that when it is actuated in tunnels and on all stretches without a safety space, the braking is not automatically enabled so that the passengers are not able to stop the train without the possibility of staff to intervene and keep the train running to an appropriate stopping point.

2.9.9.3 Fire Fighting Equipment

Extinguishers will be suitable for their intended use. They conform to relevant parts of EN 3 or to an equivalent local standard if available. Each car will be equipped with at least two portable fire extinguishers in the saloon area and one fire extinguisher in each driver's cab.

2.10 Noise

2.10.1 Noise Limits and Requirements

Unless otherwise stated, noise herein means the A-weighted sound pressure (according to EN 61672) level re. 20 µPa as the overall level over the complete frequency range of 16 Hz to 16 kHz or at least of the third-octave bands from 31.5 Hz to 10 kHz as defined in DIN EN ISO 3095 (Ref. 1) and DIN EN ISO 3381:2005-11-01 (Ref. 2). For the pass/fail, criteria the A-weighted overall sound pressure levels will be applied as it is outlined in Table 12.

The noise limits specified are based on measurements taken in essentially a free-field environment such as outdoors, away from any reflective surfaces other than a ballast-and-tie track bed and the adjacent ground. Interior noise criteria apply to measurements taken in a complete but empty car (train).

For tests and measurements the contractor a sound level meter or a multi-channel measuring combination consisting of measuring microphones, cables, amplifiers and a data recorder meeting the requirements for a type 1 instrument specified in EN 61672 shall be used. Where octave band or one-third-octave band measurements are specified, an analyser meeting the requirements for filters as given in EN 61260 shall be used.

2.10.2 Interior Noise Levels

2.10.2.1 Auxiliary Equipment Noise in Stationary Condition and Train Moving on At-Grade Ballasted Track

The measurement quantity for auxiliary equipment noise in stationary condition and train moving on at-grade ballasted track shall be L_{pAeqT} (A-weighted equivalent continuous sound pressure level). The measuring result shall be the arithmetic mean noise level $L_{pAeqT/mean}$, calculated from the measurements taken at all specified microphone positions throughout the train under uniform conditions.

2.10.2.2 Microphone Positions for Interior Noise

The microphones in the passenger compartment shall be installed on the car centre line 1.5 m above the floor. M1 shall be located centrally above the first bogie and M5 above the second bogie. M2, M3 und M4 shall be situated at approximate equal distances apart between M1 and M5 (M3 is in the middle of each car).

The driver's cab to be measured should be at the front in the direction of travel. In order to measure the equivalent continuous sound pressure level affecting the driver, the measuring microphones should be placed near by the driver's ear and also in a second alternative position in the middle of the cab at 1.5 m above the floor.

Both measuring points are to be located so that the minimum distance between the microphone and enclosing surfaces will be 0.3 m.

2.10.3 Exterior Noise Levels

2.10.3.1 Auxiliary Equipment Noise in Stationary Condition

The measurement quantity for trains in stationary condition shall be L_{pAeqT} (A-weighted equivalent continuous sound pressure level).

The measuring result shall be the arithmetic mean noise level $L_{pAeqT/mean}$, calculated from the measurements taken at all specified microphone positions around the train under uniform conditions.

2.10.3.2 Train Moving at Constant Speed

The measurement quantity for trains moving at constant speed shall be TEL (A-weighted transit exposure level, determined during the measurement time of a single train passage).

The measuring result shall be the mean noise level TEL_{mean} (arithmetic average of three recordings) calculated from the measurements taken at the specified microphone position under during the passage of the test train.

2.10.3.3 Microphone Positions for Exterior Noise

The microphone positions shall be vertical 1.6 ± 0.2 m and 3.5 ± 0.2 m, lateral 7.5 m from centre line from the track. For stationary condition the microphones shall be located at approximate equal distances on one side of the train and also in front/back of the train.

2.10.4 Test Conditions

2.10.4.1 Test Environment

The test site will be such that free sound propagation exists, the ground will be essentially flat.

No noise reflection from buildings, walls or any other objects, no noise-reflecting surfaces within a radius of three-times the measuring distance but at least 50 m. The area between the train and microphone will be as free as possible of vegetation, high grass, other tracks, concrete or water. The ground will not be covered with snow or ice or soaked with water.

The A-weighted background sound pressure level will be at least 10 dB below the values obtained when measuring the noise from the train. No influence the measurements by meteorological conditions, wind speed < 5 m/s, humidity < 90 %.

2.10.4.2 Vehicle Conditions

Noise level tests will be performed on the first completed car (train). All equipment must be complete and installed on the car (train), and all components of each system must be operating at normal conditions during tests for noise level.

2.10.4.3 Track Conditions

The track of the measuring section shall be on ballast, even, free of corrugation and welded without any gaps (rail joints). The preferred track type is UIC 60E1 rails with mono block concrete sleepers in ballast. The rail pads shall have a static stiffness of about 800 ± 50 MN/m.

Noise generated by moving railway vehicles is strongly influenced by the surface roughness of the rail head. The surface rail roughness of the test track shall have at least the given limit (curve) in the standard DIN EN ISO 3095:2005 (Ref. 1) (rail roughness limit spectrum) or better. (The surface rail roughness according to a wavelength in the range from 0.05 m to 0.005 m must not exceed the limit curve of DIN EN ISO 3095:2005 (Ref. 1).)

If the required track conditions are not supplied, especially the surface roughness, a process of revision to the noise limits shall start. This means that a corrective value in dB(A) agreed between customer and vehicle supplier shall be added to the specified noise limits. This additional correction is based on the limit curve of the surface roughness according to DIN EN ISO 3095 (Ref. 1) or DIN EN ISO 3381 (Ref. 2) and the relation "$10 \log_{10} (r^2/r_0^2)$" with $r_0 = 1$ µm and r as the measured values of the rail surface roughness in µm.

The wheels must have a smooth, faultless running surface and have travelled at least 500 km under normal conditions. All specified noise values shall be agreed for a "new wheel condition".

2.10.5 Referenced Standards

Ref. Nr.	Standard	Title
1	DIN EN ISO 3095:2005-11-01 (GB/T 5111)	Railway Applications – Acoustics Measurement of Noise Emitted by Railbound Vehicles
2	DIN EN ISO 3381:2005-11-01 (GB/T 14893-94)	Railway Applications – Acoustics Measurement of Noise Inside Railbound Vehicles
3	DIN EN 61672, Part I and II	Integrating-Averating Sound Level Meters
4	DIN EN 61260:2003	Electro-Acoustics – Octave-Band and Fractional-Octave-Band Filters

Table 11 Standards for Noise Measurement

2.10.6 Noise Values Inside and Outside

Location & Condition	Noise Measurement Quantity	Limit Values Eight-Car Train
Inside, passenger compartment, train stationary on elevated or at-grade structure, with all doors and windows closed and the air ventilation/air condition operating at full capacity	$L_{pAeq\_T/mean}$	69 dB(A) +1.5/-2 dB(A)
Inside, passenger compartment, train[1)] moving at 80 km/h ±5 % on elevated or at-grade structure in ballast, all auxiliaries running normally, and doors and windows closed	$L_{pAeq\_T/mean}$	77 dB(A) ±1.5 dB(A)
Outside the train[1)], stationary on an open, level tangent railway section with all underframe equipment operating and air ventilation/air condition operating normally	$L_{pAeq\_T/mean}$	69 dB(A) +1.5/-2 dB(A)
Outside the train[1)] moving at 60 km/h ±5 % on an open, level tangent railway section (ballast substructure), all auxiliaries running and air ventilation/air condition operating normally	Transit Exposure Level	80 dB(A) +1.5/-1 dB(A)

Table 12 Noise Levels of the Train

2.11 Materials and Workmanship

All equipment will be constructed in a sufficiently robust manner and arranged so as not to suffer deterioration, wear or damage due to vibration or shock loads encountered in traction service.

All equipment will be protected against damage such as those caused by dirt, dust and moisture.

Equipment will be arranged into groups where practicable, the items of any one group being mounted on a common frame or the equivalent, complete with such as wiring and piping.

All material, fasteners, tools, etc. will be metric-sized and meet international standards. All dimensions will be expressed in SI-units.

3 RB Car Body

3.1 General

The car body will meet the requirements of structure, strength, safety, reliability and design. The car body is designed to have an expected life of at least 30 years under normal service conditions.

3.2 Overall Structure and Arrangement

The car body consists of the following subassemblies:

- Underframe structure
- Side wall elements
- End wall structure
- Cab structure
- Roof

The car body structure is designed in compliance with the structural requirements of European Standard EN 12663:2000 "Structural Requirements for Railway Vehicle Bodies" for vehicle category P-III.

The natural frequencies of car body are sufficiently detuned to the frequencies transmitted by the bogie.

The visible outside area is painted for corrosion protection. The aluminium profiles are of large extrusion profile type.

3.3 Material Requirements

The car body is a welded structure made of aluminium alloy large extrusion profiles.

The used aluminium alloy's strength data will meet the requirement of standards EN 755-2, EN 13981 or equivalent standards. The heat treatment will meet the specification of EN 515 or corresponding European or International standard.

3.4 Structural Requirements

The structural verification of the car body shell is done acc. to EN 12663:2000 "Structural requirements for Railway Vehicle Bodies". The corresponding vehicle category is P-III, e. g. underground and rapid transit vehicle. The structural verification is based on combinations of both analyses and tests.

These include loads due to:

- Emergency pull out conditions
- Jacking conditions in workshops
- Re-railing conditions
- Track-induced loads

The longitudinal loads acting on the car body structure depend on the crashworthiness results and may differ from the values given in EN 12663.

Permissible static and fatigue stresses are derived from international standards and fulfil the requirements of EN 12663. Safety factors are determined acc. to EN 12663.

3.5 Crashworthiness Requirements

The carbody is basically designed in line with the requirements of EN 15227 vehicle class C-II. It is upon the customer's decision whether the vehicle has to comply with this requirement.

3.6 Car Body Design

The car body exterior will be painted due to corrosion protection and to aesthetic design.

The car body will be painted with a railway-proven paint system. Painting procedure will be submitted during design process. Coating assessment will follow the criteria of document A6Z00375141359.

Side walls, roof and car ends where visible to the public will be painted in one homogenous colour. A Customer logo made from adhesive foil will be applied to the front of the Mc-car or at other suitable place. Details will be finalized in mutual agreement.

Underframe equipment requiring painting will be painted with one homogenous colour.

Routine maintenance of the vehicle exterior surface will be restricted to periodically driving the trains through a washing plant, employing non-corrosive cleaning agents. Cleaners used diluted with water shall have a pH-value of 5…9. The range has to be agreed in detail.

3.7 Car Body Welding

Car body welding will meet the requirements of the relevant German, European or equivalent international standards.

4 RC Vehicle Outfitting

4.1 Windows

4.1.1 Passenger Side Windows

Each car will be equipped with minimum three windows of approx. 880 mm height (clear view) on each side of passenger compartment. Single pane windows will be provided.

All windows units will be waterproof and adequately sealed to prevent ingress of humidity.

4.1.2 Windshield

The windshield will be designed to ensure drivers safety and to prevent pushing out of the glass into the cab. It comprises two separate parts (side parts) located on left and right side of the detraining door. Side parts will be directly glued to the cab mask. The impact resistance will fulfil the test requirement of UIC 651 (TB/T2868-1998) adapted for metro applications. Metro trains do not require the high impact speed of mainline trains as specified in UIC 651. Following the philosophy of UIC 651 an impact speed of maximum speed of the train plus the maximum speed of other trains operating on the system is sufficient. The material for the windshield will be an untinted, laminated high-impact type safety glass with sealed edges. A ceramic layer will be provided in the edge area to protect the bonding zone.

Assembly or removal of the windshield will be only possible from outside of the cab.

4.2 Flooring

The floor covering, thickness approx. 2.5 mm, will be glued to the aluminium floor profiles or to separate floor plates. The type of floor covering will be chosen to meet safety (fire, slip resistance), maintenance and aesthetic requirements. Special attention will be paid to keep the number of joints of the floor covering to a minimum.

Maintenance procedures acc. to the recommendations of the manufacturer will ensure a good appearance of the floor covering in long-term operation.

4.3 Ceiling Panels

Panels will consist of a basic material providing the structural properties, e. g. aluminium, High Pressure Laminate (HPL) or FRP compliant with the fire safety requirements specified. If made of aluminium or FRP, parts will be coated with a decorative finish to meet the interior design. Insulation against air duct will be provided on the duct itself.

Ceiling coving panels and door coving panels will be provided.

4.4 Sidewall Panels

The design of the panels (size, shape, joints) will form part of the interior styling concept. Panels will be interchangeable as far as possible with a minimised number of joints and will be rounded at exposed edges. Special attention will be paid to avoid noise generation and to minimise noise transmission via panels.

Panels will consist of FRP and will be compliant with the fire safety requirements specified. The parts will be coated with a decorative finish to meet the interior design. Panels are intended to have the same service life as the train referring to the basic structure of the panel; surface coating will have a shorter life span.

Removal of the window pane can be done without removal of window panel.

The bodyside door cladding will provide an inner surface to the door leaf in accordance with the overall interior styling.

4.5 Draught Screens

Draught screens can be provided as an option.

4.6 Cabinets

Cabinets will be provided to house the electrical equipment if and where necessary. Doors with appropriate locks will allow for necessary access to the equipment inside the cubicles.

4.7 Exterior Cladding

A painted cab front mask made of FRP will be provided at the cab ends of Mc-cars.

4.8 Body Finish

The car body will be painted with one colour to protect materials other than stainless steel or anodised aluminium, i. e. for cab front mask, doors, bogies and underframe members. Small parts mounted to the car body may be unpainted.

The vehicle will meet the requirement of international advanced level. Coating assessment will follow the criteria of document A6Z00375141359.

Regular maintenance will be limited to regular cleaning of the cars in a washing plant. The interval has to be agreed on in detail.

4.9 Insulation

The car body will be insulated at the inner side to limit heat transmission as necessary. The insulating material used will have non-rotting and non-degrading properties and if mineral fibre products are used, will be lined with an aluminium foil to ensure retention of particles, even if access panels are open.

Anti-drumming agent proven for railway applications and compliant with the fire safety requirements will be applied to the inner side of the car body structure in areas where flat metal sheets are used. Areas with corrugated shells and aluminium extrusions will not get a coat of anti-drumming agent.

Acoustic insulation will be provided by means of the thermal insulation material combined with the interior linings or floor plates respectively.

Thermal insulation will be arranged between car body structure and interior linings..

4.10 Signage

Signage will be provided. Special attention will be paid to clearly indicate emergency instructions and areas for disabled people.

Decals will be made of self-adhesive film.

5 RD Interior Appointments

The general layout can be seen on Figure 2

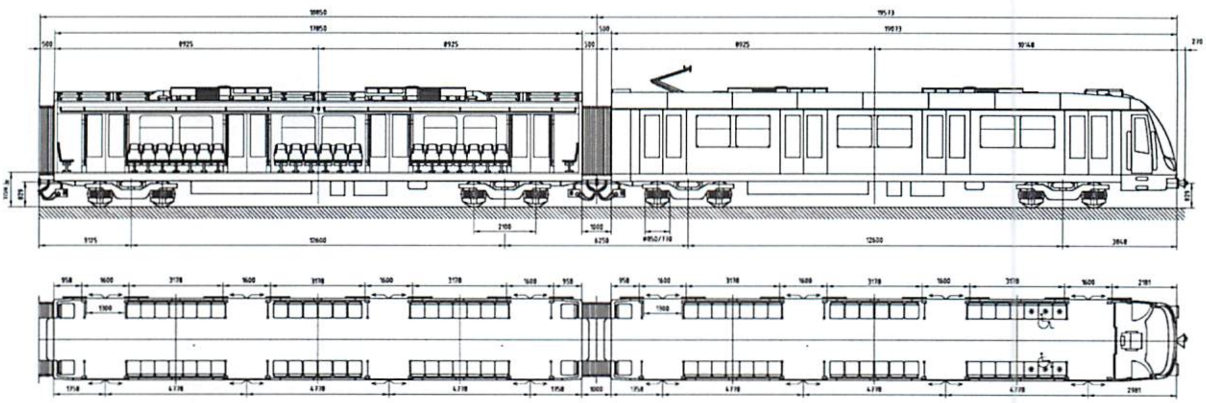

Figure 2: Interior layout (typical)

The drawing shows the typical layout, please note that dimensions may therefore vary slightly due to detailed design.

Colours will be specified acc. to the natural colour system (NCS) or to the RAL system that different parts with the same colour/finish will match to a high degree. Samples of finishes and colours will be provided during the design phase.

The proposed dimensions of the car are indicated on the layout drawings. The ceiling level is kept to nominal 2100 mm above finished floor level, although this height impacts significantly the design of saloon air conditioning units.

Materials will comply with the requirements of DIN 5510 fire protection level 3.

5.1 Passenger Retention

The vehicles will be provided with a sufficient number of grab poles and handrails to enable people standing in the saloon to reach a handhold.

Grab poles and handrails and their attachments will be designed to withstand service loads without permanent deformation of the grab poles and handrails or their attachments to the car.

Interfaces and joints will be simple, avoid dirt traps, smooth to touch with no burrs or sharp edges and will use fastening elements of proven design. The design will minimise assembly and disassembly time; disassembly of a central grab pole will be possible by one competent maintenance person and it will be possible to remove individual horizontal rails without disturbing other parts of the assembly. Joints between grab poles and handrails will be covered by suitable fastening elements forming part of the interior styling concept.

5.2 Seating

Passenger seats in the compartment will be arranged along the compartment longitudinal direction. Cantilever structure will be realized.

Seat shells will be made out of FRP without cushions. Their contour will meet ergonomic requirements; frame structures which are mounted to the car body support the seat shells.

5.3 Driver's Cab Design

5.3.1 Ergonomics

The cab design will incorporate a modern, aesthetic approach with considerations to train operator comfort, safety and reliability. Driver's cab will be full width type. Driver viewing angles will meet standard UIC 651.

The ergonomic design will provide comfortable operation conditions for the driver.

In order to reduce the risk of injury, all shapes have rounded edges and corners where applicable.

5.3.2 Driver's Desk

All control equipment for normal operation will be located on the driver's desk. Recovery or isolating equipment will also be arranged in the driver's cab.

The surface material of the driver's desk will be wear-resistant, easy to clean and will not fade. Arrangement and lighting of instruments allows convenient watching and operation.

5.3.3 Internal Panels

The design of the panels (size, shape, joints) will form part of the interior design concept. Panels will be interchangeable with a minimised number of joints and rounded at exposed edges. Special attention will be paid to avoid noise generation and to minimise noise transmission via panels.

Panels will consist of a basic material providing the structural properties, e. g. aluminium, HPL or FRP compliant with the fire safety requirements specified. Parts made of aluminium or FRP will be coated with a decorative finish to meet the interior design.

5.3.4 Cab Partition Door

A hinged or sliding type door will be provided between the driver's cab and the passenger compartment. Clear opening of the door is approx. 700 mm.

5.3.5 Cab Side Door

Please refer to section 13.9.

5.3.6 External Handrails and Steps

Steps will be provided below each cab side door to allow easy access from track level. Handrails or moulds will be provided to enable the driver to enter the train.

5.3.7 Key System and Cab Door Lock

On the front side of the cab door leaf a door lock with a handle is provided. This lock can be unlocked from outside the driver's cab with a key or from inside with a knob. The operator can open and close the door through rotating the handle after the door is unlocked from both inside and outside of the driver's cab.

6 RE Running Gear

6.1 General

Bogies of the modular build up bogie family SF 1000 for motor bogies and trailer bogies will be provided. The SF1000 platform bogie was designed especially for the light Metro segment.

During development and design, the state-of-the-art to the related regulations in UIC, EN, DIN and CEN standards have been considered.

Standard parts respectively parts that are currently in use at railway employers, have been considered as far as possible.

Most of the used components of the SF1000 platform are service proven in different metro vehicles such as SF2000 Metros for Taipei and Bangkok.

The SF1000 bogie is in service:

- Metro Nürnberg since 2004 (120 bogies).
- Metro Oslo since 2006 (498 bogies).

6.2 Arrangement

Typical arrangement can be seen on Figure 3.

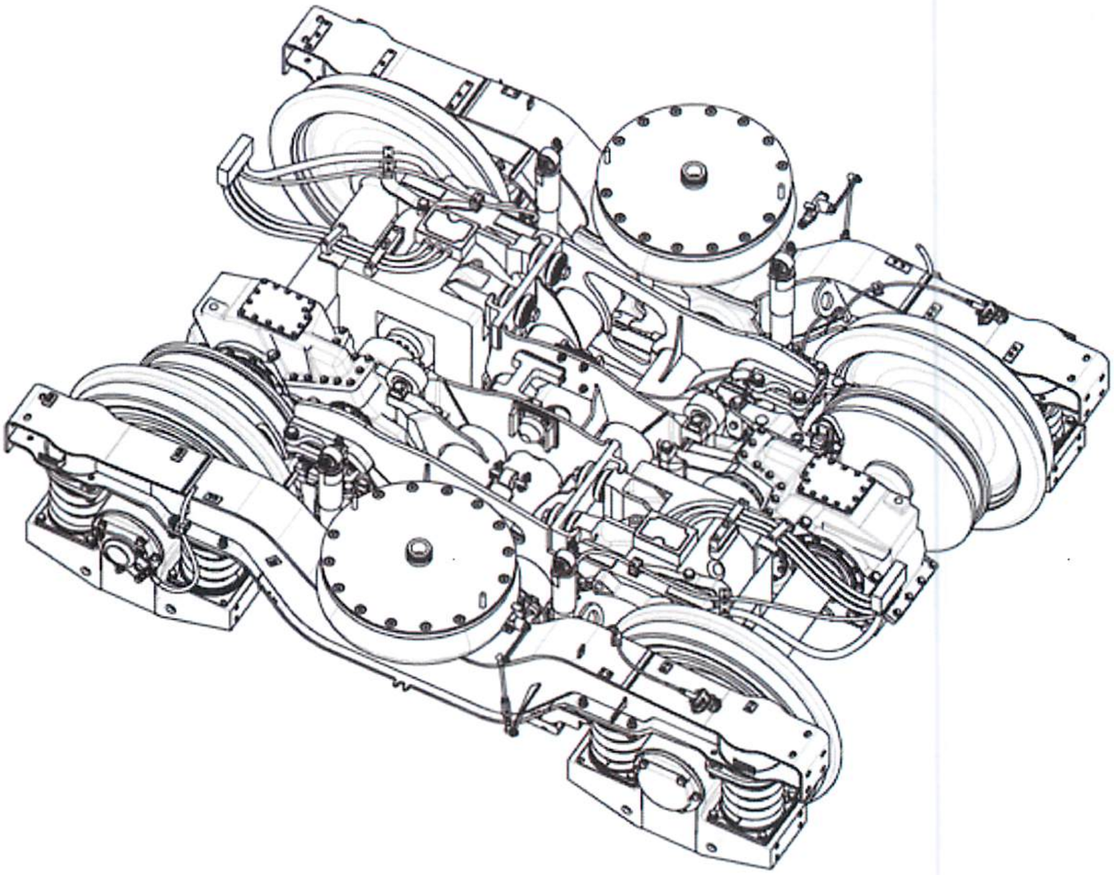

Figure 3: Bogie Arrangement SF1000 Motor Bogie

6.3 Technical Data

Technical data are given in Table 13 below.

	Eight-Car Train
Max. service speed / max. speed	80 km/h / 90 km/h
Axle distance	2,100 mm
Gauge	1,435 mm
Wheel tread diameter new / worn	850 / 770 mm
Minimum curve radius service / depot	100 / 70 m
Maximum static axle load (crush laden)	13 t

	Eight-Car Train
Bogie weight1)	motor bogie approx. 6,700 kg1) trailer bogie approx. 5,050 kg1)
Primary suspension / axle guidance	steel coil spring / rubber guidance
Secondary suspension	air spring
Secondary transmission of longitud. forces	traction rod
Traction drive	partially suspended
Primary lateral play (spring and bearing)	±8 mm
Secondary lateral play	max. ±40 mm
Primary suspension distance	1,900 mm
Primary suspension displacement max. (downwards till fixed stop)	40 mm
Primary suspension travel upwards (to lift-off device)	25 mm
Secondary suspension distance	1,900 mm
Secondary spring deflection max. (final stop)	60 mm
Secondary spring travel upwards (to lift-off device)	50 mm
1) Depending on installed equipment (options, such as wheel flange lubrication, bogie-mounted equipment of signaling system, derailment detection, obstacle detector, etc.)	

Table 13 Technical data Bogie SF1000

7 RF Main Circuit

7.1 Main Circuit and High Voltage Distribution Net

The nominal DC 1500 V supply is picked up via the pantographs. The pantograph feeds the traction system and additionally the DC 1500 V trainline supplying the auxiliary inverters on T1- and M1-cars.

The DC 1500 V line from the pantograph to the first protective device in the high voltage box is installed mechanically short-circuit-proof in a metallic pipe (short-circuit in train disconnects the supply in substation).

A surge arrestor is located on the roof close to the pantograph to protect the equipment and discharges any overvoltage to the car body.

The main power circuit in M-car with pantograph includes following:

- Pantograph.
- Surge arrester.
- High speed circuit breaker(s)
- Traction inverter.
- Fuse(s) for the DC 1500 V trainline.
- DC 1500 V trainline for auxiliary inverter supply.
- Fuse(s) for auxiliary inverters.
- -1500 V busbar.

The main power circuit in M-car includes following:

- Traction inverter.
- DC 1500 V trainline for auxiliary inverter supply.
- Auxiliary inverter (M1 car)
- -1500 V busbar.

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7.2 Propulsion System

The propulsion system of each motor car includes one VVVF inverter, each for four traction motors or two bogies. A typical propulsion system for one motor car is shown in Figure 4. All components within the dashed line in Figure 4 are located in the traction container.

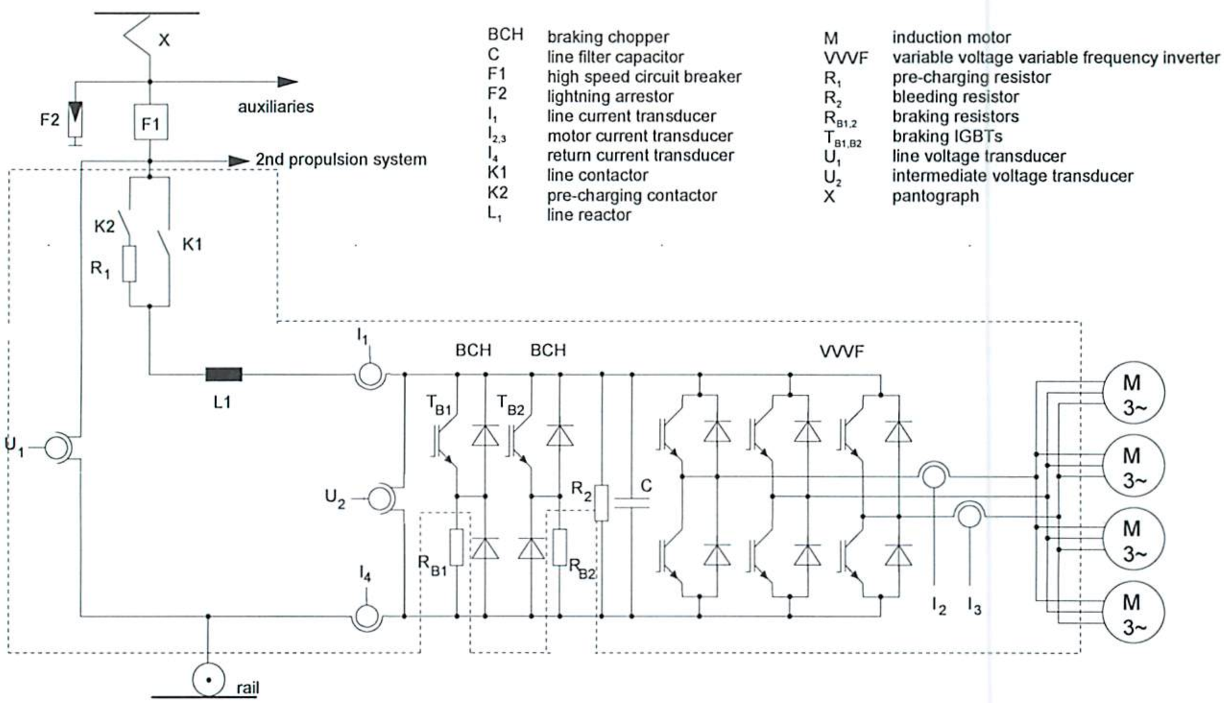

Figure 4 Main Circuit Diagram per Motor Car (typical)

7.3 SIBAC Traction Inverter System (VVVF)

The SIBAC traction inverter family is specially designed for the use in EMU's and metros and is a standardised inverter for DC 1500 V nominal line voltage for a large power range. The SIBAC traction inverter container houses the main elements of the traction inverter system.

The VVVF inverter system comprises of the following basic control modes:

- Propulsion: To convert DC input power of the overhead line into a variable voltage variable frequency (VVVF) three-phase AC output for the traction induction motors (driving mode).
- Regeneration brake: To convert the kinetic energy of the traction induction motors into a DC power suitable for recuperation by the overhead line (braking mode). During the braking process, regenerative brake is given priority, considering the line voltage conditions. As much energy as possible is fed back into the line.
- Rheostatic brake: If the line is not receptive the braking resistor will be used.

7.3.1 Traction Container

The SIBAC traction container is designed for underframe mounting and is manufactured of stainless steel. The container is divided into various compartments for IGBT modules, the line filter, contactors and additional electronic equipment. The arrangement of the components in the traction container is similar in design to other containers world wide successfully introduced by Siemens. The design is service proven and easy to maintain.

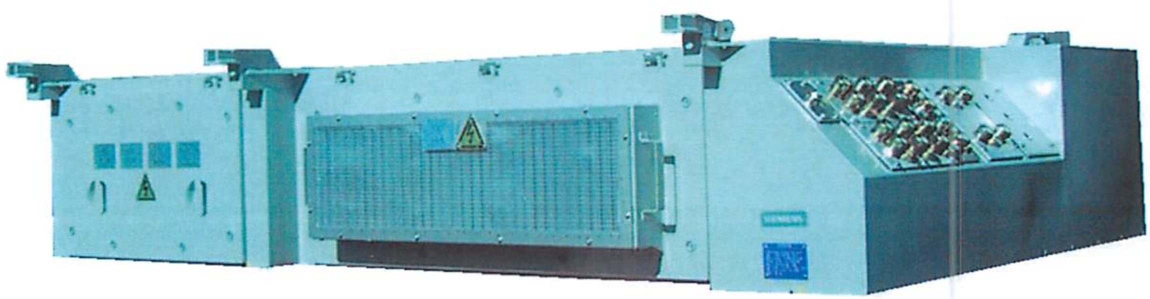

Figure 5: TractionInverter (typical)

7.3.2 Component Arrangement in the Traction Inverter Container

The components require minimum maintenance and have no wear parts except contactors and fan motor bearings. The heat sink area with the cooling fins is separated from the clean compartments inside the container in order to avoid the interior components being exposed to dirt and moisture. The heat sinks are electrically isolated from the power circuit and connected to ground potential.

The following additional main components are mounted within the underframe traction container:

- Inverter kernel.
- Line contactor.
- Line reactor.
- Pre-charging unit.
- Cooling fan with air ducts.
- Cable terminal box.

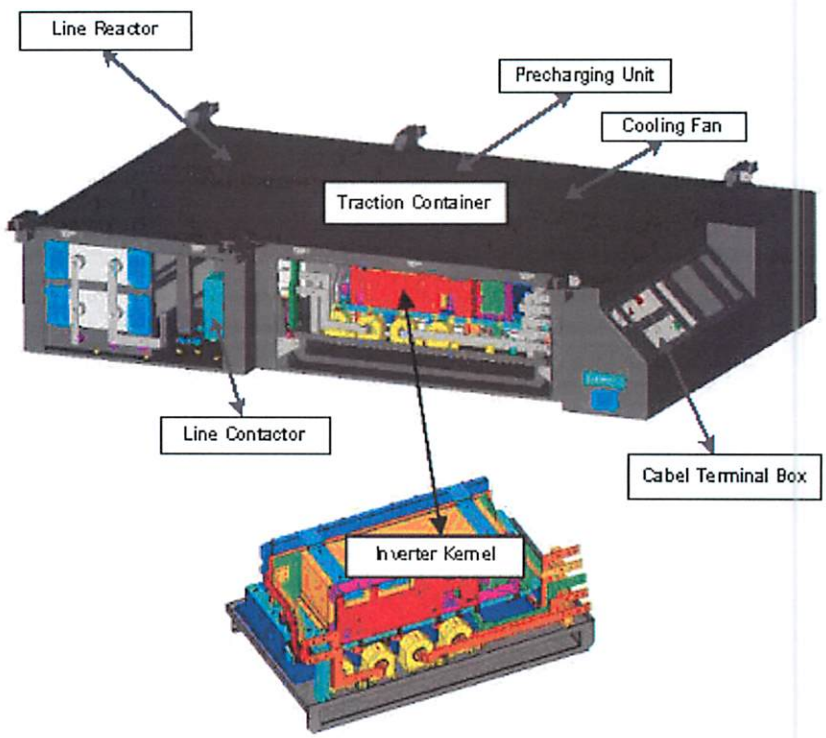

Figure 6 Component Arrangement in the Traction Inverter Container (typical)

7.4 Traction Motor and Drive System

7.4.1 Traction Motor

The drive system is comprised of the traction induction motor, the coupling and the gear. The traction induction motor represents the core of the drive system. The motors provide the torque and speed for the train set.

The self-ventilated motor is fed by a three-phase AC voltage provided by the SIBAC traction inverter. To keep the dimensions of the motor small in size, traction motors have to operate at high speed to produce the necessary power. The motor is a transversely mounted three-phase induction motor with squirrel cage rotor. The traction motor will cope with stress and requirements for rail vehicles laid down in IEC 60349-2.

During the braking of the train, the motor works as a generator and recuperates the kinetic energy of the train. Siemens offers a standardised drive system for DC 1500 V nominal line voltage for a large range of power.

Acc. to different wheel diameters, the load distribution between the four motors in parallel is not always equal. Therefore the max. wheel diameter difference between the motorized axles, which are fed by the same VVVF inverter is restricted to max 1 % of the wheel diameter. This effect of load imbalance between the traction motors is considered in the thermal motor design.

Figure 7 Traction Motor (typical)

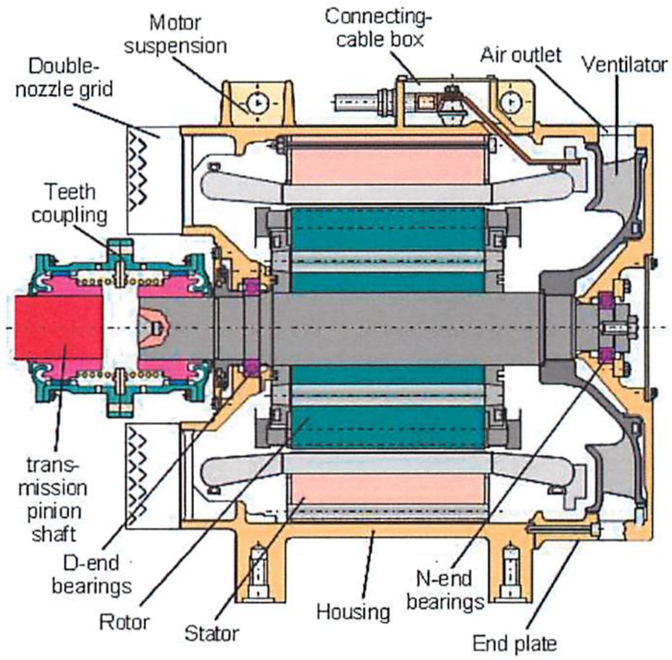

Figure 8 Cross-Section of Traction Motor (typical)

7.4.2 Tooth Coupling

The coupling is necessary to compensate misalignment between motor shaft and gear box shaft. The misalignment originates from vertical, horizontal and lateral movement of the wheelset shaft due to the primary spring.

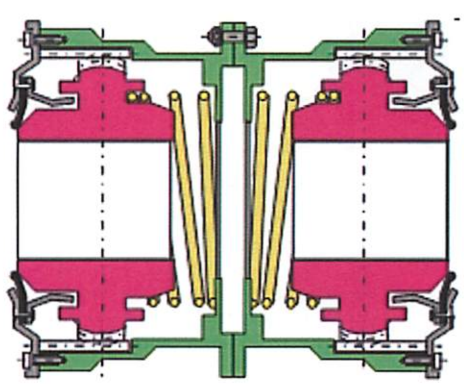

Figure 9 Schematic Illustration of a Tooth Coupling

The coupling consists of two identical halves, screwed together. One half of the coupling is fitted to the cone-shaped pinion shaft and the other half to the motor shaft via an oil pressure fit. The coupling is oil lubricated. With the except of regular lubrication the coupling requires no maintenance.

Type of construction	Tooth coupling
Lubrication	Oil lubricated

Table 14 Main Data of Tooth Coupling

7.4.3 Gear Unit

The transmission is a single-stage or double stage helical-toothed gear unit driven by the traction motor via a tooth coupling. The gear wheel is shrink fitted on the axle. The gear box is supported by the two bearings on the axle and on the opposite side on the bogie frame by a torque reaction bar. The bearings of the pinion and the axle are both oil lubricated. Oil is supplied by splash lubrication. The gear wheel plunges into the oil sump of the gear box and transports oil to the bearings and gear teeth while rotating. The transmission is sealed with a contact less labyrinth seal arrangement. Except for regular oil changes the gear box requires no additional maintenance.

The split plane of the two-piece gear housing goes through the centre of the axle. Through the split of the gear box, the gear box can be removed without dismounting the axle. The gear box has also a control cover in the lower housing half, which allows checking the contact pattern of the gear wheel.

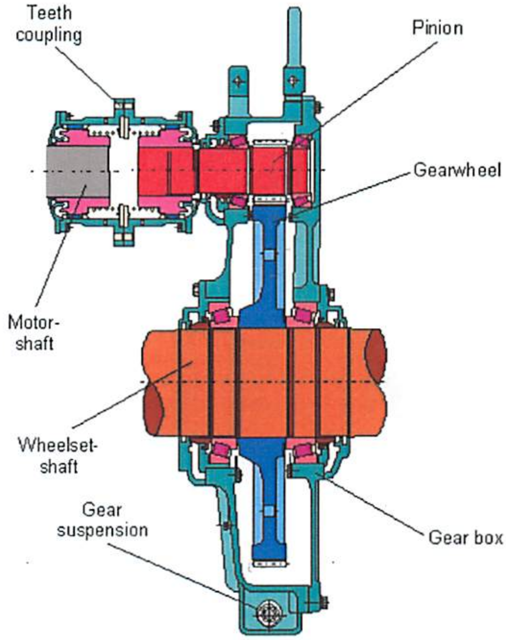

Figure 10 Longitudinal Section of a Speed Axle-Mounted Transmission (typical)

7.5 Earthing Concept

The earthing of vehicles is mainly required to ensure effective operational earthing and protective earthing.

- Operational earthing provides a negative return for the line current via the track.
- Protective earthing provides protection for persons and equipment against high touch voltages in the case of fault.

The basic design of the operational and protective earthing concept corresponds to EN 50153.

8 RG Control Apparatus for Train Operations

8.1 General

The control level consists essentially of:

- Control elements for train- and cab-activation/-deactivation.
- Pantograph and high-speed circuit breaker control.
- Control elements for manually controlled driving.
- ATC system for semi-automatic driving (if applicable)
- Traction and braking control units.

The signals for driving and braking are transmitted via the multifunction vehicle bus (MVB).

In each car the MVB connects (like a local bus) all the electronic control elements

For the data communication between the cars there are MVB repeaters for the MVB in each car. The MVB repeaters connect the local MVB with the MVB in the other cars. This part of the MVB connecting the cars is called MVB backbone.

The fully redundant MVB consists of two lines in separate, halogen-free, shielded twisted pair cables and fully redundant MVB repeaters. If one line is defect, the MVB controller transmits a fault message to the VCU and uses automatically the other line.

Some safety relevant signals and signals for train activating are installed as conventional hardwired trainlines.

8.2 Train Control Functions

8.2.1 Train Activation

In a train switched off and parked all electric circuits are de-energized.

Before a cab can be "manned" with the master key, the train must be activated. The train activation signal is generated by actuating the momentary "train activation" rotary switch in "on" position. The train activation switch is placed in the right bulkhead rack in cab.

The turn on/off pulse is fed to all other cars from the cab via trainline. With the train activation signal the main contactors for the emergency and the electronic circuits are energized.

8.2.2 Cab Activation

The signal "cab manned" is generated by switching on the master key. Pre-condition to activate the cab is that the train is activated. An activated cab generates the "train manned" trainline signal.

If there is already one cab activated and someone tries to activate another cab, an error message on the display of the active cab will be displayed. The actual cab keeps active because the "train manned" signal interlocks the cab activation of another cab.

8.2.3 Cab Deactivation

After deactivating a cab the "train manned" signal becomes low and the master controller key can be taken out in order to activate another cab. If this happens the main contactors for supplying the electric circuits remains switched on. All systems remain in service.

8.2.4 Train Deactivation

The train can only be deactivated by switching off the "train activation" switch, if no cab is activated. That means the "train manned" signal on the trainline must be low. The train deactivation signal is wired to all cars via trainline and switches off all main contactors.

When the train is activated and not manned, a lot of loads are energized. If in this case the battery can not be charged (e. g. high voltage not available) a low voltage protection switches off the train at a battery voltage lower than 84 V.

8.2.5 Pantograph Control

The pantograph supplies the traction inverter Further all auxiliary inverters in train are supplied, if the knife switches are in pantograph position

Normally the pantograph is lifted by air pressure from the main reservoir. Each single pantograph can be blocked by a separate cut-out air cock. If air pressure is low (less than 400 kPa), the pantograph has to be pumped up by a foot-operated air pump (duration approx. 5 min). It lowers by force of gravity.

By pressing the "panto up" pushbutton in the activated cab, all pantographs of the train are lifted, except those that are cut-out with the corresponding cut-out air cock.

By pressing the "panto down" pushbutton all lifted pantographs are lowered. Lifting and lowering is only possible at standstill of the train.

The state of the pantographs are monitored at the display in the driver's cab at the "pantograph operation screen".

8.2.6 High-Speed Circuit Breaker Control

The high-speed circuit breaker (HSCB) is used to switch the high voltage line to traction inverter and to protect it (overcurrent or short-circuit).

The HSCB control signals are transmitted via MVB to the VCU. Switching on of the HSCB is only possible, if the VCU agrees. Because of lifespan reasons, the driver will not be able to switch on and off as often as he likes or too often within a certain interval.

The HSCB can only be switched on and off at the active cab by pushbuttons.

8.3 Drive and Brake Control

8.3.1 General

Each motor car is equipped with one propulsion system to supply the four motors in the two bogies. Each propulsion systems is controlled by one integrated ICU. The ICUs of each motorcar are coordinated by the VCU.

The train is equipped with two brake systems:

- The electro-dynamic brake system (ED brake).
- The electro-pneumatic brake system (EP brake).

Priority is given to the electro-dynamic brake system for service braking. Emergency brake is provided only by the pneumatic brake.

The control level essentially consists of the control elements for manually controlled driving and braking, as well as an ATO system for automatic driving and braking.

8.3.2 Driving Operation

Driving is only enabled if the following conditions are fulfilled:

- DC 1500 V available.
- Main reservoir service air pressure available.
- All brakes are released.
- Safety loop is not interrupted.
- Cab side doors are closed and locked.
- All passenger doors are closed and locked.
- No emergency brake by the ATP or emergency brake push button required.

In the activated cab the driver can prepare the train for operation. In case of a defective system or under emergency conditions the following starting inhibits can be bypassed by a sealed switch:

- All passenger doors closed and locked monitoring bypass.
- All brake released monitoring bypass.
- Safety loop bypass.
- Insufficient air pressure (main reservoir) monitoring bypass.

Two operation modes are available:

- ATC mode.
- Manual mode.

For both modes of operations, the ATP ensures the safe train operation on the line.

8.3.2.1 ATC Mode[1]

In ATC mode the drive and brake commands are generated by the ATO system. Driving from one station to the other station must be initiated by pressing the “ATO start” push button on the drivers desk. Arriving at the station the ATO will decelerate the train automatically to standstill. The correct positioning of the train corresponding to the platform screen doors in the station will be controlled by the ATO and is monitored by the ATP.

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1 Please note: The ATC system is not part of Siemens’ supply. Therefore the conditions for ATC mode may be different.

The dead man function is deactivated in ATO mode operation.

The ATO mode will be interrupted by moving the master controller out of the "0" position. The demanded command (driving/braking) will be executed.

Our requirements on the ATC system are:

- The equipment can be installed in a box in the Mc-car.
- The ATO is equipped with an MVB interface to exchange all not safety relevant data with the VCU.
- The whole ATC does not need more than ten hardwired trainlines between the two Mc-cars.

8.3.2.2 Manual Mode

With the master controller the driver controls the acceleration (and deceleration) of the train under following conditions:

- Manual mode is selected.
- Forward or reverse is selected on direction handle.
- The a. m. driving conditions are fulfilled.
- Dead man button is pressed.

The driver is responsible for speed regulation, station stopping and door control. The ATP system supervises the speed limits and stops the train on blocked sections.

The VCU controls the maximum speed to 80 km/h in forward direction and 10 km/h in reverse direction. Driving is slip controlled and jerk limited ($r = 0.75\ m/s^3$).

In emergency conditions the ATP supervision can be bypassed by a sealed switch.

8.3.3 Braking Concept

8.3.3.1 General

The electro-dynamic braking system is provided by the traction systems of the motor cars and is controlled steplessly. The braking energy is fed back to the line. If the line is not completely receptive the remaining braking energy is diverted into the braking resistor.

If the ED braking effort is not sufficient to meet the required total braking effort the pneumatic brake can be added additionally in the T1-cars.

The electronic brake control unit (EBCU) controls the pneumatic brake in service brake mode.

When the train comes to standstill, the ED brake takes over to pneumatic holding brake.

8.3.3.2 Service Brake

The service brake is used in normal service situations. The reference value for braking is given in manual mode from operator by moving the handle of the master controller backward in the continuous service brake level or in automatic mode from ATO. For the service brake the electro dynamic brake is favoured in use. The pneumatic brake provides the rest of the required deceleration. The maximum service brake rate is 1.0 m/s^2. Service braking is slide controlled and jerk limited ($r = 0.75\ m/s^3$).

The ED brake as well as the EP brake are slide controlled.

8.3.3.3 Emergency Brake

The emergency brake is designed for a brake rate of $\geq 1.3\ m/s^2$. The emergency brake is provided by the pneumatic brake only. The emergency brake command is irretrievable and will be interlocked with standstill.

In every operation mode (ATC mode, manual mode) the emergency brake initiation is always active. During emergency brake the electric brake and the jerk control is cut out. Emergency brake is controlled by emergency brake valves independent from the EBCU. Emergency brake is slide controlled.

Upon initiation of the emergency brake, the safety loop is interrupted and the emergency brake valves are de-energized.

8.3.3.4 Parking Brake

The parking brake is automatically applied on a "bleed on/bleed off" basis once the air within the brake reservoir is drained due to long term leakage when the train is parked in the depot. So the train can be held safely on the track or in the depot. Normally, if there is enough pressure, the parking brakes are automatically released.

9 RH Auxiliary Power Supply

9.1 General

The purpose of the auxiliary power supply system is to provide a power supply for that equipment on the vehicle which cannot be directly connected to the catenary. The traction motors are an exception because they are supplied by the traction inverter.

9.2 Voltage Levels

To supply the various items of equipment on the vehicle, the following voltage levels are provided by the inverter:

Three-phase voltage	3 AC 400 V ±5 %, 50 Hz ±1.0 %, THD < 5 % rms 1)
Single-phase voltage	AC 230 V ±5 %, 50 Hz ±1.0 % 1)
DC voltage	DC 110 V (tolerances acc. to IEC 60077)
Battery charger	DC 110...130 V (tolerance ±2 %)
60 Hz are available as option	

Table 15 Voltage Levels of the Auxiliary Power Supply

The voltage levels are supplied by auxiliary inverters which can be fed from the catenary or from a workshop supply plug. The DC level is fed from auxiliary inverter or from batteries.

9.3 Load Distribution and Calculation

9.3.1 AC Supply

The following AC loads are supplied by the inverters:

- Air compressor.
- Saloon ventilation
- Equipment ventilation (e. g. braking resistor blower, traction inverter fan).
- Cab ventilation.
- Convenience plugs (one for each car).

9.3.2 DC Supply

DC loads are supplied from the auxiliary inverter or the batteries. The batteries are mutually decoupled by diodes. There are two DC 110 V main lines. One line supplies the normal loads, the other line supplies emergency loads in the train.

9.3.2.1 Normal Loads

- ATC.
- Displays (Multimedia).
- CCTV.
- Electronic control units.
- Passenger lighting.
- Auxiliary equipment.
- Passenger information system.
- Train control circuits.
- Windshield defroster (optional).

9.3.2.2 Emergency Loads

- Train radio.
- Train communication system.
- Exterior lighting.
- Internal lighting control.
- Cab lighting.
- Passenger emergency lighting.
- Emergency ventilation for all VAC units.

9.4 Control of Auxiliary Power Supply

When the train is activated, the auxiliary inverters are enabled and switched on automatically. High voltage via catenary or workshop supply must be present.

The AC loads are likewise switched on in sequence via the VCU. Both DC/DC-auxiliary inverters supply the DC loads in the train. Each auxiliary inverter charges its associated battery.

If the battery terminal voltage in a not manned train drops below 84 V the loads are automatically disconnected by the battery voltage monitoring control from the battery supply. The electronic equipment is switched off with a delay whenever the DC power supply is regularly shut down.

9.5 Failure Concept

In case of breakdown of one auxiliary inverter the others have to supply additional power for following devices:

- All equipment ventilation (brake resistor and traction inverter ventilation).
- The ventilation units will work in the reduced operation mode
- Air compressors

In case of short circuit or overload the auxiliary inverter has the function of automatically cut off and automatically restart. After three re-starts the inverter is switched off finally by its own controls.

In case of breakdown of all inverters (or missing catenary voltage) it is no longer possible to supply any AC load. All VAC units are switched to emergency ventilation. Propulsion and brake resistor fans are no longer running. Traction will continue until choke or heatsink reach a critical temperature. Afterwards train is coasting.

In case of a breakdown of all inverters (or missing catenary voltage) the passenger lighting is automatically switched to emergency lighting to save battery capacity. If it isn't possible to reach the next station or make a round trip the driver can switch to emergency operation to supply the emergency loads as long as possible from the battery (driving is not possible). Only the emergency equipment will be supplied from batteries the other equipment is automatically switched off. As a minimum the battery with a 90 % charge can supply these loads for 45 min.

9.6 Battery

The battery is able to support emergency loads for 45 min with a charge of 90 % of nominal capacity.

Moreover, the battery terminal voltage does not drop below the minimum value (84 V) if the train is parked for 60 h with inactive inverters and inactive driving/braking handle. This means, the train activation is off and the battery supplies the following loads as a maximum:

- Voltage control circuit.
- Train activation control.

10 RJ Operation and Control, Train Management System

10.1 General

This section describes the electrical safety equipment consisting of the safety loop and the dead man function. Further this document describes the monitoring and diagnostic functions of the train.[2]

10.2 Safety Equipment

The function of the electrical safety equipment is to stop the train in case of a critical situation.

10.2.1 Safety Loop

If an EBCU detects a low signal (0 V) on its emergency supply input, it triggers emergency braking. In this case the traction systems (ICU) in all motor cars are blocked.

The safety loop function is realized by the following hardwired trainlines:

- Safety loop supply.
- Safety loop operation.
- Propulsion enable.

A line interruption in the "safety loop supply " trainline triggers an emergency brake. Such a line interruption can be caused by:

- Pressing the emergency brake pushbutton in any cab of the train.
- The VCU recognizes a dangerous situation (e. g. the dead man button not pressed for more than 3 s).
- The master controller is moved to "EB" position.
- The ATC recognizes a dangerous situation.

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2 The automatic train protection (ATP) system is not Siemens' scope of supply and is not described in this document.

10.2.1.1 Safety Loop Bypass

If the safety loop is interrupted (e. g. a line interruption in the "safety loop supply" trainline), the driver can bypass the "safety loop supply " trainline with the sealed switch "safety loop bypass" in the manned cab. In this situation it is not possible to trigger an emergency brake by interruption of the "safety loop supply" trainline (ATC, VCU or master controller in "EB" position). The train must be taken out of service after the passengers have left the train in the next station. An emergency brake is only possible by pushing the emergency brake pushbutton in the manned cab. Whenever the safety loop is bypassed, the train speed is limited.

10.2.2 Dead Man Function

The dead man function is to monitor the vigilance of the driver. In manual driving the driver has to press the dead man pushbutton continuously while the train is in motion. If he releases the dead man pushbutton integrated in the master controller handle, an alarm sounds and a message appears on the drivers display. If the driver does not press the dead man pushbutton within 3 s, the VCU triggers an emergency brake.

In the automatic mode the dead man function is not active.

10.3 Monitoring

The data communication between the microprocessor systems in the train is realized with the MVB, acc. to the international standard IEC 60375-1.

One vehicle control unit (VCU) is installed in each Mc-car to control and monitor the electric circuitry within the train, for diagnostic functions and for the management of the data transmission. The VCU in each Mc-car controls and monitors also the propulsion system in the M- and M1-cars.

SIBAS-KLIP stations are installed in each car to gather digital and analogue input resp. output signals (e. g. status signals of components, control signals of contactors, etc.).

One MVB compact I/O (digital inputs and outputs) is provided in each driver's cab for signals from the master controller and the driver's desk (reference value, switches, pushbuttons, indicators, etc.).

In each driver's cab an HMI display indicates the status of components and possible failures within the train to the driver.

Other microprocessor sub-systems are connected to the MVB in the train (door control units, auxiliary inverters, passenger information systems, brake control units, etc.) and transmit their status and diagnostic information to the active VCU. All these microprocessor systems provide among the diagnostic functions also control functions.

10.4 Data Communication

10.4.1 Multifunction Vehicle Bus

The MVB operates as an "electrical middle distance bus" (EMDB). The data on the bus are transmitted bi-directionally.

The electrical lines (one line = one pair of wires) of the MVB within the vehicle are physically redundant to increase the availability. The data are transmitted via two lines (= two pairs of wires) in separate cables. Even in the event that one line fails data can still be transmitted via the second line.

The cable utilized for the MVB is a twisted pair and shielded cable, which performs a synchronized and duplicated physical transmission (redundancy) of the data over two distinct data lines (line A, B). Even in the event that one line fails, data can still be transmitted via the second line.

10.4.2 Vehicle Control Unit

The vehicle control unit (VCU) is a 32-bit microprocessor system. The VCU consists of modular printed board assemblies of the SIBAS family. Resulting from the higher level of integration and the higher performance of the used modules, especially of the central processing unit, the VCU became smaller and able to perform new tasks, e. g. central control functions, in addition to the traction control functions.

10.4.3 Master/Slave Control

In normal duty a determined VCU in the train remains always master and realizes the central control functions besides the traction control functions (TCF). The other VCU realize only traction control functions.

With the help of die MVB communication the function of the master is observed. In case of a failure of the master VCU the master function is taken over by the other VCU.

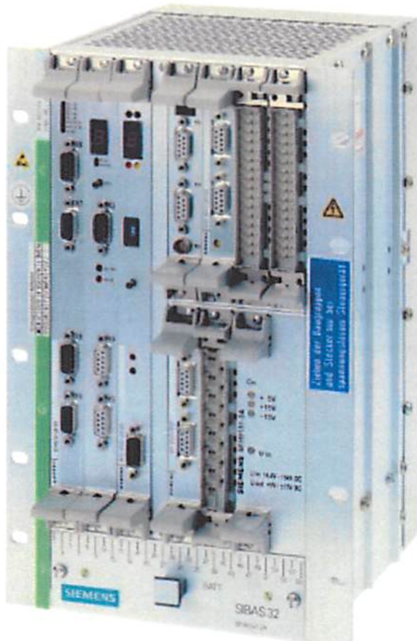

Figure 11 Example for a Vehicle Control Unit

10.4.4 SIBAS-KLIP Station

SIBAS-KLIP stations are used to decentralize the control system and to gather the following signals:

- Digital input signals like control commands or status signals.
- Digital output signals like contactor control signals.
- Analogue input and output signals (DC 0…10 V, 0…20 mA if required).

These signals are transmitted via the MVB to the VCU for processing.

SIBAS-KLIP stations are used to reduce the amount of wiring and terminals and therefore to improve the reliability and availability of the electric vehicle control system.

Each SIBAS-KLIP station includes an MVB interface, a variable number of bus modules, SIBAS-KLIP input and output modules and a power supply module (input voltage DC 24…110 V, internal supply DC 24 V).

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The interface, the bus modules and the power supply module fit on a standard mounting top-hat rail.

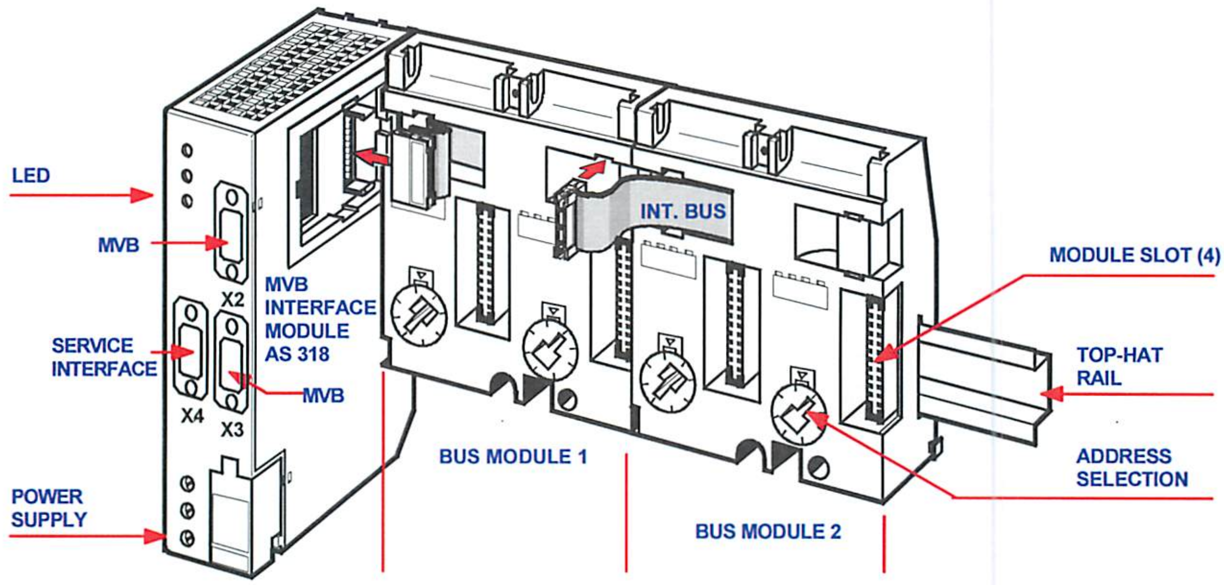

Figure 12   SIBAS-KLIP Station

10.4.5 MVB Compact I/O

The MVB compact I/Os act as an interface from the MVB to decentralized input and output signals at the driver's desk like:

- 32 digital input signals DC 24 V (push buttons, switches, master controller switches).
- 8 digital output signals for indicators DC 24 V (2 W each).
- 2 x 10 digital inputs to connect two digital reference value encoders.

These signals will be transmitted via the MVB to the VCU for processing.

The MVB compact I/O is fed by an isolated power supply. Inputs and outputs are not electrically isolated.

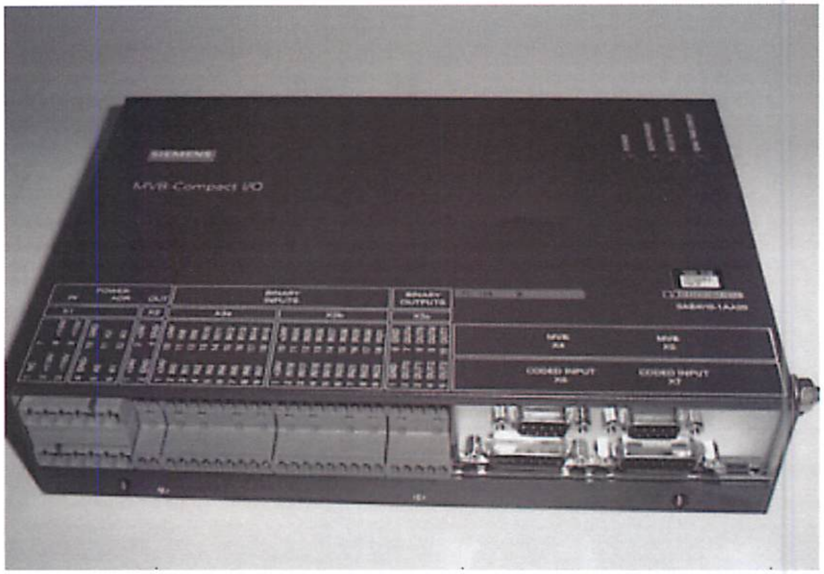

Figure 13 MVB Compact I/O

10.4.6 MVB Repeater

The MVB repeater is used for conditioning the physical MVB signals in one MVB segment and for initializing the MVB device addresses (in case new MVB devices are installed).

Figure 14 MVB Repeater

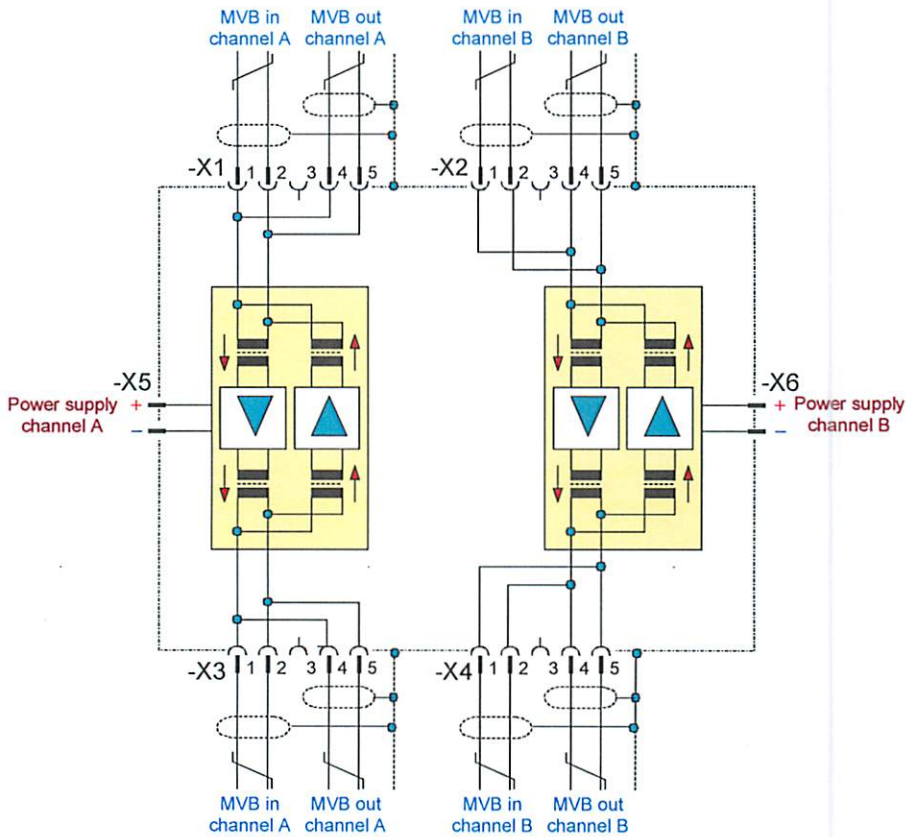

Figure 15 Schematic Circuit Diagram of MVB Repeater

10.4.7 Human Machine Interface

Each driver's cab is equipped with a human machine interface (HMI), which is connected to the vehicle control and diagnostic system via MVB.

The HMI consists of a display for monitoring and a modular PC for industrial use.

The HMI is mounted in a manner that ensures that the display can be read under all circumstances. A day/night changeover function is provided.

10.4.7.1 Display in Driver Mode

A whole overview of the train conditions is shown on the operation screen. The operation screen is divided in different areas (see Figure 16).

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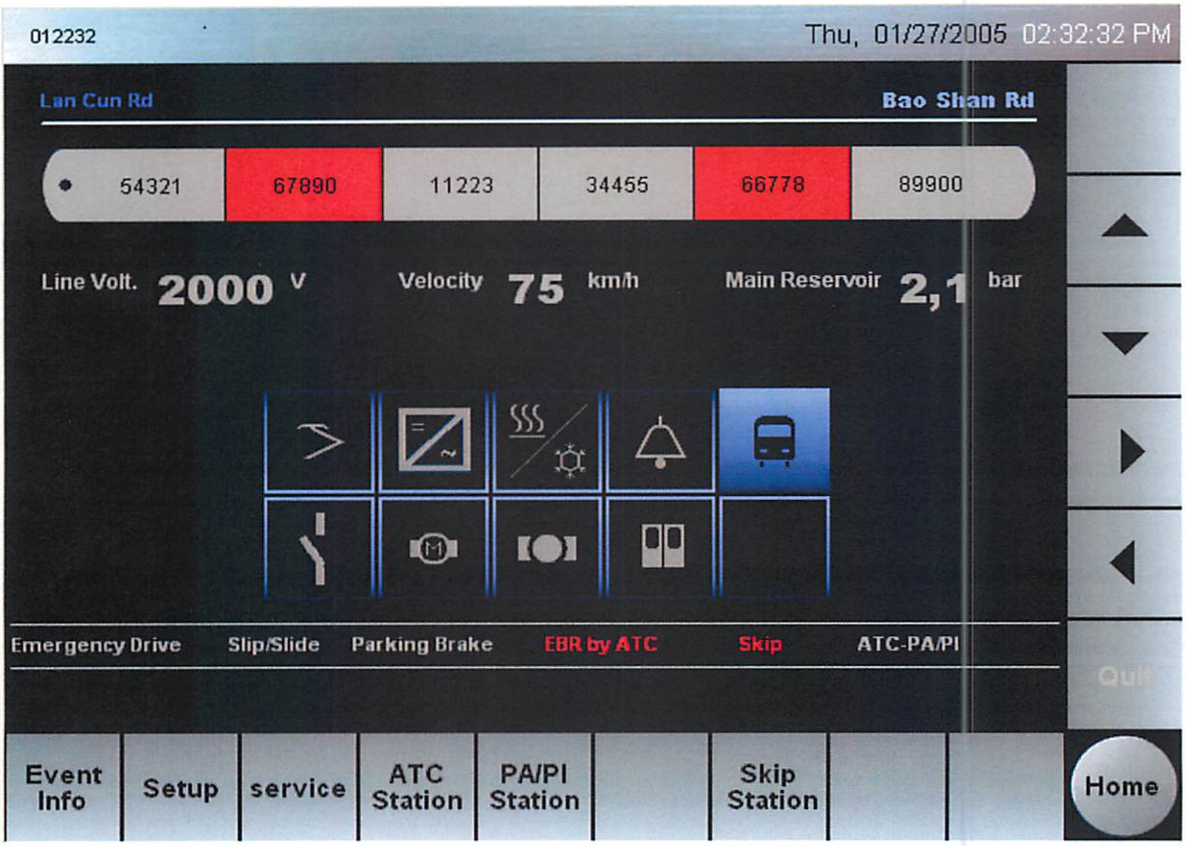

Figure 16 HMI Operation Screen (Example)

<u>Header line</u>

In the header line the train number, the screen title and the actual date and time are shown.

<u>Passenger information area</u>

The current station (left) and the destination (right) are displayed.

<u>Trainset area</u>

The trainset is displayed, within the cars additional information acc. to the evaluation by the driver will be shown (e. g. car number, brake status, activation of an emergency intercom, etc.). The objects within the trainset or several cars are shown in different colours.

Subsystem area

The driver can choose a function overview, which will be displayed inside the trainset area. The chosen function will be marked.

The symbols shown in Figure 16 represent:

- Pantograph.
- Auxiliary inverter.
- VAC.
- Emergency intercom.
- Car numbering.
- High speed circuit breaker.
- Traction system.
- Brakes.
- Doors.

11 RK Lighting

11.1 Interior

11.1.1 Passenger Compartment Lighting

The passenger compartment lighting is powered by the DC 110 V battery system. In normal operation, both circuits for normal lighting and the circuit for emergency lighting are switched on. In case of failure of the overhead power supply, of one auxiliary inverter or one battery charger, one or both circuits for normal lighting are switched off to prevent the battery from being discharged. The circuit for emergency lighting remains switched on without any interruption. The emergency lights will provide an appropriate illumination level at floor level and in doorways.

Arrangement of the light fittings will be such to avoid that shadows will be cast on seated passengers, signage or advertising panels.

11.1.1.1 Power Supply

All lighting is driven from the DC 110 V circuit. Ballasts are used to create the AC 230 V supply for standard fluorescent lamps.

11.1.1.2 Lighting Circuit

There are two separate lighting circuits for normal light and one for emergency light. The failure of one lighting circuit will not affected the other circuits, the light will be evenly distributed throughout the car from the other circuits.

11.1.1.3 Lighting Intensity

The interior lighting will be evenly distributed throughout the vehicle, the average lighting intensity is approx. 300 lx at height of 0.8 m above TOF at the whole voltage range.

11.1.1.4 Lighting Fixtures

Lamps for both normal and emergency lighting are mounted on the vehicle ceiling. The lamps, fixtures and lamp covers are easy to replace and cleaning. The lamps are covered with a polycarbonate cover to minimise dazzle. The cover is of minimum thickness to minimise lighting loss.

11.1.1.5 Lighting Control

A lighting control switch is provided in the driver's cab and is enabled by the master controller key.

11.1.2 Cab Lighting

The driver's cab lighting is powered by the DC 110 V battery system. The ceiling lamps can be switched on or off together by the driver as required. In case of emergency the lighting remains switched on without any interruption.

11.2 Exterior Lighting

11.2.1 Head Lights

The head lights on the right and left side are located at the No. 1 end of each Mc-car. They are powered from the DC 110 V supply via DC/DC converters. Both "high beam" and "low beam" intensities are provided.

The lamp fixtures are adjustable, so horizontal and vertical adjustment can be done.

11.2.2 Tail Lights

The red tail lights are equipped with LED technology, they are located close to the head lights. The tail lights are powered from the DC 110 V system via DC/DC converters.

12 RL Air Conditioning and Ventilation

12.1 Ventilation of Passenger Compartment

12.1.1 System Description

The vehicles will be equipped with a heating and ventilation system (HV) system offering a high level of comfort to passengers considering the environmental conditions. Special attention will be paid to ensure high reliability in function, good access for maintenance, maximum effectiveness and minimum energy consumption.

The HV system will provide the following functions for passenger compartment and for driver's cab:

- Heating
- Ventilation.

12.1.2 Air Flow

The units are designed to supply the air flow necessary to achieve the specified interior conditions, e. g. temperature, relative humidity and fresh air rate, as fundamental requirements. Design will be in line with the requirements on EN 14750 Railway applications – Air conditioning for urban and suburban rolling stock.

Ducting will be specially designed to achieve adequate noise levels. The adjustable air diffusers will be designed to avoid condensation.

During emergency ventilation, cab ventilation will be switched off and 100 % fresh air will be supplied to the cab via the passenger compartment due to overpressure.

12.2 Air conditioning of Driver's Cab

Drivers cab will be equipped with a roof mounted compact unit.

13 RN Doors

13.1 Passenger Doors

13.1.1 General

Each car will have four doorways per car side.

The door mechanism system will be composed of or based on service proven products. The system will provide high reliability and safety and its key elements will be reliable, wear resistant and will have long operation life.

The door will be double leaf outside sliding plug door or sliding door and electro-motor driven.

Clear opening width will be 1400 mm ±10 mm up of mid height of door leaf. In lower portion (below 300 mm above Top of Floor) a slight reduction to 1375 mm (door post cover-lining) is permitted; height will be 1950 mm.

Crew key and anti-slip footstep will be provided at one door of each side per car. Vertical handrail at doorpost lining will serve as comfortable handrail for maintenance people entering passenger compartment from line side.

Gauge requirements of door opening and closing will satisfy the relevant stipulations.

In order to secure safely and timely operation, door will be designed with mechanical locking and unlocking configuration and trouble isolation device.

The door open and close situation of each door will be displayed on cab's screen display.

13.1.2 Door Closing Time and Force

Function of adjustable door opening and closing speed will be provided meaning door opening and closing time will be adjustable.

The opening and closing time will be 3 s ±0.5 s, the adjustable range will be from 2.5 s to 4.0 s. The door closing force will not be more than 150 N for the first closing attempt.

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13.1.3 Door System Configuration

Each door system includes the following main parts:

- Upper mounted door driving device.
- Door hanging device.
- Two door leaves.
- Electronic door control unit (EDCU).
- Emergency egress device (EED).
- Integrated guide rail (in door leaf).
- Sealing components.
- Signal and indication light output.

13.2 Door Operator System

The entire operating blocks will be designed to be a pre-assembled and pre-wired sub-assembly and ready for installation in the cars.

13.3 Door Hanger and Movement

Hanger and movement mechanism will be designed to provide normal operation under specified climatic conditions. Movement will be smooth, unobstructed and quiet. The passenger door will be designed to secure door opening and closing being insensitive to changes in car camber and passenger loading. Door leaf mounting system will ensure easy adjustment of correct position and gap between adjacent door leaves and, between door leaves and car body.

13.4 Driving Characteristics

Door driving device will be provided with electro-motor and gear or belt. Motor current will be controlled by the electronic door control unit (EDCU). Towards the end of door opening and closing stroke damping will be provided.

13.5 Driving Mechanical Configuration

The DC motor directly drives a spindle rod/nut or notched belt, pulley drive system and is adopted for driving mechanical configuration. Driving mechanism will be designed to bi-park door leaf from centring point synchronously.

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13.6 Locking Device

Safe and reliable door mechanical locking device is installed at the upper part on the door operator and will be designed to provide for door closing and locking and automatic un-locking for door opening.

The following functions can be implemented:

- Door closing automatic locking.
- Door opening automatic unlocking.
- Manual emergency release.

13.7 Car Door Control

Electric control portion will be designed to meet high reliability.

If any door is detected not closed and locked for train in stopped condition, propulsion will be disabled by a train line actuation.

If a passenger door is opened while the train is moving, braking will not be initiated, but train will be prevented from starting by the door open signal after the first stop. Therefore operation will be consequently stopped in the next station.

It will be impossible to open the car doors unless the train stops completely and is at standstill.

Door control will communicate with other correspondent microcomputer control systems through train control net. Display at cab's desk will be designed to display each door's state of opening/closing, cut-off and the state of trouble. The information of cut-off door and trouble state will be stored in vehicle control unit.

The cab's desk display will be still kept with the position message of all cars opening or already closed.

For the driver's operation of the doors of the left train side, there will be a control button located on the left sidewall of the driver's desk.

For the driver's operation of the doors of the right train side, there will be a control button located on the right side wall of the driver's desk.

13.7.1 Door Edge Structure

A soft edge on each side will be provided to prevent injury of passengers.

13.7.2 Obstacle Detection

Automatic obstacle detection system will be provided and controlled by the EDCU electronic door control unit of each door via monitoring the motor current.

The leading edge rubber sealing will allow objects like clothing to be withdrawn and are not detected as obstacle. Combined with the leading edge rubber obstacles with a size of minimum 25 mm x 60 mm will be detected.

13.7.3 Acoustic Signal

Via the EDCU, the public address system allows acoustic signal when door is moving in opening or closing direction.

13.7.4 Door Indication Lamp

An output for indication of door status (opening, closing, cut out) is implemented on the EDCU.

13.7.5 Door Cut Out Device (DCOD)

A door cut out device with its switch is provided on one door leaf of each passenger entrance door with restricted access. It allows isolation of doors that cannot be closed correctly, i. e. "closed and locked" status is not detected. To activate this device, the driver has to close the door leaves manually. Due to the mechanical synchronisation, both door leaves are then closed and can be locked respectively cut out. The switch disconnects the power supply to the motor, switches on the door status indicator lamp and allows bridging of the safety loop (permanent door closed status). Such a door cannot be opened (automatically or manually) before the cut out device is reset.

13.7.6 Emergency Egress Device (EED)

A manual unlocking device will be provided inside the car adjacent to each door, so that passengers are capable to unlock doors in case of an emergency situation. The "unlocked" message of the concerned doors will be indicated at cab's control panel. Passenger emergency unlocking device will be provided with proper measures and warning signal aiming at protection against unauthorized door opening by passengers.

13.7.7 Crew Key Switch

In order to allow access to car form outside and inside for staff, firemen, rescue parties and driver, on each car side (inside and outside) one crew key switch is provided.

To open the adjacent door, neither power supply nor battery power is required. The function is realized by using the EEDC and the EADC to open the door manually. For location refer to **Error! Reference source not found.**.

The EEDC has the same size and function as the EED but additionally allows the passenger to use it for emergency opening, also drivers or staff to use it as crew key switch.

To activate the EEDC without breaking the protection, a standard square key is used. This key also allows activating the EADC, which is located outside of the car.

13.8 Door Leaf Construction

Each door leaf will be provided with a fixed window made of safety glass, which will be well sealed against water and moisture. The size of the window will be approx. 380 mm x 880 mm (clear view). Each door leaf is equipped with a smooth rubber sealing at the leading edge, which allows easy removing of small and tiny items e. g. clothes and guarantees also smooth jamming of obstacles e. g. passengers.

The window leaf will be designed to meet the interior and exterior appearance requirements of train general design as well as functions of thermal and noise isolation and excellent tightness.

Construction of door leaf will use aluminium frame with honeycomb core bonded by aluminium sheets.

13.8.1 Door Control

Each door system is equipped with an electronic door control unit (EDCU). Each EDCU is a microprocessor unit and communicates with the train line interface. It is of service proven design which meet the standards of EN 50155 and EN 50121-3-2. The EDCU software is not regarded as safety related software.

13.9 Cab Side Door

13.9.1 General

Each cab will be equipped with a hinged type door on each side.

The structure of cab side door will be designed to be simple, high reliable and wear resistant. The inside material will be equivalent to that of the passenger doors.

On both sides of the cab side door proper handrails or moulds will be provided. Anti-skid footstep enabling driver to climb into the cab directly from the rail level will also be provided. Neither handrail nor foot step will infringe kinematic envelope.

13.9.2 Cab Side Door Window

Each door leaf will be provided with a single glass window. Safety qualification mark will be labelled on safety glass.

13.9.3 Cab Side Door Lock

The cab side door can be locked and opened from inside and outside. Inside a simple locking mechanism (knob) will be provided. Outside a locking key (e. g. square key) will be used to unlock the door. The lock will have sufficient strength and can resist a certain force of impact. One simple handle at suitable height will be used to open the door from outside (track or platform level) and inside. It will be avoided that the driver locks out himself.

13.10 Cab Partition Door

A hinged or sliding type door will be provided between cab and saloon. Clear opening of the door will be approx. 700 mm.

14 RP Train Communication and Passenger Information

For the convenience of the passengers the eight-car trains are equipped with a communication and passenger information system (PIS). This arrangement incorporates acoustic information with a passenger announcement system (PA system with announcements from the operation control centre via radio, driver and automatic digital announcement devices), a passenger emergency communication system and a system for visual information (destination, next stop, etc.).

The communication and passenger information system (PIS) consists of two subsystems:

- Communication system (public address and passenger emergency communication).
- Display system.

It is based on an audio information network and a train data network and controlled by the active PI/PA control unit.

14.1 Functional Description of Communication and Passenger Information System

The communication and passenger information system (PIS) will be configured for operation on the intended route, when the train driver enters the set up data (for example train number, route code) at the cab communication panel.

As the train is in service on specified route, the PIS provides passenger information. This is achieved via public announcements (digital voice announcement system) and displays (internal and optionally external). The automatic route information is operated by distance and door open/close signal.

To generate digitized station announcements and display messages for modification of the pre-programmed PIS, adequate equipment can optionally be provided. Modification is possible to some extend. The maintenance personnel can reload the new data into the PIS by using a storage medium.

Besides the automatic operation the driver has the alternative for manual operation (information given directly via microphone, control of digital station announcement and display messages). Announcements from the operation control centre via radio is possible.

14.1.1 Communication System

14.1.1.1 Public Address System (PA)

The PA system will provide the following functions:

- Announcements from driver to the passengers via microphone.
- Announcements from operation control centre to the passengers via train radio communication.
- Automatic pre-recorded passenger announcements.
- Cab-to-cab communication.
- Automatic volume control depending on background noise.

14.1.1.2 Passenger Emergency Communication System

In the passenger compartments one passenger emergency communication unit (PECU) is provided per car for half duplex communication. If a passenger activates a PECU in case of an emergency an optical and/or an acoustic signal is given to the driver to catch his attention.

14.1.2 Passenger Information System

The passenger information system will provide the following visual information to the passengers:

- Indication of the next stop via two internal passenger information displays (PID) in each car.
- Passive indication of route position via ten route map stickers in each car.

The main features of the PI/PA control units include:

- Interface for loading route data.
- Storage of route data.
- Control and supervising of communication and passenger information system (PIS).
- Service and diagnosis interface.
- Automatic test and check routines for fault recognition and fault monitoring of the PIS.

14.1.2.1 Passenger Information Display (PID)

The internal passenger information display (PID) will provide next stop information to the passengers inside the saloon on one text line. Two PID's of LED display technology per car will be installed in the passenger compartment.

14.1.2.2 Route Map Sticker

The traffic net including stations is represented on up to ten route map stickers which are fixed along the ceiling in the passenger compartment.

15 RQ Pneumatics and Air Supply System and RR Brake System

15.1 General

The train is equipped with two brake systems:

- An electro-dynamic braking system (ED brake).
- An electro-pneumatic braking system (EP brake).

Priority is given to the electro-dynamic braking system for service braking. Emergency braking is provided by the pneumatic brake only.

A direct EP brake is used as brake system, the safety function is achieved by a hardwired electric train line (safety loop).

15.1.1 Main Groups

Equipment is comprised of the following main groups:

- Air Supply Equipment - Group A
- Brake Control Equipment - Group B
- Bogie-Mounted Brake Equipment - Group C
- Microprocessor Controlled Wheel Slide Protection Equipment - Group G
- Air Suspension Equipment - Group L
- Pneumatic Signalling Equipment - Group P
- Pantograph Actuating Equipment - Group U
- Coupling Operating Device - Group W

15.2 System Functional Description

15.2.1 General

The system concept is based on a distributed per car brake.. The microprocessor controlled pneumatic friction brake system with mechatronic control for the service brake includes air-applied brake units without and with spring actuators for the parking brake.

Air supply, air suspension control, and microprocessor controlled wheel slide protection equipment are also offered together with auxiliary equipment such as signalling devices.

The supplied brake system is designed for:

- High accuracy and short response times
- High reliability and therefore availability.
- Easy maintenance.
- Low weight.
- Failure identification and indication.

15.2.2 Brake Control Functions

Following brake control functions will be provided:

- Service Brake Control
- Wheel Slide Protection Control
- Emergency Brake Control

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16 RS Vehicle Linkage Devices – Coupler and Draft Gear

16.1 General

Semi-automatic couplers will be fitted at the front ends of the Mc-cars. Within the train semi-permanent couplers will be provided. Couplers will be compatible with the gangway with respect to passenger load, movements during operation and coupling procedures.

The coupler types as listed below will be provided. Arrangement of energy absorption elements within the train will be provided as necessary for compliance with EN 15227 Vehicle Category C-II if specified.

16.2 Semi-Automatic Coupler

The semi-automatic coupler is designed to ensure automatic coupling of rail vehicles. With two vehicles mating, a rigid and slack-free connection is ensured without manual aid even at very low coupling speeds.

16.2.1 Mechanical Head

The steel-made mechanical head protects the coupler lock. Its face is provided with a male and a female cone which allow the couplers to be automatically aligned and centred and ensure a large gathering range both in horizontal and vertical direction The head face is provided with a broad plane edge which transmits the buffing loads. The draft load is transmitted by the locking system. When coupled, the locking system forms a parallelogram in order to distribute the draft load uniformly to both coupler locks. By that each coupler lock has to transmit half of the load only. This ensures minimisation of wear and increased safety of the locking system.

16.2.2 Air Pipe Connections

Air pipe connections for the main reservoir pipe are arranged in the coupler head face. The connections are automatically opened and closed after completion of the coupling and uncoupling actions.

16.2.3 Energy Absorption System

- The energy absorption system consists of the drawgear, the irreversible shock absorption device (deformation tube) and if necessary the overload protection device.

Maintenance-free rubber cushions providing high energy absorption and damping absorb the draft and buffing loads. The cushions are slack free and subjected to shear stress both on buff and draft. The gear bracket is provided with pivots and maintenance-free bushes, which allow side swivelling of the coupler. The big diameter of the pivots ensures minimisation of wear. The rubber cushion allows the coupler to swing vertically and to absorb torsion movements. The bearing bracket is fixed to the car underframe with four bolts.

The shock absorption feature is designed to ensure absorption of high buffing loads. It is arranged in the coupler shank between the mechanical head and the bearing bracket and protects the car underframe from being deformed. The impact load is converted into deformation energy by plastic deformation of a tube. The force and stroke curve is rectangular without peak load. Both the release load and the stroke of the shock absorption feature is synchronised with the compressive strength of the car.

16.2.4 Centring Device

A mechanical centring device is provided.

16.2.5 Vertical Support and Height Adjustment

The semi-automatic coupler is supported by a maintenance-free rubber spring which is fastened to the draft gear. The spring is provided with adjusting screws which allow adjustment of the coupler horizontal plane.

16.2.6 Operation

The semi-automatic coupler is designed to ensure automatic coupling of rail vehicles. With two vehicles mating, a rigid and slack-free connection is ensured without manual aid even at very low coupling speeds. Gathering range provided, thus ensuring perfect coupling in case of different height and on vertical and horizontal curves; detailed combinations to be applied should be discussed during tender evaluation phase and design phase.

With the cars coupled mechanically, the air pipe connection is automatically connected. Uncoupling is done manually at trackside. After uncoupling and separation of the cars the coupler is again ready to couple.

16.2.6.1 Coupling Action

With two mechanical heads brought together, the spring loaded locking systems are automatically turned and coupled.

16.2.6.2 Uncoupling Action

Uncoupling can be done manually at trackside.

A wire rope has to be pulled when uncoupling manually from trackside. The rope is connected to the coupler lock.

16.3 Semi-Permanent Coupler

The semi-permanent coupler is designed to ensure a permanent connection of railcars which form an operating unit and therefore need not be separated unless in an emergency or in the workshop.

16.3.1 Mechanical Coupler

The drawbars are connected by means of a muff coupling set. The set can be detached easily, thus allowing quick separation of the cars for repair.

The drawbars are provided with a centring hole and a centring pin, which help to align the drawbars during coupling.

16.3.2 Air Pipe Connections

Each drawbar is provided with a connection for main reservoir pipe. When coupled, the air pipe connection is automatically connected thus ensuring a safe and tight connection.

16.3.3 Electrical Connection

The electrical connection between the cars of a train is done by jumper cables (please refer to section 19.1.3).

16.3.4 Energy Absorption System

At the semi-permanent couplers it might be possible to have an energy absorption device only on one side of a coupler-connection, when it is consistent with the complete energy absorption system of the train. For the semi-permanent couplers no overload protection is foreseen.

In the basic version the energy absorption devices are deformation tubes either on one side or on both sides of the coupler connection.

16.3.5 Horizontal and Vertical Adjustment

Please refer to section 16.2.5.

16.3.6 Gangway Support

On both coupler halves are fixed consoles for mounting the gliding plate of the gangway.

16.3.7 Operation

16.3.7.1 Coupling and Uncoupling Action

Coupling and uncoupling of the mechanical heads and the electrical connections are done manually.

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17 RS Vehicle Linkage Devices – Gangway

The gangway is a flexible part of the train, offering passengers a secure and comfortable passageway between adjacent cars even during travelling. It also accommodates the relative movements between the vehicles.

17.1 Description

The gangway comprises two gangway halves that can be connected. These are each made of corrugated bellows, bridge plates, vehicle and connection frame, gliding support on vehicle's coupling.

The corrugated bellows are made of flexible fabric corrugations. The corrugations are sewed together and connected at the outside with powder coated aluminium frames. In the floor area the corrugations are coated with felt on the inside. The ends of the corrugated bellows are connected with the connection and screwing frame by special end-fabrics.

A retaining device prohibits free movement and pitching of the gangway halves and especially the connection frames in an uncoupled position.

The bridge plates on the connection side are built of moveable floor flaps, a floor plate, a support sheet metal, hinges and a security bracket as well as gliding ledges. The floor plate is connected movably with the support sheet metal by a hinge. The floor flaps are each connected by a hinge with the support sheet metal. The gliding ledges are located under the floor flaps.

Because of the fact that the bridge plate segments can move relatively to each other, height misalignments and rolling movements can be compensated.

Finally the bridge plates can be flipped up for inspection or cleaning and be secured with the security bracket.

17.2 Main Properties

The fabric used for the corrugated bellows meets the fire requirements acc. to DIN 5510, fire protection level 3.

Due to experiences in laboratories with similar executions a sound insulation of approx. 27 dB(A) can be expected.

The heat insulation value (k-value) is: $k_{total} < 4\ W/(m^2\ K)$.

The operating temperature is approx. -30…+80 °C in case of normal environmental influences. At a temperature below -10 °C a more sluggish coupling can be expected.

Experience has shown that a service life of approx. 10…15 years can be expected for the corrugated bellows.

18 RT Supporting Systems, Enclosures

18.1 Material Requirements and Surface Treatment of Underframe Equipment Enclosures

Boxes, hardware and latches will be made of stainless steel, corrosion resistant coated steel or aluminium. The equipment boxes will be reliably and safely grounded.

Equipment boxes made of stainless steel need not to be painted inside and outside. Boxes made of aluminium will be painted outside.

18.2 Underframe Equipment Supports

All equipment enclosures will be safely supported, the connections between them will be easily dismounted so as to replace equipment boxes.

Equipment containers will be attached to the car body structure acc. to the following principles:

- Brackets are mechanically fixed and secured against longitudinal movement. Bolts and nuts (if used) will be tightened to the specified torque.
- Nuts and bolts will not carry the vertical load unless adequate alternate suspension measures are undertaken, but have to provide the necessary clamping force as to avoid any movements due to design loads.
- Container brackets rest on top of the brackets as to provide safety against falling off.
- Controlled torque tightening will be indicated by means of paint marking of the nut.

18.3 Underframe Equipment Enclosures

All underframe mounted equipment will satisfy train profile gauge. Location will take into account necessary accessibility within the given limits of weight distribution and supporting structure for brackets.

In order to protect people's safety, all equipment that could possibly pose a danger will be permanently and clearly marked with easily visible safety signs.

Openings will be of sufficient size and the cover can be removed to permit removal and replacement of any component in common enclosure, except for the brake resistor units of the brake resistor enclosure.

Equipment and equipment supports will be designed acc. to EN 12663.

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19 RU Electrical Wiring

19.1 Wiring Requirements

19.1.1 Wiring Inside the Car Body

One cable duct runs each on the left and the right side of the roof through the passenger compartment. At the car ends cross ducts will be used to guide the cables and wires. Cables and wires will be fixed with cable ties.

Cables and wires to the cab will run through conduits via the underframe area.

19.1.2 Underframe Wiring

At the underframe area wires with insulation and without additional sheath will be protected by cable ducts, conduits or other enclosures, except for wiring inside of underframe boxes (e. g. junction box, low voltage box, high voltage box, etc.). Cables and wires with additional sheath may run free from the carrier (cable duct, conduit or other enclosure) to the underframe box without ducting. However, protective elements will be provided in locations where these cables may be vulnerable to foreign object damage. Cables and wires will be fixed with cable ties.

All wire and cable entrances and exits to all enclosures, excluding punched underframe cable ducts, will be watertight acc. to IP54. Sealing gaskets will be provided.

Wires in wire ducts, closed or open, will be fixed to ensure stable position during operation.

19.1.3 Inter-Car Connection

19.1.3.1 Jumper Cables

Basically, jumper cables will be used to connect two cars. The cables and wires will be protected with flexible conduits.

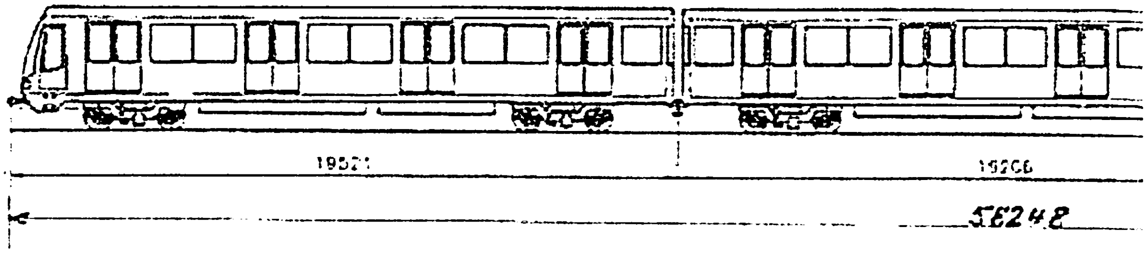
20 Abbreviations

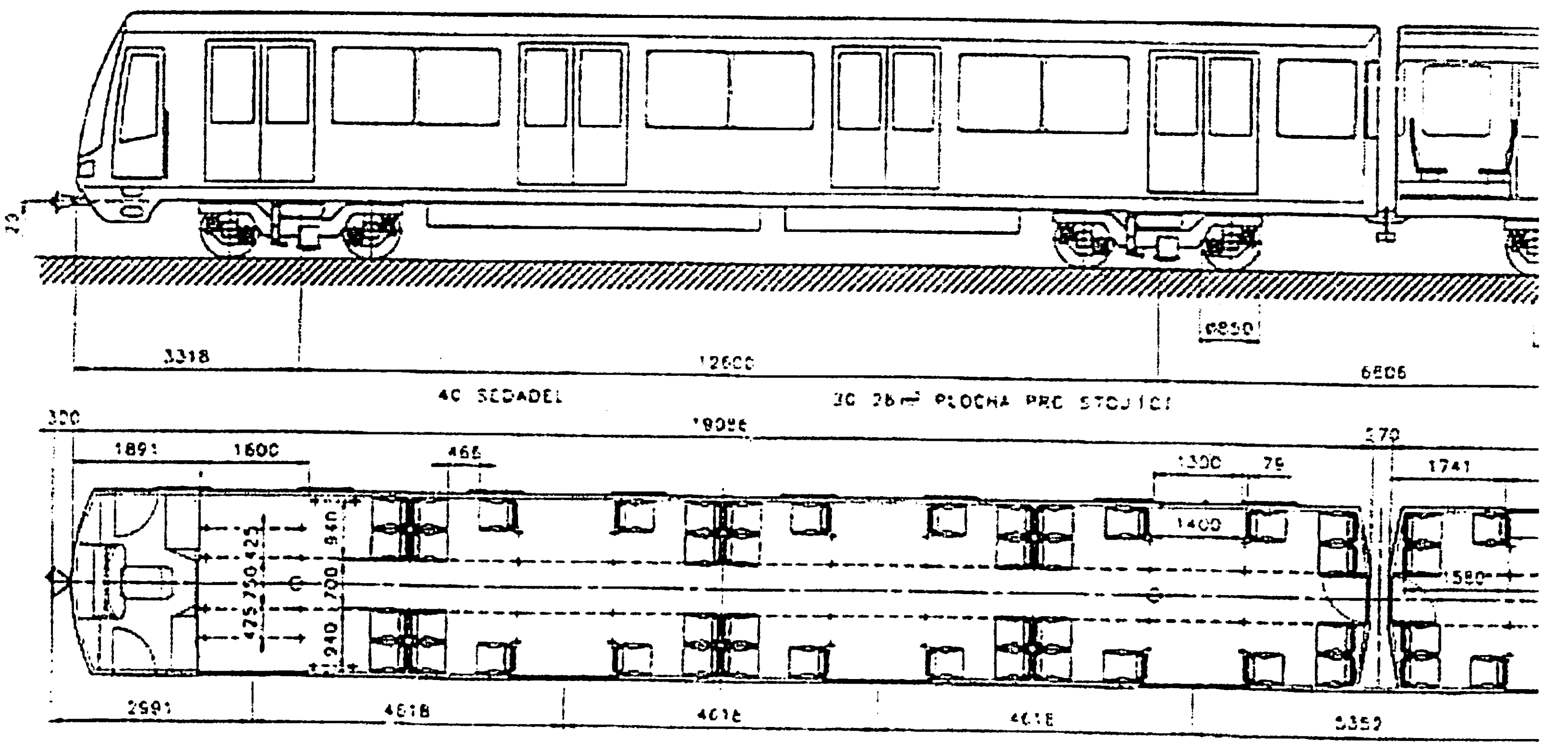
Abbreviation	Definition
AC	Alternating Current
AF	Audio Frequency
AI	Auxiliary Inverter
ASM	Air Supply Module
ATC	Automatic Train Control
ATO	Automatic Train Operation
ATP	Automatic Train Protection
BCP	Brake Cylinder Pressure
BSR	Brake Supply Reservoir
CACU	Cab Audio Control Unit
CAN	Controller Area Network
CCF	Central Control Functions
CCTV	Closed Circuit TeleVison
CIO	MVB Compact I/O
DC	Direct Current
DCOD	Door Cut-Out Device
DVAS	Digital Voice Announcement System
EAD	Emergency Access Device
EADC	Emergency Access Device with Crew key
EB	Emergency Brake
EBCU	Electronic Brake Control Unit
ED	Electro-Dynamic
EDCU	Electronic Door Control Unit
EED	Emergency Egress Device
EEDC	Emergency Egress Device with Crew key
EMC	Electro-Magnetic Compatibility

Abbreviation	Definition
EMDB	Electric Middle Distance Bus
EMI	Electro-Magnetic Interference
EMU	Electric Multiple Unit
EP	Electro-Pneumatic
EPDM	Ethylene Propylene Diene Monomer
FDD	Final Destination Display
FRP	Fibre-Reinforced Plastic
FSM	Flashing Station Map
HMI	Human Machine Interface
HPL	High Pressure Laminate
HSCB	High Speed Circuit Breaker
I/O	Input/Output
ICU	Inverter Control Unit
IGBT	Insulated Gate Bipolar Transistor
KLIP	Interface unit to connect common hardware to the MVB (KLIP: German notation)
LAHT	Low Alloy High Tensile
LED	Light Emitting Diode
M-car	Motor car
MCB	Miniature Circuit Breaker
Mp-car	Motor car with pantograph
MRE	Main Reservoir Equalising
MVB	Multifunctional Vehicle Bus
NCS	Natural Colour System
PA	Public Announcement
PC	Personal Computer
PCB	Printed Circuit Board
PECU	Passenger Emergency Communication Unit

Abbreviation	Definition
PID	Passenger Information Display
PIS	Passenger Information System
PROM	Programmable Read-Only Memory
PVC	Polyvinylchloride
RAM	Random Access Memory
SACU	Saloon Audio Control Unit
SCU	Sub Control Unit
SIBAC	Siemens railway traction container (SIBAC: German notation)
SIBAS	Siemens railway automation system (SIBAS: German notation)
SKS	SIBAS-KLIP Station
Tc-car	Trailer car with cab
TCF	Traction Control Functions
THD	Total Harmonic Distortion
TOF	Top Of Floor
TOR	Top Of Rail
VAC	Ventilation Air Conditioning
VCU	Vehicle Control Unit
VVVF	Variable Voltage, Variable Frequency
WSP	Wheel Slide Protection

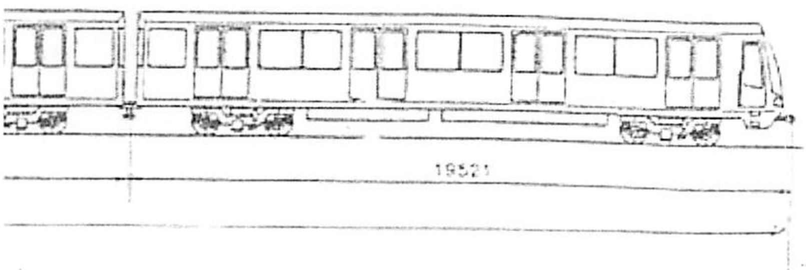
Table 16 Abbreviations





Main Tecnical Data

Length of the Unit	58.250 mm	Acceleration	1,2 m/s²
Width of the car body	2.712 mm	Desceleration	1,1 m/s²
Height of the car	3.600 mm	Nrc. of Seats	128
Track gauge	1.435 mm	Nrc. of standees	554 (6Pers./m²)
,ximun service speed	80 km/h	Line Voltage	750 V DC 1500 V DC (Panto)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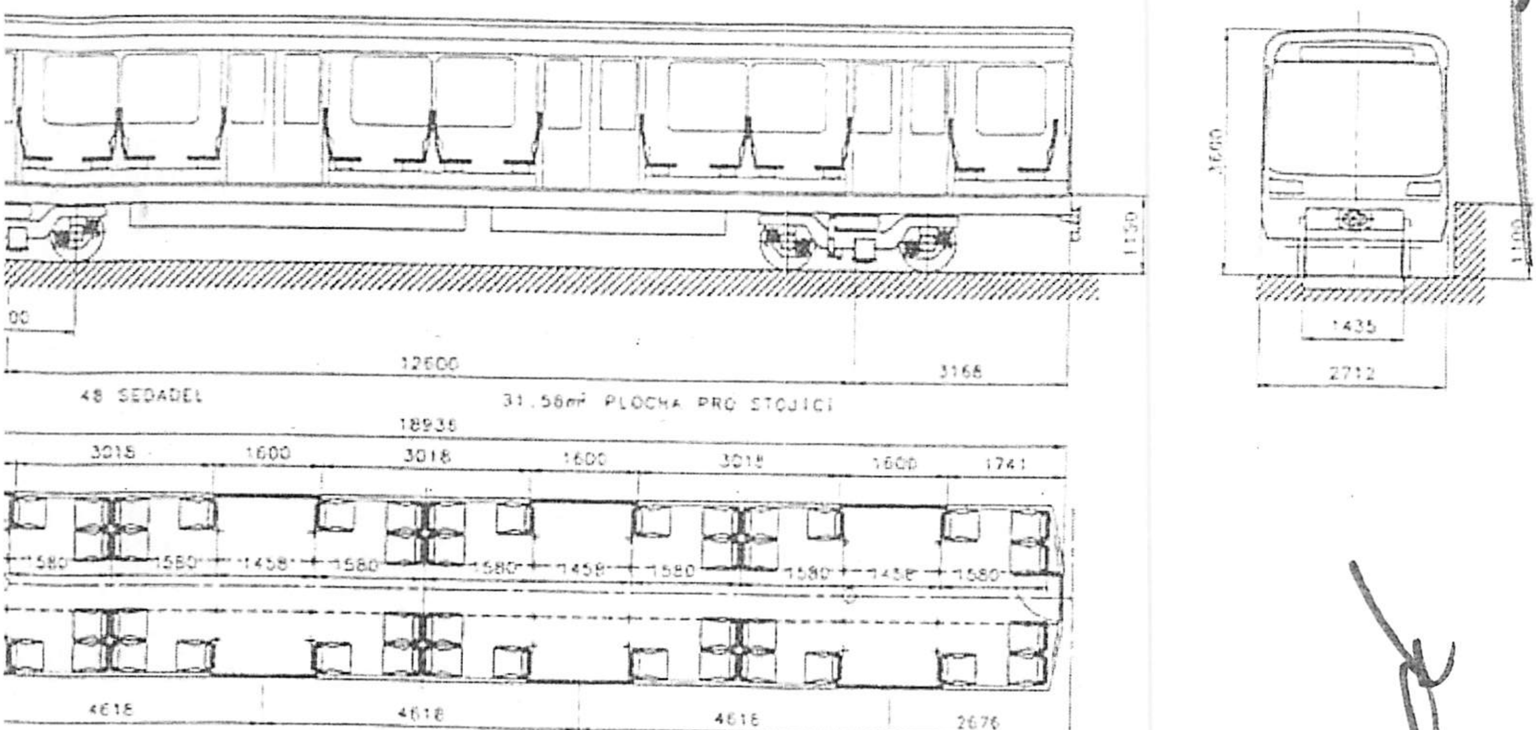
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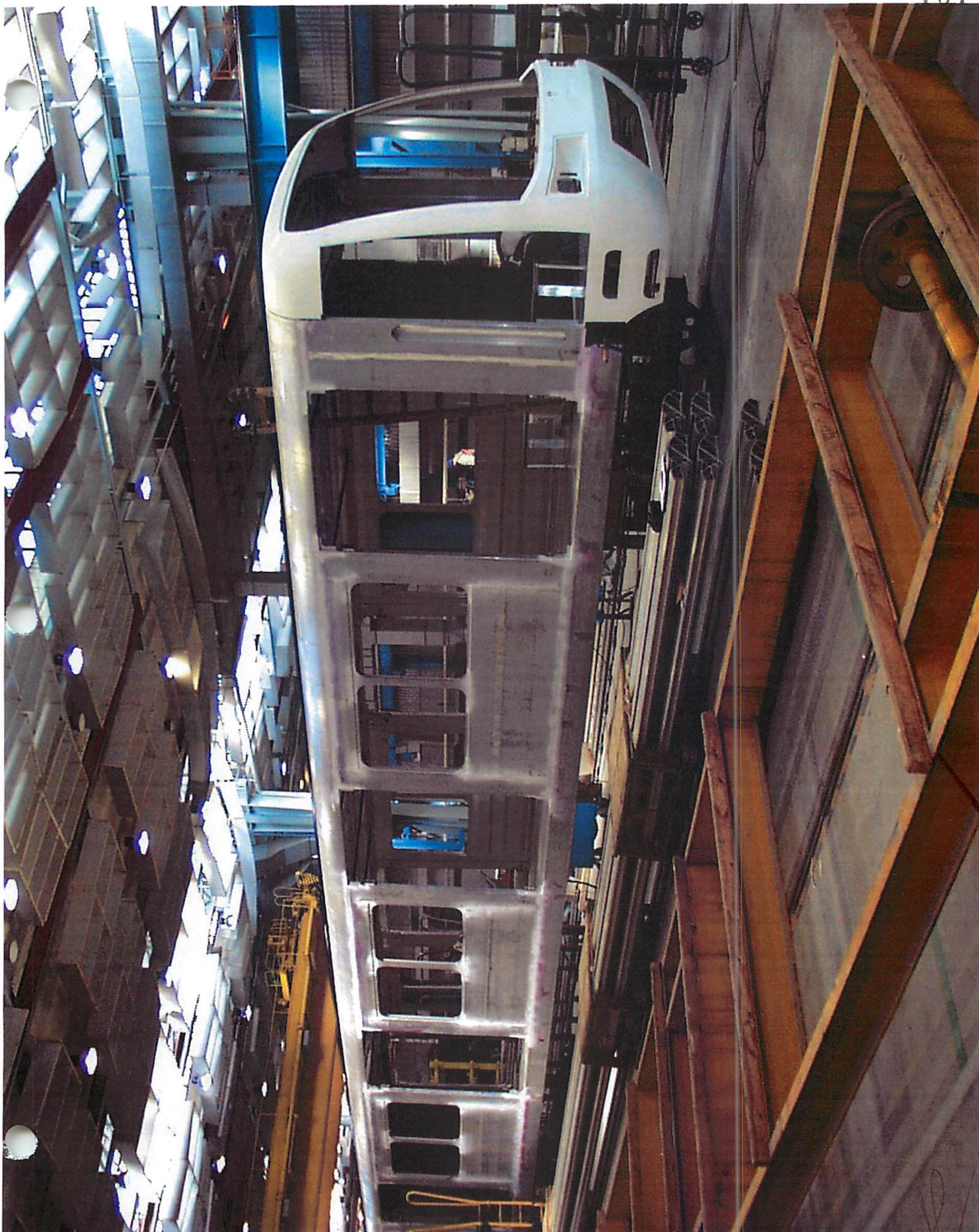

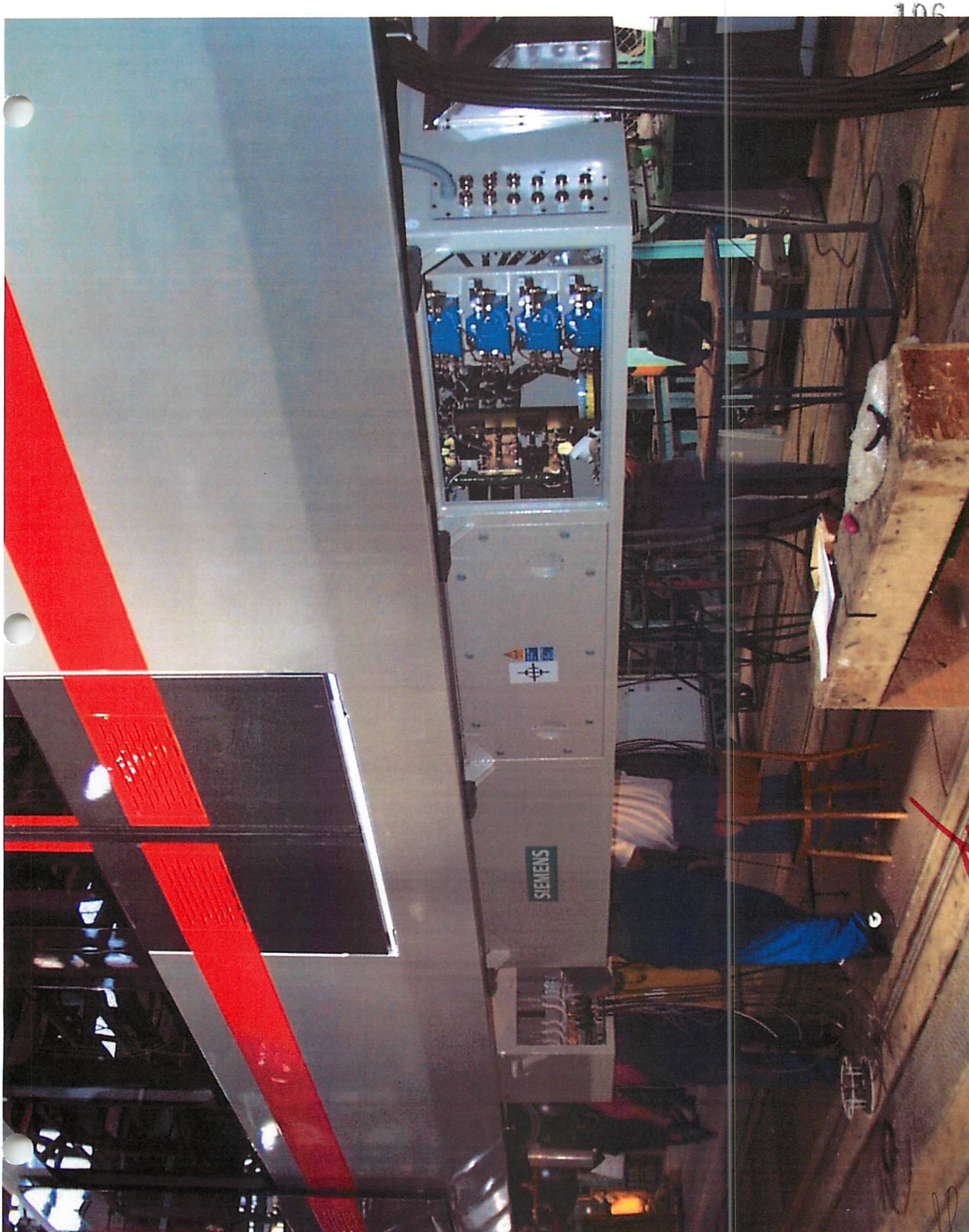
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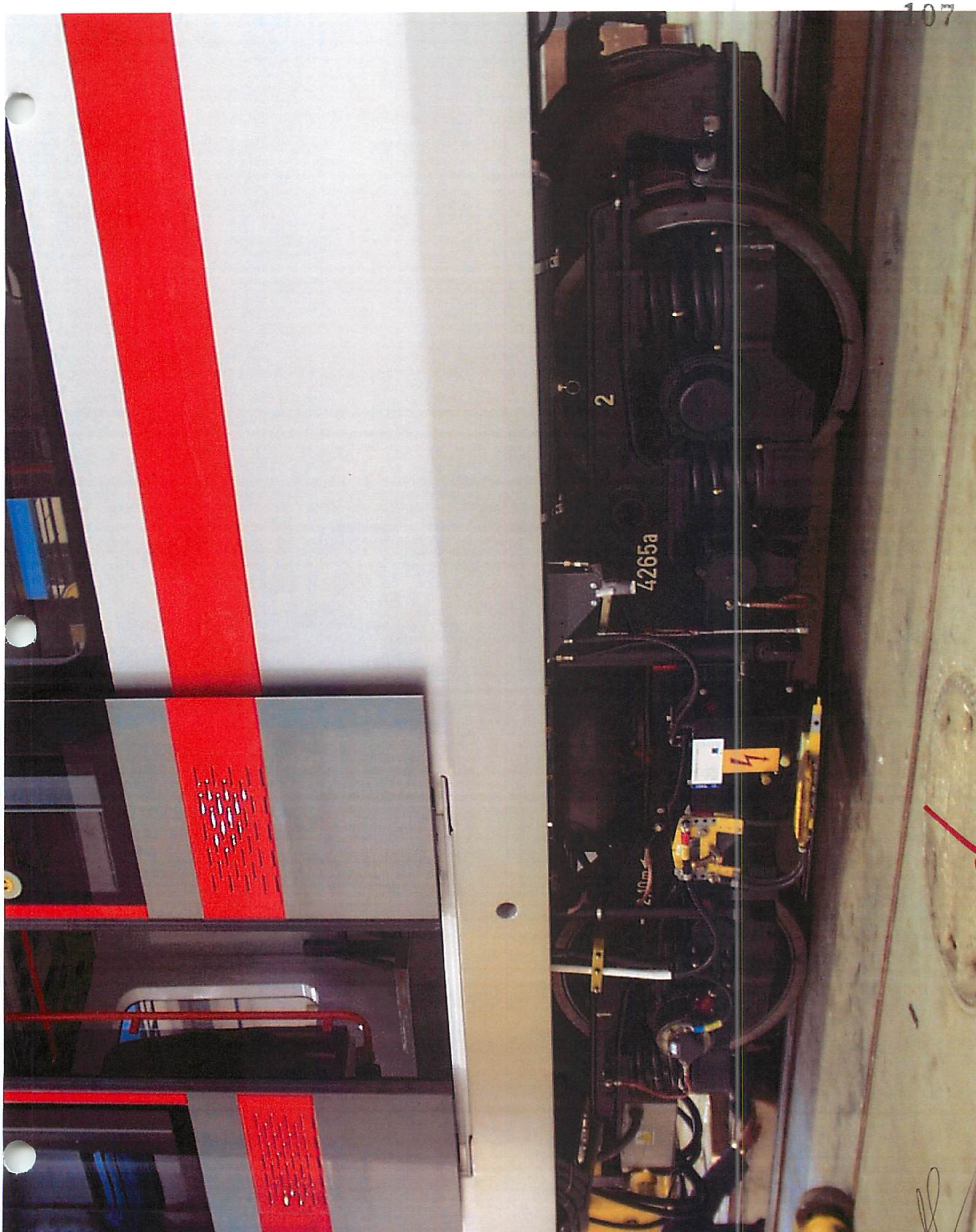
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