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Product Description

Mini Toy Train

Issued On: 10th October 2020

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1. INTRODUCTION

1.1 About the Project

This document gives a brief description of how we CC Engineers Pvt. Ltd. has been developing a Smart Mini Bullet Train (SMBT) project at ***Nandankanan Zoological Park, Barang, Bhubaneswar.*** The document mainly revolves around the prime features that are present in the SMBT and key aspects of our project.

2. ABOUT CC

C.C. Engineers is the pioneer and leader in India for imparting and contributing towards quality training in Railway and is proud to announce to all our valued customers, whom we consider a partner in the progress of our organization, that we have been supplying quality simulator/fault simulators for the last 30 years. C.C. has been manufacturing and supplying Simulators to various Railway and Metro Training Centre's for 15 years now and is proud to be the largest ***Indian Service Provider for Training Equipment*** to the Indian Railways.

Our Performance Report:
We have supplied several pieces of equipment to World Bank Funded Projects. Our client list of more than 150 Vocational and Technical Institutes stand testimony to our qualifications.

Projects for Indian Railways:
We have successfully executed projects for Indian Railways of developing Supervisor Training Centers. The job involved Civil Works, Development ofTrainingSystemsspecificallyforRailwayapplicationsviz.Refrigeration& Air Conditioning Lab, Carriage and Wagon Lab, and Multimedia e-Learning Software for the Training Centers.

We have designed, developed, supplied, and commissioned Toy train at National Rail Museum, New Delhi.

Quality Management:
We are an ISO 9001:2015 Certified company and follow Quality Systems strictly.

This document provides a brief overview of the Toy Train that M/s.C.C. Engineers Pvt. Ltd., Pune, Designs, and Develops.

3. Abbreviation

3D	3 Dimensional
AC	Alternate Current
AR	Auxiliary Reservoir
ART	Auxiliary Reservoir Tank
ATO	Automatic Train Operation
ATP	Automatic Train Protection
BC	Brake Cylinder
BG	Bogie
BLDC	Brushless Direct Current
BP	Brake Pipe Pressure
C-SIDE	Cab Side
CCEPL	Cc Engineers Pvt. Ltd.
CCTV	Closed Circuit Television
CCU	Central Computing Unit
D-SIDE	Door Side
DC	Direct Current
DMC	Driver Motor Car
DVA	Digital Voice Announcement
DVR	Digital Video Recorders
ESD	External Side Displays
g	Grams
HDMI	High-Definition Multimedia Interface
HDSCL	Hubballi Dharwad Smart City Limited
HMI	Human Machine Interface
HVAC	Heating Ventilation and Air Conditioning
ISD	Internal Single Displays
km/h	Kilometers Per Hour
LED	Light Emitting Diode
LSD	Later Stages of Design/Development
m	Meter/ Meters
mm	Millimeters
MS	Grade 43 mild steel
MR	Main Reservoir
MRP	Main Reservoir Pipe
PA	Passenger Address
PECU	Passenger Emergency Communication

PIS	Passenger Information System
sq. m	Square Meter
SMBT	Smart Mini Bullet Train
TCMS	Train Control and Management System
TDS	Train Diagnostic System
TPC	Trailer Passenger Car
W/m^2	Watt Per Meter Square
USB	Universal Serial Bus
V	Volts

4. PRODUCTOVERVIEW -

The SMBT is a scaled-down model or replica of a bullet train. The SMBT has an outer structure similar to a bullet train which makes our product stand out among the rest. It is designed in such a way that it can provide a train ride to all age groups. Special attention is given to the safety and security of both the passengers and visitors. The train is powered by two powerful electric motors located at either end of the train. The coaches are well equipped with all the modern facilities to give comfort and keep the ride entertaining for the passengers.

The train consist of two different car types:

i. Driver Motor Car (DMC) with a battery bank, propulsion system, and driver Cab.

ii. Trailer Passenger car (TPC).

The cars are put together in two sets of three-car units, DMC – TPC – TPC – TPC – TPC - DMC forming a 6-car configuration operational in both directions. The six-car configuration accommodates approx. 64 adults / 80 children.

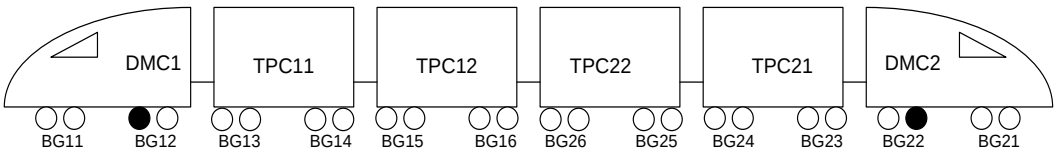

Figure 1 Train configuration

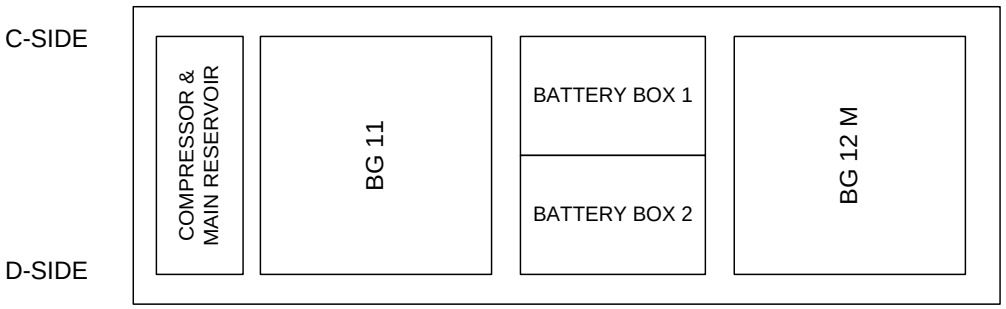

Figure 1: DMC Configuration

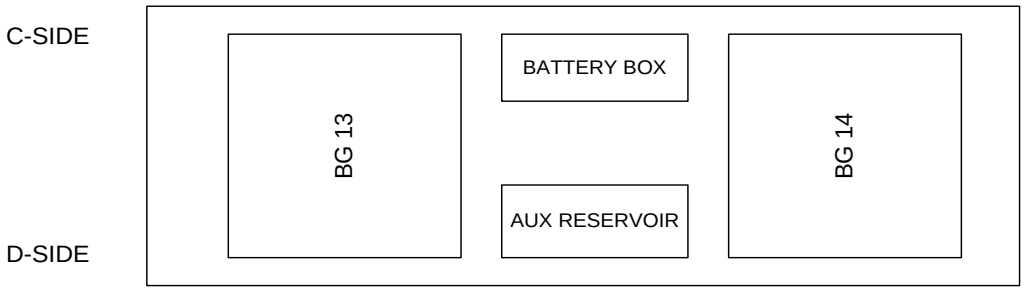

Figure 2: TPC Configuration

The passenger comfort is provided by an air comfort system through roof-mounted HVAC units. One passenger door on the platform side of each car provides passenger access to and from the interior saloons. The interior design creates a welcoming environment for passengers with special emphasis on children. With the climate system, longitudinal seats, side rails, and a well-developed information system (audio and visual) ensure passengers a safe, comfortable, and enjoyable journey. The train is based on the latest technology available with a BLDC motor-based battery-operated propulsion system, centralized train control including a monitoring system, and a communication network connecting many of the on-board systems.

4.1 Nomenclature

DMC1	-	Driver Motor Car 1
DMC2	-	Driver Motor Car 2
TPC11	-	Trailer Passenger car 1 powered by DMC 1
TPC12	-	Trailer Passenger car 2 powered by DMC 1
TPC21	-	Trailer Passenger car 1 powered by DMC 2
TPC22	-	Trailer Passenger car 2 powered by DMC 2
BG11	-	Bogie 1 - DMC 1
BG12M	-	Motorized Bogie 2 - DMC 1
BG13	-	Bogie 3 -TPC 1 of DMC 1
BG14	-	Bogie 4 -TPC 2 of DMC 1
BG15	-	Bogie 5 -TPC 2 of DMC 1
BG16	-	Bogie 6 -TPC 2 of DMC 1
BG21	-	Bogie 1 -DMC 2
BG22M	-	Motorized Bogie 2 -DMC 2
BG23	-	Bogie 3 -TPC 1 of DMC 2
BG24	-	Bogie 4 -TPC 1 of DMC 2
BG25	-	Bogie 5 -TPC 2 of DMC 2
BG26	-	Bogie 6 -TPC 2 of DMC 2

4.2 Equipment Locations

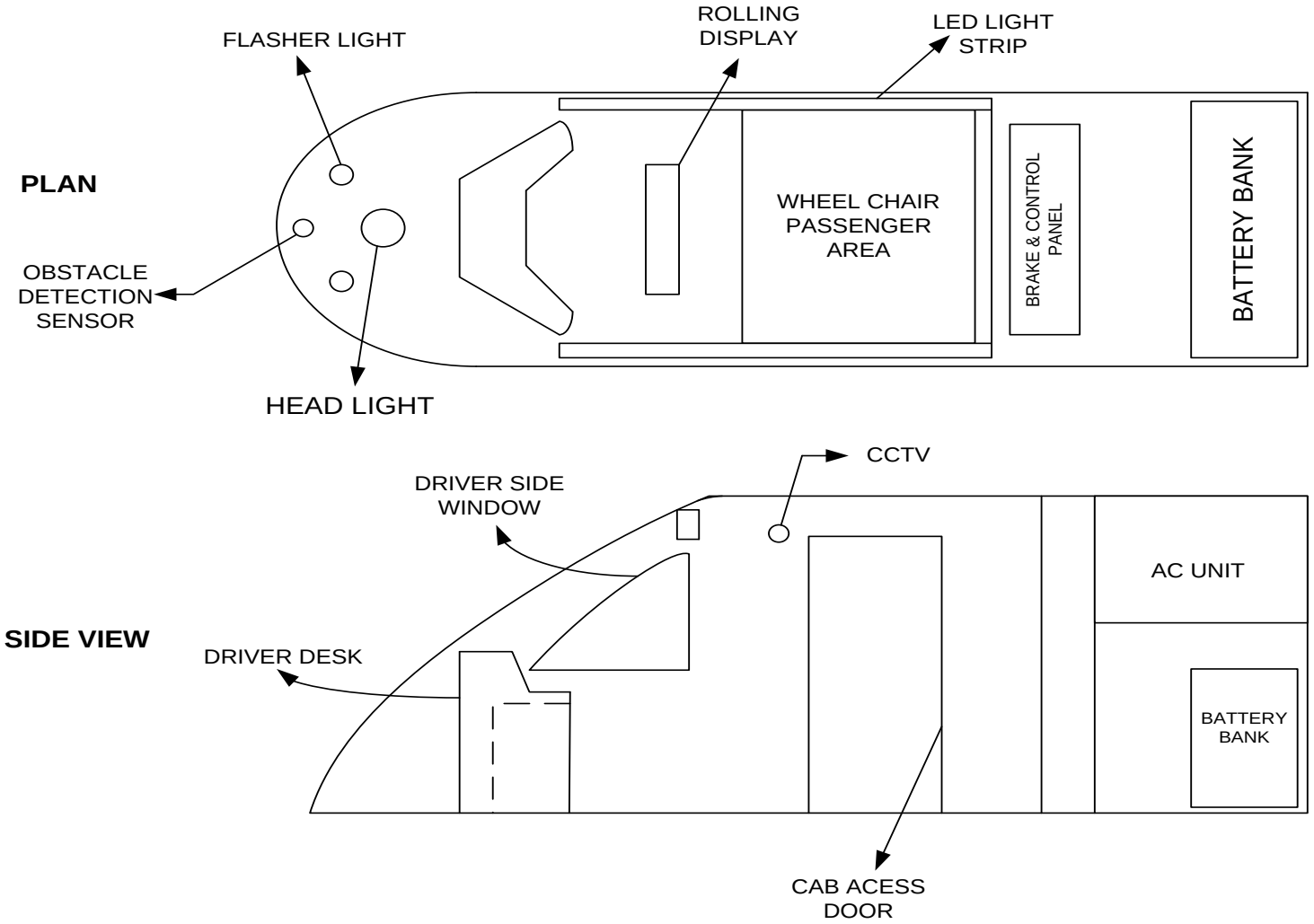

Figure 3: DMC Equipment Location

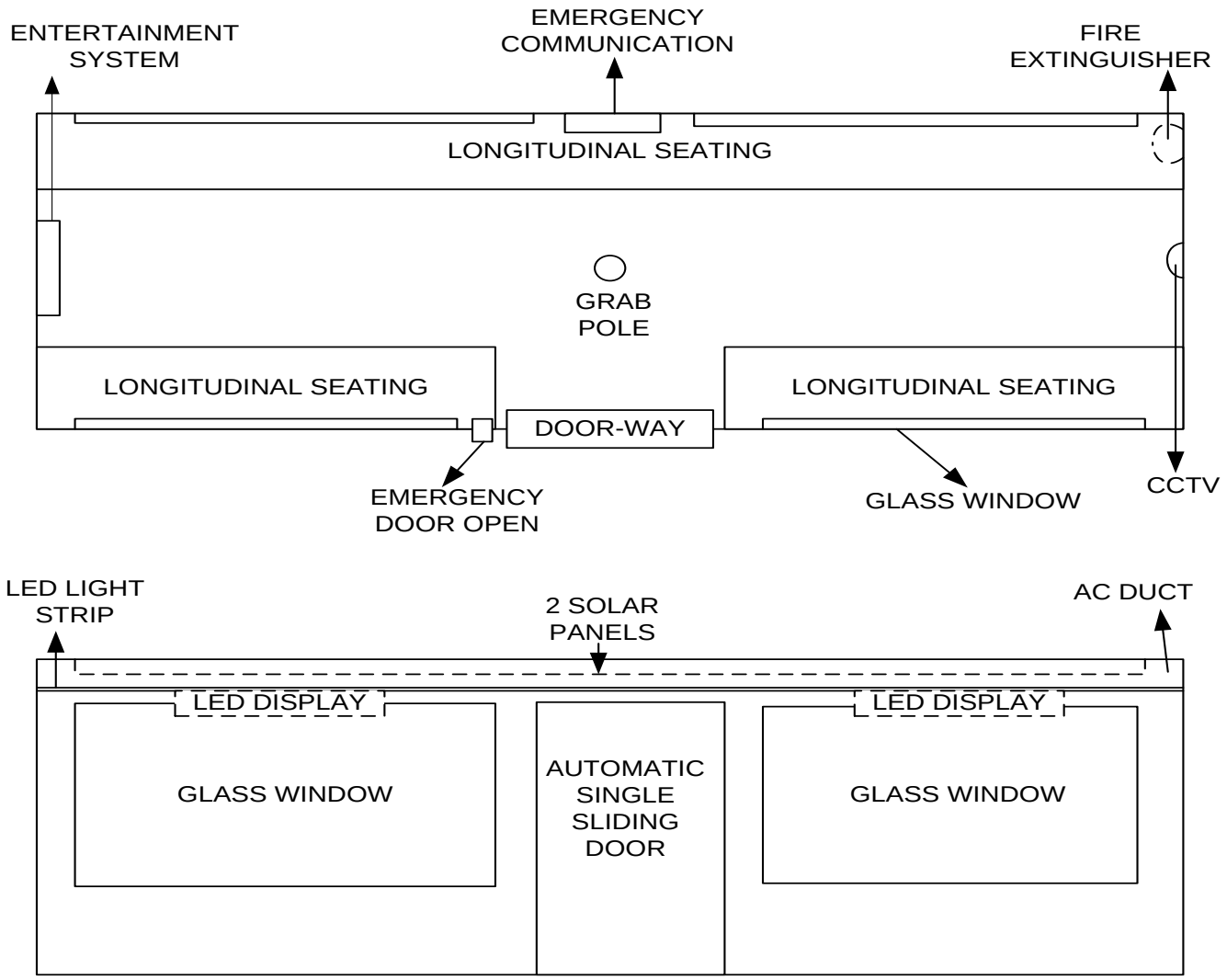

Figure 4: Layout of Equipment in Trailer Car

5. SMBT

The SMBT consists of 1DMC - 4TPC - 1DMC configuration, with the driving DMC acting as the leader and the other as a follower. We have made sure that there is enough space for visitors to have an enjoyable ride. It is designed to run on a 610mm track around the park. It runs to and fro between the main station and the platform. Three is also a bridge in between which takes the SMBT's ride experience to the next level. As for safety, the whole track is fenced off on one side to avoid direct contact with the passersby and there are railway crossings provide at certain locations to allow people to cross the track safely.

Some of the built-in key features are:

- Vehicle designhasa pleasant, cheerful passenger environment with low noise levels, climate control, facilities for children's entertainment.
  `
- Integrated Passenger Information System with external and internal displays as well as digital route maps given the passengers on board as well as those standing on the platform's information about the route.

- Closed Circuit Television (CCTV) cameras inside and outside, enabling the train operator additional information.

- Energy-efficient battery and solar operated train propulsion technology, utilizing BLDC motors with high capability to regenerate electric braking.

- Rugged bogie design, providing excellent performance, safety, reliability, and high tolerance to passenger overloading.

- Computerized control and communication technology and an easy to handle and ergonomically designed man-machine interface.

- IP-technology integrating many systems over one common backbone

5.1 Driver Motor Car

The Driver motor car is a major part of the train that defines the whole train. It is designed on the lines of a bullet train engine. It providesthe majority of power for hauling the TPCs.Each DMC is equipped with an electric motor mounted in the underframe which hauls the train.

Cooling requirements for the SMBT are met through the HVAC units in DMC. There are separate HVAC units in each DMC from which the cooling channels are extended into the TPCs.The DMC has a battery bank that can power all the subsystems of the SMBT for a minimum of 3 hours.The

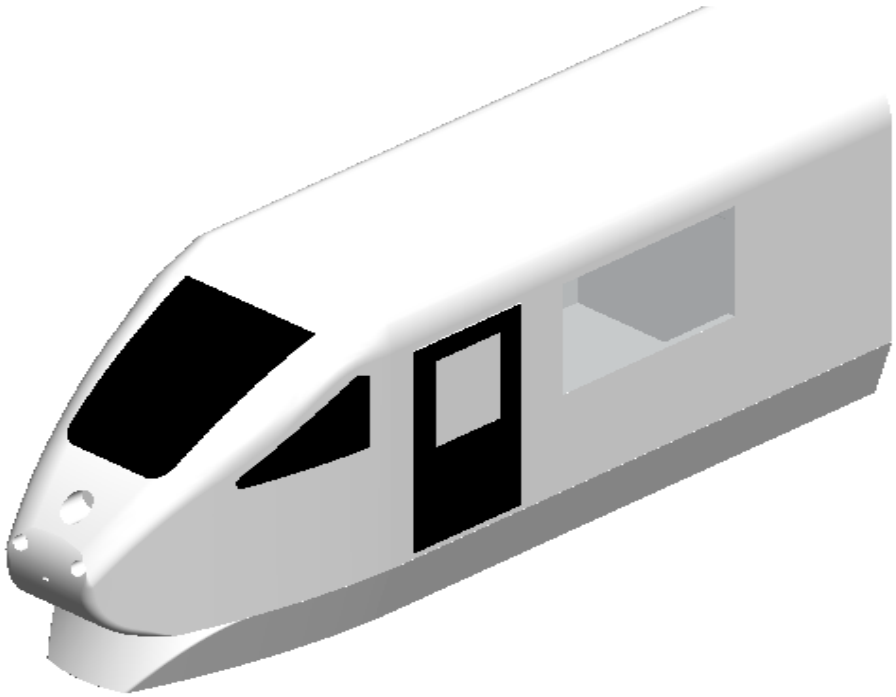

Figure 5: DMC

batteries are charged at thecharging points located in the railway station. In addition to all these the DMC also has space to accommodate a specially-abled person and his/her guardian. The DMC has a driver desk from which the driver gives the control commands to run the train.

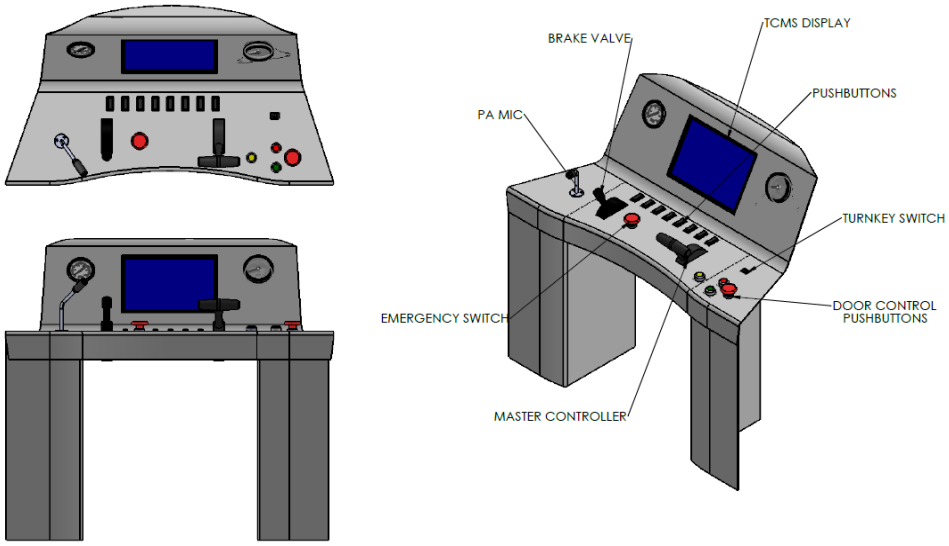

Figure 6: Driver Desk

The driver deskhasalltheimportantcontrol functions requiredfor the properfunctioningoftheSMBT. It is integrated with all the subsystems like HVAC, Brake, Traction, Doors, CCTV, PECU, PIS to constantly monitor and control the train and hence enhance safety and security.

The driver desk mainly comprises of the following

- TCMS HMI
- BL key (for energizing the train)
- Motor ignition switch
- Master Controller
- Brake lever
- HVAC control button
- Door control push buttons
- Emergency stop Pushbutton
- Emergency door open Pushbutton
- Horn
- Wiper controller
- Saloon Light switches
- Gooseneck mic (For addressing passengers)

5.2 Trailer Passenger Car

The SMBTis equipped with 4TPCswhich can accommodate 12-16 passengers each. The TPCs are designed to mimic the internal environment of a bullet train. The scale of the TPCsis customized as per the DMC's scale. The TPCs are equipped with some of the advanced features like an Automatic Door, Air Conditioning system, Fire Detection System, Emergency or Distress Communication System, Passenger Information System, and Soundproof Windows. Moreover, the internal environment is well insulated for sound and heat to improvethe comfort level.

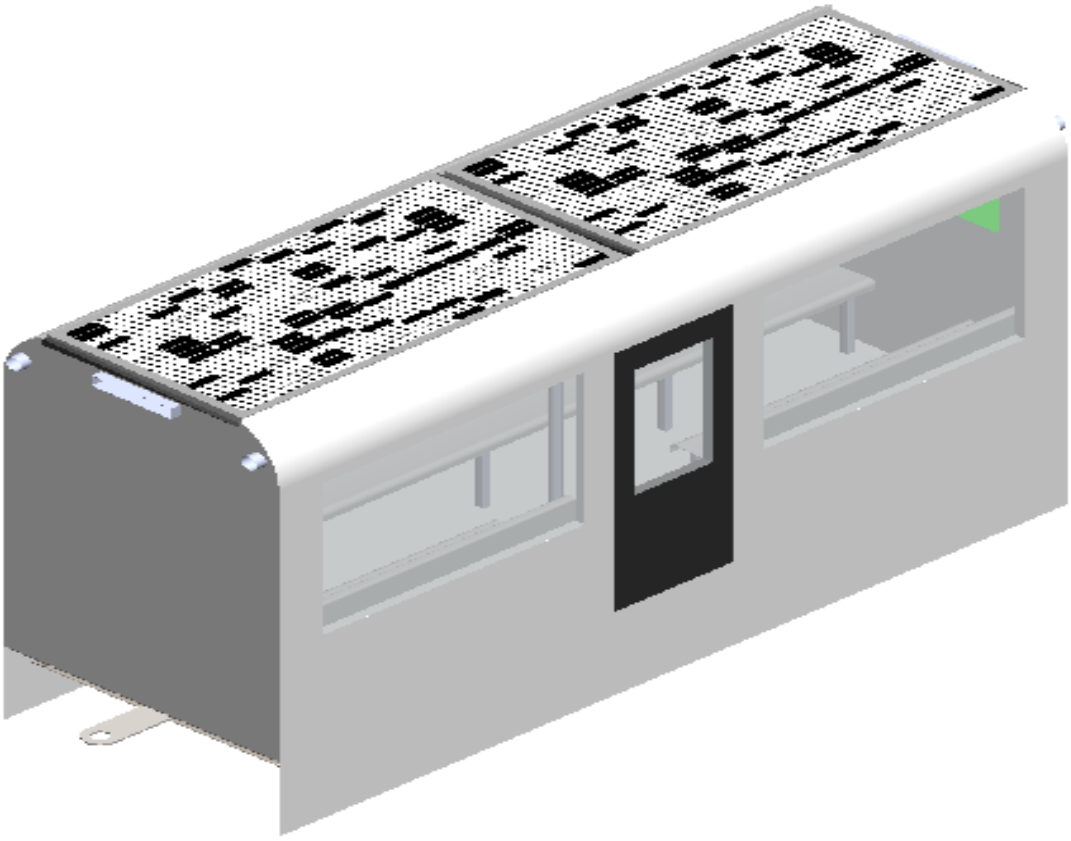

Figure 7: TPC

6. Vehicle Description

We have loaded the SMBT with some of the modern facilities along with advanced safety and security features. The list includes

- Train Control and Management system (TCMS)
- Automatic Doors with an obstacle detection system
- HVAC System
- Fail-safe Pneumatic Braking system
- Two-level suspension system
- Solar charging system
- Passenger Information system
- Passenger Emergency Communication Unit
- Fire detection system
- Anti-Collision system
- Smart Signaling System
- Closed-circuit television monitoring system

6.1 TCMS

The train control and management system, TCMS, is the system for controlling and monitoring onboard systems and subsystems. The TCMS is a centralized computer system, where all the sub-systems are centrally monitored and controlled from the Drivers cab. The TCMS HMI displays are used for real-time reporting of the different system's current status and performance, faults, and failures of control functions. The HMI displays are in the driver's cab. Events are displayed differently depending on the priority of the event.

The on-board part of the train diagnostic system, TDS, is a sub-system of the TCMS. The CCU (Central Computing Unit) collects, stores, and acts upon relevant information about events, faults, and vehicle status from the connected systems. If the status of the system didn't match the intended status. Moreover, the train can still be operational even if the TCMS is not working through manual operation. During manual operation mode, the driver has to control the train by using the master controller and control pushbuttons. The event information stored in the TDS database is presented on a color touch screen, the HMI display on the driver's desk.

The train control system consists of:

- TCMS HMI
- TCMS Computer and Controller

6.1.1 TCMS HMI Display

The two TCMS HMI displays in the two cabs are connected to the Ethernet network in each cab. Under normal operating conditions one TCMS HMI display provides the TCMS functionality (e.g. event presentation) and provides functionality for PIS and CCTV (e.g. activation of manual messages).

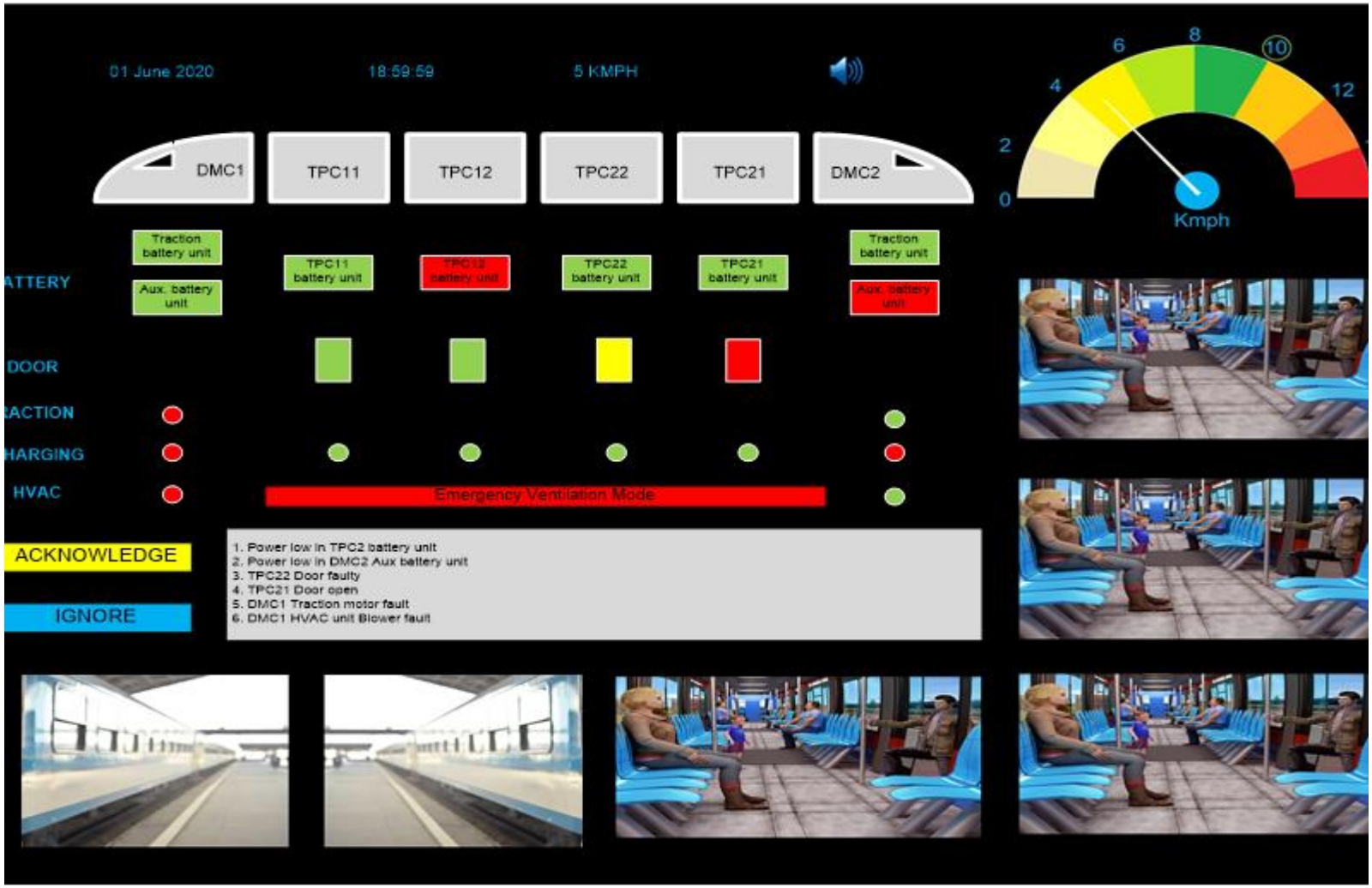

Figure 8: TCMS HMI Layout

6.1.2 TCMS Computer and Controller

This SMBT has a centralized computer-controlled system for controlling and monitoring onboard systems and subsystems connected to the train communication network either directly or via discrete IO.

- The vehicle control application runs on one Train control unit (TCU) each for a 3-car unit
- The train has an Ethernet train network (ETN) which forms communication network between the two 3-Car units and provides a pathway for system redundancy management
- DMC from which the train is controlled is termed as leader DMC (DMC-L) and the other one is termed as a follower (DMC-T)
- In the same manner, the PLC which is in leader DMC is known as masterTrain control unit (TCU-L) and the other is termed as slave Train control unit (TCU-T)
- There are two TCMS computers one each in DMC-L & DMC-T which monitors, stores the data and gives indications to the driver

In addition to a computer-centric control system, there are separate controls to manually operate the train known as Train Lines. The Train lines bypass the emergency systems like Doors, Traction, Brakes, and Ventilationfrom the controller.

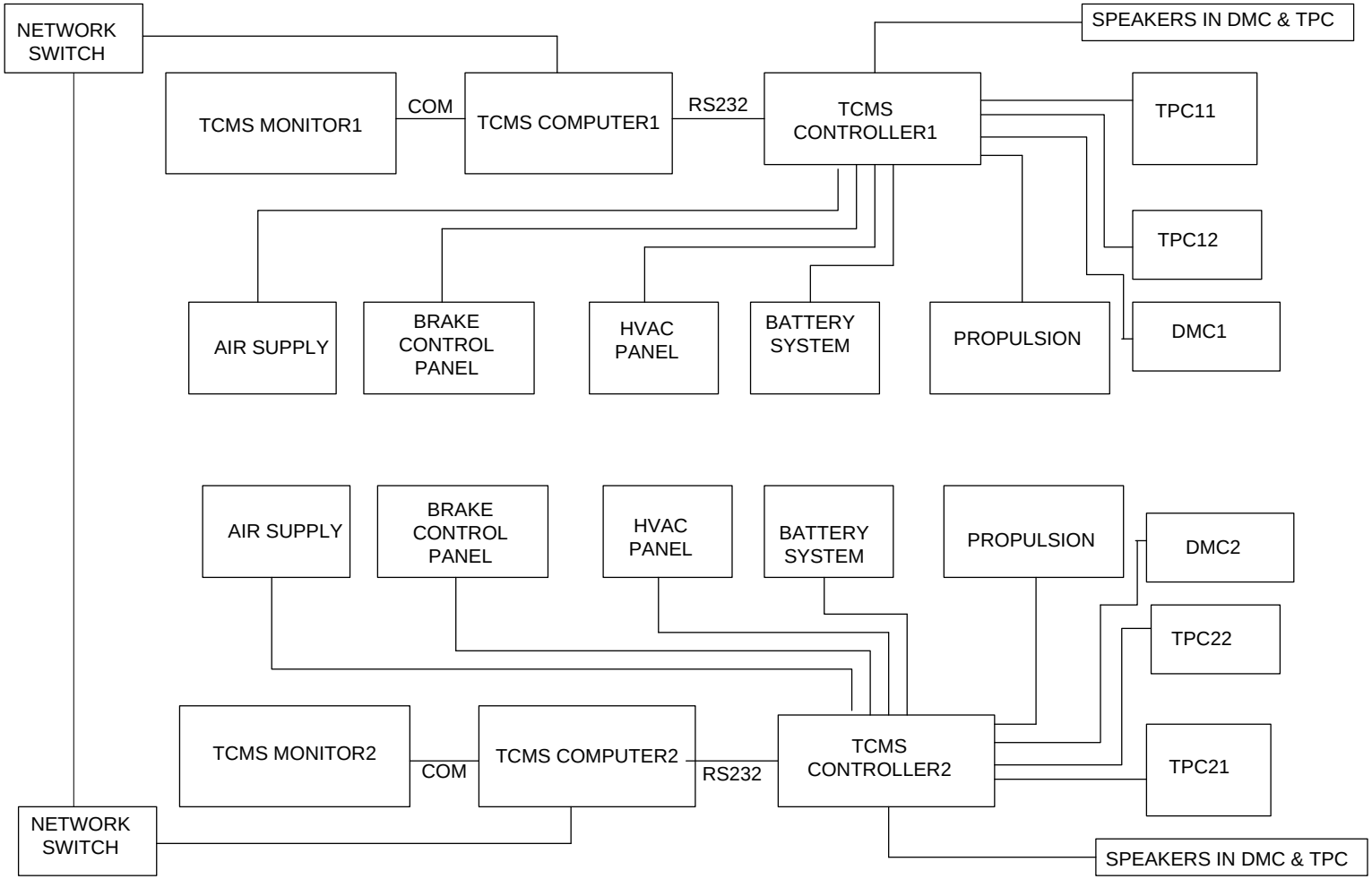

Figure 9: SMBT Communication Network

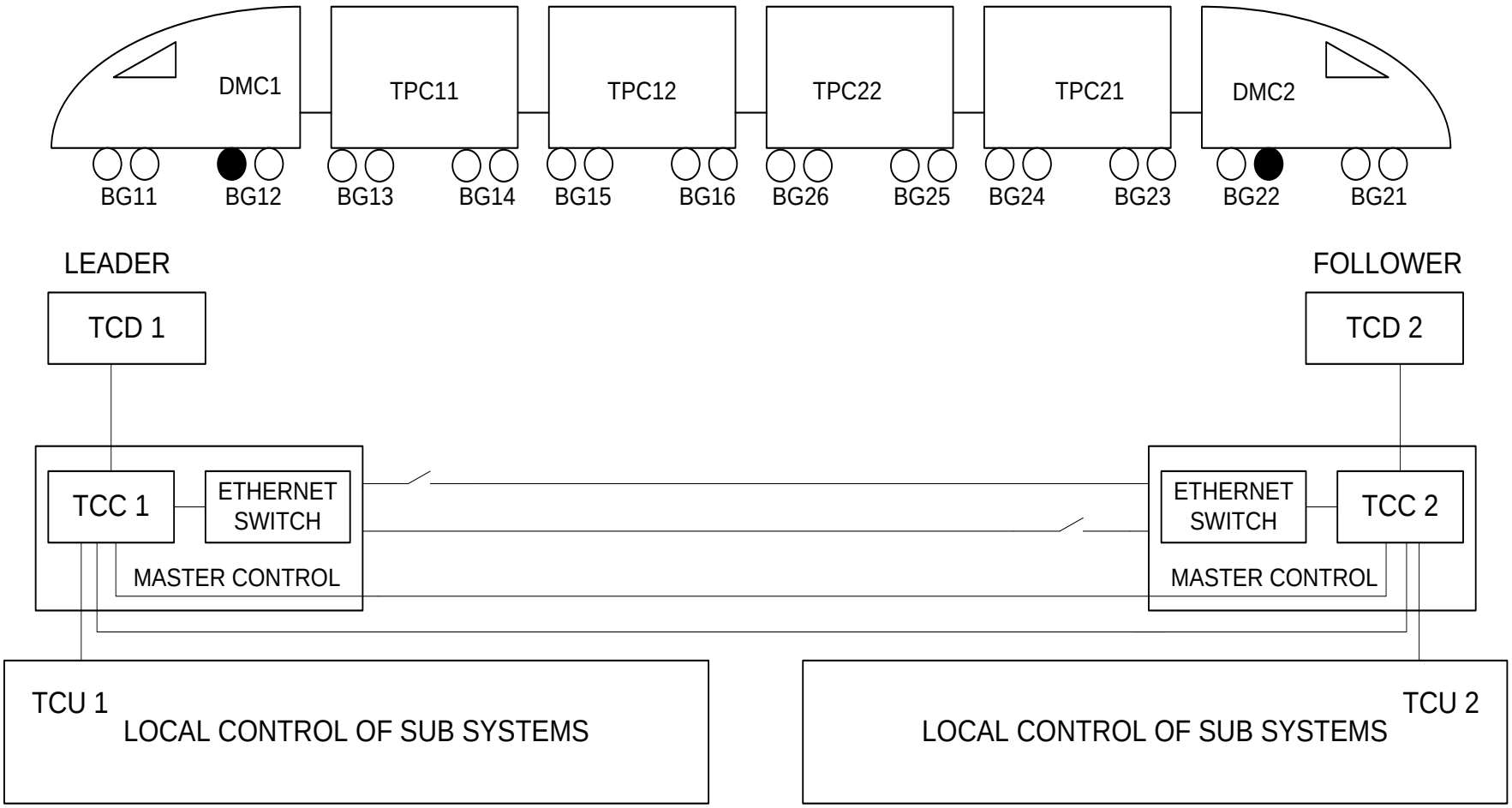

Figure 10: SMBT Control Communication

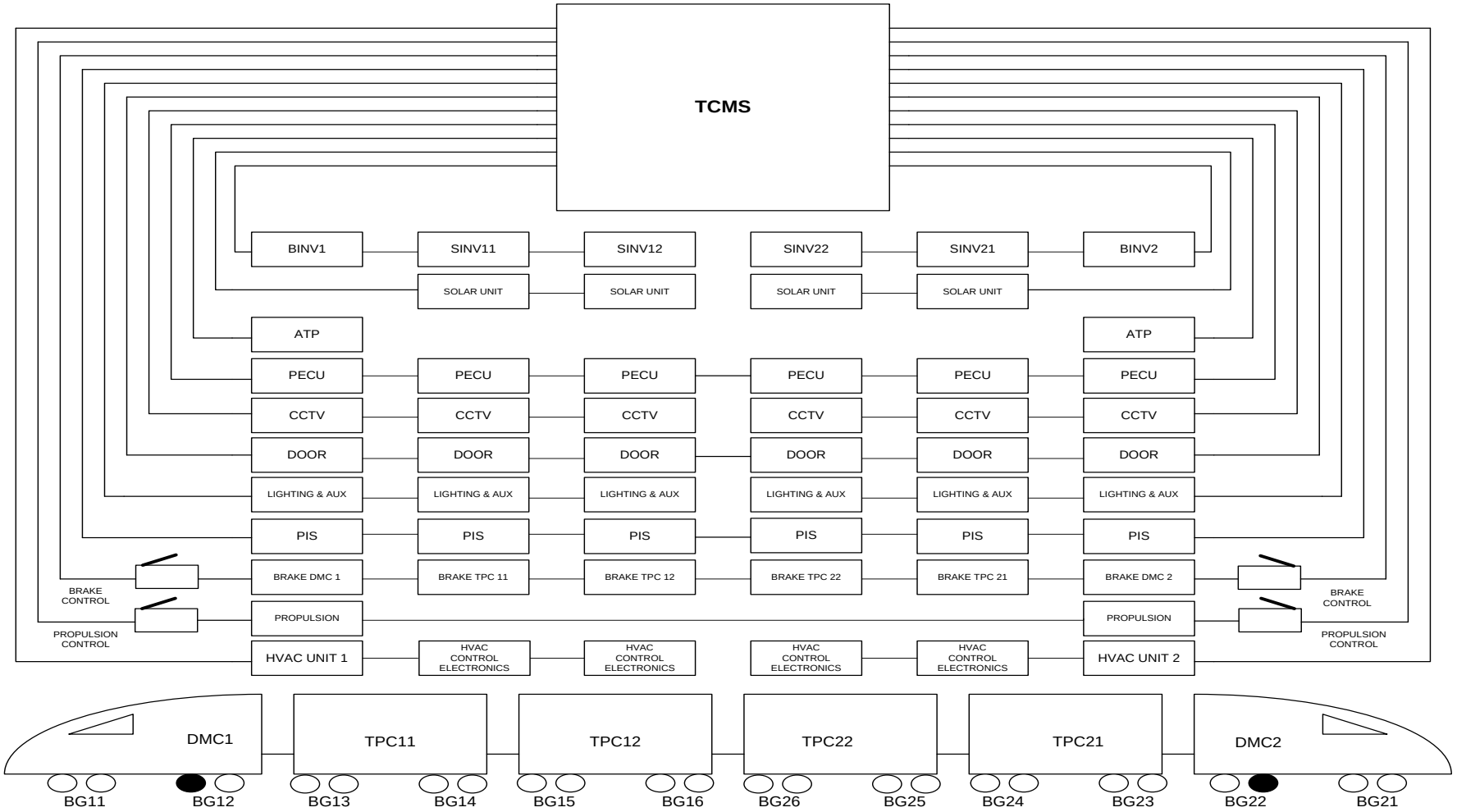

Figure 11: TCMS Control Network

6.2 HVAC

The primary function of the HVAC unit is to achieve cooling and maintain acceptable indoor climate and air quality for the passengers at operating conditions. The heating mode is not available considering the climatic conditions in the region.

Each DMC has a single-ended compact HVAC unit. Each unit has separate cooling circuits with one hermetic scroll / reciprocating compressors each. The HVAC units are independent of each other and a fault on one unit does not affect the other unit in the same car. During the start-up time, theunit is fed through 230V AC shore supply line and when the train is in operation it is fed through 230V ACsupply provided by a battery inverter.

Fresh air is sucked in through weather grills on the side of the unit. There is a fresh air damper to close the fresh air intake for pre-cooling mode. The system automatically goes into emergency ventilation mode if auxiliary power goes off this means that the supply air fans are fed from the backup batteries via an emergency circuit. The duct system consists of the main duct running along with the whole car. Inside the main duct, there is a secondary duct with holes to allow for airflow distribution.

However, it must be noted that the extreme cooling capacity for one car in combination with the internal heat load from 32 adult passengers, direct sun load through windows, and electrical installations makes it very difficult to meet requirements of cooling. There is no air-conditioning for the DMC but there is a provision to extend AC into DMC if required in the future.

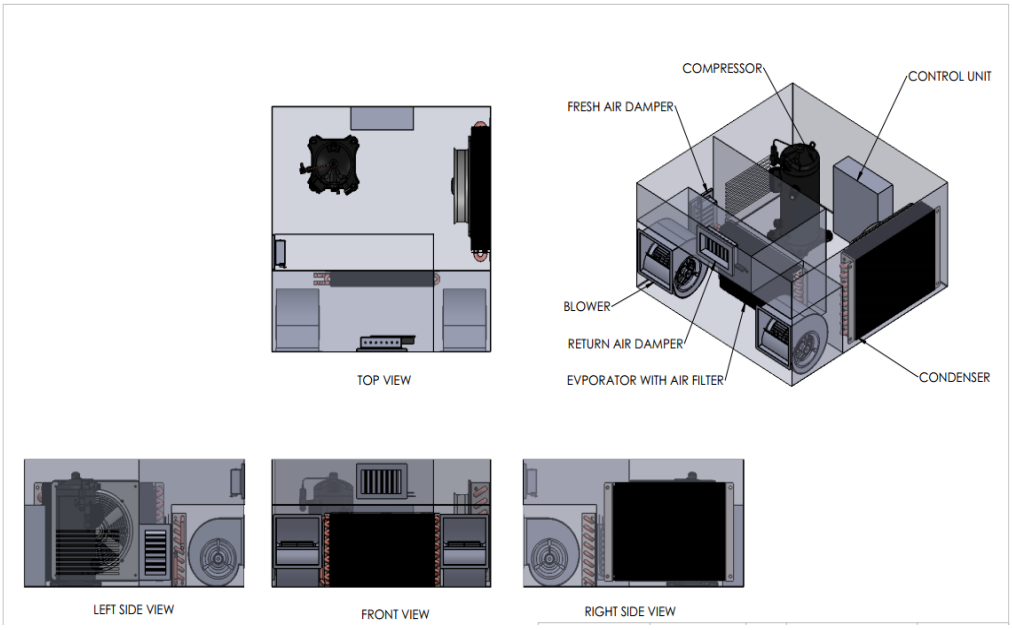

Figure 12: HVAC Unit

6.3 Fail-Safe Pneumatic Braking System

The vehicle has a friction air brake system. The speed can also be controlled with the throttle by controlling the traction motor. The air operated friction brake system with wheel-mounted brake discs on the motor car and axle-mounted discs on the trailer cars and the accompanying brake caliper units. The DMC has one power bogie and one trailer bogie. The TPC has two trailer bogies each. The power bogie does not house a brake caliper. The power bogie friction brakes and is also controlled by the traction motors. The trailer bogies have only friction brake. Disc brace units with calipers acting on each brake disc carry out friction braking.

Brake Control

The brake system has three types of brake controls:

i. Service Brake
ii. Parking brake
iii. Emergency Brake

The service brake is the normal way of braking the train and is a manual blending of friction brake and speed control with the traction motor. The parking brake prevents the train from rolling when the train is deactivated. The parking brake is applied in the event of low (or no) pressure in the brake reservoir or by the push button in the cab. When no main reservoir pressure is present, the parking brake is fully applied and can hold a fully loaded train at standstill at a gradient of 1%. The parking brakes can be released by the push-button when the compressed air supply is present. With no air supply available, it is possible to release individual parking brake units manually by a tool fitted in the parking brake cylinder.

The emergency brake is the most reliable way of braking the train and the brake mode with the highest retardation. The function of the emergency brake is to achieve as short braking distance as possible and it provides the safest way to stop the train. The emergency brake system uses only the friction brake. Once applied, the emergency brake cannot be released until the train has come to complete stop. It is mainly activated via the emergency stop push button on the driver's desk. It can also be activated by putting the brake controller to the emergency stop position.

In the DMC, the driver desk has a brake controller that permits the variable application of friction air brake. The brake controller generates Brake pipe pressure (BP). The BP is connected to all the vehicles on the train via the BP pipe running through the train till the last vehicle / DMC. Each DMC and TPC holds a distributor control valve assembly, this generates Brake cylinder pressure (BC). The BC signal is then boosted and delivered to the brake cylinders. The brake cylinders are fitted with a caliper that operated the disc brakes on the wheel axle. In case of a pneumatic circuit failure in a coach, then it is made sure that the brakes don’t apply to the whole system by isolation cocks provided in each coach.

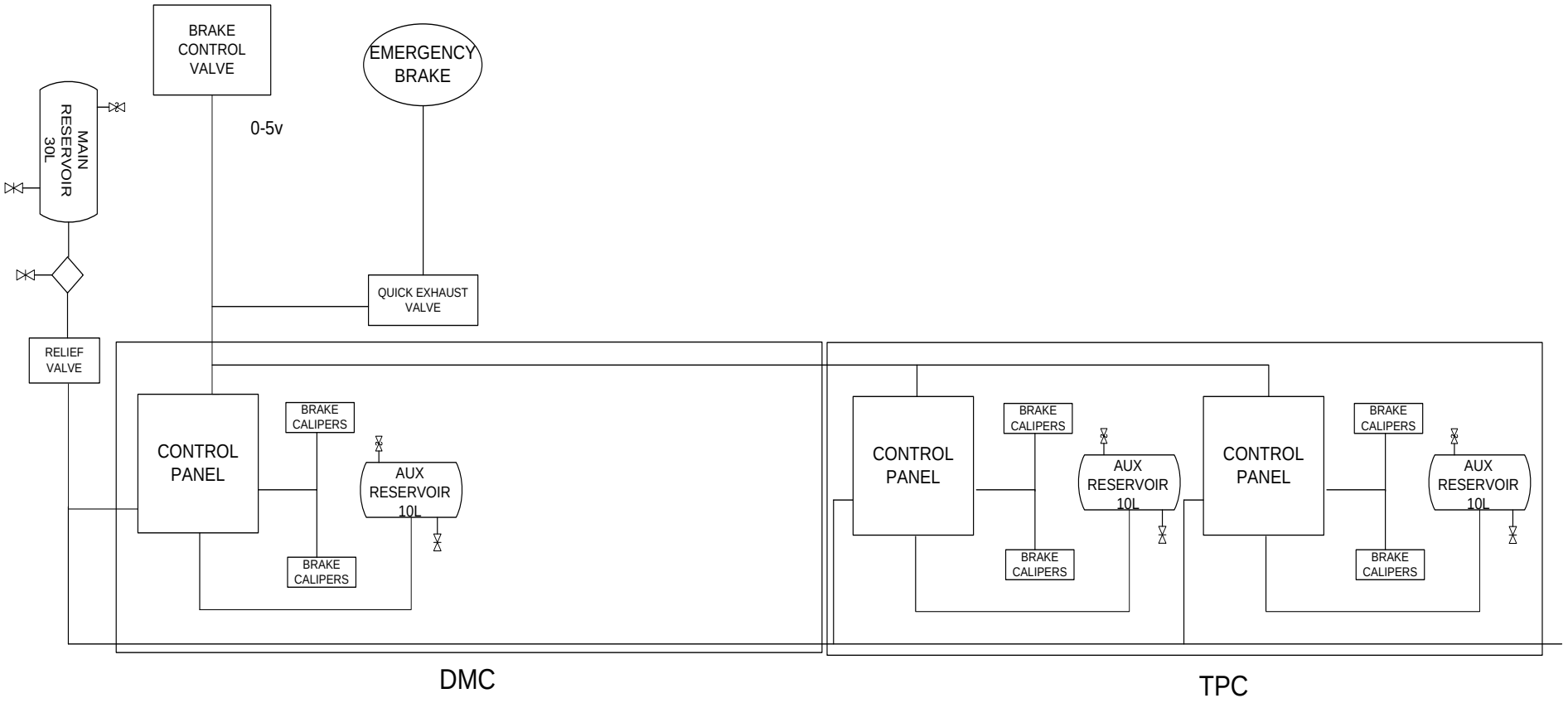

Figure 13: Pneumatic Control Circuit

6.4 Passenger Information System

The Passenger Information System (PIS) provides passengers with travel-related information and provides communication channels between passengers and the train operator. The PIS consists of both an audio and a visual part. The audio system includes loudspeakers, public address (PA), and passenger emergency communication. The visual part includes external and internal displays as well as a dynamic route map.

The main functions of the PIS are:

- Public announcements by train operator to make announcements to all passengers from the driving and non-driving cab.
- Public announcements by TCMS to make announcements to all passengers.
- Pre-recorded messages with synchronized audio and visual.

6.5 Passenger Emergency Communication Unit (PECU):

Each TPC is fitted with a PECU system which enables the passengers to communicate with the Driver in case of an emergency. The Driver can respond to passengers through a microphone installed on the driver's desk.

6.6 Fire Detection

The purpose of the fire detection system is to warn and inform the person if a fire has appeared in the unattended cab area in the TPC or the non-operative DMC. The fire detection system is in the form of one smoke detector in each cab the power to which is supplied by the inbuilt battery system.

6.7 Anti-Collision System

The train is fitted with a proximity sensing device on both the DMCs. Any object that comes in the proximity generates an alarm for the driver to take corrective action.

6.8 CCTV Saloon CCTV

The vehicle is equipped with a video surveillance system, Closed Circuit Television (CCTV), for monitoring the passenger's saloons. The CCTV is fully integrated and includes main functions for monitoring passenger saloons on the cab HMI display and to store video images to be reviewed later in playback station off-board the train.

There is one surveillance camera in each car. Each camera primarily covers the vestibule and PECU.The HMI display is used as the CCTV-monitor and displays images from the CCTV system on-board the train. It is possible to view the camera images live on monitors in both cabs. The train has two digital video recorders (DVR) installed. The CCTV system is based around the control unit included in the DVRs. There are cameras connected directly to the DVRs in the DMC and directly to remote units in all the other cars. All images are streamed to the DVRs where they are stored.

Rear-view CCTV: The train has two cameras covering the platform, rear-view video monitoring system. The cameras are mounted on the DMC on platform sides of the cab. In normal operation, the cameras are displayed on the driver's desk HMI.

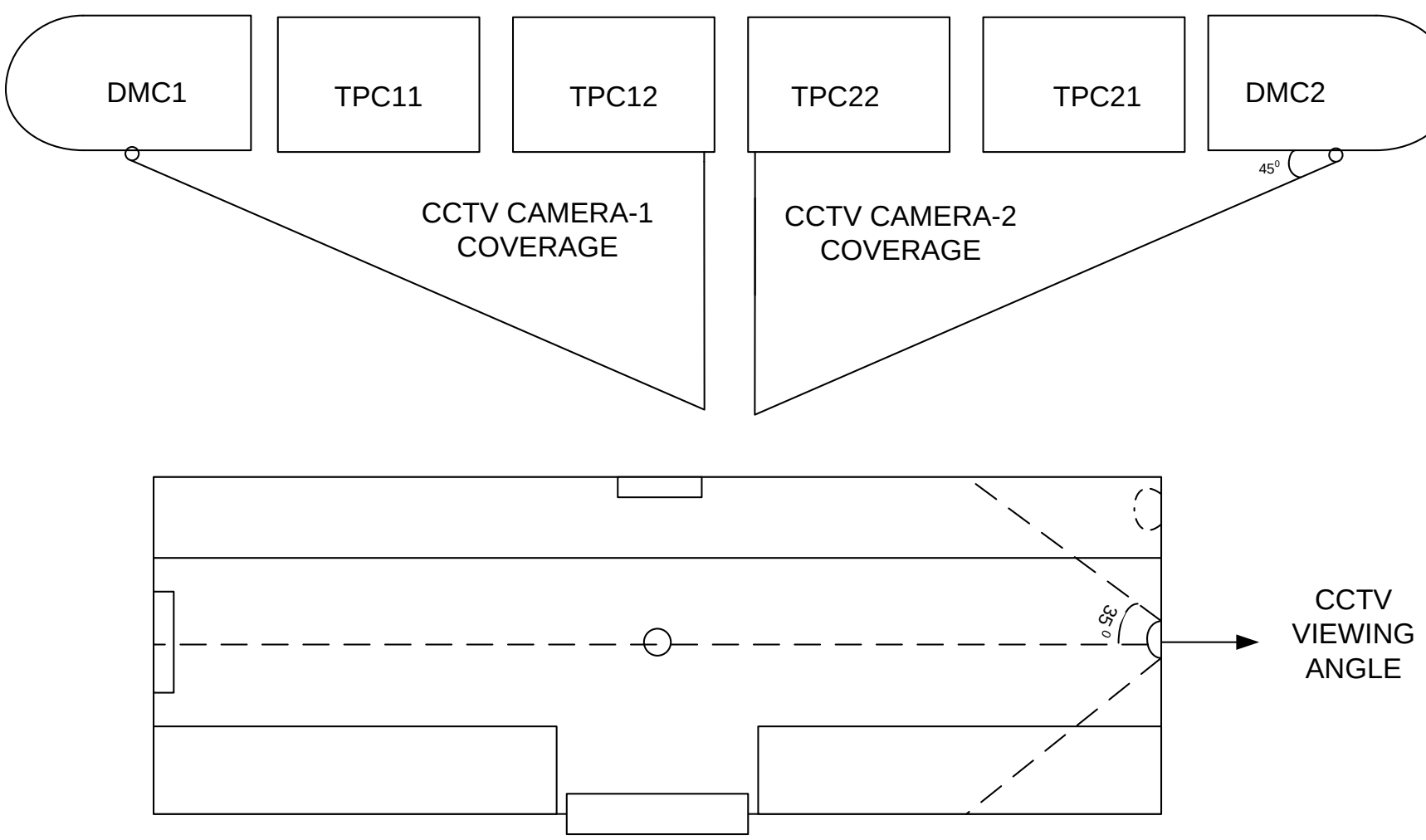

Figure 14: CCTV Coverage Angles

7. SPECIFICATION – suggested

Gauge	:	610mm
Rails	:	Steel Rails of the Railsection.
Fishplates	:	Steel
Sleepers	:	Concrete
Ballast	:	Local ballast with rough angular surfaces tolevel
Sub ballast / soling	:	Level Ground prepared to laysleepers
Maximum Gradient	:	2%

7.1 DMC

Drive	:	Powerful DC drive capable of hauling the whole train.
Maximum Speed	:	Controlled at 10 Kmph on level track
Transmission	:	Mechanical gearbox
Brakes	:	Air brakes on all wheels along with electrodynamic braking through DC drive. Emergency brake for train brakes.
Suspension system	:	Coiled spring primarysuspension. Air Bellow secondary suspension
Anti-Collision System	:	Passive infra-red motion detection sensor with 6m detecting range
HVAC System	:	Ton capacity better operated.

7.2 TPC

Seating Capacity	:	15 children / 12 adults / 780 kgs.
Seating	:	Metro Bench type
Suspension	:	Coiled spring primarysuspension. Air Bellow secondary suspension
Brakes	:	Air brakes on bogies with emergency bakes. Brakes to apply automatically on loss of air pressure.
Electricals	:	LED battery operated light. Waterproof Speakers
Sound System	:	For PA System and Audio effects
HVAC	:	Ducting connected to HVAC Unit in DMC.