Vande Bharat Express

MILESTONES

Two routes

Rake-1 (NDLS-BSB Route) since 17.2.2019

Rake-2 (NDLS-SVDK Route) since 05.10.2019

Covered **cumulative run** of **15 lakh plus kms.**

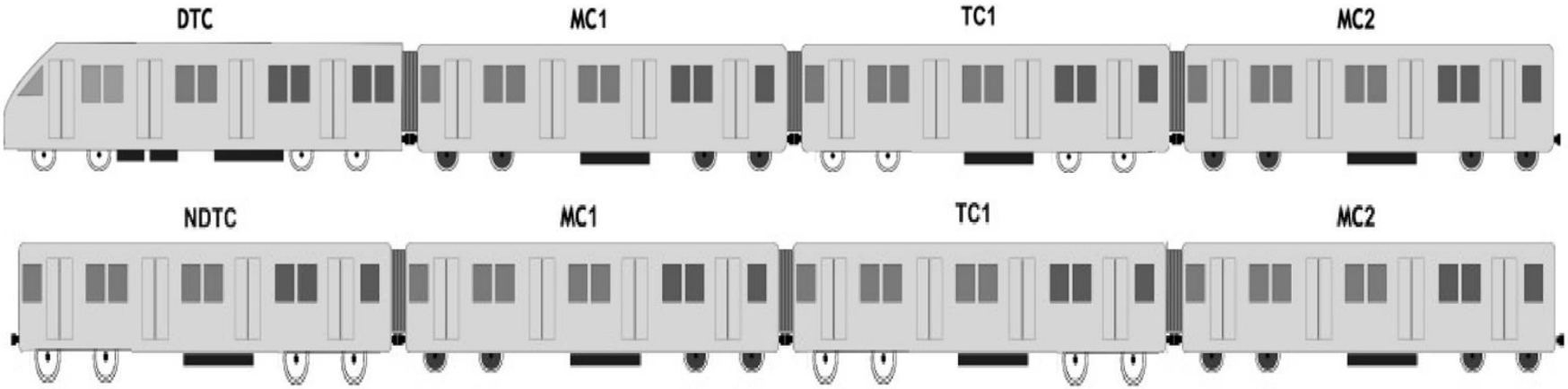
Only 4 line failures so far
Two nos. – Insulator of surge arrester flashed over due to surge in OHE Voltage
One – Primary spring failure detected at BSB
One – Air system pipes broken due to Ballast hitting

1 Line Failure in 15 lakhs km on account of VBE

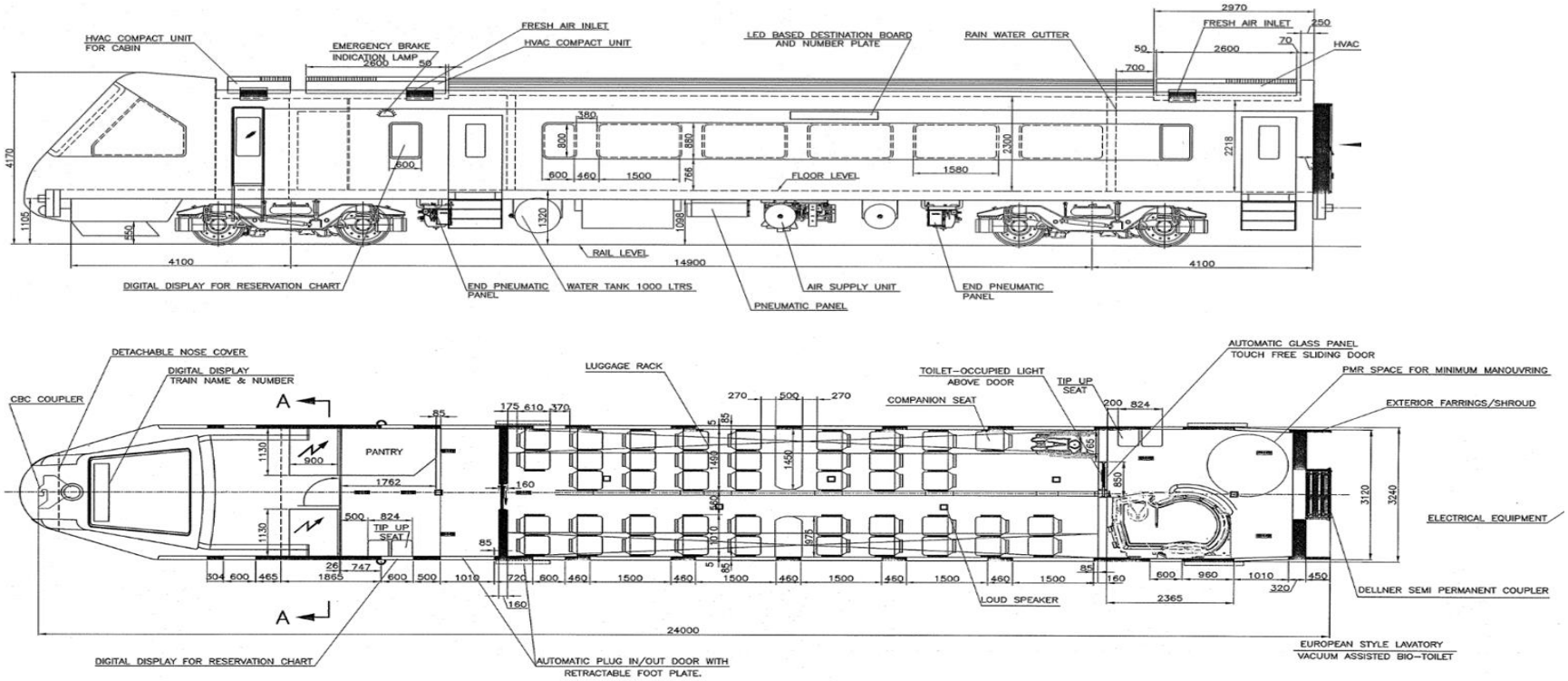
Successful completion of the **SS-1 schedule** of both rakes by Rolling Stock Workshop, CB & Trainset Depot SSB.

Basic Unit and Rake Formation

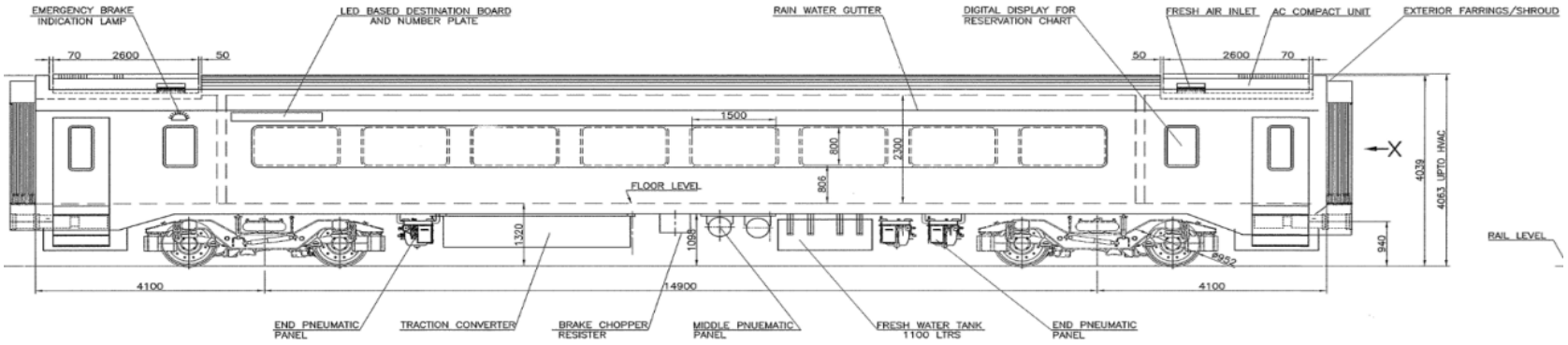
- Train 18 is 16 car train with 4 basic units i.e. two number of end basic units (DTC-MC-TC-MC) and Two number of middle basic units (NDTC-MC-TC-MC)
- All power components such as Line & Traction converters, Auxiliary converter, Air Compressor, Battery box, Battery charger, Brake chopper resistor are mounted under the frame
- Electronics distributed across all the coaches.

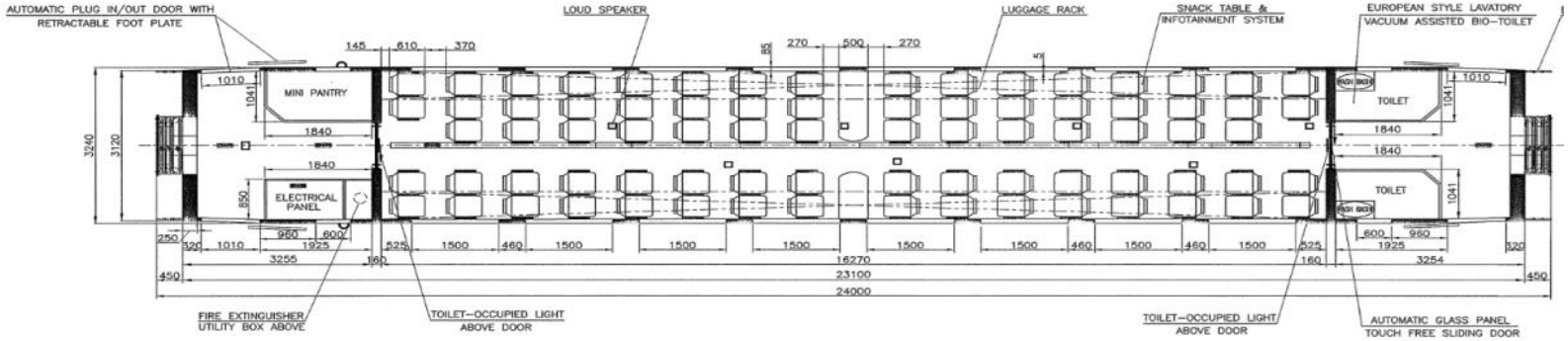


DTC Layout

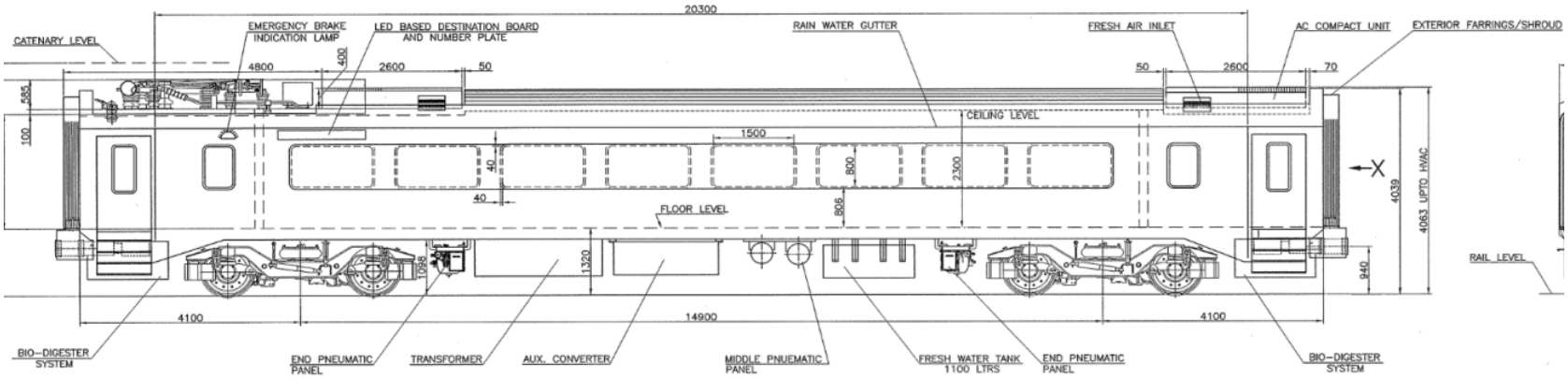

HVAC COMPACT UNIT FOR CABIN
EMERGENCY BRAKE INDICATION LAMP
FRESH AIR INLET
HVAC COMPACT UNIT
LED BASED DESTINATION BOARD AND NUMBER PLATE
RAIN WATER GUTTER
FRESH AIR INLET
HVAC
FLOOR LEVEL
RAIL LEVEL
DIGITAL DISPLAY FOR RESERVATION CHART
END PNEUMATIC PANEL
WATER TANK 1000 LTRS
PNEUMATIC PANEL
AIR SUPPLY UNIT
END PNEUMATIC PANEL
14900
4100
4100
DETACHABLE NOSE COVER
DIGITAL DISPLAY TRAIN NAME & NUMBER
CBC COUPLER
LUGGAGE RACK
TOILET-OCCUPIED LIGHT ABOVE DOOR
TIP UP SEAT
COMPANION SEAT
AUTOMATIC GLASS PANEL TOUCH FREE SLIDING DOOR
PMR SPACE FOR MINIMUM MANOUVRING
EXTERIOR FARRINGS/SHROUD
PANTRY
TIP UP SEAT
ELECTRICAL EQUIPMENT
LOUD SPEAKER
DELLNER SEMI PERMANENT COUPLER
24000
EUROPEAN STYLE LAVATORY VACUUM ASSISTED BIO-TOILET
DIGITAL DISPLAY FOR RESERVATION CHART
AUTOMATIC PLUG IN/OUT DOOR WITH RETRACTABLE FOOT PLATE.

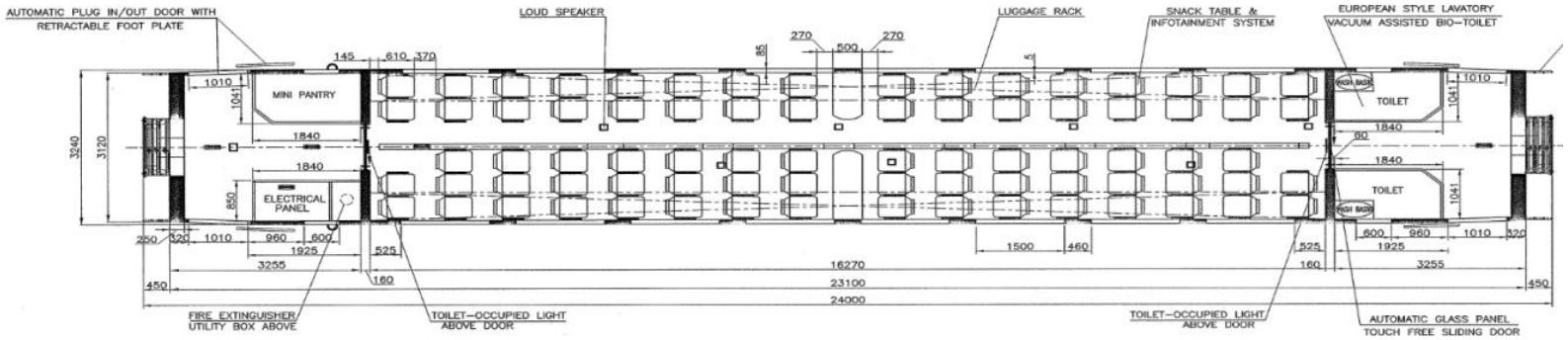
MC Layout


EMERGENCY BRAKE INDICATION LAMP
LED BASED DESTINATION BOARD AND NUMBER PLATE
RAIN WATER GUTTER
DIGITAL DISPLAY FOR RESERVATION CHART
FRESH AIR INLET
AC COMPACT UNIT
EXTERIOR FARRINGS/SHROUD
70
2600
50
1500
800
2300
806
FLOOR LEVEL
4039
4063 UPTO HVAC
940
RAIL LEVEL
1320
108
8952
4100
14900
4100
END PNEUMATIC PANEL
TRACTION CONVERTER
BRAKE CHOPPER RESISTER
MIDDLE PNUEMATIC PANEL
FRESH WATER TANK 1100 LTRS
END PNEUMATIC PANEL


AUTOMATIC PLUG IN/OUT DOOR WITH RETRACTABLE FOOT PLATE
LOUD SPEAKER
LUGGAGE RACK
SNACK TABLE & INFOTAINMENT SYSTEM
EUROPEAN STYLE LAVATORY VACUUM ASSISTED BIO-TOILET
145
610
370
85
270
500
270
MINI PANTRY
1010
1041
1840
ELECTRICAL PANEL
850
TOILET
3240
3120
250
320
960
600
1925
525
1500
460
3255
160
16270
23100
24000
3254
450
FIRE EXTINGUISHER UTILITY BOX ABOVE
TOILET-OCCUPIED LIGHT ABOVE DOOR
TOILET-OCCUPIED LIGHT ABOVE DOOR
AUTOMATIC GLASS PANEL TOUCH FREE SLIDING DOOR

TC Layout


20300
CATENARY LEVEL
EMERGENCY BRAKE INDICATION LAMP
LED BASED DESTINATION BOARD AND NUMBER PLATE
RAIN WATER GUTTER
FRESH AIR INLET
AC COMPACT UNIT
EXTERIOR FARRINGS/SHROUD
4800
400
2600
50
50
2600
70
555
100
CEILING LEVEL
1500
800
2300
40
40
FLOOR LEVEL
808
X
4039
4063 UPTO HVAC
RAIL LEVEL
1048
1320
940
4100
14900
4100
BIO-DIGESTER SYSTEM
END PNEUMATIC PANEL
TRANSFORMER
AUX. CONVERTER
MIDDLE PNUEMATIC PANEL
FRESH WATER TANK 1100 LTRS
END PNEUMATIC PANEL
BIO-DIGESTER SYSTEM


AUTOMATIC PLUG IN/OUT DOOR WITH RETRACTABLE FOOT PLATE
LOUD SPEAKER
LUGGAGE RACK
SNACK TABLE & INFOTAINMENT SYSTEM
EUROPEAN STYLE LAVATORY VACUUM ASSISTED BIO-TOILET
145
610
370
85
270
500
270
1010
1041
MINI PANTRY
1840
1840
ELECTRICAL PANEL
850
3240
3120
250
320
1010
960
600
1925
3255
525
160
450
1500
460
16270
23100
24000
TOILET
TOILET
60
1840
1840
1010
1041
1041
600
960
1010
320
1925
3255
525
160
450
FIRE EXTINGUISHER/ UTILITY BOX ABOVE
TOILET-OCCUPIED LIGHT ABOVE DOOR
TOILET-OCCUPIED LIGHT ABOVE DOOR
AUTOMATIC GLASS PANEL TOUCH FREE SLIDING DOOR

Train18 important Specification Details

Particulars	Details
Number of Coaches in Basic Unit	4 car per BU, DTC-MC-TC-MC (End BU) NDTC-MC-TC-MC (Middle BU)
Train formation	16 coaches- 4 BU per Train
% Motoring	50%
Maximum Test Speed	176 kmph

Train18 important Specification Details

Particulars	Details
Maximum Service Speed	160 Kmph
Average Acceleration from 0 to 40 Kmph	0.8 m/sec2
Deceleration	0.8 m/sec2
Jerk Rate	0.7 m/sec3
Ambient Temperature	Max =50 deg C Min =-5 deg C

Key Figures

Attribute	Rake 1	Rake 2
Mileage Earned (kms)	879411	659051
Lifetime Total Energy Consumed (kWh)	21738311	17365738
Lifetime Total Energy Regenerated (kWh)	2779702	2946889
Lifetime Regeneration %	18.42%	15.07%

Time for 0-100 kmph	: 50 seconds
Time for 0-130 kmph	: 85 seconds
Time for 0-160 kmph	: 182.2 seconds
Maximum Tractive effort	: 800 kN
Max Electro-Dynamic Braking Effort	: 94 kN per motor car
Maximum EP Braking Effort during emergency braking	: 1082.2 kN
Maximum Braking Effort during Full- Service ED + EP braking	: 866.5 k

EBD Values

The stopping distances for different brake modes are also lower, given the quicker deceleration.

Speed/Mode	FS with ED + EP	FS from Auto Brake Handle	Emergency Brake
100 to 0	516 m	419 m	392 m
130 to 0	858 m	696 m	654 m
Effective deceleration	0.8 m/s^2	1.05 m/s^2	1.15 m/s^2

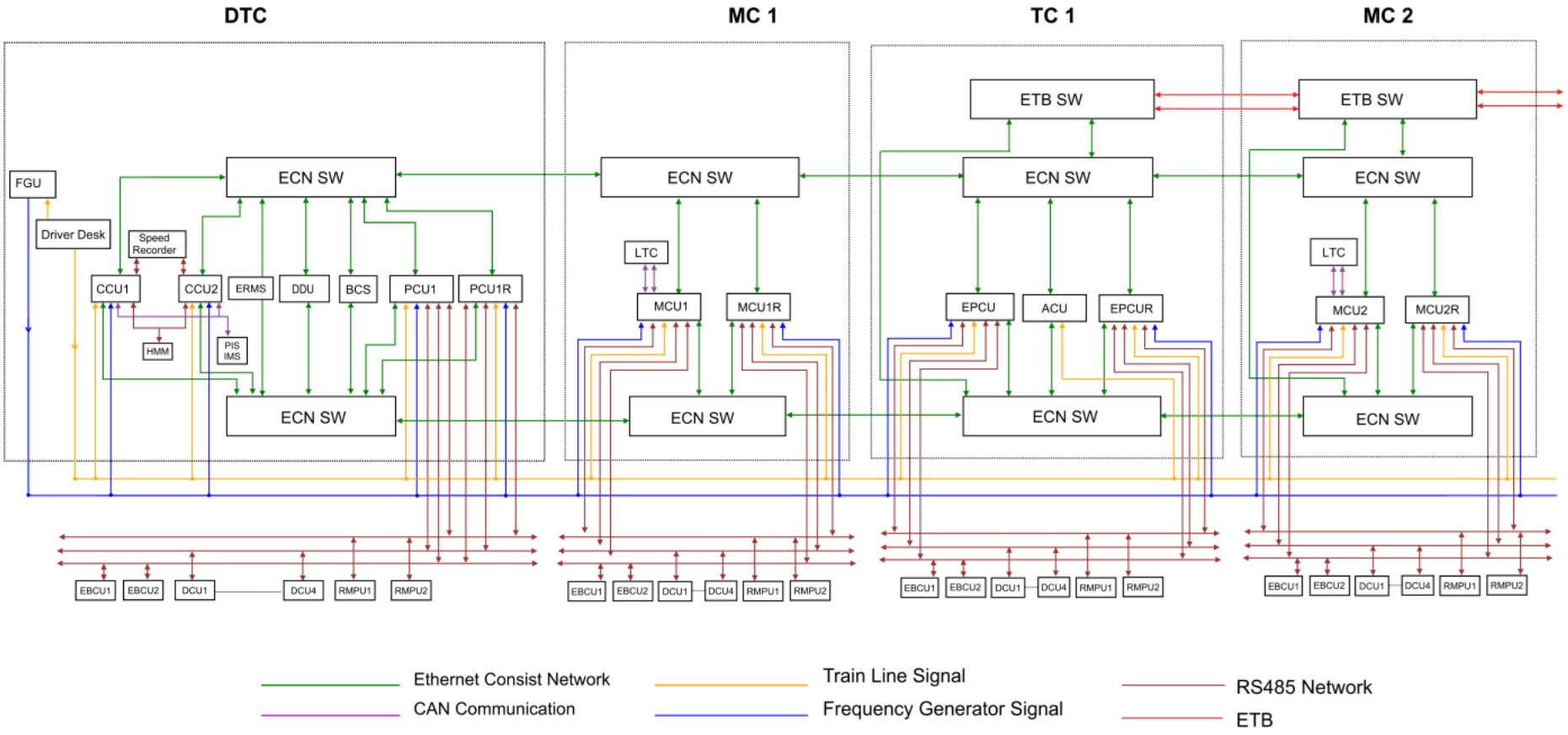
Train Control & Management System (TCMS)

- ✓ Interface with Driver Desk
- ✓ Pantograph Control
- ✓ VCB Control
- ✓ Traction Control
- ✓ Regenerative Brake Control and total brake calculation
- ✓ Brake Blending
- ✓ Interface with RMPU control
- ✓ Interface with Door control
- ✓ Interface with Brake control
- ✓ Compressor control
- ✓ Parking Brake control
- ✓ Light Control.

Train Control & Management System (TCMS)

- ✓ Rollback Detection
- ✓ Vigilance control
- ✓ Cruise Control
- ✓ Neutral Section Control
- ✓ Test Modes
- ✓ Settings through DDU
- ✓ Event Recording
- ✓ All train level protection (Ex: EOL, EBL, BAL).

Communication network



Redundancy Concept

- Control Unit level redundancy
- Communication media redundancy
- Data recording redundancy
- Aux redundancy.

Equipment Layout

Description	Equipment
DTC	Underframe-Compressor, Battery, Battery Charger
MC	Underframe-Line and Traction converter, Motor, Brake chopper resister
TC	Underframe-Transformer, Auxiliary converter Roof-Pantograph, VCB.

Braking System

The brake system includes:

- Piston type Oil-free air compressor and air dryer unit.
- An electro-pneumatic, microprocessor controlled direct service brake
- An automatic indirect brake which is applied for redundancy reasons for an emergency brake application and in the event of failure of the direct service brake
- Towing mode operation based on brake pipe (indirect brake).
- Wheel mounted brake discs with compact brake caliper units
- Designated quantities of the compact brake caliper units have a spring operated parking brake portion integrated.

The Electro-dynamic brake in motor cars is the main brake system, it will be generally used in preference to the EP- brake.

Brake Control Unit EP-BGE [B03,B04] - scheme

BCU

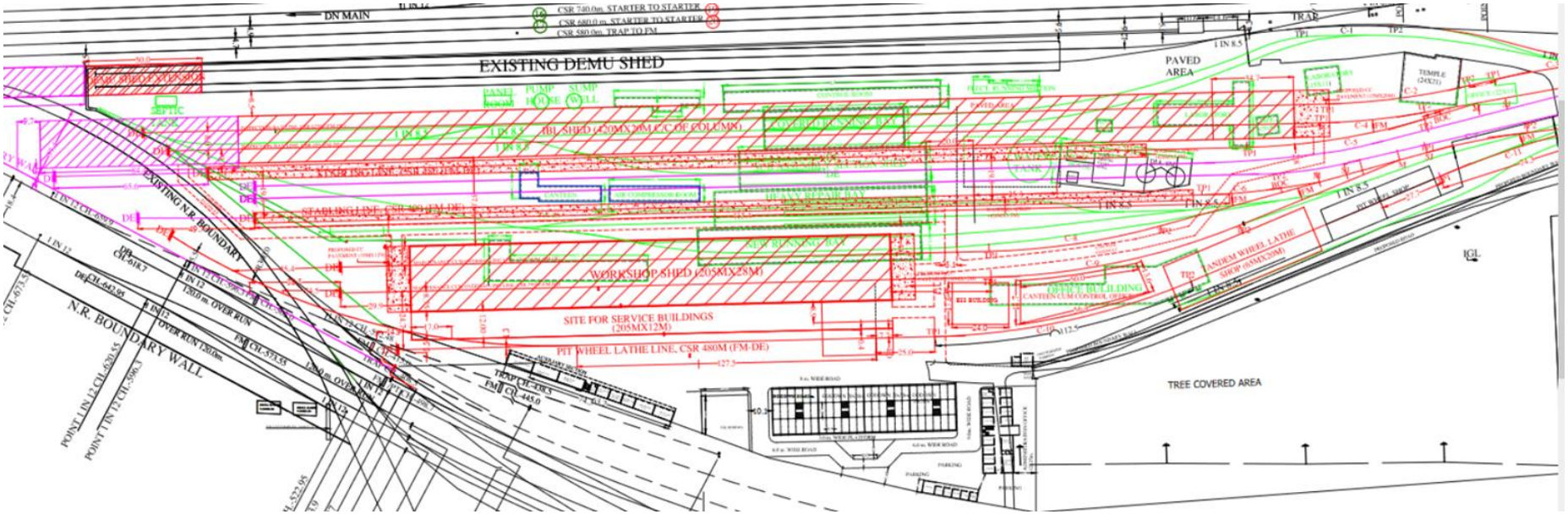
B02

B07

B01

Infrastructure

Depot Layout TSD SSB



Key Features

- ✓ Equipped with all modern facilities required for train maintenance.
- ✓ Retractable OHE at each IBL for ease of maintenance.
- ✓ Equipped with centralized announcement system.
- ✓ Maintenance practices that meets quality, safety and environmental norms.
- ✓ Planned Utilization of Solar power for auxiliary loads
- ✓ Train cleaning facility with advanced machinery.
- ✓ Skilled/Expert manpower.

Depot Facilities

- ✓ Inspection bay lines
- ✓ Stabling bay lines
- ✓ Workshop
- ✓ Effluent & sewage treatment plant
- ✓ Custody Stores
- ✓ Different M&P’s
- ✓ Auxiliary sub stations
- ✓ Through line for UFWL

M&P Planned

M&P has been planned to minimize the labour intensive works and maximum degree of automation to ensure safety, quality and reliability

1. **Automatic Coach Washing Plant**: Multistage external cleaning system for coaches/trains, by using high pressure water jet, horizontal and vertical rotating nylon combination brushes
2. **Synchronized Pit Wheel Jacks**: Facilitate the lifting of multiple train consists. The complete lifting plant is placed below the workshop floor, and when lowered, there is an unobstructed working and traffic area
3. **Underfloor Pit Wheel Lathe**: specifically designed and cost-saving machine for the preventive and corrective maintenance of railway wheels and brake-discs without the need of dismounting the axle from the bogie
4. **Laser Wheel Profile Scanning Machine**: fully-integrated optical inspection system for the precise measurement of the key railway wheel flange dimensions
5. **Bogie Drop Tabl**e: for in-situ bogie replacement.
6. Battery operated Shunter
7. EOT Cranes
8. Material handling equipment
9. Aerial Work Platform
10. Pneumatic/Electric tooling

Video Links

- https://youtu.be/6_cDGqnFJds : Synchronized Pit Wheel Jacks
- https://youtu.be/UtMA5NbWCPM: Laser based wheel profile scanning machine

Issues Encountered During Train Operation & Maintenance

Maintainance Schedules

Following maintenance scheme is proposed for preventive maintenance schedules of train set coaches:

Schedule	Periodicity	Schedule Time
Daily	Every day	4 hrs
Trip	Every 3 days or 5000 kms whichever is earlier.	6 hrs
Monthly	30 days ± 2 days	6 hrs
Quarterly	90 days ± 3 days	8 hrs
9 monthly	270 days ± 3 days	1 day
Shop schedule 1	18 months ± 5 days	15 to 20 days
Shop schedule 2	36 months ± 5 days	
Shop schedule 3	72 months ± 5 days	

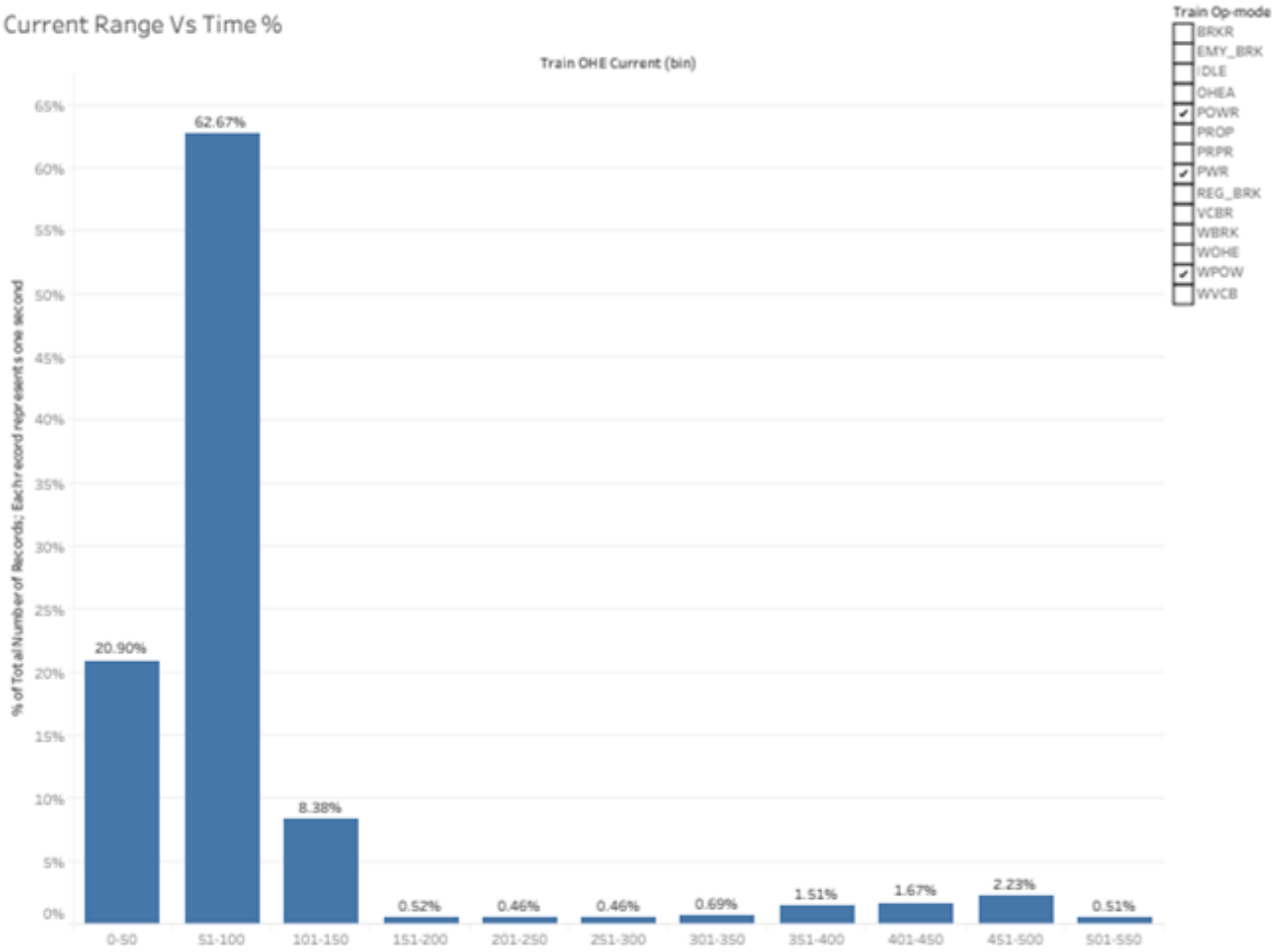
Maintenance Philosophy

- Only 2 rakes
- Stocking each item would have led to huge inventory cost. Only consumables & frequently changed items stocked.
- Comprehensive AMC
  - Propulsion System
  - Automatic Doors (IC & Plug doors)
  - RMPU's
- In-house – Non-stock procurement
  - Bio-vac toilets
  - Air Brake System
- Capital Spares through RSP

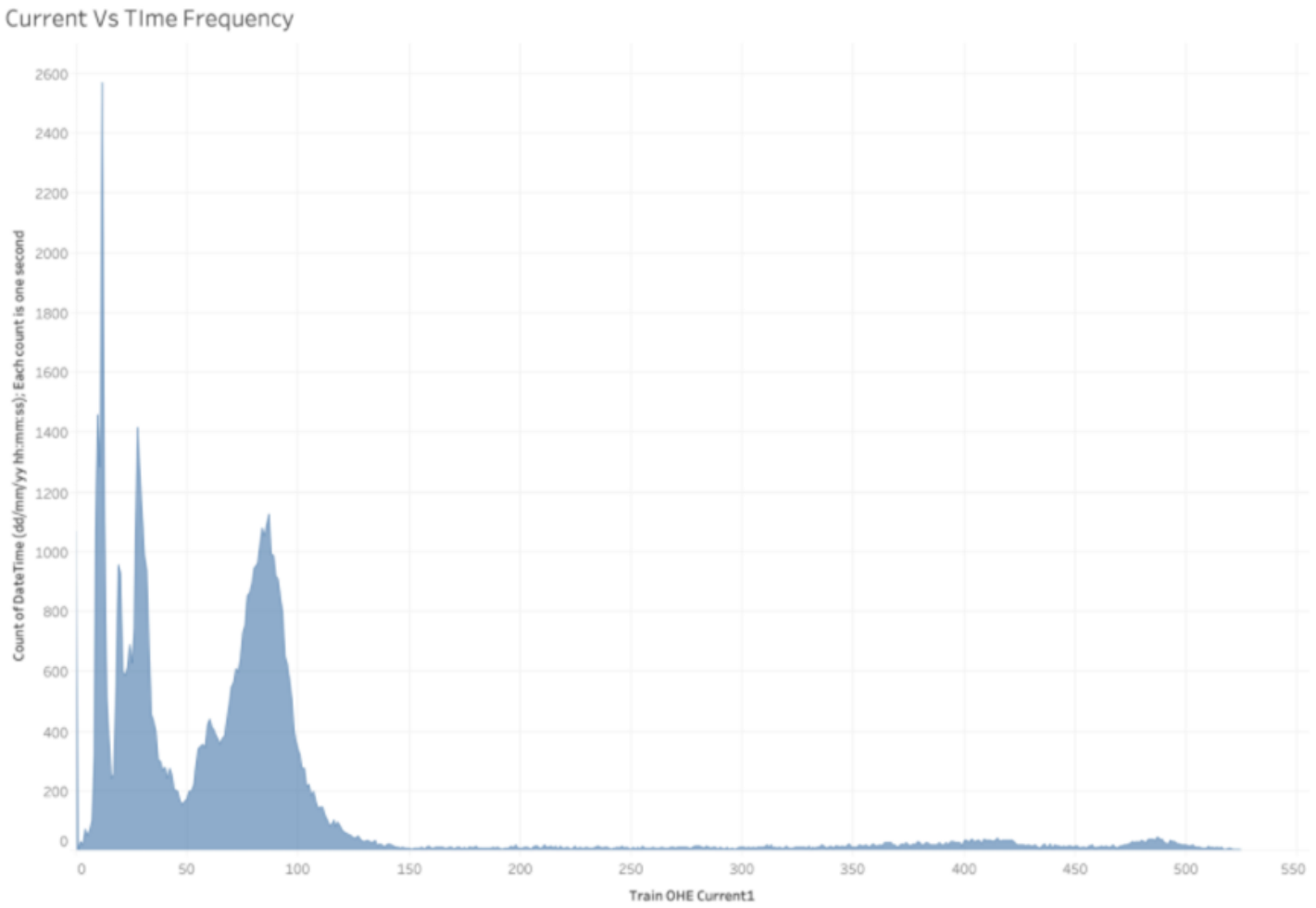
Service Disruptions

Route	Interruption	Reason
NDLS-SVDK	21-23 Nov 2019	Abnormal sound in Axle Bearing of Coach No. 193481
	09-01-2021	Primary Spring Breakage in coach 188327
	30-01-2021	Primary Spring Breakage in coach 193471
	08-03-2021	Primary Spring Breakage in coach 193467
	02-06-2021	Primary Spring Breakage in coach 188321
NDLS-BSB	17-07-2021	Ballast hitting in Under frame and subsequent damage to the brake system components in coach number C12,C-10,C-3
	28-08-2021	Primary Spring Breakage in coach 188328

Current Drawn



Current Drawn



No Spare coach/BU/rake available.

8 different types of coaches techno commercially in one rake formation of 16 coaches.

Hence, full rake or at least 8 coaches required for availability of spare

Need to have entire rake as UTEX.

A Tejas rake kept as standby to be used in case of any service interruption.

S. No.	Coach Type	Population per rake	Technical difference	Commercial difference (Seating Capacity)
1	DTC	2		44
2	MC1	4	Electrically different from MC2 in terms of 415V changeover contactor.	78
3	MC2/CC	2	Electrically different from MC1 & MC3 in terms of 415V changeover contactor and inter-coach power couplers respectively	78
4	MC2/EC	1		52
5	MC3	1	Electrically different from MC1 & MC2 in terms of inter-coach couplers	78
6	NDTC/CC	1	415V changeover contactor available in this coach	78
7	NDTC/EC	1		52
8	TC	4		78

Failures of Primary Helical Coil Springs

- Main reason of service disruption
- 10 cases so far
- Failure started after train services were restored post Covid lockdown
  - Improper heat treatment
  - Notch formation due to stamping marks
- During SS-1 done by Rolling Stock Workshop, CB springs having slightest doubt were changed
- Failures stopped after SS - 1

Central Chemical & Metallurgical Laboratory
Northern Railway Locomotive Workshop Charbagh, Lucknow-226004
Mob:- 09794830610, Email ID:- cmtcblko@gmail.com

TC-8286

T.C. No: - CM/MI/HELICAL SPRING/FL-01 Dated-16.06.2021

FAILURE INVESTIGATION REPORT

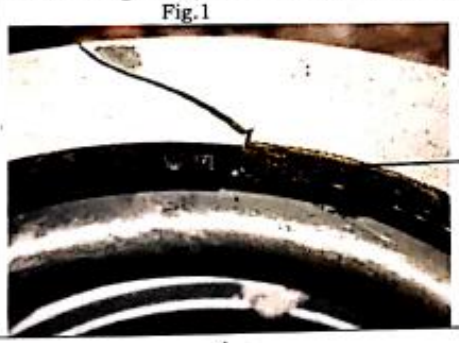
1.0 Particulars-

Name of customer and address	Dy. CME/DSL/Loco workshop/CB/LKO
Reference No. & date	L.No – Nil Dated- 14-06-21
Received on	14-06-2021
Name of sample	Broken Coil Spring
Temperature & humidity at which test conducted (+-2)	24ºC & 72%
Date of completion of report	16.06.21

Description of samples

Sample ID	Coach No.	Date Of Failure	Train No.	Type of spring	POH Place And Date	Stamp Particulars
S/469/21	New T-18 Spring	----	----	Primary Inner Spring	POH: NA Ret Date: NA	CMYRJ011955

2.0 Observations

Sample ID	Visual Examination	Dia. Of the spring
S/469/21	Primary Inner Spring had broken from the last coil at the distance about 200mm from the tip into two pieces. The entire fractured surface was having crystalline appearance in nature indicating sudden breakage. Notch formation was noticed near the fractured surface due to deep stamping marks on the both side of the flat portion of the spring (As shown in fig 1 & 2). No other defect was viewed at the fractured surface.  Fig.1  fig.2 DEEP STAMPING MARKs	28 mm

382350/2021/O/o SSE/DEMO/I/Tech/HQ/NR

3. Metallurgical test:-

Sample ID	Hardness (As specified in RDSO Spec CG-01/2017/Rev1 Test Method-IS:1500/13		Chemical Composition % of Test Method-ASTM E-415/2017								As specified in EN 10089/02 Gr. 52CrMoV4
	Surface (419-486 BHN)	Core (Diff Not more than 20 BHN)	C	Mn	Si	Cr	V	Mo	S	P	
S/469/21	475 BHN	464 BHN	0.55	0.57	1.35	1.02	0.16	0.03	0.008	0.006	% of C- 0.46-0.59 Mn- 0.66-1.15 Si- 0.43 Max Cr- 0.85-1.25 V- 0.08-0.22 Mo- 0.12-0.33 S-0.30 Max P-0.30 Max

3.1 MICRO EXAMINATION: – (Tested as per IS: 7739(Pt-1)/1975) (RA-2017)

One piece was cut at the foot along with the fractured face ground, polished and examined under microscope.

Sample ID	MICRO STRUCTURE (ETCHED WITH 2% NITAL (X 100):	Cause of failure
S/469/21	It revealed as the structure consisting of martensite and partial tempered martensite. 	Failure took place chiefly due to the improper heat treatment i.e. tempering of the spring, resulting in retain ~~of~~ martensite against fine tempered martensite structure. Improper chemistry and notch formation due to deep stamping of number were also a contributory factor for the same.

4. REMEDIAL MEASURES:-

a) Firms must be advised to carried out proper heat treatment to obtain suitable micro structure as stipulated in relevant specification.
b) Stamping of number should be punched properly in accordance with the spec. as to avoid notch formation at the surface of the spring.
c) Any type of dent/tool/pits mark appears on the surface of springs at the time of fitment, the springs must be discarded from the service.

(R. Akhtar) 19/6/21
Dy.CCMT/NR/CB (HOD)

Copy to: - (1) Chief Workshop Engineer/NR/Baroda House/New Delhi for kind information pl. (110001)
2) Dy. CME/DSL/Loco workshop/CB/LKO

Problem due to Neutral Section in Train-18

Water Raising pump gets switched off when train passes through neutral section.

As there is no overhead water tank, passenger may face water problem for a short duration.

On practically checking it was found that disruption in mobile charging is for approx. 20 sec and in toilet water supply is about 60 sec

Solution provided in next rakes with a 415V Bus

Effect of Neutral Section
HOG vs. Train-18

HOG	Train-18	Effect on Passenger
Mobile & Laptop charging is stopped	Mobile & Laptop charging is stopped	Felt by passenger as message beeps in mobile & laptop
Air Conditioning Equipment stop working	Air Conditioning Equipment stop working	Felt in HOG since sound of blower suddenly stops. Not felt in Train-18 as ventilation blower keeps working
Toilet ventilation fans stop working	Toilet ventilation fans stop working	Felt if passenger is using toilet since sound of fan suddenly stops
All pantry equipment stop working	All pantry equipment stop working	Not felt by passengers
Water raising pump stops working	Water raising pump stops working	Not felt by passengers in HOG since there is a small overhead tank over toilets. Felt in Train-18 as water supply will stop being no overhead tank available.

Effect of Neutral Section
HOG vs. Train-18

Type of Coach/ Train	Devices remain Working	Devices get switched off
T-18	110V DC Supplies remains in working. Following devices are ON due to 110V DC supply, · All Control Computers · Saloon and Gangway Lights, Headlight, marker light, Reading lights · Ventilation blowers · CCTV System · PAPIS · Passenger Alarm System · Anti skid device · Lighting contactors · AC compact controller (CPU) & all contactors of RMPU · Brake Electronic Control Units · Passenger Emergency Communication Units · Internal Compartment Doors · External Doors · Auxiliary Air Compressor	All devices working on 415V 3 phase AC supply,220V AC & 110V AC single phase supplies get switched off
LHB	· Lights · Smoke detection system. · Toilet System · Camera · PAPIS · Passenger Alarm System · Anti skid device · AC compact controller (CPU) & all contactors of RMPU · Pump controller & it's contactors · Lighting contactors · Exhaust Fan contactor	· Feeder contactors(K01 &K02) - 415 VAC · output contactor (K-44) - 220 VAC · Local main contactors (K-41, K42) - 220 VAC · Local main contactor main (K-43) - 415 VAC · RBC contactor - 415 VAC

Poor Quality Seats

- Seat covers in about 7 coaches (438 seats) sourced from M/s Airflow peeled off giving shabby look.
- Warranty claim raised
- After a lot of correspondence, firm has finally replaced the defective seat covers

Bio-Vacuum Toilets

Bio-vac toilets supplied by M/s BFG (sourced from E-vac, Germany) has poor support system for spares in India. M/s Sanrok, the authorised dealer for E-vac, was not able to fulfill the spares requirement.

23 PO's on M/s Sanrok

19 - DP extended

2 - failed to supply

2 - supplied within DP

M/s Knorr Bremse is the new agent of M/s Evac

Nose Cone Profile Cover

- Frequent breakage of nose cone due to CRO.
- Nose cone not designed to withstand impact from CRO.
- Gives shabby look when damaged.
- Repair not successful.
- One set costs Rs. 3.16 lakhs.
- Numbers replaced so far – 22 worth Rs. 70 lakhs
- No. of times Nose Cone repaired – 40
- Design of nose cone to be improved by ICF based on Indian conditions

Reading lights poorly designed, with frequent breakage of holders and lights getting defective.

Warranty Claims -485 nos

Design needs to be changed to Shatabdi type of reading lights

Window blinds frequently gets defective as the guiding wire breaks during usage.

Design needs to be improved to sustain rough usage by travelling passengers.

Warranty claims - 46

- Disabled toilet door frequently gets defective as its motor burns in case passenger tries to open/close it manually when it is in auto mode. Design needs to take care of this situation.

  No. of cases - 4

- Reclining gear not provided in CC seats. Will need to be changed in the existing rakes also as the existing seats are uncomfortable. Feedback given to Hon'ble MR during his on-board inspection

Window Glass Replacement

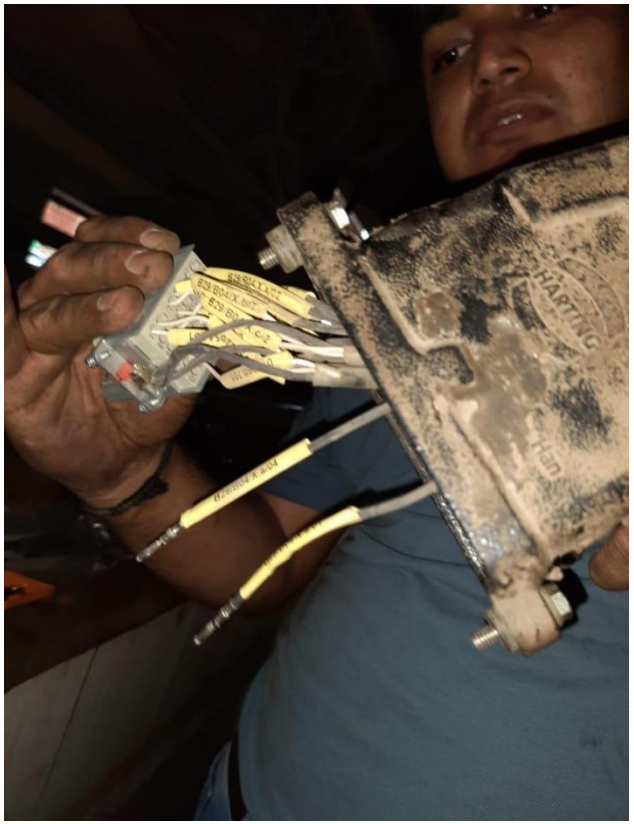
1Procedure for fixing of glass needs rethinking.
2. Present design is too much time consuming. Same for front lookout glass.
3. Curing time of sealant is quite high

Ballast gets stuck between Axle and TM and may damage Axle

Gangway Design needs to be revisited. Coach attachment and detachment takes too much time in present design

Better protection needed for all under slung equipment against CROs & Ballast Hitting

- Case of ballast hitting on 16.07.2021
- C3 - Emergency brake signal wire pin connection worked out
- C12 - MR steel pipe worked out from its seat
- C10 - Coach parking brake flexible pipe punctured



Extra shroud has been provided in BCU of 4 TC's where BCU is slightly less protected due to the presence of Transformer in the under frame

Frequent Choking of Filters of Auxiliary Converters and Traction Motors

Solution provided in new rakes with:
Side wall Duct for traction motors.
Filter mesh size increased for Auxiliary Converters.
Oil cooled Line and Traction converters

No. of warranty complaints indicating the items that fail frequently

Passenger Amenity Items

Component	No of Complaints
Roller Blind	46
Seat Rexine	20
Bio Vacuum Toilets	9
Linoleum Flooring	16
Snack Tables	2
Bottle Holders	2
Total	**95**

Safety & Electrical Items

Component	No of Complaints
Reading Light	18
RMPU	1
I/C Doors	2
Deep Freezer	1
Brush Holder	1
Hot case	2
LCD	4
Water Boiler	3
Primary coil spring	12
Wipers	3
Exhaust Fan	1
Traction Motors	1
Head Lights	1
Jumper assembly	3
BECU	1
DGU	1
Vestibule	1
Air Spring	6
Damper	4
Vacuum Toilet	2
Total	**68**

Major Changes in new Rakes

- Fire survival requirement for Alarm system, PA/PIS
- 415 V synchronization requirement for Auxiliary converter.
- 3 hours battery backup for emergency system. Lithium Iron phosphate battery requirement
- Battery charger from 415 V AC in place of DC input.
- SIL 2 requirement for a major functions of TCMS. 3rd party certification for SIL2.(1 in 100 to 100 Failures)
- New requirement for CCMS with 18 inch touch screen

Major Changes in new Rakes

- Two displays in each cab for TCMS compared to one display in earlier design
- VVVF compressor requirement for RMPU
- SIL2 Fire detection system
- Limiting weight of scope of supply item to 410 tons even if lot of scope has been increased. As electrical equipment weight can't be reduced much, Bogie need to be designed lighter to cater for weight reduction along with propulsion equipment. Also riding index limitation to 3.5 (3.25 preferred) compared to earlier limit of 4.0.

Major Changes in new Rakes

- Gigabit comfort network for PIS and CCTV. No of frame for CCTV is 25 fps
- 100 % power availability in case of failure of Aux converter equivalent to one basic unit in place of one Aux converter failure in earlier design.
- Easter oil (Class K) and Class H with enamel insulation for Transformer
- Time to reach 160 kmph changed to 140 sec. Also Residual Acceleration is required is 0.1 m/sec2 at 160 kmph
- Flood proofing requirement for underslung equipment of traction converter to 650 mm

Any Questions?

Thank You