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E-loco Push-pull Trains- Overview & Ideal solution for passenger transport for Indian Railways.

CRRC Zhuzhou Locomotive Co., Ltd.

Designed and produced by CRRC ZELC

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Part 1	Introduction-about us
Part 2	CRRC Group and CRRC ZELC at glance
Part 3	Need For E-Loco Push-Pull trains in India
Part 4	E-Loco Push-Pull Train details
Part 5	Implementation of E-loco Push-Pull Operation

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Part 6 Benefits of E-Loco Push-pull Trains

Part 7 Recommendations and Suggestions

Part 8 Make in India' Envisage

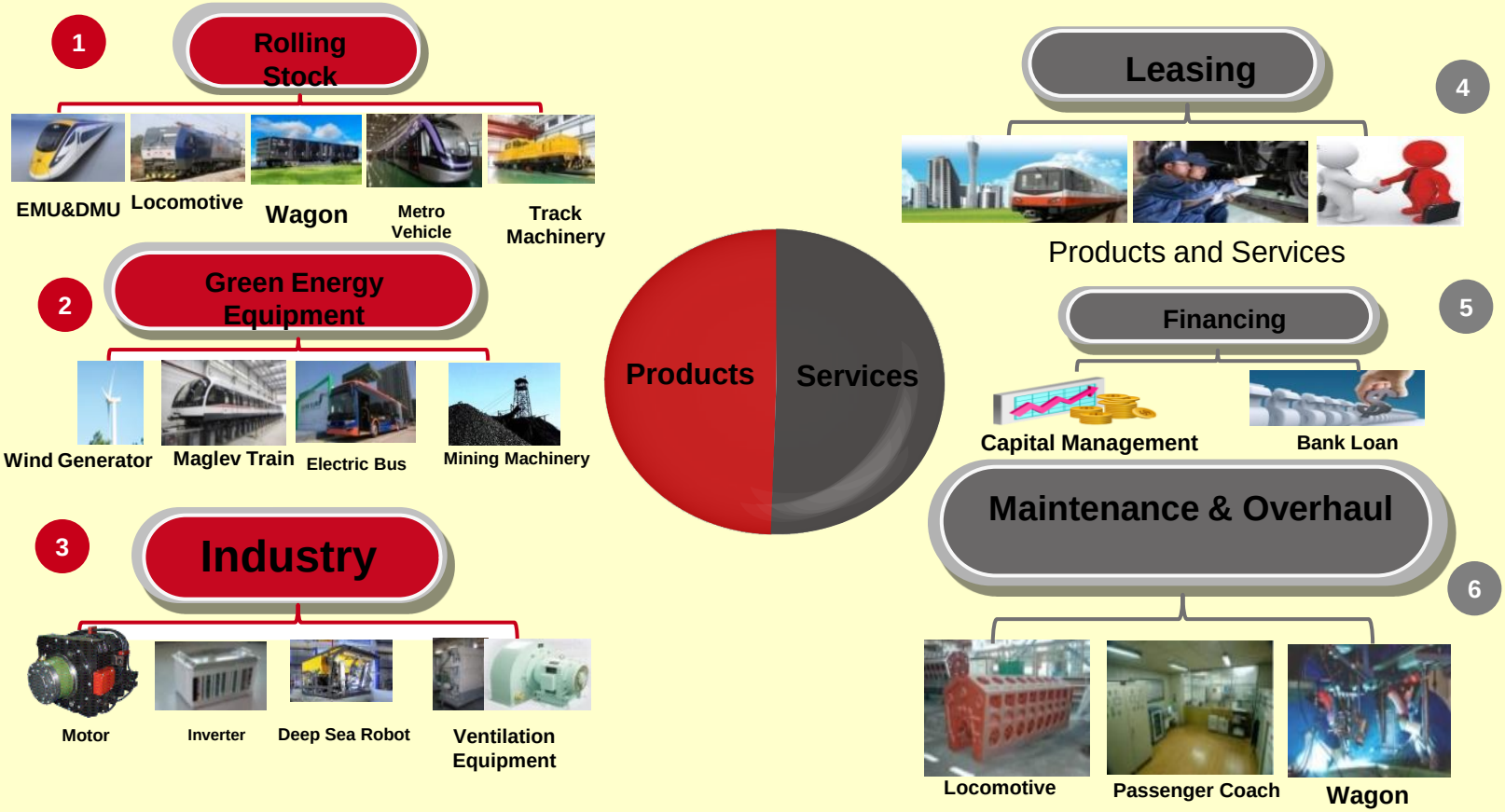
1. INTRODUCTION - ABOUT US:

- **Stanhopes has been promoted by YSK Holdings Private Limited (incorporated in 2014) for focusing on Railway sector.**
- **CRRC ZELC with its local partner YSK/Stanhopes Coaches Private Limited (“Stanhopes”) proposes to set up the project.**

2. CRRC Group and CRRC ZELC at Glance

2.1 CRRC Group and CRRC ZELC at Glance.

CRRC Group is the world-wide professional rail transit system company, owned and controlled by the Chinese Government. It is ranked at 385 of top 500 global companies in 2017.



2. CRRC Group and CRRC ZELC at Glance

2.2 CRRC ZELC Rolling Stock at Glance

Central Land Star
1999
1 set

Blue Arrow
2000
8 sets

China Star
2002
1 set

SCS Malaysia
2011
38 sets

ETS Malaysia
2014
10 sets

Macedonia
2015
6 sets

India
2016
8 sets

CZT China
2016
2 sets

2016 till now

160 kmph push-pull trains

200 kmph push-pull trains

300 kmph push-pull trains

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2. CRRC Group and CRRC ZELC at glance

2.3 CRRC ZELC- at glance

- Total employees - 10,000
- Total Revenue - 2.83 billion USD in 2017
- Total Rail Vehicle - >13000
- Total area of plant - 3.5 km^2
- Subsidary: India, Malaysia, Turkey, South Africa,Austria.
- Business: India, Malaysia, Turkey, South Africa,Austria, Singapore, Uzbekistan, Kazakhstan, Ethiopia, Macedonia, Iran, Georgia, etc.

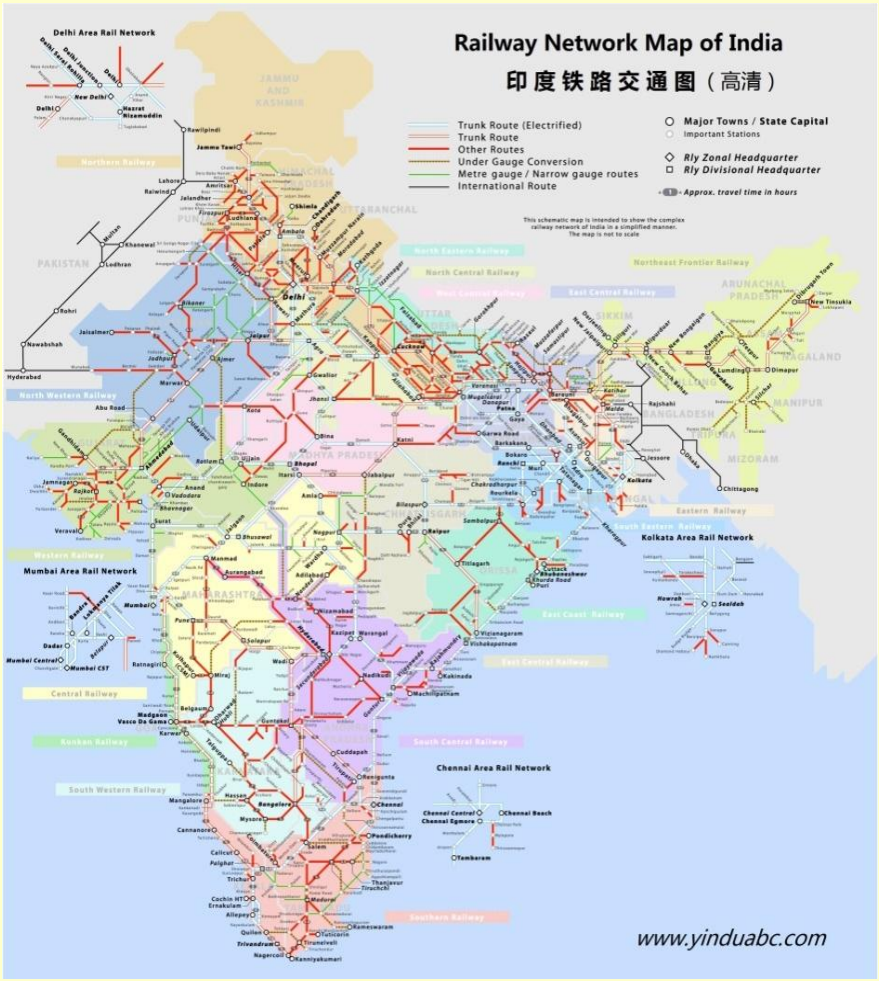
2. CRRC Group and CRRC ZELC at glance

2.4 CRRC ZELC Projects in India.

- **The Rapid Metro Gurgaon Line Project (signed in 2010)**
  - Totally 15 cars (5 trainset, each is 3-car formation) in operation for five years.
  - Rapid Metro Gurgaon South Extension Line Project (signed in 2013)
  - Totally 21 cars (7 trainset, each is 3-car formation) in operation over 1 year.
- **The Navi Mumbai Metro Project (signed in 2014)**
  - 24 cars (8 trainset, each is 3-car formation)- plus 3 years maintenance.
- **CRRC ZELC (I) established in 2015 for marketing, trading, maintenance in India.**

3. Need For E-Loco Push-Pull trains in India

3.1 Indian Railway's at glance



- Indian Railways has decided to achieve 100% electrification of total 66,687km track.
- Up to end of year 2017, the total electrification route 30,500 km .
- 23 million passengers are carried every day.
- Railway is prime passenger carrier system in India.

3. Need For E-Loco Push-Pull trains in India

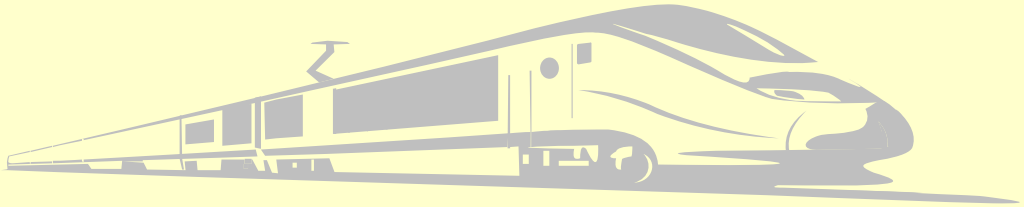
3.2 World Wide Major Railway Status

Countries	India	China	USA	Germany	France
Railway line length (km)	66,687	124,000	250,000	43,468	29,640
Electrified railway	30,500	80,000	<1,500	19,973	15,140
Railway length per area km^2	48.34	77.4	372.12	8.22	21.53
Population/ Railway length	17,796	11,048	1,373	1,881	2,201
Railway passenger demand	Large	Large	Small (mainly freight)	Medium	Medium

3. Need For E-Loco Push-Pull trains in India

3.3 World Wide Railways Overview

- For countries with vast land and relatively medium population (e.g. USA), highway transportation is more preferred for medium and short distance travel;
- For countries with medium land and relatively less population (e.g. Germany, France and other European countries), the railway mode needs higher acceleration and relatively more frequent start-stop;
- For countries with vast land and large population (e.g. India, China),Railways has been enhancing passenger capacity.
- In terms of Railway Mode Selection, India and China situations and requirements are similar



3. Need For E-Loco Push-Pull trains in India

3.4 Train operation options available to Indian Railways in current Scenario.

Two major Options	 E-locos Push-pull	 Power-distributed EMU
Main Features	• Power centralized • Most equipment located onboard in the powered unit, Suitable for large passenger capacity (e.g. India, China)	• Power distributed • Most located below the floor, relatively hard to maintain. • Suitable for frequent stop (e.g. Europe, Japan, China)
Existing Track & Maintenance Facilities Adaptability	• Will directly operate on existing tracks upto speed below 160 km/ph. • Will use existing maintenance facilities in India	• Generally it will need to construct exclusive new railway lines. • Need to construct new maintenance facilities.

3. Need For E-Loco Push-Pull trains in India

3.4 Train operation option available to Indian Railways in current Scenario(Cont.)

Two major Options	 E-locos Push-pull	 Power-distributed EMU Trainset
Passenger Carrying Capability	Flexible formation to increase passenger carrying capability	Fixed formation. Formation can be changed in multiples of 3 or 4.
Financial Benefits	• Infrastructure investment less; • Lower Rolling Stock cost • Lower maintenance cost	• Higher Infrastructure cost • Higher Rolling Stock cost • Higher maintenance cost.
High Speed Systems	TGV (France), ICE1 (Germany), Eurostar, etc.	• CRH (China) , Shinkansen (Japan)

3. Need For E-Loco Push-Pull trains in India

3.5 Chinese Railway Migrates to E-loco Push-Pull Trains

- **Currently in China, passenger operation is at speed120 km/h-160 km/h. With single electric locomotive (Left Picture).**
- **According to current Chinese railways plan released on August 30th, 2018, wihtin 3 years , E-loco Push-pull trains will gradually replace the single loco-hauled train to increases train speed capacity and comfort (Right Picture).**
- **Till 2020, the E-loco Push-pull trains operation railway will be up to 50,000Km.**

4. E-Loco Push-Pull Train Details

4.1 Why E-Loco Push-Pull Trains

- It is a very economical option due to less investment required
- Usage of existing coaches and E-locos, with some modification, as a short term measure.
- Usage of existing coaches with some modifications and even with new higher H.P. new design loco.
- Higher passenger transport capability to cater for the higher traffic volume;
- Higher usage of existing track, maintenance and other facilities.
- Highly efficient system due to flexibility in train set formation.
- Higher reliability due to the use of proven and mature technologies.
- Longer economical lifespan due to the robustness of the design.
- Higher speed operation with the use of existing, matured design and manufacturing platforms.

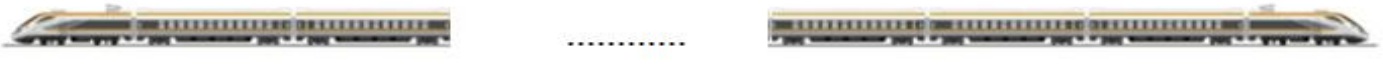
4. E-Loco Push-Pull Train Details

4.2 E-loco Push-pull Trains Composition

- **Indian Railways is operating most of passenger trains including Rajdhani and Shatabdi trains with Single Electric loco. Most of the trains are operating at 110 km/hr and select Rajdhani and Shatabdis upto 140 km/hr. Acceleration and declaration are also low, resulting into lower average speeds and higher journey time and inefficient utilization of line capacity.**
- **E-Loco push-pull trains operating at higher speeds upto 200km/hr is only solution at present with Indian Railways, to improve average speed, reduce journey time, efficient utilization of line capacity, with least investment.**
- **Few E-Locos push-pull arrangements are as follows:**

E LOCO — Short train formation (E loco+12coaches+E loco) — E LOCO

Long trains formation (E loco+16coaches+E loco) — E LOCO



E LOCO — Flexible train formation (E loco+20~24Coaches+E loco) — E LOCO

4. E-Loco Push-Pull Trains Details

4.3 Overview of Exterior and Interior Designs

4. E-Loco Push-Pull Trains Details

4.4 Driver's Cab in Powered Car

- New materials adopted and fully wrapped operation panel
- Ergonomical design
- Two driver's seats.
- High level of air impermeability

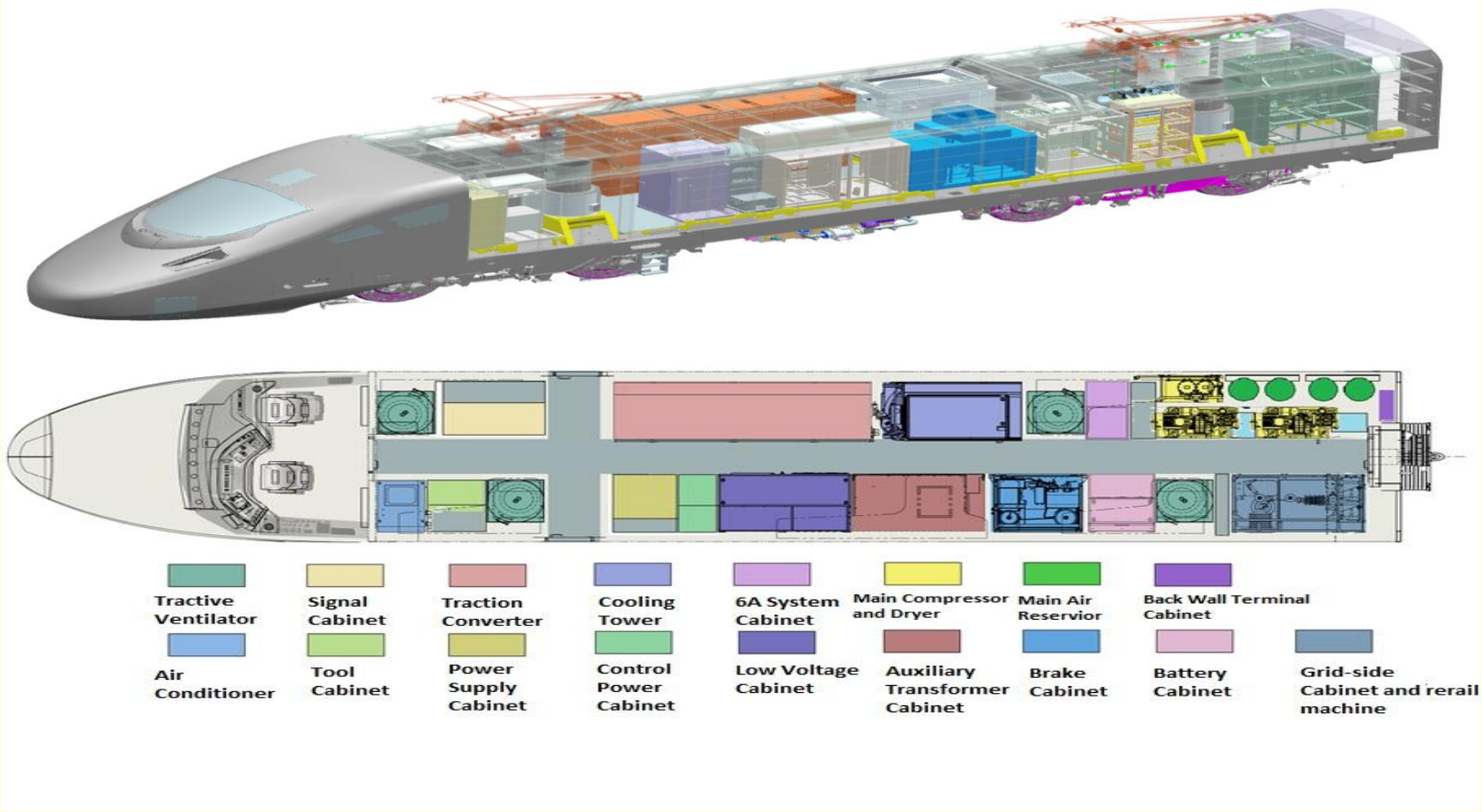
4. E-Loco Push-Pull Train Details

4.5 Technical Details

Power supply		25kV 50Hz
Track gauge		1,676mm
Maximum operation speed		200 km/h
Design speed		210 km/h
Acceleration		0.35 m/s^2 (0-40 km/h)
Emergency brake distance in flat and straight line (m) Initial speed 200 kmph Initial speed 160 kmph		≤2,200 ≤1,400
Formation	Short formation	E loco+12coaches + E loco
	Long formation	E loco+16coaches +E loco
	Flexible formation	E loco+20~24coaches+1Eloco
Bogie type		B_0-B_0
Axle load		18 t
Wheel rim traction/ brake power		≥5,600kW/7500 h.p
Starting tractive force		240kN
Regenerative brake force		130 kN
Continuous tractive force		183 kN

4. E-Loco Push-Pull Train Details

4.6 E-Loco Equipment Layout & Profile.

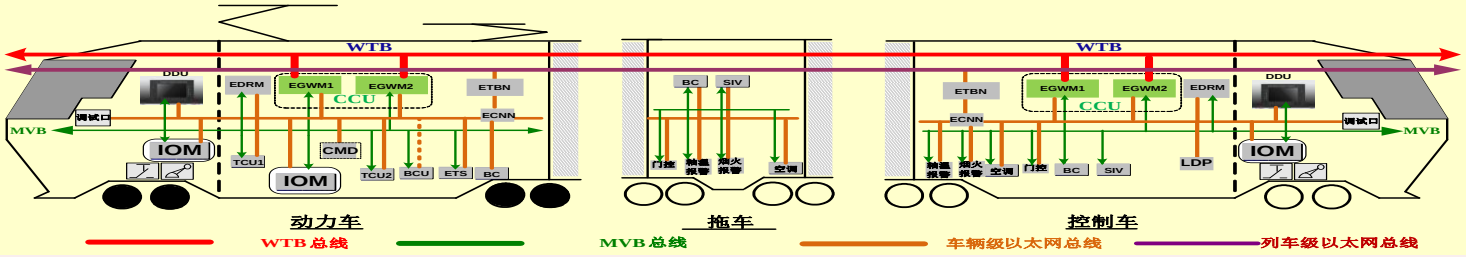


4. E-Loco Push-Pull Train details

4.7 Train Control &Communication Network

- Train Control & Communication Network is generally based on IEC 61375 regulation.
- Network comprises of WTB(Train wire bus), Ethernet bus for train communication. WTB and Ethernet bus and serve as redundancy for each other.
- Vehicle communication is through MVB(Multi function Vehicle Bus) bus and Ethernet marshaling bus serve as redundancy for each other.

Schematic diagram of communication system is as follows.



Network Provides

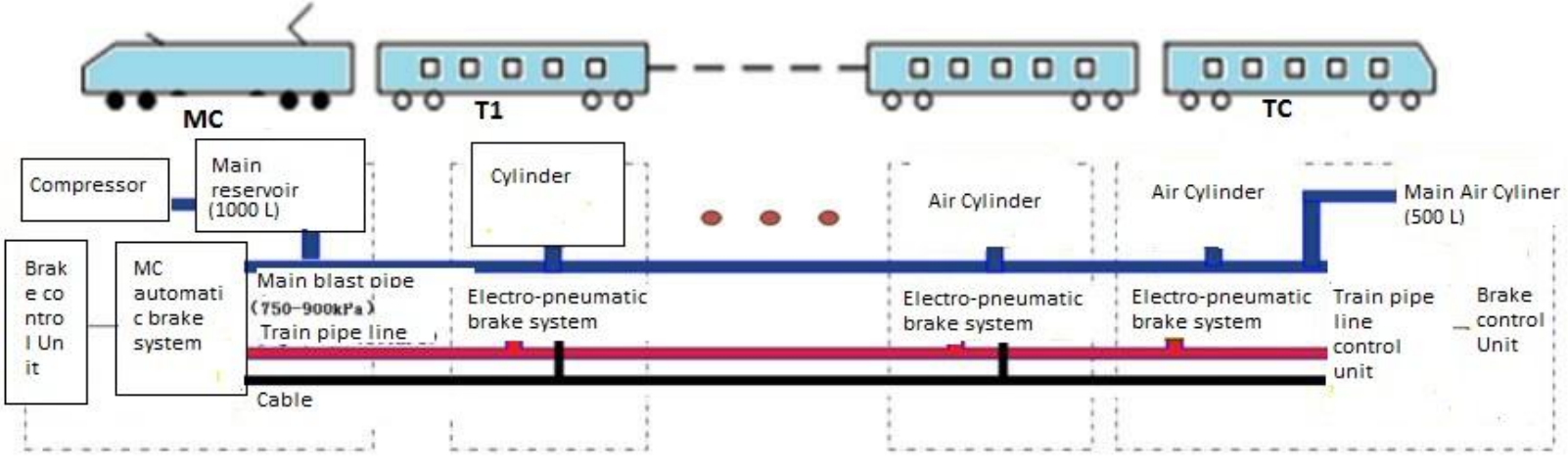
- Remote Traction control.
- Centralized Managing and monitoring of auxiliary devices all over the train;
- Different levels of information for the crew in order to rapidly react in case of failure;
- Remote Monitoring of maintenance requirement.
- Passenger Information.

4. E-Loco Push-Pull Train details

4.8 Brakes system of Trains

Train is equipped with of Automatic Electric Pneumatic Brake, Electric Pneumatic Brake with gradual release function, Emergency Brake, Independent Brake, Back-up Brake, Parking Brake, etc.

Schematic diagram is as follows.



5. Implementation of E-loco Push-Pull Operation

5.1 Short Term proposal

I. Indian Railways shall operate single loco hauled Rajdhani and Shatabdi trains with two E-locos in push-pull arrangement. Existing WAP-5 locos, having BO-BO arrangement, speed potential upto 160 km/hr upgradable upto 200km/hr, shall be used.

II. Train may be provided with Train control & communication Network (TCN), having WTB, MVB system through multicore cable running from end to end, as in Para 4.8. Indian Railways have adequate experience to use multicore cable for train control & communication.

III. The train brake system shall be modified to EP brake system, to enhance brake effort and to improve application & release time.

IV. Short term proposal is to run Rajdhani and Shatabdis with E-loco Push-pull arrangement, incorporating following features:

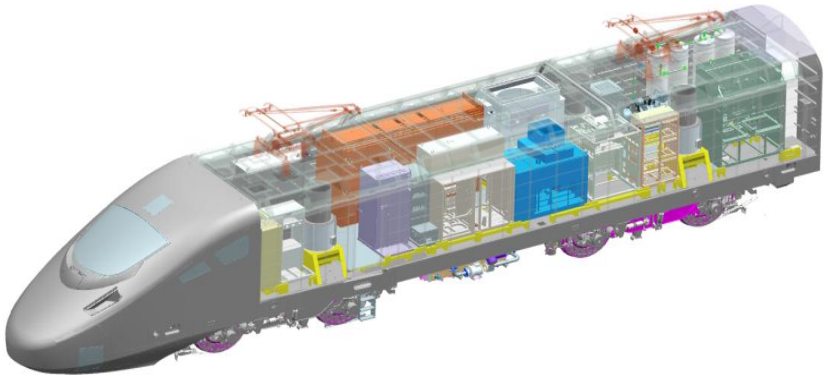
a) Operating trains with two WAP5/WAP7 loco in push-pull arrangement.
b) Providing train control & communication network(TCN).
c) Replacing Air brake of trains with EP brakes.

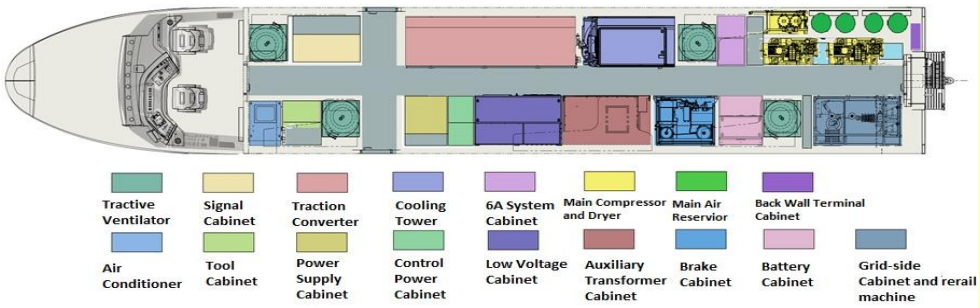
5. Implementation of E-loco Push-Pull Operation

5.2 Long Term Proposal

I. New Electric Loco

- Indian Railways shall plan new electric loco for Push-pull operation of passenger trains. E-Loco shall be of modular design, inline with Coach profile, long hood and axle load around 18 Tons.
- Chinese Railways are operating trains with E-loco Push-Pull arrangement, using similar locos.
- Layout of E-Locos used by Chinese Railways is as follows.





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5. Implementation of E-loco Push-Pull Operation

5.2 Long Term Proposal (Cont.)

II. Train Control and communication Network

Train control & communication network shall be developed generally confirming IEC 61375, having adequate redundancy as being adopted by Chinese Railways. All the coaches being built in future shall be provided with multicore bus coupler, to facilitate train control and communication.

III. Train brake system

All the new coaches being built shall have EP brake system, in line with international practices

IV. HOG system should be adopted for train lighting and air conditioning. In case of traction supply failure, the emergency lighting and ventilation to be provide by coach batteries, using higher power batteries. Hence during such period ventilation will be available not air conditioning.

This way Indian Railways can do away use of power cars in Rajdhani & Shatabdis.

6. Benefits of E-Loco Push-pull Trains

6.1 Benefits

- Technical proposal is based on a Mature Technology and Platform, using proven major components' of latest design ;
- Redundancy design is applied in major and safety related systems.
- Lower capital cost of rolling stock compared with EMU type trainset.
- Life cycle costs is better by 25% compared with EMU type trainset.
- Complete network with expertise integration, enhance the trouble shooting ability;
- Ventilation device, online inspection, main air duct self monitoring, learning and diagnosis system, on board monitoring maintenance parameters enhances reliability and availability.
- On board data management.

6. Benefits of E-Loco Push-pull Trains

6.1 Benefits (Cont.)

- Flexible formation according to different transportation demand.
- Time tested design of locomotives to operate at High Altitude, Temperature Ranges （-50℃~+45℃), Wet, Windy and Dusty Conditions.
- Time tested E-locos available.
- Environmentally friendly design with no pollution and low energy consumption.
- HVAC guarantees the internal humidity, temperature and air flow comfortable.
- Pressure protection when two trains pass each other；
- Illumination system guarantees the comfortable atmosphere；
- PIS provides audio/video entertainment and WIFI.
- Better riding comfort than power distributed EMU train set.

7. Recommendations and Suggestions

I. Considering all above aspects, CRRC ZELC recommends use of E-locos Push-Pull arrangement both as SHORT TERM and LONG TERM measures by Indian Railways, being most efficient, reliable, cost effective, energy efficient and meeting all passenger aspiration in terms of safety, time and comfort.

II. Train control and communication Network, shall be used in all trains operating with E- Loco push-pull arrangement (Ref Para 4.7).

III. EP brake shall be provided in all coaches in place of air brakes, to improve braking effort, reduce braking distance and improve safety to train. (Ref Para 4.8).

IV. Limited E-Locos capable of hauling 24 coaches trains upto 200km/hr in push-pull arrangement, with axle load not exceeding 18T shall be procured. Then manufactured in India either in JV/PPP mode.

V. CRRC ZELC have ready loco, suitable for E-loco push-pull operation of 24 coaches at 200km/hr. and shall be able to deliver in shortest possible time. (Ref Para 5.2).

8. ‘Make in India’ Envisage

8.1 CRRC ZELC have implemented different models of socio-economic plans where they doing business. The models differ from country to country depending and immediate socio-economic needs:

Malaysia

Manufacturing base and maintenance

Support as part of the after-sale services.

Turkey

Joint-venture and manufacturing plant focusing mainly on transfer of skills

South Africa

Subsidiary and JV, manufacturing plant and maintenance base – Skills development and job creation

India

Subsidiary and maintenance team – Transfer of skills and job creation

Turkey

South Africa

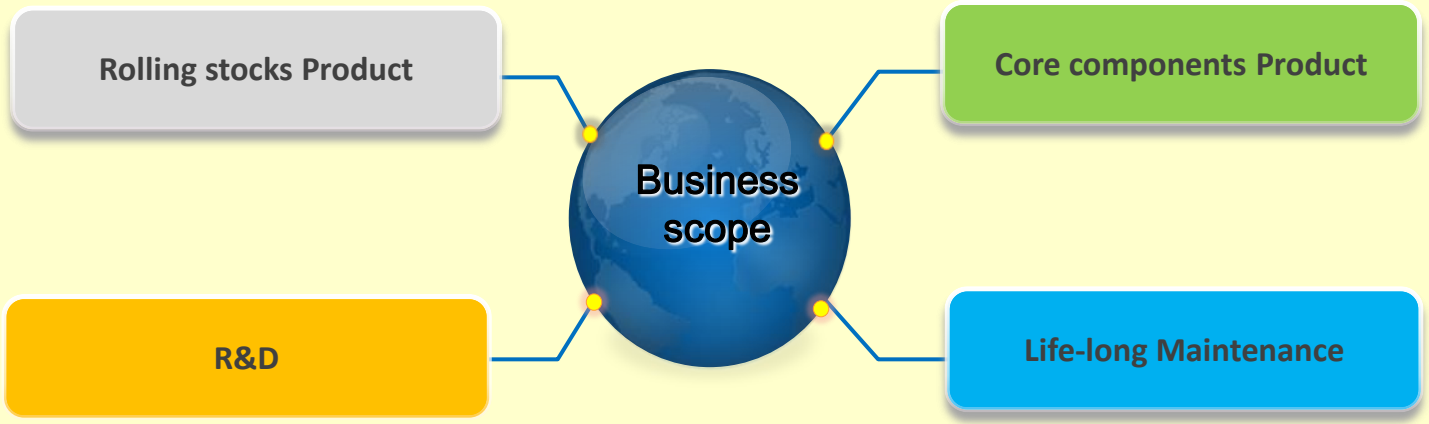
Europe Branch

Kuala lumper

8. ‘Make in India’ Envisage

8.2 Proposed Indigenization Plan

The following business scope is proposed by CRRC ZELC& Local partner (YSK/Stanhopes)



8. ‘Make in India’ Envisage

8.2 Proposed Indigenization Plan (Cont.)

Push-pull e-loco trains/Core Components

R&D/Maintenance

Phase I

Phase II

8. ‘Make in India’ Envisage

8.3 Proposed Indigenization Plan – Benefits

- **Provide impetus to “Make in India” initiative. Manufacture rolling-stock in India for the local and regional market.**
- **Development of local supply chain for the supply of sub-components and related goods and services.**
- **Job creation from managerial, high tech engineers and technicians, artisans (craftsmen and craftswomen) down to semiskilled and unskilled personnel – Estimated to be in the hundreds.**
- **Training and development of managerial and technical skills in project management, logistics, manufacturing, testing and commissioning**
- **Collaboration with local universities and research institutions in the customization of the technologies.**


THANKS