ELECTRIFICATION SYSTEM FOR DEDICATED FREIGHT CORRIDOR
Indian Railways - An Overview

High Density Corridor (Golden Quadrilateral + Diagonals)

16% of route Km carries
52% of passenger &
58% of freight
Indian Railways- Concerns For Freight Traffic

- Falling market share (90% to 30%)
- Capacity constraints on high density network
- Differential speeds of trains
- Inability to carry longer/heavier trains
**Mandate & Objectives of DFCCIL**

- **Special Purpose Vehicle** to undertake planning & development, mobilization of financial resources and construction, maintenance and operation of the Dedicated Freight Corridors.

- **Objectives**
  - Reduce unit cost of transportation:
  - Create rail infrastructure to carry higher throughput per train;
  - Offer IR's customers guaranteed, faster transit at economic tariff;
  - Increase IR's share in freight market;
  - Improved overall transport efficiency of national rail network
Western Corridor (1520 km)
Rewari-Vadodara (963 km)
Vadodara-JNPT (430 km)
Rewari-Dadri (127 km)

Eastern Corridor (1856 km)
Khurja - Bhaupur (343 km)
Bhaupur-Mughalsarai (402 km)
Khurja-Ludhiana (401 km)
Khurja-Dadri (46 km)
Mughalsarai-Sonnagar (126 km)
Sonnagar-Dankuni (538 km)
Operating Aspects of DFCC

- DFCC to manage train operation on DFC.
- DFCC to have own stations and control centers.
- Rolling stock ownership & its maintenance by IR.
- Feeder Routes /Sidings to be upgraded by IR.
- All LCs to be replaced by ROBs / RUBs.
Basic Design Features

Moving Dimensions

Height

4.265 m

Width

3200 mm

3660 mm

Container Stack

Train Length

700 m

700/ 1500 m

Train Load

4,500 Ton

13,000 Ton

Indian Railway

DFC Routes

Western Corridor

Eastern Corridor
### Heavier Axle Loads

<table>
<thead>
<tr>
<th></th>
<th>Indian Railway</th>
<th>DFC Routes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Axle Load</td>
<td>22.9 t / 25 t</td>
<td>25 t</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bridges &amp; formation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>designed for 32.5 t</td>
</tr>
<tr>
<td>Maximum Speed</td>
<td>75 Kmph</td>
<td>100 Kmph</td>
</tr>
<tr>
<td>Average speed</td>
<td>25 kmph</td>
<td>70 kmph</td>
</tr>
<tr>
<td>Grade</td>
<td>Upto 1 in 100</td>
<td>1 in 200</td>
</tr>
<tr>
<td>Basic Design Features (Contd.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Indian Railway</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>DFC Routes</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Traction</strong></td>
<td>Electrical</td>
<td>Electrical</td>
</tr>
<tr>
<td></td>
<td>(25 KV)</td>
<td>(25 KV AT Feeder System)</td>
</tr>
<tr>
<td><strong>Station Spacing</strong></td>
<td>7-10 Km</td>
<td>40 Km (Approx.)</td>
</tr>
<tr>
<td><strong>Signalling</strong></td>
<td>Absolute /Automatic with 1 Km spacing</td>
<td>Automatic with 2 Km spacing</td>
</tr>
<tr>
<td><strong>Communication</strong></td>
<td>Emergency Sockets</td>
<td>Mobile Train Radio</td>
</tr>
</tbody>
</table>
Operational Requirements

- Heavy haul train operation with electric traction
- Train load 4500/6500 tonne & 9000/13000 tonne trains in the ratio of 2:1
- Maximum Speed - 100kmph
- Deployment of high horse power locomotive (9000/12000 HP) i.e 7000/10000 MVA.
- Long Haul Operation with train length of 1500 m or more.
- Western Corridor suitable for Double Stack Container operation
## DFC Cost Estimates

<table>
<thead>
<tr>
<th>Project Cost (in Rs. Crores)</th>
<th>WDFC (1503 km)</th>
<th>EDFC (1318 km)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Civil works</td>
<td>25312</td>
<td>16009</td>
<td>41321</td>
</tr>
<tr>
<td>Electrical works</td>
<td>4278</td>
<td>2980</td>
<td>7258</td>
</tr>
<tr>
<td>S&amp;T</td>
<td>3110</td>
<td>1993</td>
<td>5103</td>
</tr>
<tr>
<td>Mechanical</td>
<td>160</td>
<td>160</td>
<td>320</td>
</tr>
<tr>
<td><strong>Total Hard Cost</strong></td>
<td><strong>32860</strong></td>
<td><strong>21142</strong></td>
<td><strong>54002</strong></td>
</tr>
<tr>
<td>Soft cost*</td>
<td>13858</td>
<td>5531</td>
<td>19389</td>
</tr>
<tr>
<td><strong>Total cost</strong></td>
<td><strong>46718</strong></td>
<td><strong>26673</strong></td>
<td><strong>73391</strong></td>
</tr>
<tr>
<td>Land cost</td>
<td>4383</td>
<td>3684</td>
<td>8067</td>
</tr>
<tr>
<td><strong>Grand Total</strong></td>
<td><strong>51101</strong></td>
<td><strong>30357</strong></td>
<td><strong>81459</strong></td>
</tr>
</tbody>
</table>

*Soft Cost – Escalation (11,141), Insurance/Taxes (651), Contingency (1,954), IDC (5,641)*
## Funding Plan

(All figs. in INR Crores)

<table>
<thead>
<tr>
<th>Particulars</th>
<th>Eastern Corridor</th>
<th>Western Corridor</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equity from MoR</td>
<td>10,352</td>
<td>7,996</td>
<td>18,348</td>
</tr>
<tr>
<td>Loan from JICA</td>
<td>-</td>
<td>38,722</td>
<td>38,722</td>
</tr>
<tr>
<td>Loan from World Bank</td>
<td>16,322</td>
<td>-</td>
<td>16,322</td>
</tr>
<tr>
<td><strong>Total Funding (without Land)</strong></td>
<td><strong>26,674</strong></td>
<td><strong>46,718</strong></td>
<td><strong>73,392</strong></td>
</tr>
<tr>
<td>MoR (Land)</td>
<td>3,684</td>
<td>4,383</td>
<td>8,067</td>
</tr>
<tr>
<td><strong>Total Funding with Land</strong></td>
<td><strong>30,358</strong></td>
<td><strong>51,101</strong></td>
<td><strong>81,459</strong></td>
</tr>
</tbody>
</table>

**Ratio of External funding: MoR funds is 3:1**
<table>
<thead>
<tr>
<th>Section</th>
<th>Phased commissioning sections</th>
<th>Compressed timelines</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bhaupur-Khurja: 343 km</td>
<td>Bhaupur – Khurja (343 km)</td>
<td>Mar ’18</td>
</tr>
<tr>
<td>Bhaupur-Mughalsarai: 402 km</td>
<td>Jeonathpur - New Karchana (139 km)</td>
<td>June-18</td>
</tr>
<tr>
<td></td>
<td>New Karchana - New Bhaupur (241 km)</td>
<td>Dec-18</td>
</tr>
<tr>
<td></td>
<td>Mughalsarai – Jeonathpur (22 km)</td>
<td>Jun-18</td>
</tr>
<tr>
<td>Mughalsarai-Sonnagar: 126 km</td>
<td>Sasaram – Durgawati (56 km)</td>
<td>Mar 16</td>
</tr>
<tr>
<td></td>
<td>Durgawati – Mughalsarai (61 km)</td>
<td>Mar-18</td>
</tr>
<tr>
<td>Dadri-Khurja: 46 km.</td>
<td>DADRI-KHURJA: 46 km.</td>
<td>Dec’18</td>
</tr>
<tr>
<td>Khurja-Ludhiana: 401 km</td>
<td>Pilkhani – Ludhiana (179 km)</td>
<td>Mar-19</td>
</tr>
<tr>
<td></td>
<td>Khurja – Pilkhani (222 km)</td>
<td>Dec,19</td>
</tr>
<tr>
<td>Original Timelines</td>
<td>Revised phased commissioning sections</td>
<td>Compressed timelines</td>
</tr>
<tr>
<td>----------------------------------------</td>
<td>----------------------------------------</td>
<td>----------------------</td>
</tr>
<tr>
<td>Rewari-Iqbalgarh (639 km)</td>
<td>Rewari-Phulera (217 km)</td>
<td>Mar’18</td>
</tr>
<tr>
<td></td>
<td>Phulera-Bangurgram (117km)</td>
<td>Mar’18</td>
</tr>
<tr>
<td></td>
<td>Marwar-Palanpur (207 km)</td>
<td>Mar’ 18</td>
</tr>
<tr>
<td></td>
<td>Bangurgram – Marwar (98 km)</td>
<td>June’18</td>
</tr>
<tr>
<td>Iqbalgarh-Vadodara (308 km)</td>
<td>Makarpur-Udhana (119 km)</td>
<td>Mar’19</td>
</tr>
<tr>
<td></td>
<td>Palanpur-Makarpura (294 km)</td>
<td>Mar’19</td>
</tr>
<tr>
<td>Vadodara-JNPT (430 km)</td>
<td>Udhana-Kharbao (241 km)</td>
<td>Mar’19</td>
</tr>
<tr>
<td></td>
<td>Kharbao-JNPT (84 km)</td>
<td>Oct’19</td>
</tr>
<tr>
<td>Rewari-Dadri (127 km).</td>
<td>Rewari-Dadri (127 km)</td>
<td>Sept ’19</td>
</tr>
</tbody>
</table>
## Phased Commissioning

<table>
<thead>
<tr>
<th>Year-wise commissioning</th>
<th>Eastern DFC (Kilometres to be commissioned)</th>
<th>Western DFC (Kilometres to be commissioned)</th>
<th>Total Kilometres</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>During 2015-2016</strong></td>
<td>56 ((\text{Durgawati-Sasaram}))</td>
<td>-</td>
<td>56</td>
</tr>
<tr>
<td><strong>2017-2018</strong></td>
<td>413 (\text{Bhaupur-Khurja (343 km), Durgawati-Mughalsarai &amp; Karwandiya-Sasaram (70 km)})</td>
<td>541 (\text{Rewari-Phulera (217 km), Phulera-Bangurgram (117 km), Marwar-Palanpur (207 km)})</td>
<td>954</td>
</tr>
<tr>
<td><strong>2018-2019</strong></td>
<td>627 (\text{Jeonathpur-New Karchana (139 km), New Karchana-New Bhaupur (241 km), Mughalsarai-Jeonathpur (22 km), Dadri-Khurja (46 km), Pilkhani-Ludhiana (179 km)})</td>
<td>752 (\text{Bangurgram-Marwar (98 km), Makarpur-Udhana (119 km), Palanpur-Makarpur (294 km), Udhana-Kharbao (241 km)})</td>
<td>1379</td>
</tr>
<tr>
<td><strong>2019-2020 (upto Dec 19)</strong></td>
<td>222 (\text{Khurja-Pilkhani (222 km)})</td>
<td>211 (\text{Kharbao-JNPT (84 km), Rewari-Dadri (127 km)})</td>
<td>433</td>
</tr>
</tbody>
</table>
Contracting Strategy

- Construction through lump-sum Design & Build contracts
- Document preparation for contracting being done through internationally reputed General Consultants (GC)
- Contract management through Project Management Consultants (PMC)
- Quality and Safety Management through QSAC
Contracting Strategy

- Packaging and Slicing based on Road shows
- ICB based on WB/JICA Procurement Guidelines
- Design and Build LUMP SUM
- Completion Period: 3 to 4 yrs
- Defect Notification Period: 2 yrs
Contracting Strategy

- FIDIC Yellow Book customized for Design-Build railway infrastructure works.
- Slice & Package System - enhanced competition.
- PQ followed by one/two stage bidding-
  - Pre-Qualification followed by two stage bidding – EDFC
  - Pre-Qualification followed by single stage bidding – WDFC
  - Engagement of consultant through Quality-Cum-Cost-Based-System (QCBS)
- New technology encouraged.
  - New technologies as per Acceptance Criteria
Approach For New Technology

- Performance Specification Based on EN, IEC and other International standard.
- Acceptance Criteria of PROVEN New Technology
- Transfer of Technology for local sourcing (upto 50%) and encouragement for Make in India
Acceptance Criteria for Materials

- Three years of satisfactory performance
- Should have supplied equipment of 70% (min.) rating of the equipment offered
- Should have supplied 50% quantity to be used in the contract in last seven years
- Can supply two times (max.) the quantity supplied in last seven years
Make In India Initiative

- 50% quantity can be sourced locally through Technology Transfer to any Indian Company

- Extended Guarantee for 3 years beyond DNP for such items

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The Incremental Approach

- 25 KV AC Traction has served IR very well in terms of meeting the capacity and throughput requirements.

- Increased demand has been met by upgrading the transformers (12.5/13.5 to 21.6/30 MVA). Also by introduction of additional Traction Sub Stations (TSSs).

- Incremental approach not feasible for High Speed and Heavy Haul.
Need For Quantum Upgradation Of AC Traction System

- To meet additional power requirements due to

  - Increase in Axle load from 20.0 ---- 22.5 ---- 25.0
    27.5 ---- 30.0 ---- 32.5 T.
  
  - Increase in train haulage capacity (Long haul).

  - Increase in train frequency
What NEXT?
For High speed & heavy haul railway network.

25 kV AT feed system?
AC Supply Systems - Why Choose AT Feed System

VOLTAGE DROP COMPARISON

Reason: Supply condition would improve drastically
Major Operational Advantages Of 25kv AT Feeding System

- The insulation level will remain at 25 kV
- Feed voltage doubles up to 50 kV reducing OHE current by 50%
- Permits traction supply points to be at 60-80 km apart.
- Improved voltage regulation and power density >1MVA/RKM
- Same EMUs & locomotives can be used
- Provides quantum jump of 100% in haulage capacity
What is 2x25 kV AT Feeding System
DFCCIL APPROACH FOR ELECTRIFICATION
DFCCIL Project Mandate

- Heavy haul train operation with electric traction with 13 minute head way; 4500/6500 tonne & 9000/13000 tonne trains in the ratio of 2:1, speed- 100kmph, deployment of high horse power locomotive (9000/12000 HP) i.e 7000/9000 MW.

- Traction system matching with line capacity to meet traffic projection of 2031-32.

**EDFC:** Traffic volume/capacity increase 64 Billion NTKM to 250 Billion (4 times).

**WDFC:** Traffic volume/capacity increase 44 billion NTKM to 260 billion NTKM (6 times).
## Power Supply Arrangement

<table>
<thead>
<tr>
<th>Corridor</th>
<th>Total TSS</th>
<th>TSS Spacing</th>
<th>Planned with DISCOM’s Connectivity</th>
<th>Planned with CTU connectivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>EDFC</td>
<td>19</td>
<td>60 kM (DL) &amp; 90 kM(SL)</td>
<td>7</td>
<td>12</td>
</tr>
<tr>
<td>WDFC</td>
<td>25</td>
<td>60 kM</td>
<td>*25</td>
<td>NIL</td>
</tr>
</tbody>
</table>

In WDFC, 11 TSS are having integrated supply arrangement with IR & common connection with DISCOM.

In EDFC transmission line is being constructed through POWERGRID with CTU connectivity to provide supply to 12 TSS. The network is also interconnected with existing IR network.
Power Supply Arrangement (Contd...) 

- Spacing of traction sub-station (55 ~ 65 km) 
- Spacing of switching posts (15 ~ 17 km) Auto transformer (8 MVA) 
- Ratings of traction power transformer (60/84 MVA)
Power Supply Arrangement (Contd…)

- Higher Current carrying capacity for switch gears and isolators
- SF-6 CB for HV side & VCB for 25 kV side
- Protection: Fast acting Intelligent Numerical Protection
- Dynamic Reactive Power Compensation
OHE Design

- OHE design as per EN 50119
- Feeder wire all along the section.
- Overhead Aerial Earth Conductor (AEC) for traction earth return current, all along the section
- Buried Earth Conductor (BEC) for limiting the step and touch potential with in limits specified in EN 50122-1.
- Dropper; current carrying, flexible
- Modular cantilever in representative section (WDFC)
OHE Design

- Cylindrical Foundations based on UIC ORE method

- Steel structures – Higher length in WDFC (MMD 7.1 m)

- Suitable steel structure to support thicker conductor
OHE Design (Contd…)

- Contact wire : (Copper Alloy)*
- Catenary wire : (Copper Alloy)*
- Feeder wire : AAAC
- Aerial Earth Conductor (AEC): As per earthing and bonding requirement
- Buried Earth Conductor (BEC): As per outcome of traction power simulation study.
- The critical values of all these parameters can be found out by simulation study.

* Material to withstand temperature up to 100°C (EN 50119/IEC-60913-2013)
OHE Design (Contd…)

- High rise OHE with 7.47 m height suitable for double stack operation on flat wagons on Western DFC.

- First in the world at such MMD.
Need For Simulation

- Traction Power Simulation to finalize ratings of major equipment & sizing of OHE conductors

- OHE Pantograph Simulation – to ensure current collection quality

- Earthing & Bonding Simulation- To keep the system safe under fault & normal condition for the users
## Traction Power Supply Simulation Outcome

<table>
<thead>
<tr>
<th>ITEM DESCRIPTION</th>
<th>EDFC Bhaupur-Khurja</th>
<th>WDFC (Rewari-makarpura)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traction Power Scheme</td>
<td>Single Phase with centre point earthed</td>
<td>Scott Connected 55kV secondary</td>
</tr>
<tr>
<td>Transformer rating</td>
<td>38/63 MVA ONAN/OFAF single phase</td>
<td>60/84/100 MVA ONAN/ONAF/OFAF</td>
</tr>
<tr>
<td>Auto transformer rating</td>
<td>16.5 MVA</td>
<td>10/8 MVA</td>
</tr>
<tr>
<td>Contact Wire</td>
<td>150 sqmm</td>
<td>150 sqmm</td>
</tr>
<tr>
<td>Contact material</td>
<td>Cu-Ag</td>
<td>Cu-Tin</td>
</tr>
<tr>
<td>Catenary Wire</td>
<td>120 sqmm</td>
<td>120 sqmm</td>
</tr>
<tr>
<td>Catenary material</td>
<td>Cu-Mg</td>
<td>Cu-Tin</td>
</tr>
<tr>
<td>Feeder Wire</td>
<td>288 mm²</td>
<td>288 mm²</td>
</tr>
<tr>
<td>Feeder material</td>
<td>AAAC</td>
<td>AAAC</td>
</tr>
</tbody>
</table>
## Traction Power Supply Simulation Outcome

<table>
<thead>
<tr>
<th>Item Description</th>
<th>EDFC</th>
<th>WDFC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cantilever Assembly</td>
<td>Design Awaited</td>
<td>Design Awaited</td>
</tr>
<tr>
<td>Auto Tensioning Device</td>
<td>Design Awaited</td>
<td>Possibly 5 Pulley type</td>
</tr>
<tr>
<td>Tension</td>
<td>3000 kgf</td>
<td>2400 kgf</td>
</tr>
<tr>
<td>Mast</td>
<td>B-175, B-200, B-225, B-250</td>
<td>B-225 and above</td>
</tr>
<tr>
<td>Temperature rise in OHE</td>
<td>&lt;100 deg cent</td>
<td>&lt;100 deg cent</td>
</tr>
<tr>
<td>Temperature rise in Feeder Wire</td>
<td>&lt; 80 deg cent</td>
<td>&lt;80 deg cent</td>
</tr>
<tr>
<td>Arial earth wire</td>
<td>91.97 mm²</td>
<td>Design Awaited</td>
</tr>
<tr>
<td>AEW material</td>
<td>ACSR</td>
<td>ACSR</td>
</tr>
<tr>
<td>Droppers</td>
<td>10 mm² Cu-Mg</td>
<td>Design awaited</td>
</tr>
<tr>
<td>Maximum span</td>
<td>58.5 m</td>
<td>54 m</td>
</tr>
</tbody>
</table>
OHE Layout

Feeder

Protection wire

Contact Wire

Messenger Wire

Contact Wire

Feeder

Protection wire

Rail

Rail

Buried Earth Wire

CONDUCTORS IN AT FEEDING SYSTEM
Mechanized Construction
Mechanized Construction

- Foundations through auger

- Mast erection by machine and grouting by concrete mixing plant mounted on rail/road vehicle.

- Conductor (contact and catenary wire) stringing by rail mounted twin conductor stringing machine.

- Droppering and clipping by rail/road mounted trolleys
Mechanised Construction (Contd)

- Mechanized construction of cylindrical foundation
- Achieve reliability & consistency in design
- Improved pace of work (saving in construction time)

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Mechanised unwinding and anchoring of catenary and contact wires.
SCADA Design

- TCP/IP based open protocol SCADA system (IEC- 60870-5-104)
- Video Wall display
- Fault Locator: Current measurement neutral CT base accuracy 100 m.
- Infrastructure to create Railway smart grid.
OCC Building at Allahabad
OCC Building at Allahabad
OCC Building at Allahabad
SCADA Architecture

LEGEND
- SCADA NETWORK (OPC PROTOCOL)
- IEC 104 NETWORK
- IEC104 N/W FOR RTU SWITCH 1
- IEC104 N/W FOR RTU SWITCH 2
- MODBUS TCP
- IEC61850
- TMS SCOPE (LV & DISPLAY CONTROLLER PROCUREMENT/INSTALLATION)
- E&M SCOPE
- TELECOMM SCOPE

CABLE DETAILS:
1) COPPER WIRE, SIZE 0.75 SQ MM, TERMINATION FROM FIELD TB TO ANALOG CARD
2) COPPER WIRE, SIZE 0.05 SQ MM, TERMINATION FROM FIELD TB TO DIGITAL INPUT/DIGITAL OUTPUT CARD
3) ETHERNET CABLE CAT6a FROM RTU CPU TO RTU SWITCH
4) OPTICAL FIBER CABLE BETWEEN RMX128 MODULES FOR REDUNDANCY

NOTE:
1) AS INDICATED IN ARCHITECTURE, ALARM SERVER/DOMAIN SERVER RESIDE INSIDE THE DATABASE SERVER
2) TENTATIVE DISTANCE B/W DEVICES – TO BE DECIDED
Ergonomically Designed OCC Layout
Video Wall Display
Web Access For Monitoring of SCADA

➢ Web Access functionality allows user to access SCADA HMI from remote location over internet through Firewall
➢ Only Monitoring facility will be provided to remote users

Diagram:
- Web Server
- SCADA Switch
- Firewall
- Internet
- Remote Device (PC or Mobile)

Connections:
- TCP/IP (100mbps)
- Encrypted Message
Green Initiatives

- Green Building construction for OCC.
- Deployment of Green Energy for emergency lighting load.
- Use of BEE endorsed Star labeled products.
- Buildings to comply ECBC code.
Green Initiatives

Carbon Footprint of Dedicated Freight Corridor

Cumulative GHG emissions over 30 years

Eastern Corridor
(1975 Billion Tonne-Km)

No-DFC Scenarion: 116
DFC Scenarion: 47.5
- 2.5 x

Western Corridor
(3241 Billion Tonne-Km)

No-DFC Scenarion: 466
DFC Scenarion: 77
- 6 x

Green DFC - to save 457 million-tonne CO₂ over 30 years period.

Source: Report on ‘Green House Gas Emission Reduction Analysis for DFC’ by Ernst & Young

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Mechanized Maintenance

- Fixed Traffic Block of 4 hrs.
- Deploying 0.2 man per TKM.
- OHE monitoring car for directed maintenance.
- Asset Management software
OHE MONITORING CAR
Mechanised Maintenance (Contd...)

Mechanized Maintenance

- Self-propelled & off-track maintenance machinery
OHE MONITORING & INSPECTION CAR
Mechanised Maintenance (Contd...)

- Mechanised unwind and anchoring of catenary and contact wires.
What Railway Can Learn From DFCCIL Experience

- Design build lump sum based procurement contracts (turnkey contracts)
- QCBS based consultancy & project management contracts
- Adopting 2x25kV system for High Density Routes
- Use of simulation tools to optimize equipment sizing
- Use of superior conductors to meet future demand
What Railway Can Learn From DFCCIL Experience (contd....)

- Mechanized Cylindrical Foundation
- Simultaneous catenary/contact wiring
- Modern SCADA based on TCP/IP protocol
THANKS