

**SYNOPSIS OF PAPERS PRESENTED IN SEMINAR ON ‘LHB COACH AND NEW
MANUFACTURING TECHNOLOGIES’ HELD AT RCF, KAPURTHALA
ON 4TH AND 5TH NOVEMBER’ 2003**

(I) **LHB Coach Design Features (Mechanical) :**

[Presented by Sri S.Mathur, Dy.CME(TOT)/RCF]

1. This Paper covers salient features of design of LHB Coaches being manufactured at Rail Coach Factory, Kapurthala. The above Paper deals with fabrication/manufacture of following components for LHB Coach :
 - a) Side Wall
 - b) End Wall
 - c) Roof
 - d) Underframe
 - e) Shell
 - f) Flooring

2. The comparison of Design features of LHB Coach with ICF Coach has also been elaborated. Major features are as under :
 - Positive interlocking has been provided between horizontal and vertical members on LHB Coaches resulting in better strength, reduction of Side Wall thickness and better geometrical integrity.
 - TIG Welding on Sidewall Sheets is presently being undertaken during fabrication. Later on it is planned to undertake Laser Welding for Sidewall fabrication.
 - Turn under provided in ICF Coaches has been eliminated in LHB Coach, thereby, avoiding accumulation of water and muck.
 - Body Side Pillar rests on Sole bar in LHB Coach, which is superior design in comparison to ICF Coach where load transfer is through vertical welded joint.
 - In LHB Coach End Wall overhangs beyond Headstock and gap between 2 coupled Coaches is 300 mm only, which results in more space inside Coach and reduces wind resistance due to turbulence between Coaches.
 - Ferritic Steel (X2 Cr 8) is used for manufacture of Side Wall, End Wall and Roof Structure of LHB Coach. Austenitic Steel (X5 Cr Ni 18 10) is used for manufacture of Roof Sheet and Trough Floor of LHB Coach. LHB Coach Underframe is manufactured from IRS M-41 /Corten Steel. The details regarding chemical composition of above Steels used for manufacture of LHB Coach have also been indicated.
 - Corrugated Under frame Trough floor is plug welded from top with the Cross Members
 - Corrugated Steel Sheet provided on Roof. Roof weighs around 1000 Kg .
 - Car line (Cant Rail in Conventional ICF Coaches) is part of Sidewall unlike ICF Coaches where it is part of Roof. This results in better rigidity of Sidewall and positive location of Roof.
 - Provision for CBC as well as Side Buffer mounting in Headstock

- LHB Coaches have been provided with AAR ‘H - Type’ Tight lock Centre Buffer Couplers. These Couplers have Anti-climbing feature due to vertical interlocking.
- Separate Doorframe fitted before Sidewall in LHB Coach during fabrication, thereby, eliminating problem of Door size/squareness etc.

3. Comparison of LHB and ICF Coach:

- Weight per Metre length of LHB Coach is approximately 10 % less than the Conventional Coaches.
- Better Payload to Tare Weight ratio.
- No change is required in Shell design for speed upto 200 Km/Hr.
- **Dimensional Comparison:**

Parameter	ICF	LHB
Length over Body	21770 mm	23540 mm
Length over Buffer	22280 mm	24700 mm
Width over Body	3245 mm	3240 mm
Inner Width	3065 mm	3120 mm
Window Opening (AC Sleeper)	1220 mm x 610 mm	1180 mm x 760 mm

4. Superior Insulation on LHB Coach :

- Use of ‘Resonaflex- Alu’ on Side Wall and Floor and Glass Wool on Roof and Side Wall (above Window) for providing heat insulation.
 - ‘Baryskin V 60 DB’ Sound insulation PU Paint provided on full Coach Shell interior for better insulation and Corrosion resistance.
 - Rubber De-Coupling elements provided on Flooring for superior noise and vibration absorption.
 - Noise level inside LHB Coach limited to 60 DB (approx.).
5. Fire retardant FRP Items have been used in interiors of LHB Coach for improved aesthetics, better Strength to Weight Ratio, Scratch Resistance and easy Repairability. Major FRP Items used on LHB Coach are as under :
- FRP Roof Panel
 - FRP Commode Fairing
 - FRP Lavatory Module
 - FRP Side Wall Panel
 - FRP AC Unit Trough
6. (a) Sealed Window Glass Unit has been provided on LHB Coach with Krypton/Argon Gas filled between glasses. Window Glass is secured to Aluminium extrusions with rubber profiles and Aluminium Frame is glued to Car body.
- (b) Four Nos. Emergency Openable Windows have been provided for evacuation of passengers.
- (c) Hopper Window has been provided in Lavatory
- (d) Roller Blinds have been provided on Windows of AC Chair Cars instead of Curtains.

7. Lavatory and Plumbing :

Major features are:

- Provision of Controlled Discharged Toilet System (CDTS).
- Waste is retained in Tanks and discharged only when Train crosses Speed of 30 Km/Hr.
- Foldable Door for space optimisation.
- 'Loro' Fittings with Thread-less joints provided for effectively sealing water leakage.

(II) LHB Coach Design Features (Electrical) :

[Presented by Sri R.K.Gupta, Dy.CEE (D&D)/RCF]

1. This Paper covers salient features of Electrical Design of LHB Coaches. The positive features of LHB Coach are as under:

- Micro-Controller based AC Package
- Micro- Processor based Pump Unit
- Integrated Switch Board Cabinet
- Provision of IGBT based Battery Charger
- Provision of Electron Beam Irradiated Cables.
- Provision of DC-DC Converter for Galvanic Isolation to Switchgears
- Wheel Set Earthing Equipment for high life of Axle bearings.
- Cable Protection System with IP-68 Protection and UL-94 VO Fire Retardancy.
- 400 Amps Inter-Vehicular Coupler (IVC).
- Light weight Epoxy molded Transformer
- Provision of thin plate, light weight Lead Tin Batteries with much better Charging/Discharging characteristics.
- Integrated Modular Pantry Unit
- Uniformity of Illumination as per UIC
- Modular and elegant interior Light Fittings and Reading Lights.

2. Roof Mounted AC Package Unit on LHB Coach :

- Servo-Motor controlled Fresh Air Dampers for Automatic Pre-cooling
- Micro-Processor Control (with RS 232 Port) with Fault Diagnostics and Data Acquisition System
- Motors protected with Thermal Switches for better life.
- Humidity Control through Hygrostat
- Condensor Fan Impellers of Engineering Plastic
- Automatic Temperature Setting based on Ambient and switch over to Pre-Cooling/Heating Mode

3. Disconnecting and Earthing Device :

- Disconnects Coach Feed at 750 V in case of emergency like Contactor Jamming etc.
- Earths the Coach for maintenance even during run.

4. Wheel Set Earthing Equipment :

- Prevents Return Current flow through the Axle bearings and creates a connection by means of Contact Brush to the Rotating Wheel.
- 400 Amp Current allowable through Earthing Brush
- 0.1 Ohm Earthing Resistor provided

5. 110 V / 70 AH VRLA Battery :

Main Features are :

(a) Constructional Features:

- Pure Lead -Tin Plate (Thin)
- 12 Volt Battery Module
- UL 94 V-O Noryl Plastic Container with Metal Jacket

(b) Performance Features:

- 400 + Full Depth Discharge Cycles
- 8 + Years Float Life [@ 25 °C]
- High Discharge Rate [@ 25 °C]
- Rapid Recharge
- Deep Discharge Recovery

6. The following are major LHB Coach Electrical Items under development at RCF:

- Micro-processor based AC Package Unit
- SMF Batteries
- DC-DC Converters
- IGBT based Battery Charger
- Wheel Set Earthing Device
- Inter-Vehicular Coupler (IVC)

7 .It has been decided to introduce Self Generating (SG) Non-AC and AC LHB Coach Variants. The following two schemes are presently under trial at RCF :

(a) 4.5 KW Alternator with V- Belts (C112) and ERRU :

- System developed and tried out on 1 FIAT Bogie rigorously in FZR – JUC (Northern Railway) Section for about 300 Km.
- 3 Coach Sets received at RCF. System developed by M/s HMTD
- Trail Orders also given to M/s KEL and M/s Stesalit

(b) 6 KW Mid Axle mounted Alternator with Split Bearings and ERRU :

- System developed and tried out on a train in Mumbai-Pune (Central Railway) Section. Teething troubles faced for mechanical strengthening of End plates. Still under Development with M/s HMTD.
- PO for 10 Coach Sets on M/s HMTD

(III) Salient features of FIAT Bogie Design:

[Paper Presented by Sri Ramnik Singh, Dy.CME (IT/Design), RCF]

1. This Paper covers salient design features of FIAT Bogie (used on LHB Coach) and its components. The main features of FIAT Bogie are as under :

(a) Bogie Frame :

- Solid Welded Frame manufactured from Steel Sheets (St – 52) and Forged/ Cast Parts
- 2 Side Frames connected by two Cross Beams support Brake Units
- Bogie Frame rests on Primary Suspension Spring Units and supports Vehicle Body by means of Bolster Beam. The Bolster Beam is connected to Bogie Frame by Secondary Suspension.

(b) Primary Suspension :

- Comprises of two Coil Springs , one Vertical Damper, Articulated Control Arm with twin-layer elastic joints connecting axle bearing to the Bogie Frame.
- Better Curve negotiation

(c) Wheel and Axle :

- Provided with two Brake discs (Diameter 640 mm and Width 110 mm)
- In-built Slack adjusting Brake Cylinder fitted.
- Two Wheel Disc of Tread Dia. 915 mm (New) and 845 mm (Worn)
- Wheel Re-profiling and Balancing required on LHB Coach. Dynamic balancing undertaken at 320 RPM (Imbalance \leq 50 gm-m)

(d) Axle Bearings :

- Taper Roller Cartridge Type Bearing
- Pre- assembled Unit
- Maintenance free Overhaul at 1.2 Million Km.
- Sensors for detecting Speed.

(e) Disk Brake System :

- Axle mounted Disc brake. Two Discs (Dia 640 mm) per Axle
- In-built Slack Adjusters provided in Brake Cylinders
- 35 mm Brake Pads fitted

(f) Secondary Suspension :

Consists of following:

- Nest of Flexi- Coil Springs (Inner and Outer Rubber Spring)
- Vertical and Lateral Dampers
- Yaw Dampers
- Anti-Roll Bar
- Anchor Links

(f) **Buffer Height Adjustment :**

- By adding or removing shims from Body/Bogie connection
- Shims will not be added/removed in Primary and Secondary Suspension for Wheel Wear Compensation or Buffer Height Adjustment.

2. Details of Maintenance Schedule for LHB Bogie have also been indicated.

(IV) **Air Brake System, Disk Brake System and Wheel Slide Protection (WSP) on LHB Coach**

[Paper Presented by Sri Lalit Kishore, SME (TOT)/RCF]

This Paper covers features of Axle Mounted Disc Brake System with Wheel Side Protection (WSP) provided on LHB Coach. The salient features are as follows :

- No Threads/Flange Joints have been provided in LHB Coach Brake piping . ‘Bite’ Type fittings have been used.
- No Brake Rigging
- Wheel Slide Protection (WSP) Unit has been provided to take care of Wheel flattening.
- Braking on Axle Mounted Disc results in no Wheel wear due to braking.
- Brake Accelerator provided for sharp reduction of BP Pressure in complete Train set.
- All Pipes have been provided below Underframe for ease in maintenance.
- Brake Indicators provided (RED means ‘Brake Applied’ and GREEN means ‘Brake Released’)
- Distributor Valve (DV) with Relay provided for ensuring proper Brake application time and release
- Brake Caliper (Type UP-10) and Brake Cylinder (Type UP-10X) have been provided in Brake System.
- Speed Sensor Cable (One per Axle) with Pole Wheel (having 80 Teeth) have been provided on Axle. Gap between Speed Sensor and Pole Wheel should be 0.7 – 1.1 mm

(V) **Adoption of LHB Features on ICF Coaches :**

[Paper Presented by Sri Ravi Narula, Dy.CME(Design)/RCF]

1. This Paper covers LHB Coach features adopted on ICF Coach by RCF. The features already implemented on ICF Coach are as under:

- PU Painting
- Stainless Steel Trough Floor
- LHB Type Stainless Steel Water Tanks
- Aluminium Vestibule Door
- Composite FRP Lavatory Module
- Aluminium Compartment Doors

- Capsule Type Auxiliary Water Tank

2. LHB Coach Modifications which are under process of implementation on ICF Coach are as under:

- Centre Buffer Couplers
- FRP Side Wall and Roof Panelling
- Emergency Openable Window
- Stainless Steel Coach
- Honeycomb Panels for Partition Frame
- LHB Type Duct Design

VI) Concepts of LASER:

[Paper presented by Sri Shishir Dutt, Professor (WMT)/IRIMEE]

This Paper details basic principles regarding generation of LASER (Light Amplification by Stimulated Emission of Radiation). Einstein had predicted in 1917 that there must be some second emission process to establish thermodynamic equilibrium. Photons in the light field induce excited atoms to fall to lower energy state and give up excess energy in the form of Photons. This emission is called Stimulated Emission and is the basic postulate resulting in discovery of Laser in 1960. The conditions for Light Amplification and Large Stimulated Emission have been discussed. Laser beam has following characteristics:

- Highly Coherent
- Monochromaticity
- Less Divergence
- High Intensity.

Process by which atoms are raised from lower level to upper level is called Pumping. Various Pumping methods employed are Optical Pumping, Electrical Pumping and Direct Conversion. The following two types of Pumping Schemes are employed in Lasers:

1. Three level Pumping Scheme
2. Four level Pumping Scheme

CO₂ Laser and Nd:YAG Laser are mostly used in industrial applications. The concepts regarding generation of CO₂ Laser have been explained. Lasers have various applications viz. Surface Treatment, Electronics Industry, Welding, Medicine, Nuclear Industry, Measurement of Distance, Optical Communication, Consumer Market (viz. CDs/CD-ROMs, Super Market Scanners etc.)

(VII) Laser Cutting and Robotic Welding:

[Paper presented by Sri B. Munduia, Dy.CME (Mfg.)/RCF]

(A) LASER CUTTING :

1. Industrial Laser are of following types :

- Direct Current CO₂ Laser
- Radio Frequency CO₂ Laser or 'Slab' Laser
- Nd : YAG Laser

- High Frequency Laser
2. The following two Laser Cutting Machines are at RCF :

a) **1500 W DC excited CO₂ Laser (supplied by M/s Bystronic Laser , Switzerland):**

(i) Machine installed in 1989 at cost of Rs. 1.88 Crores.

(ii) **Technical Features** :

▪ Model No.	:	BL -1500
▪ Power Consumption	:	1500W
▪ Max. Cutting Surface	:	3 m x 1.5 m
▪ Max. Positioning Velocity	:	80 m/min
▪ Max Sheet Thickness (MS)	:	12 mm
▪ Power Consumption	:	18 KW

(iii) Main parts of Machine are :

- Gas supply Unit (CO₂, He, N₂, O₂)
- Resonator (Laser Aggregate)
- Chiller Unit
- High Voltage Supply Chassis
- CNC Control Panel
- Electrostatic Air Cleaner Unit

(iv) Main features of Resonator are :

▪ Max. Laser Power	:	1500 W
▪ Power Range	:	80 -1750 W
▪ Power stability	:	± 1%
▪ Wave Length	:	10.6 μm
▪ Beam Polarisation	:	Circular
▪ Beam Mode	:	TEM ₀₀
▪ Beam Divergence	:	± 0.05 mrad
▪ Pulse Frequency	:	Upto 4 KHz

(v) (a) Major Consumables are :

- Gases (CO₂ , N₂, O₂ and He)
- Optics (Lenses and Mirrors)
- Nozzles
- Sensor Ring
- Target Plates
- Acetone etc.

(b) Annual Cost of Consumables (CO₂ , He, N₂ and O₂) works out as Rs. 25.7 Lakh (Approx.) . High degree of purity of gases is required for Laser operation.

(b) **1500 W DC Laser Punch Press (LPP) (Supplied by M/s W.A. Whitney , Illinois , USA) :**

(i) Machine installed in 1991 at cost of Rs. 2.94 Crores.

(ii) **Technical features :**

Max. Sheet Length : 2438 mm
Max. Sheet Width : 1600 mm
Sheet Thickness : 0.6 mm to 12 mm
Punching Force : 360 KN
Max. Punching Dia. : 127 mm

Total Storage Capacity : 36
Laser Cutting Accuracy : ± 0.13 mm

3. **Safety Hazards :**

- Laser Class 4 Radiation cross section is random
- Visible and Invisible radiations
- Radiations are dangerous to eyes and skin
- Laser reflections
- High Voltage (10 KV to 20 KV)

4. **Advantages of Laser Cutting :**

- Intricate profiles made easily
- Minimum Heat Zone (HAZ)
- Square clean edges do not require additional processes .
- Fast speed on Thin Sheets
- Can-cut Non-metals like Plastic, Wood , Acrylic etc.

(B) ROBOTIC WELDING

This paper presents salient features of Welding Robot available at RCF.
The details are as under:

1. **Robotic Manipulator :**

- Manufactured by : M/s Igm Roboter System AG, Austria
- Commissioned in : October 2002
- Cost : Rs. 1.57 Crores
- Model : Rti - 2000

2. **Working Range and Speed of Axes :**

- Swiveling Range : 320°
- Angular Velocity : $15^{\circ}/\text{Sec.}$

<u>Axis</u>	<u>Working Range</u>	<u>Axis Speed</u>
1	$\pm 185^{\circ}$	$524^{\circ}/\text{Sec.}$
2	$+115/-55^{\circ}$	$152^{\circ}/\text{Sec.}$
3	$+70/-210^{\circ}$	$152^{\circ}/\text{Sec.}$
4	$\pm 350^{\circ}$	$284^{\circ}/\text{Sec.}$
5	$\pm 135^{\circ}$	$293^{\circ}/\text{Sec.}$
6	$\pm 350^{\circ}$	$604^{\circ}/\text{Sec.}$

3. **Main Parts of Welding Robot :**

- Welding Robot (Rti - 2000)
- Power Source (TS 5000)
- Rotary Gallow (RST.1-2000)
- Workpiece Turning Device (RP 500A – 1)
- Holding Device
- Torch Cleaning System
- Teach Pendant (Rci/K5)
- Pressure Amplifier

4. **System Details :**

- Control System Hardware ATX PC (2GB Hard Disk)
- Memory 64 MB
- RCI Software – One line Programming
- Robot Servo – Digital
- **Drives :** AC Drives with Resolver
- Robot Axes (M/s KUKA)
- Encoder – Absolute
- Control of Welding Power Source (By Rci)

5. **Welding Details :**

- Power Welding Torch (Type SB-395)
- Power Source [TS 5000 (Fronius)]
- Welding Current: 360 A (at 100% DC)
500 A (at 40 % DC)
- Transynergic with Closed Cooling Circuit
- Wire Speed: 0 –22 m/min
- Deposition Rate: 6.7 Kg/hr (1.2 mm Dia. Wire)
- Welding Gas [Ar (88 %) + CO2 (12%)]

6. **Salient Safety Features:**

- Arc Controlled Seam Tracking
- Laser Seam Tracking
- Closed Cycle Water Cooled Torch
- Hollow Shaft Design
- Parameters adjustable with Pedant
- Tactile Gas Nozzle Sensing
- 3 Safety Switches with Welding Torch

7. **Advantages of Robotic Welding :**

- Substantial saving in time
- Good Welding Quantity (Strength)
- Repeatability and Consistency

- Man Power saving
- Higher Productivity

(VIII) Infrastructure Facilities and Procedure for PU Painting and Air Less Spray Painting
[Paper presented by Sri A.K.Singh, SPLE -I /RCF]

This paper covers Infrastructure , Facilities and Procedure for PU Panting followed on LHB Coaches. The details are as under:

1. Types of Painting System followed in Indian Railways :

- Alkyd-Alkyd-Alkyd System (Followed in ICF)
- Epoxy – Epoxy – Alkyd System (Earlier followed in RCF for ICF Type Coaches)
- Epoxy – Epoxy – Polyurethane System (Followed in RCF for ICF Type Coaches)
- Epoxy - Polyester - Polyurethane System (Followed in RCF for LHB Type Coaches)

2. Advantages of PU Painting :

- Alkyd Painting System is less durable
- Gloss and Colour retention is very poor
- Alkyd Painting System has less resistance to salty atmosphere and Ultra violet rays
- Alkyd Painting System requires frequent repainting with increased cost of Painting

3. System of Polyurethane Painting (LHB Coach Painting) :

- Surface Preparation
- Primer Application
- Putty Application on Joints
- First and Second Coat Putty Application
- Putty Rubdown
- Fine Putty Application
- PU Primer Application
- Spot Filling
- PU Undercoat Application
- First PU Top Coat Application
- Masking
- Second PU Top Coat Application
- Demasking

4. Surface Preparation :

- Masking of machined parts , threaded holes , studs etc.
- Remove oil spot with Solvents

- ‘Garnet’ Blasting of complete Shell (Exterior and Interior)
 - Thorough Cleaning with compressed air and vacuum
 - Inspection of Surface for Sa 2½ (ISO 8501-1)
5. Details regarding Process, Infrastructure and Facilities required for Surface Preparation, Primer application, Putty application, PU Primer/Undercoat /Top coat application, Masking / Demasking etc. have also been elaborated.

(IX) Powder Coating :

[Paper presented by Sri A.K. Singh, SPLE-1 /RCF]

This paper presents process details of Powder Coating used on components fitted on ICF and LHB Coaches being manufactured at RCF. The salient features are as under:

1. (a) Powder Coating is an advanced method of applying a decorative and protective finish to a wide range of materials/products

(b) Powder Components:

- Physically Powder is a mixture of finely ground particles of pigment and resin , which is sprayed onto a surface to be coated.
- The charged Powder particles adhere to electrically grounded surfaces.
- After heating in curing Oven, it fuses into smooth coating, which is durable, high quality and has attractive finish.

2. Advantage of Powder Coating:

- One of the most economical long lasting and durable quality
- Powder coated surfaces are more resistant to chipping, scratching, fading and wearing than other methods of surface coating.
- Colour selection is virtually unlimited.
- Highly environment friendly as it contains no Solvents
- Its recycling during Process virtually eliminates waste common in liquid finishing.

3. Process of Powder Coating:

Process designed based on requirement. Broad Features are as under :

- Pretreatment
- Coating
- Curing
- Recovery

Process details regarding Pretreatment, Powder Coating including Recovery of Powder etc have also been indicated.

4. Safety Precautions:

- Equipments in operation to be properly earthed
- Proper Mask to be used for eyes, mouth and nose
- Insulating Gloves or Footwear are not be used.

(X) **SURFACE PREPARATION :**

[Paper Presented by Sri M.P.Verma, Addl. ED(M&C)/RDSO]

This paper emphasises importance of Surface preparation before further processing of metals. Salient features are as under :

1. **Objectives of Surface Preparation :**

- To ensure uniform substrate
- To ensure removal of deleterious contaminants

2. Effect of Contributory factors on surface has been indicated. Details are as under :

Sl. No.	Contributory factors	Contribution (%)	Year(s) of Service
1.	Surface Preparation	60 %	6
2.	Application of Paint	20 %	2
3.	Choice of Painting System	10 %	1
4.	Choice of Manufacturer	10 %	1

3. **Methods of Surface Preparation :**

- Pickling
- Sand Blasting
- Painting

4. Mechanism of Paint adhesion and corrosion has also been explained.

5. **Surface Preparation methods for removal of Oil, Grease and Dirt :**

- Petroleum Solvents by Vapour (TCE), Immersion or Jetting process
- Alkaline Cleaning (eg. NaOH)
- Emulsion Cleaning (eg. Detergents)
- Steam Cleaning

6. **Removal of Rust and Mill Scale:**

- Dry Sand Blasting
- Grit Blasting
- Shot Blasting
- Wet Abrasive Blasting
- Water Blasting
- Mechanical cleaning (viz. Hand / Power Tools etc.)

7. Details regarding Surface Preparation Processes are :

(A) Blasting Grades (ISO 85001):

- Sa 1 - Light Blast Cleaning
- Sa 2 - Thorough Blast Cleaning
- Sa 2½ - Very Thorough Blast Cleaning.
- Sa 3 - Blast Cleaning

Note: 'S' denotes Surface and 'A' denotes Abrasive Blasting

(B) Hand and Power Tool Cleaning:

- St 2 - Thorough Hand and Power Tool Cleaning
- St 3 - Very Thorough Hand and Power Tool cleaning

(C) Flame Cleaning

(D) Chemical Cleaning Methods:

- Sulphuric or Hydrochloric Acid Pickling
- Phosphoric Acid Pickling
- Duplex Process (Sulphuric Acid and Phosphoric Acid)
- 'Phosphating' Process