

INTERNSHIP AT INDIAN RAILWAYS

Submitted in partial fulfilment of the requirements for the
Professional Training –I of
Bachelor of Engineering Degree in
Electrical and Electronics Engineering

By

RAMAVATAR YADAV (39140708)



**DEPARTMENT OF ELECTRICAL AND ELECTRONICS
SCHOOL OF ELECTRICAL AND ELECTRONIC
SATHYABAMA INSTITUTE OF SCIENCE AND
TECHNOLOGY
JEPPIAAR NAGAR, RAJIV GANDHI SALAI,
CHENNAI – 600119. TAMILNADU.**

OCTOBER-2021

ACKNOWLEDGEMENT

The satisfaction and elation that accompany the successful completion of any task would be incomplete without the mention of the people who have made it possible. It is our great privilege to express our gratitude and respect to all those who have guided me during the course of my Professional Training.

First and foremost, we would express our sincere gratitude to our beloved Founder Chancellor **Col. Dr. JEPPIAAR, M.A., B.L., Ph.D.**, and Chancellor **Dr. Mariazeena Johnson, B.E., M.B.A., M.Phil., Ph.D.**, I extend my sincere thanks to our President **Dr. Marie Johnson, B.E., M.B.A., M.Phil., Ph.D.**, and for providing me the necessary facilities for the completion of the professional training.

I also acknowledge our Vice Chancellor **Dr. T. Sasipraba, M.E., Ph.D.**, and the Pro Vice Chancellor **Dr. E. Logashanmugam, M.E., Ph.D.**, the Pro Vice Chancellor **Dr. Wilson Aruni Ph.D., FAMPV**, for their constant support and endorsement.

I would like to express our gratitude to our Registrar **Dr. S. S. Rao, MBA, Ph.D.** and Controller of Examinations **Dr. Igni Sabasti Prabu M.E., Ph.D.**, for their valuable support offered to complete my professional training successfully.

I like to express our gratitude to **Dr. V. Sivachidambaranathan M.E., Ph.D.**, Head of the Department of Electrical and Electronics Engineering, Sathyabama Institute of Science and Technology for having been a constant source of support and encouragement for the completion of the professional training.

I would also like to express our sincere thanks to our internal guide who guided me in the preparation of the report. Also, I thank the **Almighty** and my **Parents** for supporting me in the completion of the professional.



SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY
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15 September 2021

TO WHOMSOEVER IT MAY CONCERN

This is to certify that **Mr. RAMAVATAR YADAV**, Register Number **39140708** is a Bonafide student of our Institution pursuing **BACHELOR OF ENGINEERING** in **ELECTRICAL AND ELECTRONICS ENGINEERING** during the academic year **2021-2022**. He will be completing the course in the year **2023**.

This certificate is issued for the purpose of Applying **INTERNSHIP**.

DEAN (STUDENT AFFAIRS)

Dr. G. SUNDARI, M.E., Ph.D.,

DEAN (STUDENT AFFAIRS)

SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY
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TECHNICAL TRAINING CENTRE



CHITTARANJAN LOCOMOTIVE WORKS
CHITTARANJAN

No.: TS/5/1 (20 21 - 20 22) 1/44

Phone No.: 0341-2526306

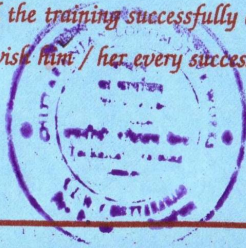
Date: 23 / 10 / 2021

TO WHOM IT MAY CONCERN

This is to certify that Sri / Smt. RAMAVATAR YADAV
Son / Daughter of Sri / Late BALESHWAR YADAV
a student of THIRD semester / year EEE (Stream) of Institute
SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY has undergone unpaid short term
Practical Training with effect from 27.09.2021 to 23.10.2021 at Technical Training
Centre / CLW / Chittaranjan

He / She has completed the training successfully and his / her performance is found satisfactory.

I wish him / her every success in life.



Principal
Technical Training Centre
CLW / CHITTARANJAN

प्राचार्य
Principal
तकनिकी प्रशिक्षण केंद्र
Technical Training
वि० रेल केंद्र
C.L.W. / CHITTARANJAN

INTRODUCTION

HISTORY OF CHITTARANJAN LOCOMOTIVE WORKS

Chittaranjan Locomotive Works (CLW) is the dream of the nation's visionaries, coming true. The planners of the Nation with their deep insight and foresight set to build a Loco building Factory in West Bengal and CLW is that vision, coming true. On the 9th of January 1948, survey of the proposed area was done.

The rocky soil was an advantage in erecting foundations for heavy structural work and the undulating terrain solved the problem of drainage for the township while the schemes of the DVC envisaged hydro-electric and thermal power stations in the vicinity assured cheap power availability in the near future. It is the only major Electric Locomotive builder in the country. It is situated just at the Border of West Bengal and Jharkhand and is at about 32 km from Asansol and 237 kms from Kolkata.



The place where today CLW is situated was actually a hamlet of small villages. The loco works with its ancillary workshops has a stores purchase office in Kolkata and inspection cells in New Delhi, Mumbai, Kolkata and Bangalore.

During pre-construction days

The Workshop has an area of 18.34 Sq. Km. The issue of setting up a loco building unit continued to be under active consideration of the Central legislature and in the late thirties, a committee consisting of M/s. Humphries and Shrinivasan was appointed to investigate the possibility of establishing a locomotive manufacturing unit and to consider its economic viability. The initial project, at Chandmari, a place near Kanchrapara, in the state of West Bengal, could not mature due to partition, which inevitably necessitated a change of site. This present site at Chittaranjan was selected after a fresh survey and Railway Board's approval was obtained in the year 1947. The loco works was initially established for production of 120 average sized steam locomotives with the capacity to manufacture 50 spare boilers.

The production of Diesel Hydraulic Locomotives was taken up during 1968. After manufacturing 2351 Steam Locomotives of 5 types and 842 Diesel Hydraulic Locos of 7 types, production of steam and diesel hydraulic locos were discontinued from 1973-74 and 1993-94 respectively

River Ajay flows past CLW along its northern side. Workshops, offices and quarters are spread over the whole area with ample space in between – surrounded by greenery and trees. There are several water bodies in CLW exhibiting a lush green environment which attract a large number of migratory birds every year. A variety of flora and fauna can be seen here all the year round.



LOCO ASSEMBLY SHOP

Long before others became environment conscious, CLW administration started planting trees, thus turning an arid area into a green one. In 1996 alone 90,000 saplings were planted with the help of the Social Forestry Division of Government of West Bengal. In 2005 also 50,000 saplings have been planted with the help of same agency. The Administration is regularly educating the staff and encouraging them to preserve the environment. Recently, an immense amount of work has been done, with a view to conserve the Environment, as well as using of all the existing natural resources in an eco-friendly manner.

The efforts have been recognized by the World Environment Foundation and **the Golden Peacock award for Environment Management 2006, has been conferred on 9th June 2006.**

CLW has complied fully with the provisions of the Industrial Safety Act, 1948. CLW in its safety policy aims to ensure 100% safety for all workers working in Chittaranjan Locomotive Works. **CLW is the proud recipient of the Safety innovation award 2006. The award was conferred on CLW on 6th September, 2006 by the Safety and Quality forum of the Institute of Engineers (India).**

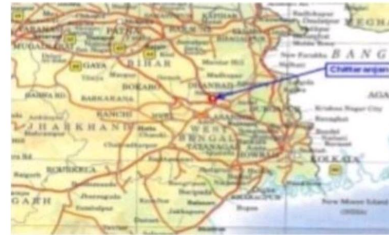
CLW has recorded the best ever performance during 2007—08 in terms of outturn of locos and financial indices. The year 2007-08 culminated with the inventory under stores at Rs. 161 crores as against the target of Rs. 172 crores communicated through Final Grant for 2007-08, which has resulted in an all-time low store turnover ratio of 10.75 as compared to 12.69 of the previous year. The WMS turnover ratio has also decreased to 5.61 in comparison to that of 2006-07 which was 8.67. The target of Rs. 284 crores for manufacture of components was surpassed and the figure was Rs.315 crores. The target of Rs. 85 crores, for sale and transfer of bought out items has been fully achieved. Auction sale proceeds exceeded Rs. 8 crores. Full credit of Rs. 1500 crores have been realized under Board's RSP for 200 locomotives as per target given by Railway Board. The target of Rs. 19 crores kept for supply of cast items (HS CASNUB Bogie) has been fully achieved. **With all these the net plan outlay is**

likely to be Rs. 32 crores only which is much below the target of Rs. 47 crores communicated by Railway Board in the Final Grant for 2007-08.

CLW enters its **Diamond Jubilee year** w.e.f 26th January, 2009. A yearlong celebration is in the offing. A kite flying Competition was held on March, 2009, to commemorate CLW's stepping into its Diamond Jubilee year. The programmed brought together the residents of the township, in celebrating the year.

HOW TO REACH CLW: -

Chittaranjan Locomotive Works (CLW), located in the land of Viswa Bharati, a great educational and cultural seat in the world, is the premier electric loco producer in this country. Situated at the border of West Bengal and Jharkhand, it is about 32 kms away from Asansol and 237 kms from Kolkata, the state capital. River Ajay flows past CLW along its northern side.



MEMORABLE EVENTS OF CLW: -

- INAUGURATION OF PRODUCTION-26 JAN, 1950
- FIRST STEAM LOCOMOTIVE COMISSIONED-1" NOV. 1950
- FIRST 1500V DC ELECTRIC LOCO 'LOKMANYA COMMISSIONED-14th OCT. 1961
- FIRST 25KV AC ELECTRIC LOCO "BIDHAN COMMISSIONED-16h NOV, 1963
- FIRST DIESEL HYDRAULIC LOCO WDS-4 INDRAPRASTHA COMMISSIONED - 6th JAN, 1968
- FIRST RAJDHANI ELECTRIC LOCO WAP-1 COMMISSIONED 1 OCT, 1980
- AWARDED ISO-9001 CERTIFICATION FOR LOCO WORKS-13TH JUL 1996
- FIRST 3 PHASE 6000 HP WAG 9 LOCO (SKD) DISPATCHED TO RAILWAYS-27 DEC, 1996
- FIRST 3 PHASE 6000 HP STATE OF THE ART WAG 9 FREIGHT ELECTRIC LOCOMOTIVE NAVYUG INAUGURATED BY HONURABLE MINISTER OF RAILWAYS 14th NOV, 1998
- 5000 HP MICROPROCESSOR CONTROL FREIGHT ELECTRIC LOCO WAG 7 "SAMARPAN" INAUGURATED BY SRI JYOTI BASU, HON'BLE CHIEF MINISTER OF WEST BENGAL 21st NOV, 1998
- 1000 HP PHASE STATE OF THE ART MOTOR INDEPENDENTLY BUILT AT CLW AND INAUGURATED BY STAFF MEMBER JAN, 1990

MILESTONES

Milestone 1

•	1947	September	Site for Chittaranjan Locomotive Works located.
•	1948	March	Construction work started.
•	1948	April	Workshop Set up
•	1950	26 th January	Production inaugurated by Smt. Basanti Devi, Wife of Late Chittaranjan Das.
•	1950	1 st November	Namkaran Ceremony of the works by President of India, Dr. Rajendra Prasad, when the first steam locomotive was turned out and flagged off from CLW.
•	1951	12 th February	KG Hospital formally opened by his Excellency Dr. K.N.Katju, Governor of West Bengal.
•	1952	1 st to 2 nd March	Prime Minister of India, Pandit Jawaharlal Nehru visits Chittaranjan accompanied by Dr. B.C.Roy, Chief Minister of West Bengal
•	1952	21 st October	Railway Minister Shri Lal Bahadur Shastri visits Chittaranjan
•	1953	10 th October	Dr. Sarvapalli Radhakrishnan, Vice President of India, visits Chittaranjan .
•	1954	6 th January	100 th Steam Loco "CHITTARANJAN 100" inaugurated by Railway Minister Shri Lal Bahadur Shastri.
•	1955	27 th April	Dr. Rajendra Prasad, President of India, drove the 200 th Locomotive from the works.
•	1955	28 th November	Visit of their Majesties the King ,Tribhuvan Bir Bikram Shah and Queen of Nepal
•	1955	17 th December	Visit of their excellencies Mr. N.A.Bulganin and Mr. N.S.Khrushchev from Russia
•	1956	14 th November	Visit of His Imperial Majesty, Mr. Haile Selassie, Emperor of Ethiopia

Milestone 2

•	1956	12 th December	Visit of Mr. Chou en lai the Prime Minister of People's Republic of China
•	1957	13 th January	Visit of their Holinesses, the Dalai Lama and the Panchen Lama
•	1958	18 th March	Visit of Mr. Churu Stoika, Prime Minister of Rumanian People's Republic
•	1958	20 th November	Visit of Mr. Marcel Roberts, Chief Occupational Safety & Health Division, International Labour Organisation
•	1960	25 th January	A technical collaboration agreement signed with Messrs. F.H.Lloyd & Co. Ltd., Wednesbury for establishing the Steel Foundry at Chittaranjan
•	1960	16 th April	Thousandth Locomotive turned out.
•	1960	April	Visit of Mr. Gamal Abdul Nasser, the President of the United Arab Republic
•	1961	January	Steel Foundry set up
•	1961	2 nd February	Visit of the illustrious daughter of Netaji Subhash Chandra Bose, Kumari Anita Bose
•	1961	16 th April	Opening of Rabindra Manch and open air theatre.
•	1961	14 th October	First CLW built WCM-5 DC Electric Loco "LOKMANYA" commissioned by Pandit Jawaharlal Nehru.
•	1962	October	Electric Loco Shop Set up
•	1963	16 th November	First CLW built WAG-1 25 KV AC Electric Loco "BIDHAN" commissioned by Pandit Jawaharlal Nehru.
•	1966		Traction Motor Shop Set up
•	1967	16 th April	Chittaranjan builds its First Traction Motor, the largest in India, at that time.

•	1993	11 th June	Inauguration of “Sidhu kanu Setu” a light bridge over the River Ajoy by R.K.Shukla, GM/CLW
•	1994	23 rd January	WAP-1 Electric Loco “PRAGATISHEEL” provided with Hitachi Traction Motor.

Milestone 4

•	1994	27 th August	First 5000 hp WAP-4 Passenger Locomotive “ASHOK” flagged off.
•	1996	13 th July	ISO-9001 certification awarded to Loco Works by IRQS.
•	1996	8 th August	ISO-9002 certification awarded to Steel Foundry by IRQS.
•	1996	14 TH September	First Modular WAG-7 Loco KARAMVIR Flagged
•	1996	27 th December	First 3 phase 6000 hp WAG-9 Locomotive (CKD/SKD) flagged off from CLW.
•	1998	29 th April	Flagging off of 2500 th Electric loco SWARNA ABHA by the Shri Nitish Kumar, Hon’ble MR
•	1998	14 th November	WAG-9, the first CLW built indigenous 3 phase state-of-the-art 6000 hp Freight Electric Locomotive “NAVYUG” inaugurated by the Hon’ble Minister for Railways by Shri Nitish Kumar.
•	1998	21 st November	Inauguration of one WAG-7 500 HP Electric Loco SAMARPAN by Shri Jyoti Basu Chief Minister of West Bengal
•	1999	10 th January	First batch of 6 nos. of CLW built 1000 hp Traction Motors for WAG-9 inaugurated by Shri K.Balakesari, Member Staff.
•	1999	12 TH April	Flagging off of NAVJYOTI by his His Excellency the Governor of West Bengal Mr. A.R.Kidwai
•	2000	25 th January	CLW completes 50 years of service to the nation
•	2000	24 th February	The first CLW built 3-phase traction motor type 6 FXA-7059 for WAP-5 locomotive inaugurated.
•	2000	10 th May	“NAVKIRAN” the first WAP-7 locomotive rolled out of CLW.
•	2000	17 th May	“NAVODIT” the first CLW built WAP-5 locomotive rolled out of CLW.

The quality policy adopted by CLW is as follows:

- Chittaranjan Locomotive Works, the leader in manufacture of Electric Locomotives, Traction equipment and Rolling Stock Castings, is committed to meet customer's requirement.
- We are dedicated to ensure customer satisfaction by establishing a quality management system and reviewing the quality policy and quality objectives for continual improvement.
- Our quality policy is communicated and understood by all in the organization and reviewed periodically.



CORRECTIVE/PREVENTIVE ACTIONS:

Since the implementation of the ISO – 9001, CLW has benefited immensely by way of reduced rejections and re-work. Further, customer feedback i.e. feedback from the various electric loco sheds of the IR are being given considerable attention. Based on customer feedback, suitable corrective and preventive actions are being initiated through Design Modifications and Correction of manufacturing processes.

Environmental Policy: -

CLW achieved ISO-14001 on 25th April, 2002. 1st surveillance Audit was conducted from 28th to 30th April, 2003. 2nd surveillance audit was conducted from 20th to 23rd June 2004. Renewal audit was conducted during 6th September to 9th September, 2005. Updated version of ISO 14001:2004 is also available in CLW.EMS up gradation audit conducted from 11th to 12th May, 2006 successfully.

The Environmental Policy adopted at CLW is:

- Improved Environmental Management System, prevention of pollution and continuous improvement of environment performance.
- Compliance with relevant environmental legislation and requirements as determined by appropriate regulatory and other corporate bodies.
- Conservation of natural resources and implementation of fundamentals of waste management.
- Setting environmental objectives and Targets and monitoring progress for sustainable development.



- Ensure awareness of all employees and contractors regarding their environmental roles and responsibilities.

Following steps have been taken for protection and improvement of environment at CLW:

- Waste generated in Shops have been reduced by 5% from the previous year by improvement of operational procedures.
- Air Pollution Control Device has been installed in Integrated Paint Shop to reduce air pollution.
- Dust collector has been installed in Sand Plant/SF for reduction of air pollution.
- To reduce air pollution, stack height of D.G.sets in Central Power House has been increased.
- Air Pollution Control Device has been installed at GEC Arc Furnaces in Steel Foundry.
- Consumption of water in plant area has been reduced by 5% by arresting major leakages and provision of water meters have been made for regular monitoring of water consumption.
- Consumption of electricity in plant and Township has been reduced by use of energy efficient lights, installation of capacitor bank etc.
- 50,000 trees have been planted in the CLW Township. Another 50,000 trees will be planted during the current year.
- Use of polybags has been totally banned inside the Township.
- New Sewage Treatment Plant (Bio-filter Plant) has been commissioned and under operation for improvement of effluent quality before discharge to surface inland and nearby water bodies.

| WAP – 7 – The “Heavy Haul” Passenger locomotives of IR: -

Intercity and interstate fare friendly Passenger market has of late shown a strong and sustained growth in recent times. This market needs very powerful Electric locos which can haul 24 to 26 coaches at speeds in the range of 130/ 140 kmph. To meet the surging demands of this amazingly exploding Passenger market segment, CLW has come out with a 6000 H.P loco premium Electric loco product – WAP-7. WAP-7 class loco is based on WAG-9 platform and differs from WAG-9 in gear ratio and the control software. Locomotive rated at 6000 hp is design to the starting tractive effort of 323 KN and maximum braking effort is 260 KN.



6000 HP 25 KV 3-phase Passenger Electric Locomotive WAP-7

Need : -

This loco also is capable to give 6000 hp on rail upto its rated speed of 100 kmph which gives superior section clearing capability especially in handling speed restriction.

Salient Details : -

Horse Power	6000
Supply System	25kV, AC, 50 Hz.
Track Gauge	1676 mm (Broad Gauge)
Total weight	123.0 + 1%t.
Wheel Diameter	1092 mm (New), 1016 mm (Full Worn)
Length over buffers	20562 mm
Panto locked down height	4255 mm
Type of Traction motors	6FRA 6068, 3-phase Squirrel Cage Induction Motors
Continuous Power at wheel rim	4500 kW (6000 hp)
Starting Tractive effort	323 KN
Max. Service Speed	140 kmph
Brake System	Air, Regenerative & parking
Drive System	3 phase Drive with GTO Thyristors and microprocessor based VVVF Control.

WAP – 5 – 5400 HP, 25 kV ac, B.G. 160 km/hr. speed, 3-phase drive: -

WAP-5 class locomotives employ advanced control and propulsion technology and are capable to deliver 5400 hp on rail. The locomotive has all the hallmarks of a high-speed propulsion unit viz. light weight, fully suspended drive and disc brake. Though presently, it has been certified for 160 kmph operation, the locomotive has been designed to give a service speed of 200 kmph with test speed potential of 225 kmph. Since IR is currently facing severe competition in Premium Passenger business market from commercial airlines, sooner or later, IR will have to introduce medium high speed intercity Passenger Services. This emerging market will call for powerful Electric locos with 150 kmph plus speed potential to be deployed in the immediate future and WAP-5 is the locomotive of choice for this Passenger Services market of IR.



5400 HP 25 KV 3 phase Passenger Electric Locomotive WAP-5

Need :-

Due to advanced mechanical design especially those of bogies, the locomotive has low unsprung masses and is truly track friendly. Presently WAP-5 is the only passenger locomotive with fully suspended drive. Anti-collision posts give locomotive superior crash worthiness. The fleet of WAP-5 class locomotives is now being geared up for the proposed 150 kmph services

Salient Details :-

Horse Power	5400
Supply system	25 kV, AC, 50 Hz.
Track Gauge	1676 mm (Broad Gauge)
Axle Arrangement	Bo-Bo
Total weight	78+ 1%t
Axle Load	19.5 + 2%t.
Wheel Diameter	1092 mm (new), 1016 mm (Full Worn)
Length over buffers	18162 mm
Panto locked down height	4237 mm
Max. Service Speed	160 kmph
Type of Traction motors	FXA 7059, 3-phase Squirrel Cage Induction Motors
Traction Motor Mounting	Fully suspended
Continuous Power at wheel rim	4000 kW (5450 hp)

Starting Tractive Effort	258 KN
Control System Voltage	110 V dc
Drive System	3 phase Drive with GTO Thyristors and microprocessor based VVVF Control.
Multiple Unit operation	Maximum 2 locos.
Hauling Capacity	26 coaches at 140 km/ hr on level.
Brake System	Air, Regenerative & parking

WAP – 4 – 5000 HP, 25 kV ac, B.G. 130 km/hr.
speed, 3-phase drive: -

This 5000 HP locomotive was evolved to meet the requirement of hauling longer trains of 24 coaches at higher speed up to 130 kmph over Indian railways. This loco is presently hauling important high-speed trains on Indian Railways. These are six axles loco with axle and nose suspended drive.



5000 HP 25 KV AC WAP 4 Passenger Electric Locomotive.

Need :-

Due to advanced mechanical design especially those of bogies, the locomotive has low unsprung masses and is truly track friendly. Presently WAP-5 is the only passenger locomotive with fully suspended drive. Anti-collision posts give locomotive superior crash worthiness. The fleet of WAP-5 class locomotives is now being geared up for the proposed 150 kmph services

Salient Details :-

system	25 KV, AC, 50 Hz.
Class of Loco	WAP-4
Track Gauge	1676 mm (Broad Gauge)
Axle arrangement	Co-Co
Brake System	Air and Rheostatic
Total weight	112.8 + 1% t.

Wheel Diameter	1092 mm (New) , 1016 mm (Full worn)
Length over buffers	18794 mm
Panto locked down height	4232.5 mm
Traction Motor type	HS 15250A, DC Series Motor
Continuous Power at Wheel Rim	5000 HP
Starting Tractive Effort	30.8 t
Control System Voltage	110 V DC

SHOP ACTIVITIES

I TRACTION MOTORS:

Cumulative production of Traction Motors during the year 2007-08, has touched an all-time high of 1225 Traction Motors. This is the **Best ever** in the 53 years history of CLW .CLW has achieved the rare distinction of being the only Production Unit in the country which can cross **1000 Traction Motors** production mark in a year.

I WHAT IS A THREE PHASE LOCO?

- Works on single phase AC- 25 kV, 50 Hz, supply but TMs are three phase Induction machines.
- Simple squirrel cage induction motor.
- Torque speed characteristics modified to suit traction application with the help of VVVF.

I SALIENT FEATURES:

- Variants

WAG-9	6000 HP, Co-Co, 460 kN Starting TE
WA9-9H	6000 HP, Co-Co, 500 kN Starting TE
WAP-7	6000 HP, Co-Co, 140 kmph
WAP-5	5400 HP, Bo-Bo, 160 kmph, Fully Suspended TM
- Microprocessor based control
- 3-Phase Induction Motor drive
- Regeneration of energy

| 3-PHASE TRACTION MOTOR TYPE 6FRA 6068 & 6FXA 7059:

3-Phase Traction Motors type 6FRA6068 for WAG-9 and WAP-7 locomotives & 6FXA7059 for WAP-5 locomotive are being manufactured indigenously by CLW since the financial year 1998-99 & 1999-2000 respectively. With the production of 3 – phase Traction Motor, CLW has entered the era of State of the art, 3-phase technology.



Traction Motor 6FXA 7079

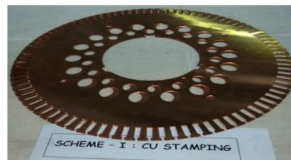
Traction Motor 6FRA 6068

| COMPARISON OF TRACTION MOTOR 6FRA 6068 and 6FXA 7059:

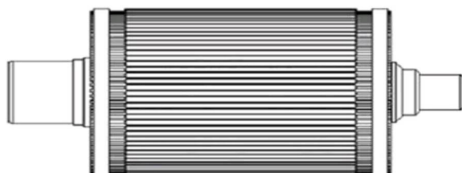
Scheme-I



ROTOR WEIGHT= 710 kg approx



Scheme-II

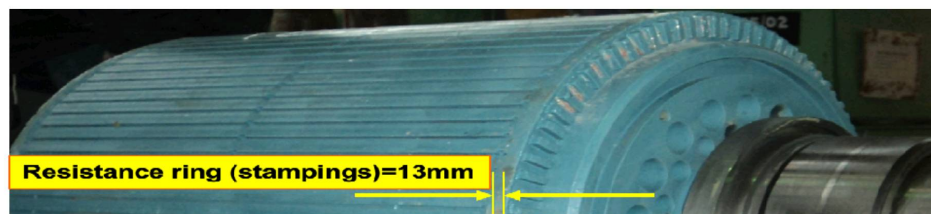


ROTOR WEIGHT= 730 kg approx

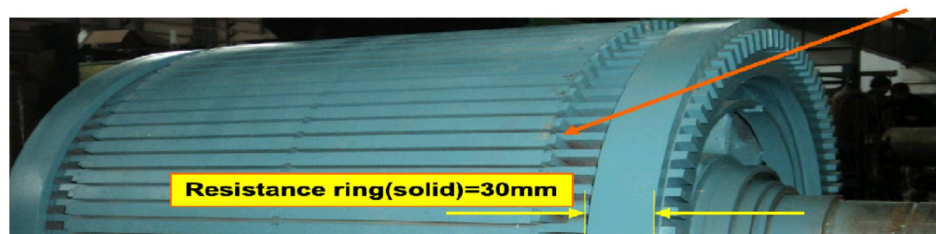


COMPARISON OF SCHEME-I & SCHEME-II ROTOR:

Scheme-I



Scheme-II



*Rotor Length difference=124mm
Rotor Weight difference=20 Kg*



SCHEME-I



SCHEME-II

	TM 6FRA 6068		TM 6FXA 7059	
	CONT.	MAX.	CONT.	MAX.
RATING	850KW		1150KW	
POWER	1283RPM	2584RPM	1585RPM	3174RPM
RPM	2180V	2180V	2180V	2180V
VOLTAGE	270A	393A	370A	593A
CURRENT	65HZ	132HZ	80HZ	161HZ
FREQUENCY	2150Kg		1990Kg	
WEIGHT	95%		96%	
EFFICIENCY				

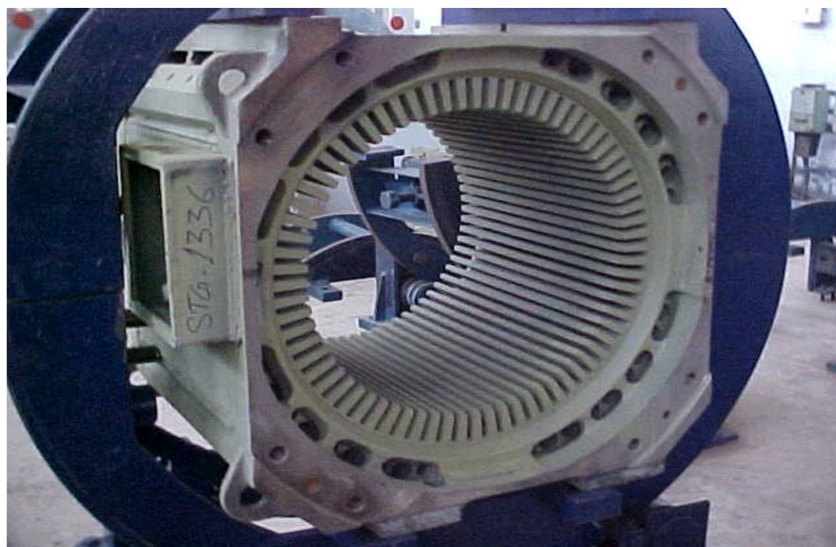
COMPARISON OF SCHEME-I & SCHEME-II ROTOR (INSIDE STATOR):



MANUFACTURING PROCESS OF STATOR:

- Stator laminations are staked in a fixture under two Stator Chambers (DE & NDE) Pressing of the stack under pressure of 70 Ton. Stack height maintained 480 mm.
- Tension Bars fitted at 4 locations. Tack welded under pressure with MIG welding process.
- Fitment of accessory bars, Rib by MIG welding process (in HMS Shop)
- Machining of Stator, fitment of Temperature Sensor Flange.
- Slot regularization of Stator to receive winding.
- 72 coils are placed in Stator Slots in double layer.
- Coil ends are brazed with phase Ring & neutral ring. Star connection is being done.

STATOR OF CO-CO



I STATOR COIL MANUFACTURING PROCESS:

- Fish shape coil formation in coil forming machine 9 layers for 6FRA 6068 type, 10 layers for 6FXA 7059 types of motors.
- Coil is speeded by pneumatically operated spreading machine.
- Insulation of coils: I) one-layer ½ lap Mica glass fabric tape 0.12 x 15mm size throughout the coil.
- II) insertion of PA Vilas on both side of each lead
- III) one layers 2/3 lap Mica glass fabric tape 0.12 x 15mm size on core length up to bend only.
- IV) One-layer ½ lap Mica glass fabric tape 0.12 x 15mm size.
- V) One-layer ½ lap polyester glass silk tape on overhang portion.
- VI) Molding of coil in hydraulic operated / pneumatic operated machine with proper shape.

I MANUFACTURING PROCESS OF ROTOR:

- Rotor End Ring placement on dummy fixture
- Rotor Stamping stacked up to a length of 480mm
- Placement of top end Ring, tightening by stud at 6 locations.
- Lifting of dummy shaft. Dummy stack ready for Rotor shaft insertion.
- Placement of dummy stack in oven for 12 hrs. at the temperature of 180°C.
- Insertion of Rotor shaft. Final pressing 40 Tons.
- Fitment of Rotor half rings in slot of Rotor shaft & welding at three locations
- Slot regularization
- Rotor Bar insertion in 88 Rotor slots by placement of two Rotor end resistance ring (MIG welding)
- Fitment of shrink ring after machining on resistance ring

MIG Welding

- * V groove at the two ends on resistance ring by machining.
- * MIG welding with Copper-Sn-wire in MIG welding plant.

Induction Brazing

- * Rotor Copper bars are induction brazed with resistance ring in induction brazing machine.
- * Silver brazing alloy used in this process.

Rotor with Copper Stamping

- * 13 Nos. Copper Stamping placed at two end during the procedure of stacking.
- * The same way is followed as earlier
- * Brazing of Rotor bar with these copper stamping carried out

I VPI (VACUUM PRESSURE IMPREGNATION) OF STATOR:

- Preheating of Stator in oven at 75°C for 12 hours.
- Placement of Stator in impregnation chamber.
- Creation of vacuum of impregnation chamber at the level of 0.07m bar pressure for 1 hour
- Pouring of silicone varnish (SI 35: Hardener 85: Auxiliary material 38 in ratio of 100:10:2)
- Wet vacuum for 15 minutes.
- Pressure with 7 bar for 3Hours.
- Lifting of Stator.
- Baking of Stator 8 hours at 120°C& 12 hrs. for 200 °C in oven.

RTV SEALING IN STATOR

- * Sealing of RTV in Terminal box and Stator end slot portion Silicone Rubber compound 622A & 622B mixed in the ratio of 10:1

I TESTING OF MOTOR (ROUTINE TEST):

1. Measurement of cold resistance

Specified limit 93.28 mΩ to 103.10 mΩ between U1 – V1, V1 – W1, W1 – U1,

2. Half an hour no load test –

Voltage applied 2810 ± 10%

- a) Measurement of Temperature at five location (Bearing Temperature DE, NDE, Winding Temp., Body Temp etc.)
- b) Speed recorded & Ambient temperature recorded.
- c) Winding Temperature limit 140°C - 170°C

3. Measurement of winding temperature rise :

Limit 120°C to 140°C

4. No load characteristics :

Specified Volt	Specified current limit	Remarks
2360 Volt	160 ± 10%	Variation of current in 3-Phase = ± 2% of average
1810 Volt	84 ± 10%	
545 Volt	22 ± 10%	

5. Short circuit characteristics :

Specified Volt applied	Specified current limit	Remarks
530	390 ± 5%	Variation of current in 3-Phase = ± 2% of average
363	270 ± 5%	
110	80 ± 5%	

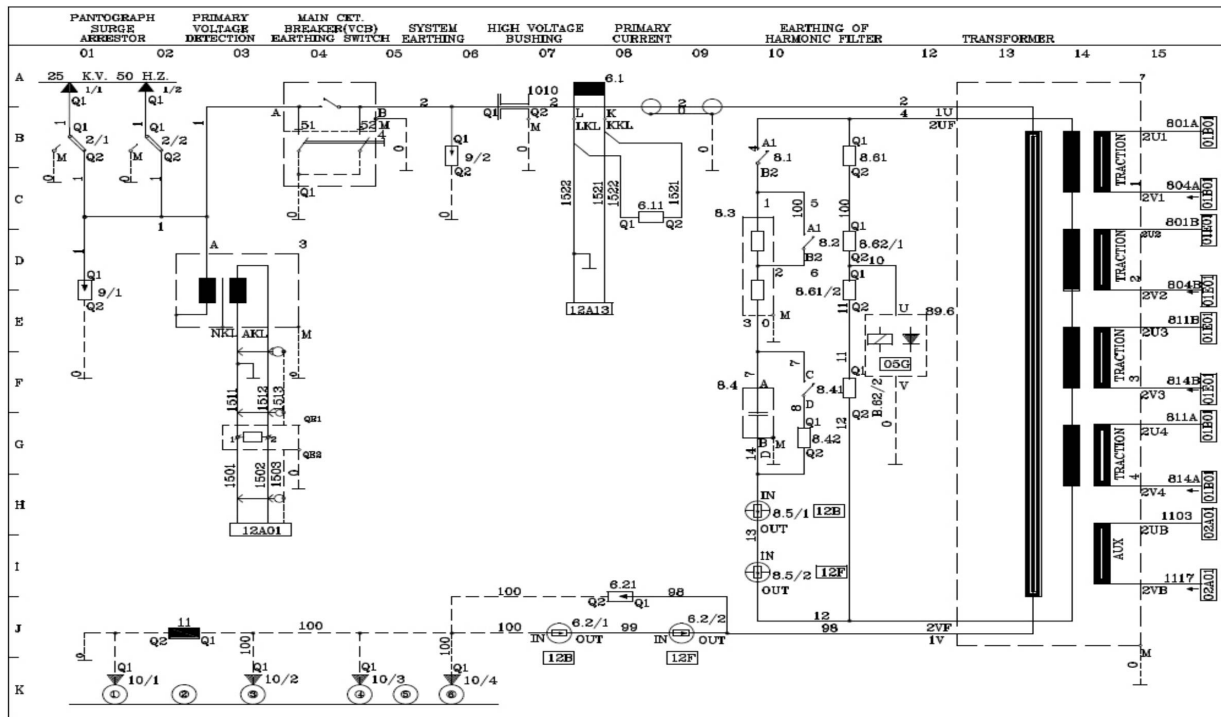
6. IR measurement – Should be more than 200 MΩ

7. Final Dielectric Test – 8.3 kV for 1 minute

POWER AND AUXILIARY CIRCUIT OF 3-PHASE LOCOMOTIVES:

OHE Parameters

- Nominal Voltage: 25 kV
- Maximum Voltage: 30 kV
- Minimum Voltage: 17.5 kV
- Frequency: 50 Hz $\pm$ 3%



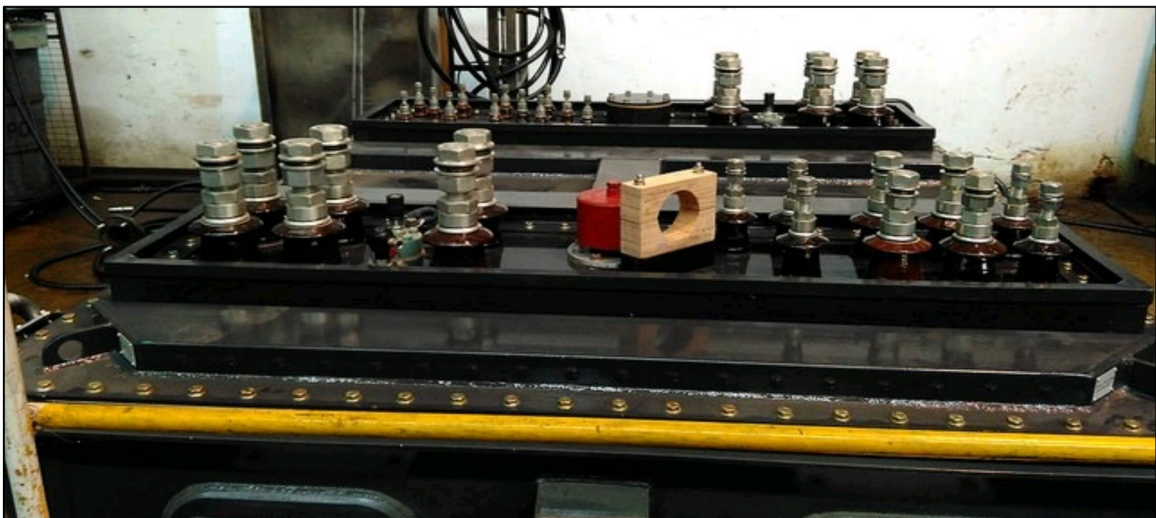
ROOF EQUIPMENT'S:



TRANSFORMER (6500 LOT):



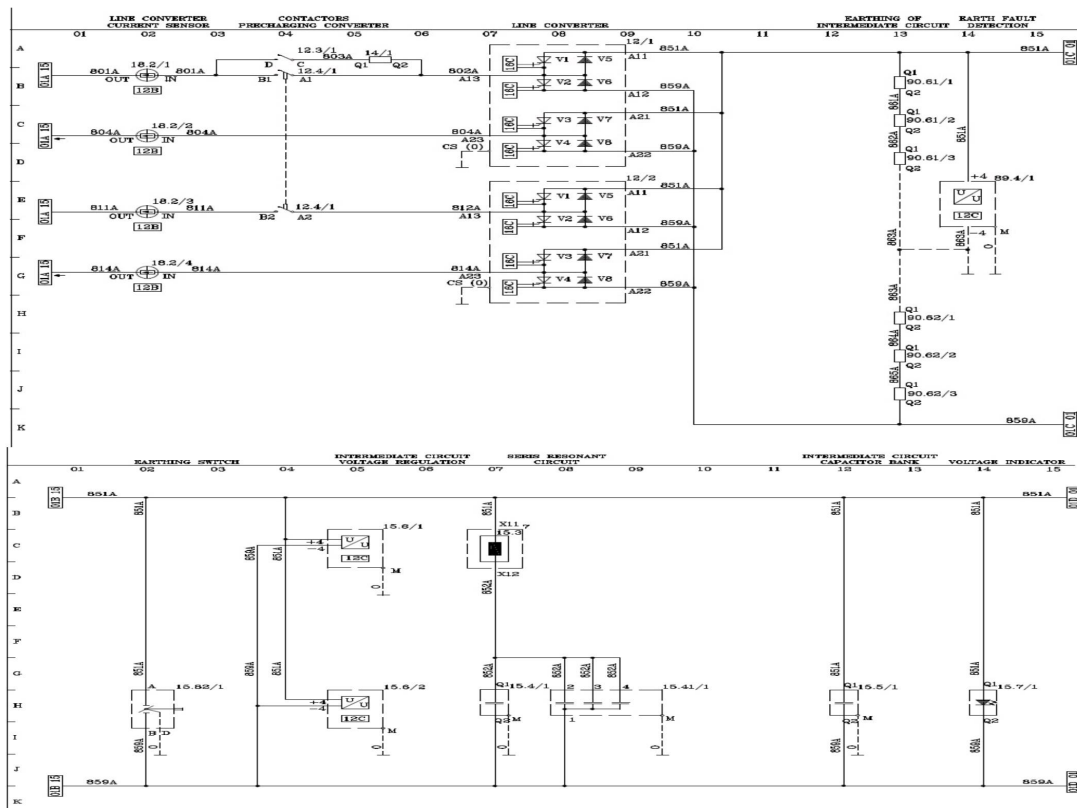
TRANSFORMER (7500 LOT):



Winding	Power (kVA)	Voltage (V)	Current (A)
Primary	6531	25 k	261.25
Traction	4x1449	1269	4x1142
Auxiliary	334	1000	334
Filter	400	1154	347
Hotel Load	2x622.5	960	2x648

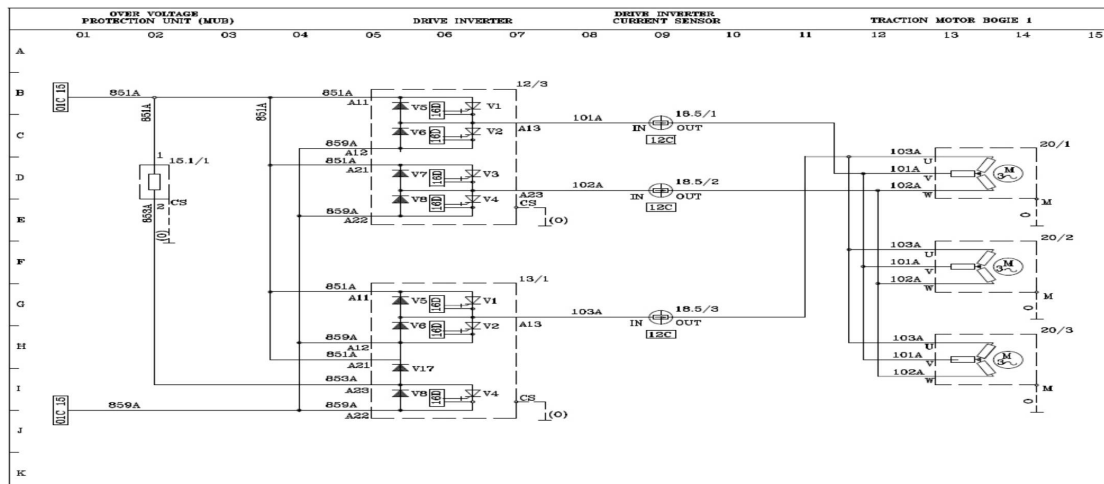
Weight of TFP: 9500 ± 3%

TRACTION CONVERTER:

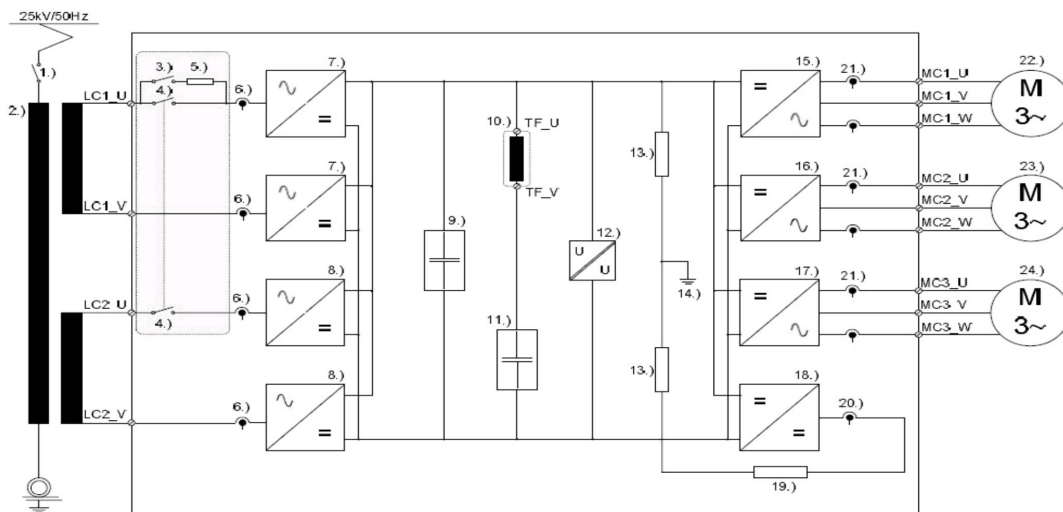


DC-LINK:

- * Nominal DC-Link Voltage is 2800 V.
- * DC-Link of Traction Converter is consist of DC-Link Capacitor, Harmonic Filter and Soft Crow-Bar Protection (Over Voltage Protection).
- * The DC-link capacitor is used to stabilize the DC-link voltage and act as an energy reservoir.
- * The DC-link capacitor neutralises power differences between the motor and the line side
- * The DC-link capacitor also absorbs the harmonic currents produced by the line converters and drive converters.
- * Each power modules requires a capacitor to limit IGBT switching over-voltages
- * The single-phase supply generates a power oscillation at twice its fundamental frequency on the DC-Link.
- * A tuned second harmonic filter (100Hz) is used to shunt this dominant second harmonic frequency component.

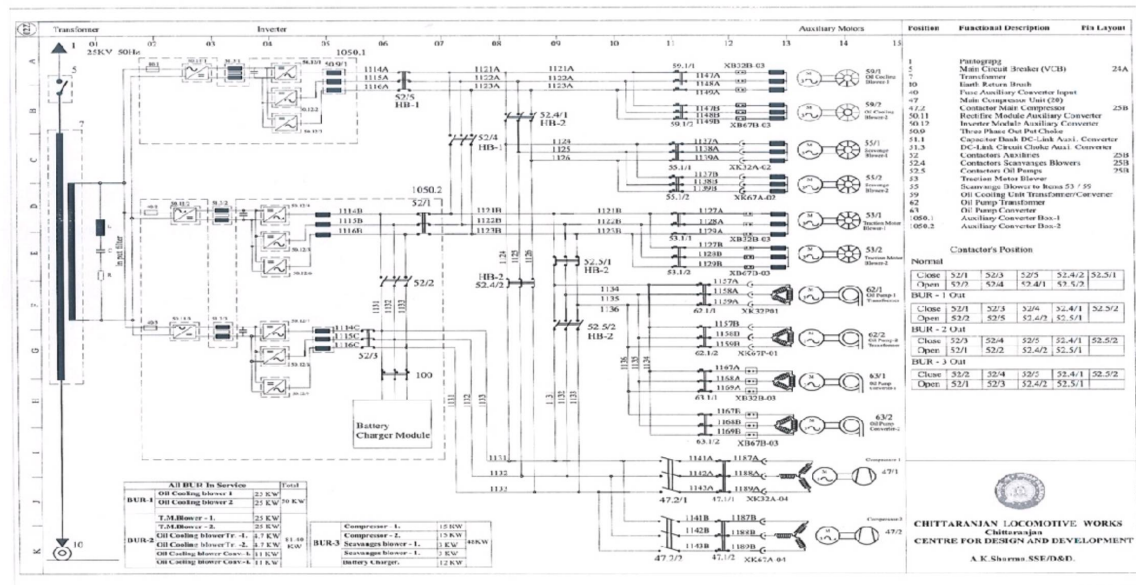


IGBT CONVERTER POWER CIRCUIT:

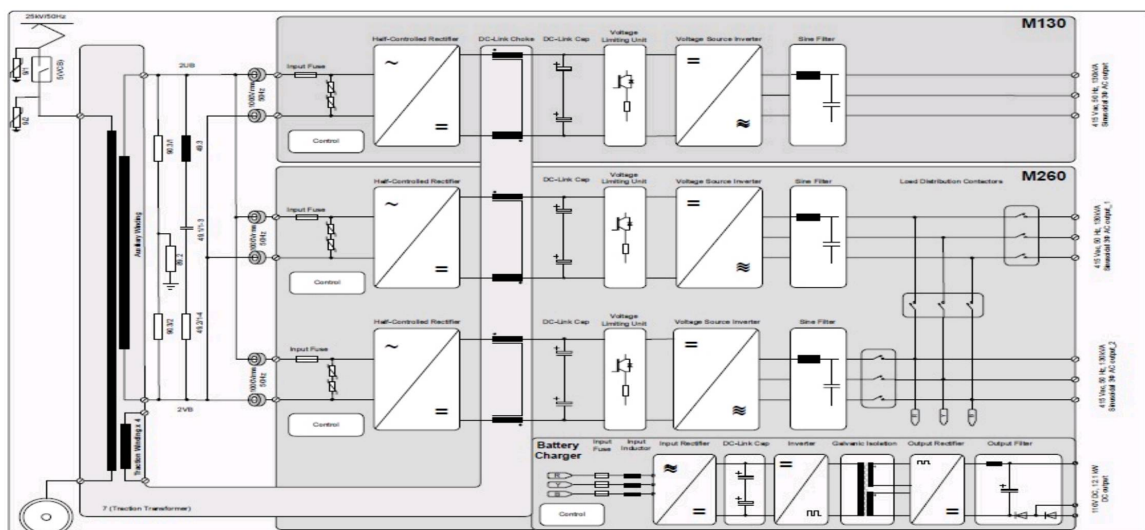


IGBT AUXILIARY CONVERTER:

- A total of 3 Auxiliary Converters (BUR1, BUR2 & BUR3) in two cubicles are provide in a locomotive.
- Each Auxiliary Converters has 130 kVA capacity.
- All three Auxiliary Converters are fed from single transformer winding of rating 1000V, 334 kVA.
- Auxiliary Converter provides 3-phase AC output of 415 V (L-L) and DC output of 110V, 80 A.
- Minimum efficiency of Auxiliary Converter in 92 % at rated load of 130 kVA (0.8 pf)



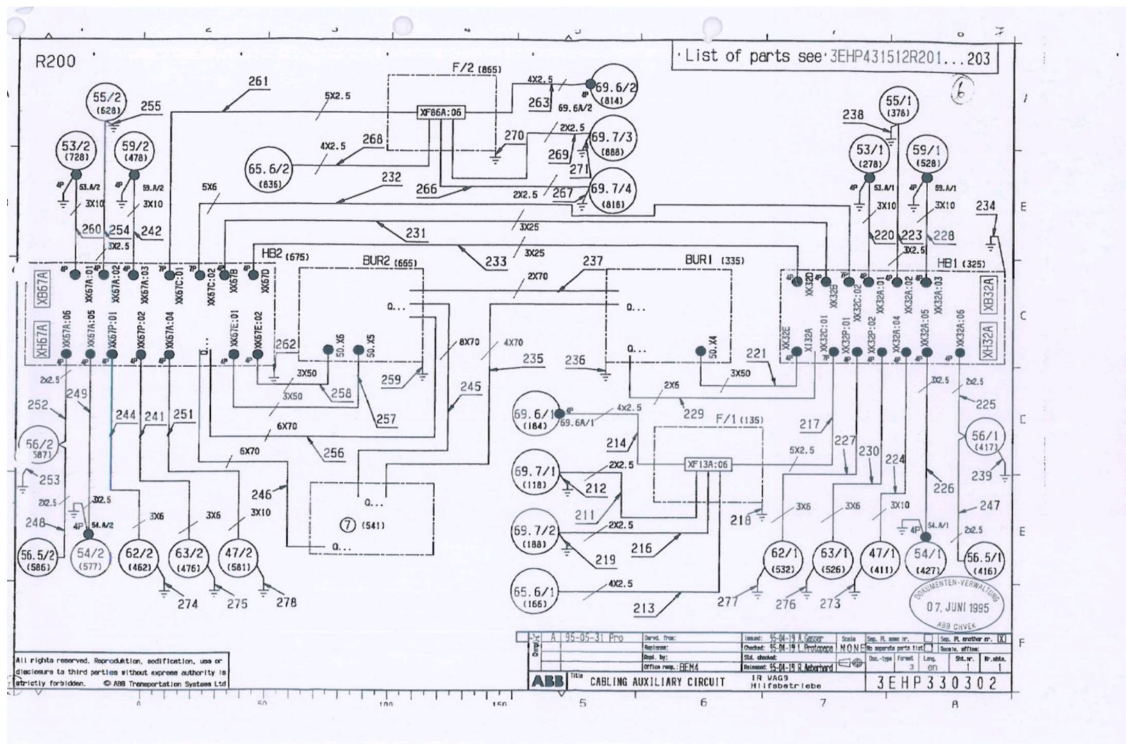
IGBT AUXILIARY CIRCUIT:



AUXILIARY CONVERTER:



AUXILIARY CONVERTER CIRCUIT DIAGRAM:

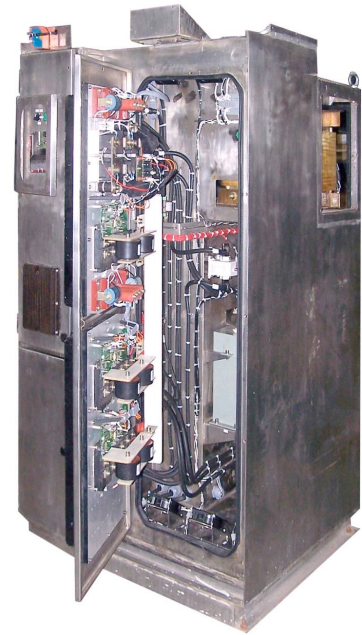


| SUB MODULES OF AUXILIARY CONVERTER:

- Input Section.
- Rectifier Section.
- DC Link Filter.
- Inverter Circuit.
- Output LC Filter.

| INPUT SECTION:

- The input section consists of input fuse and a metal oxide varistor (MOV) and input bus bar.
- Input fuse protects the circuit in event of failure of the power components in the rectifier bridge and also for ensuring safe operation of the converter under worst input conditions like over current etc.
- The MOV protects the semiconductors of the rectifier bridge over voltage spikes. It also works as surge arrestor.



| RECTIFIER SECTION:

- The rectifier section is made using two thyristors and two diodes. Its designed as half controlled asymmetrical single phase full wave bridge rectifier.
- The rectifier bridge is used to convert AC voltage into DC voltage. An external triggering unit is required for control purpose. By controlling the thyristor firing angle the output DC link voltage in the range from 630 to 800 volt may be produced. However, the DC voltage may vary from 700 to 1200 volt depending upon the overhead line voltage.
- The rectifier converts single-phase 1000 V AC input into the desired DC link voltage (630 to 800 volt) by controlling firing angle of the thyristors smoothing through DC link filter.
- The diodes are equipped with an RC- snubber to attenuate any over voltage occurred during turning the diodes off as a whole storage effect.

| DC LINK FILTER:

- The DC link smoothing choke, which is used in DC link filter is actually housed in main transformer of the locomotive.
- The DC link filter consists of DC link smoothing choke and capacitors. The DC link capacitors are connected in series parallel combination.
- DC link choke and capacitors are provided at the output of the rectifier for converting the pulsating DC output into a smooth DC for further feeding the three phase IGBT inverter. It also filters the harmonics in the line current & voltage that is fed to the inverter.

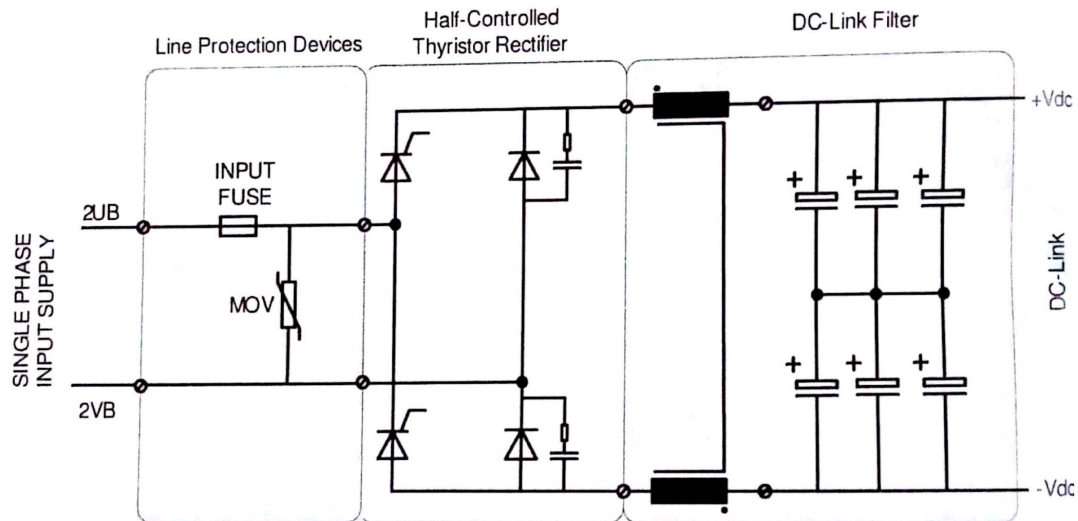
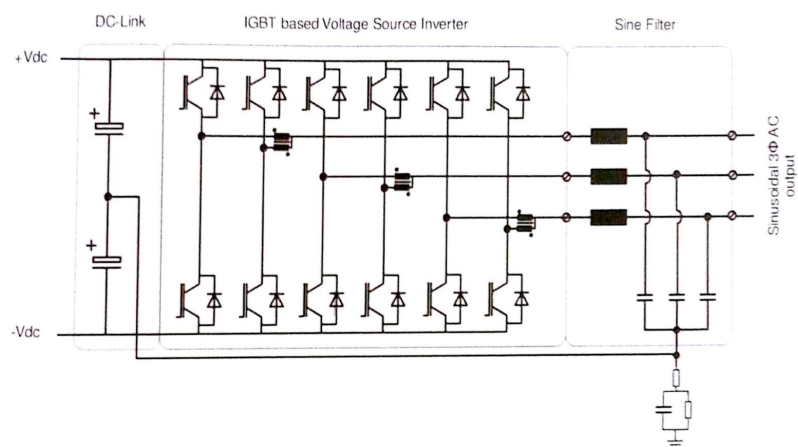


Figure 2 Input Rectifier

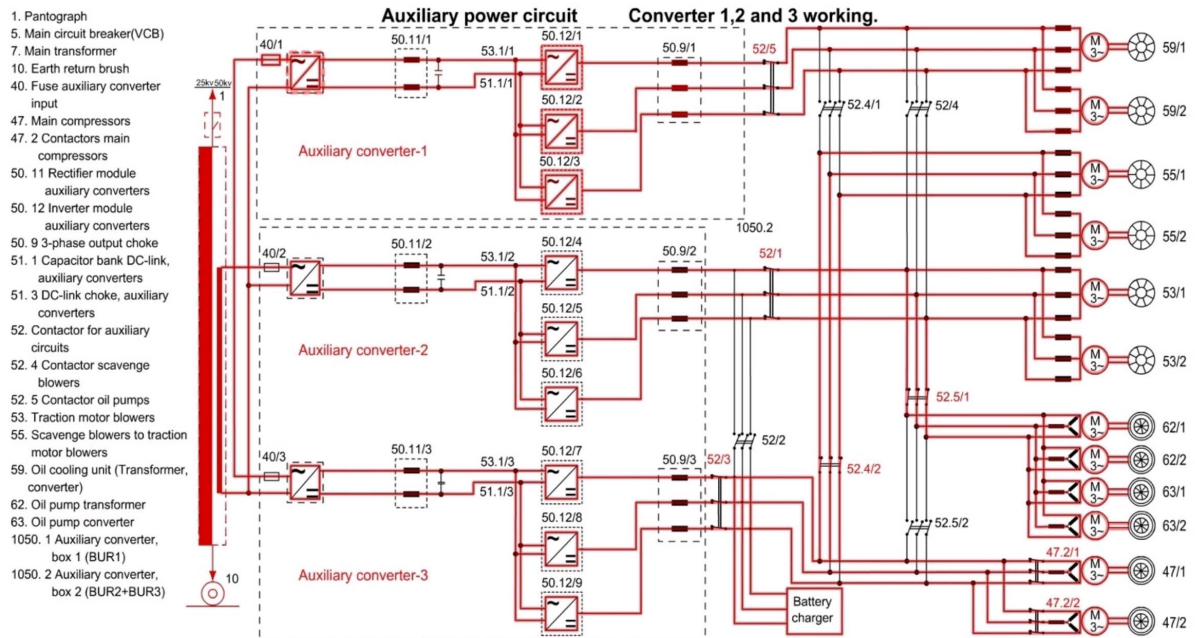
INVERTER CIRCUIT:

- The inverter consists of six (or three) IGBT modules configured as a three-phase half bridge circuit. It is made up of three identical phase branches and each branch consists of two IGBTs modules. The DC link is directly connected to the three phase modules.
- The DC link voltage is converted into PWM sinusoidal waves by being appropriately switching on and off the IGBT modules at a high frequency.
- The width of the individual pulses in the PWM wave determines the amplitude of the output voltage and the width of the pulse block determines the output frequency.
- The three-phase sine filter, consisting of 3 phases AC Choke and 3 phases Capacitor, are connected at the output of IGBT inverter modules attenuates the harmonics and provides a sinusoidal three phase output voltage of 415 volt and 50 Hz frequency, which being fed to different loads.



Three Phase IGBT Inverter

AUXILIARY POWER CIRCUIT:

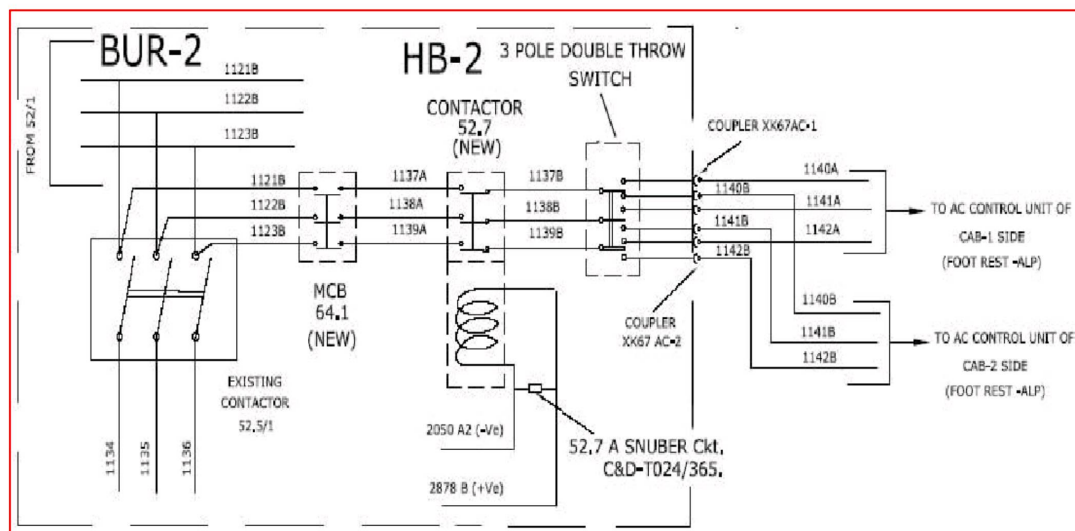


IGBT BASED 3X130 KVA AUXILIARY CONVERTER:

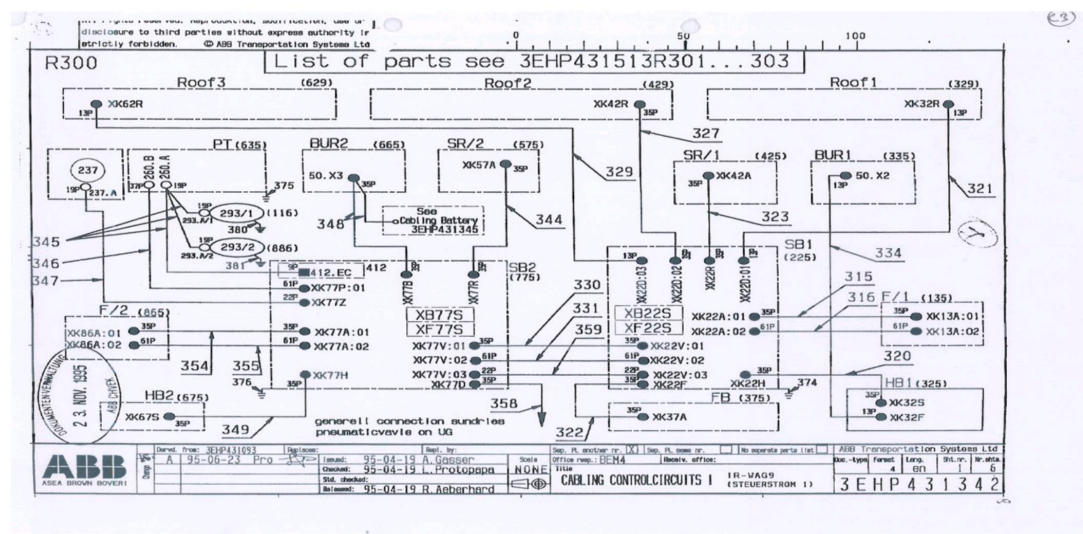
- One set of Auxiliary Converter consists 03 nos. of converters namely BUR-1, BUR-2 & BUR-3, each having rating of 130 kVA, 50 Hz. BUR-1 is placed in cubicle called Box-1 whereas BUR-2 & BUR-3 is placed in cubicle called Box-2.
- Each of the BURs takes single phase 1000 Volt, 50Hz from the secondary winding of main transformer and feeds 3-phase 415-volt, 50/37 Hz to 12 nos. 3-phase auxiliary loads and one battery charger.
- BUR-1 feeds 3-phase 415-volt AC to oil cooling blower for cooling the transformer oil and traction converter oil by taking air from the roof.
- BUR-2 feeds 3-phase 415-volt AC to traction motor blower for cooling bogie, transformer oil pump for circulating oil from transformer to cooling unit & traction oil pump for circulating oil from traction converter to cooling unit.
- BUR-3 feeds 3-phase 415-volt AC to main compressor unit for creating MR pressure to 10 kg/cm² & scavenging blower for cleaning dust from air filter of traction motor blower & oil cooling blower respectively.
- BUR-3 also feeds 3-phase 415 volt to battery charger kept within the Box-2. which converts 415-volt AC in to 110-volt DC for charging the vehicle batteries. These batteries provide a direct power supply to loco dc loads

- If one of the on-board converters (BUR) fails the whole load is distributed between the two remaining BURs. They can continue to supply the auxiliary circuits, practically without losses and full traction is also available.
- The machine room blower and the corresponding scavenge blowers are fed directly from the auxiliary transformer. It operates independently of the, as soon as the VCB is closed. Therefore, the loco can be cooled even if MCE is not in operation.
- The blowers on the traction motor and the oil cooling units are individually supplied for each bogie by the auxiliary converter (BUR).
- However, if two BUR fail, there is no traction available and the power supply to the auxiliary circuit fails, i.e., LOCO DEAD.

CAB AC CIRCUIT DIAGRAM:



CABLING CONTROL CIRCUIT:



motor provided in the locomotive are D.C. motors. So A.C. is required to be converted into D.C. & this conversion is done by the RSI block. There are separate RSI blocks for two separate secondary windings. RSI-1 for TMs -1,2&3 and RSI2 for TMs -4, 5 & 6.

3.Silicon Cells (Diode): Generally, there are 64 silicone cells(diode) in a RSI block of WAG-5 loco, which consists of 4 arms. Each arm of the block has 16 cells. These cells convert A.C. into pulsating D.C. Some locos are provided with RSI block of different make and having different number of silicon cells.

4. Tell Tale fuse (Signaling fuse): Each RSI block is provided with 4/7 bridges connected in parallels and protected by Bridge-Fuses (HRC Fuse). In the event of failure of any of the bridges, the bridge fuse blows triggering, in turn the Tell –Tale fuse which lights up a signal lamp LSRSI in the driver’s desk.

5. QRSI: This is an over current relay which checks over current in the RSI blocks. There are two QRSI - QRSI₁ for RSI block no -1 and QRSI₂ for RSI block no-2. If there is over current in any RSI block, the concerning QRSI will act and cause tripping of DJ.

6.Smoothing Reactors (SL-1 and SL-2): The A.C. current after getting rectified in the RSI Block, is a pulsating D.C. not pure D.C. Hence this pulsating D.C. is further passed through the smoothing reactor to make it pure D.C. There are two S L - SL1 for RSI block no: -1 and SL2 for RSI block no. -2.

7.Line contactors (L-1, L-2, L-3, L-4, L-5 & L-6): These are electro pneumatic contactors provided to connect the traction motors with the RSI blocks, with each line contactor one traction motor is connected. TMs 1 ,2 and 3 are connected with RSI-1, through L₁, L₂ and L₃ and TMs 4,5 and 6 are connected with RSI-2 through L₄, L₅ and L₆.

8.Traction motors: These are 6 poles D.C. series type motors. There are 6 traction motors on WAG-5 locos. All these traction motors are connected with 2 RSI blocks in parallel connection through the line contactors. Each block feeds three traction motor separately.

RSI Block no 1 feeds-TM₁ through L₁,

TM₂ through L₂, TM₃ through L₃

RSI Block No 2, Feeds-TM₄ through L₄,

TM₅ through L₅, TM₆ through L₆

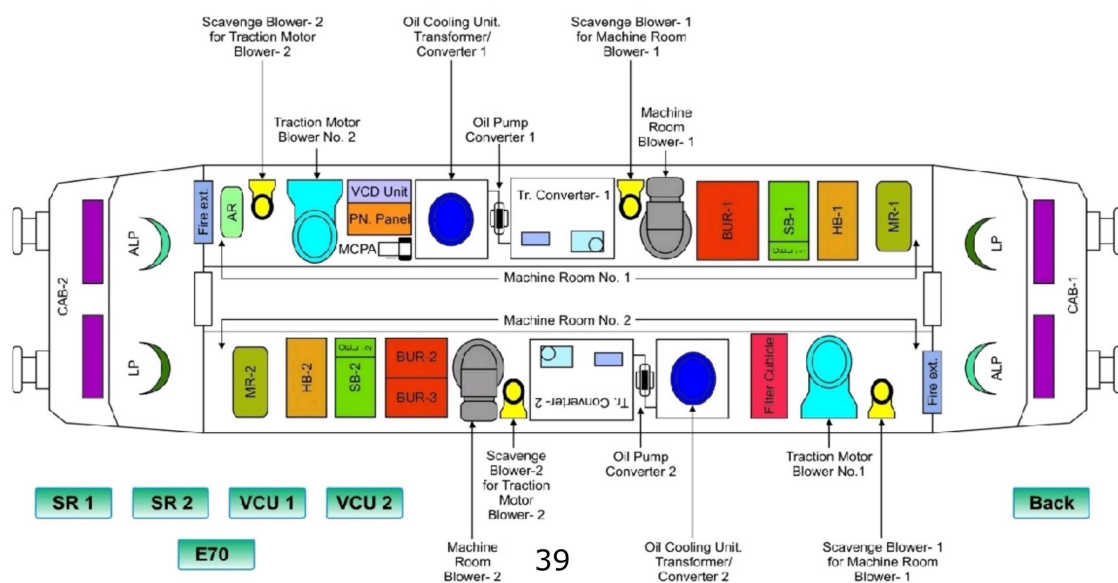
9.Reversers (J1 and J2): There are two reverses in WAG-5 locos J1 and J2. These are drum contactors provided to change the direction of flow of current in the field coils of traction motors to change the direction of movement of loco.

J1 controls-TM 1,2 and 3

J2 controls-TM 4,5 and 6

10.RPS (Permanent Shunting Resistance): This is a shunting resistance connected in parallel to the field coils of traction motor to bypass A.C. component through it to pass pure DC into the traction motors.

Machine Room Layout



GALLERY:

LOCOMOTIVE



WG



WAP 4



WAG 9



WAP 7

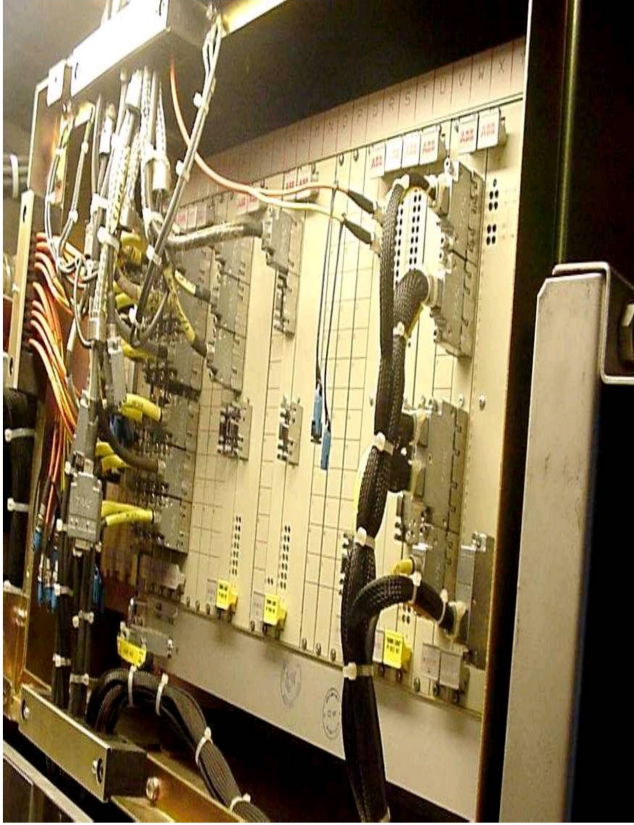


WAG 7

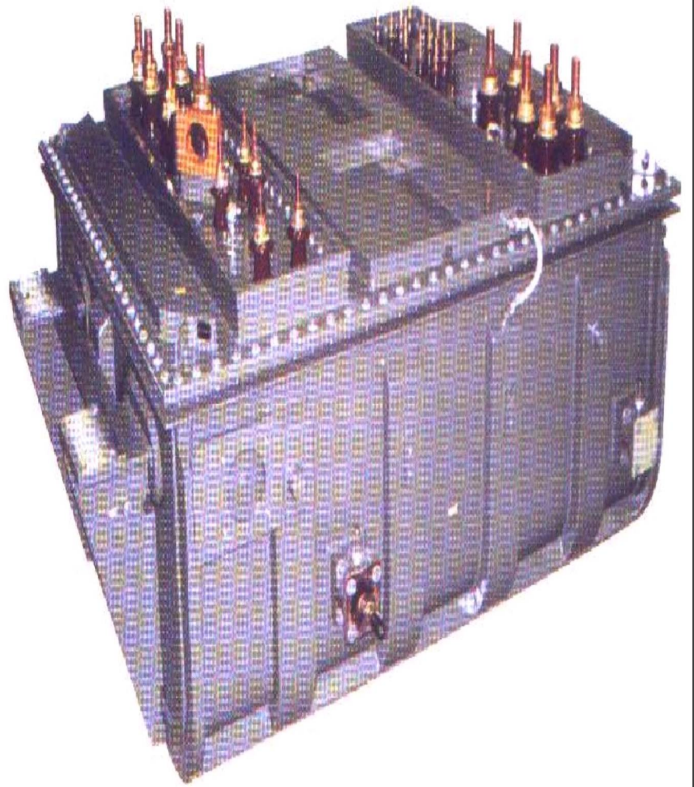


WAG 9

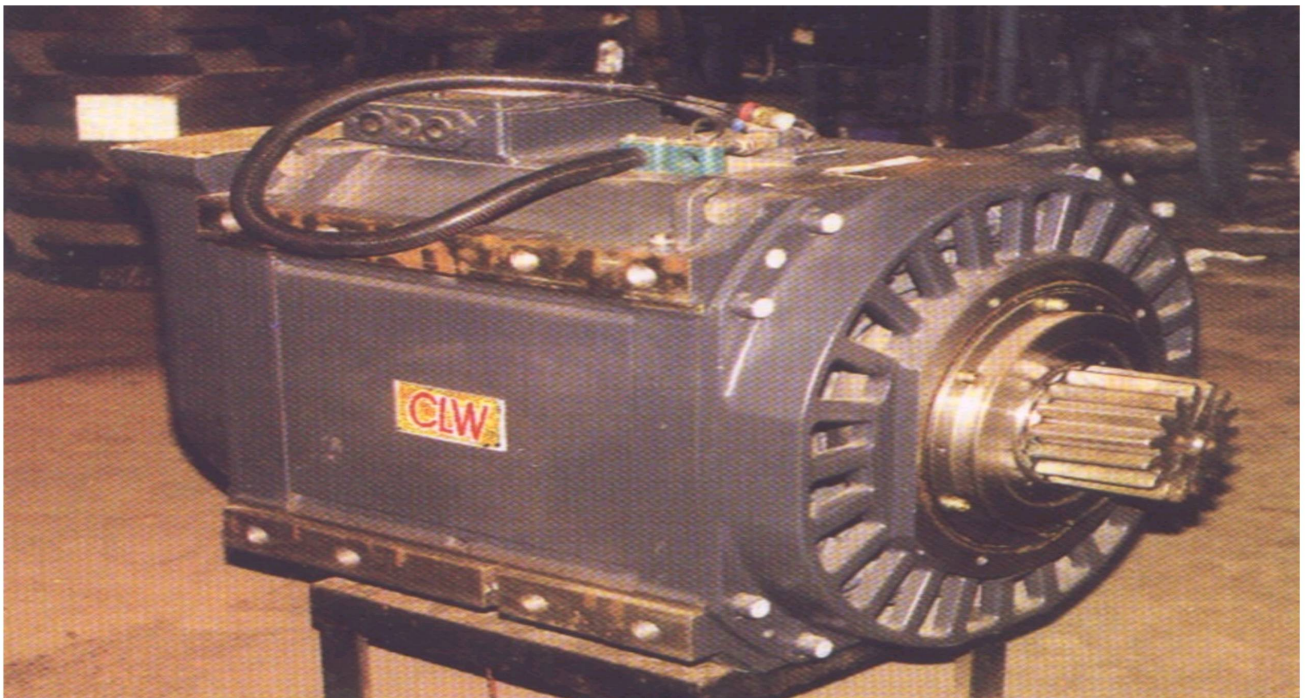
CONTROL ELECTRONICS



TRANSFORMER



TRACTION MOTOR-FREIGHT



| CONCLUSION:

The four weeks of training at Chittaranjan locomotive works has greatly benefited me in several ways. I have witnessed the immense power of technology and how it can be put to productive purposes for the benefit of mankind. I also became aware of my role as a Electrical Engineer in making this possible,

During my stint at Chittaranjan locomotive works, I have learnt several things besides engineering which include, but are not limited to the working of a giant organization, interaction and communication skills, analytical skills, importance of safety in industry, time management and the most important fact that no work is small.

The training has also inculcated in me professionalism and dedication to work. No textbook would have been able to do all this just within a span of four weeks. It has proved to be an important milestone in my academic life.

| REFERENCE:

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THANK YOU