NAGPUR METRO RAIL CORPORATION

महा मेट्रो

NAGPUR METRO

NAGPUR METRO
RAIL PROJECT

ACKNOWLEDGEMENT

I would like to express my deepest appreciation to all those who provided me with the opportunity to complete this report.

I would also like to acknowledge the people of the organization who have directly or indirectly helped me in training and gave access to use and understand the equipment and machinery used.

Submitted by:

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NITK (b.tech EEE)

INTRODUCTION

Nagpur is the third largest city of Maharashtra and also the winter capital of the state. With a population of approximately 25 lakhs. Nagpur Metropolitan Area is the 13th largest urban conglomeration in India. It has also recently been ranked as the cleanest city and the second greenest city of India. In addition to being the seat of annual winter session of Maharashtra state assembly "Vidhan Sabha", Nagpur is also a major commercial and political center of the Vidarbha region, It is also known as "Orange City" for being a major trade center of oranges that are cultivated in the region.

Nagpur lies precisely at the center of the country with the Zero Mile Marker indicating the geographical center of India. The city was founded by the Gonds but later became part of the Maratha Empire under the Bhonsles. The British East India Company took over Nagpur in the 19th century and made it the capital of the Central Provinces and Berar. After the first reorganization of states, the city lost its capital status but according to the informal "Nagpur Pact" between political leaders, it was made the second capital of Maharashtra. **Nagpur** is also declared, "Tiger Capital of India " as it connects many Tiger Reserves in India to the world.

Nagpur lies on the Deccan plateau of the Indian Peninsula and has a mean altitude of 310 meters above sea level. The underlying rock strata are covered with alluvial deposits resulting from the flood plain of the Kanhan River. In some places these give rise to granular sandy soil. In low lying areas which are poorly drained, the soil is alluvial clay with poor permeability characteristics. In the eastern part of city crystalline metamorphic rocks such as gneiss, schist and granites are found, while in the northern part yellowish sand stones and clays of the lower Gondwana formations are found.

Nagpur city is dotted with natural and man-made lakes with Ambazari lake being the largest. Other natural lakes include Gorewada Lake and Telangkhedi lake. Sonegaon lake and Gandhisagar lake are man-made lakes created by the city's historical rulers. Nag river, Pilli nadi along withnallasform the natural drainage pattern for the city. Nagpur is known for its greenery, and was judged as the cleanest and second greenest in India. Recently, Government of India selected Nagpur as a Model City for *National Clean Air Mission* by allocating 25 crores for the plan. This project will be handled by Nagpur's own NEERI.

As it is located at centre of Indian peninsula far from the Bay of Bengal and the Arabian Sea, Nagpur has a tropical wet and dry climate with dry conditions prevailing for most of the year. It receives an annual rainfall of 1,205 mm (47.44 in) from monsoon rains during June to September. The highest recorded rainfall was 304 mm on 14 July 1994.Summers are extremely hot lasting from March to June, with maximum temperatures occurring in May. Winter lasts from November to January, during which temperatures can drop below 10 °C (50 °F). The highest ever recorded temperature in the city was 49°C, while the lowest was 3°C.

DEMAND

- Traffic Study and Ridership estimation are the first tasks in DPR which imply finalizing a feasible alignment plan of the proposed metro network and then locating normal and interchange metro stations (if any). After that, Ridership Estimation is done. Estimating daily and peak hour boarding and alighting from each station, daily link load and PHPDT link loads [all together is called Ridership Estimation] are estimated. These estimates are primary inputs to other important estimates such as station design, train operation plan, estimates of revenue collection, benefits of metro, rolling stock and many other estimates including EIRR and FIRR.
- Total daily boarding ridership in 2016 is estimated as 3.52 lakhs in which share of line 1 as 47% and line 2 as 53%. Average trip length is 6.41km. The daily and peak station loads of the Metro System comprises of the following lines, are described as under in following table

BOARDING/RIDERSHIP (DAY)	**2016**	**2021**	**2026**	**2031**	**2036**	**2041**
ON LINE 1(AUTOMATIVE-KHAPRI)	168361	185531	203720	224316	248419	277704
ON LINE 2(PRAJAPATI-LOKMANYA)	184081	197908	215415	234577	260237	286031
TOTAL OF BOTH	352442	383439	419135	458893	508656	563735
AVERAGE TRIP LENGTH IN KM	6.419	6.453	6.494	6.533	6.521	6.522
MAXIMUM PHPDT ON LINE 1	10089	10936	11915	12934	14286	15729
MAXIMUM PHPDT ON LINE 2	7746	8460	9154	9906	10748	11882

how metro will change Nagpur

The infrastructures like metros need to be planned to keep the future requirements. Nagpur, a future educational hub with IIM, AIMS coming and SEZ-MIHAN. This would mean a lot of people migrating to Nagpur for better opportunities. Also, Nagpurians going out for Job might come back to settle in their native city.

Mumbai and Delhi face huge difficulties of traffic as there were planning loopholes also it was difficult to estimate surge in population as it has happened but now, they are improving.

Metro will provide better, safer, and more accessible Nagpur for present and future generations to come.

I see people answering that it's a waste of money and Nagpur doesn't need more facilities. I hope they have seen the rates Auto-Rickshaw charge which are far from economical. Also, the bus facilities are not of a very high standard and Star buses are not well maintained.

Last point which I would like to put is that Nagpur Metro will generate Jobs for youth of Nagpur which will be beneficial as getting a core job in Nagpur is difficult in present scenario.

Nagpur metro is a necessary step.

The reasons are as follows:

1. Nagpur is one of the biggest two-wheeler market, wherein every average and even poor family has half two wheeler per capita precisely with 30 lacs population, there are almost 15 lac two wheelers in and around Nagpur. With such a large number, the total investment is around 50000*1500000 = Rs. 7500,00,00,000, a whopping Rs. 7500 crores invested by public to mitigate deficiencies in public transport. For an average family it is a very painful ordeal to keep invested Rs.1,00,000 to 1,50,000 in two wheeler for almost during entire life. This money can be better invested in some gainful object. Even if there is reduction of 30% it would save Rs. 2250 crores

2. These vehicles need at least need 1/2 litre fuel per day to run that is around 7,50,000 liters of fuel. If 30% is saved, it would be 2,25,000 liters a day or Rs. 90 lacs per day (fuel cost taken at 40 per litre net of taxes), means annual savings of Rs. 328 crores or 44 million dollars of foreign currency.

3. Safety, every year around 500 people loose life in road accidents of which almost 400 are attributed to 2 wheelers. Even if there is 30% reduction in the same, we save 120 lives which means at least Rs.6 crores Saving in Insurance compensation cost (considering Rs. 5 lacs per capita). Here again national loss in terms of GDP caused due to loss of remaining working life of the victim is not considered. Also the amount spent by the Government to bring him to that level is not considered. If calculated this would be a humongous loss.

4. The working hours lost due to injury (not death) in Road accidents is uncountable. Human agony caused is another aspect which cannot be counted in money terms whether by death or injury.

5. Pollution, it can be felt due to covid 19. Before lockdown the air quality was 3 times worse than the present and was far above recommended human standard. Such difference can only be attributed to traffic because Nagpur is non industrial city.

6. Traffic jam. We loose Rs.1,32,000 crores annually in India due to traffic jams out of this 96000 crores is attributed to fuel wastage and balance 36000 crores is due to working hours lost in unnecessarily prolonged commuting time. Even attributing 2% of such loss to city of Nagpur gives a figure of Rs. 2620 crores.

7. The metro has one time capital investment and would run on electricity which is now abundantly available in India and Nagpur and is also cheap due to augmentation of non-conventional energy sources.

STATION PLANNING

THE ORANGE LINE

Line -1 (North-South Corridor) Automotive Square to KHAPRI Depot

A total of 17 Stations have been planned along the proposed NS Corridor. This corridor originates starts from Automotive square and runs southwards on NH-7 through Nari Road, Indora chowk, Gaddi Godam Square, Kastrurchand Park, Zero Mile, Sitaburdi, Congress Nagar, Rahate colony, Ajn Sqre Station, Chhatrapati Sqr Station, Jaiprakash Nagar, Ujjawal Nagar, Airport Station, New Airport Station and Khapri Station. The Corridor is partly elevated and partly at grade. Total Length of the corridor is 19.658 Km of which approximately 15.058 is elevated and 4.6 km is at grade. There are 17 stations on this corridor of which 15 stations are elevated and 2 stations are at grade. Sitaburdi Station is an Inter-change station. Average inter-station distance is 1.20km approximately varying from 0.54km to 2.4km depending upon the site, operational and traffic requirements. The sequence of stations with their respective chainages and locational and platform characteristics is presented in **Table 0.11A.**

Sequence of Stations

- AUTOMOTIVE SQRE
- NARI ROAD
- INDORA CHOWK
- KADVI CHOWK
- GADDI GODAM SQRE
- KASTURCHAND PARK
- ZERO MILE
- CONGRESS NAGAR
- RAHATE COLONY
- AJNI SQUARE
- CHHATRAPATI SQUARE
- JAIPRAKASH NAGAR
- UJWAL NAGAR
- SITABURDI

THE AQUA LINE

Line -2 (East-West Corridor). Prajapati Nagar to Lokmanya Nagar

A total of 19 Stations have been planned along the proposed EW Corridor This corridor originates from Prajapati Nagar and runs westwards, through Vaishnodevi Chowk, Ambedkar Chowk, Telephone Exchange, Chittar Oli Chowk, Agrasen Chowk, Doser Vaisya Chowk, Nagpur Railway Station, Sitaburdi, Jhansi Rani Square, Institute of Engineers, Shankar Nagar Square, LAD chowk, Dharmpeth College, Subhash Nagar, Rachna (Ring road Junction), Vasudev Nagar, Bansi Nagar to Lomanya Nagar. The entire corridor is elevated. The total length of the corridor is 18.266 kilometer. All stations are elevated stations and Sitaburdi station is an Interchange Station. Average inter-station distance is 1.00km approximately varying from 0.65km to 1.29km depending upon the site, operational and traffic requirements. The sequence of stations with their respective chainages and locational and platform characteristics is presented in **Table 0.11B**

Sequence of Stations

- Prajapati Nagar
- Vaishno Devi Chowk
- Ambedkar Chowk
- Telephone Exchange
- Chittar Oli Chowk
- Agarsen Chowk
- Dosar Vaisya Chowk
- Nagpur Railway station
- Sitaburdi
- Jhansi rani square


NAGPUR
Proposed Metro Map
N
NH-47
NH-44
NH-53
ANANT NAGAR
JARIPATKA
PRABHAT COLONY
Automotive Square
Nari Road
Kadvi Chowk
Indora Square
Kalamna RS
VANJARI
KALMANA
DAVLAMETI
SADAR
CLARK TOWN
Nagpur Moti Bagh RS
MOMINPURA
Gaddi Godam Square
SHISHAK COLONY
Itwari RS
VAYUSENA NAGAR
KOHALE
Phutala Lake
Nagpur Junction
Dosar Vaisya Chowk
Agrasen Chowk
Prajapati Nagar
Kasturchand Park
CIVIL LINES
Nagpur Railway Station
Zero Mile
LAKADGANJ
Jhansi Rani Square
Cotton Market
Chitaroli Square
Telephone Exchange
Ambedkar Chowk
Vaishno Devi Chowk
KACHIMET
Shankar Nagar Square
DHARAMPETH
GUJARWADI
MANGALWARI
PARDSINGA
Institution of Engineers
Sitaburdi Interchange
NANDANVAN
VIDHYA NAGAR
Dharampeth College
DHANTOLI
Congress Nagar
HANUMAN NAGAR
Rachana Ring Road
Ambazari Lake
LAD Chowk
Rahate Colony
Ajni RS
VATHODA
CHITNIS NAGAR
Subhash Nagar
JAWAHAR NAGAR
Ajni Square
BAJRANG NAGAR
Vasudev Nagar
Bansi Nagar
JUNA BIDIPETH
Chatrapati Square
KASHI NAGAR
KHARABI
DIGDOH
KHAMLA
Lokmanya Nagar
EKATMATA NAGAR
INDRAPRASTHNAGAR
Jaya Prakash Nagar
OMKAR NAGAR
BELDAR NAGAR
SONEGAON
Ujwal Nagar
MANEWADA
NARSALA
Dr. Babasaheb Ambedkar International Airport
Airport
South Airport
PIPLA
ISASANI
GHOGALI
ADYALI
MIHAN
New Airport
TELHARA
KHAPRI
SHANKARPUR
WELA HARICHANDRA
Khapri
Khapri RS
DHAMANA
TAKLI
DAHEGAON
KHARSOLI
Khapri Depot
Eco Park
Metro City
• Line-1: Automotive Square – Khapri Metro City (19.658 km)
• Line-2: Lokmanya Nagar – Prajapati Nagar (18.557 km)
Map not to Scale
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1st Corridor Metro Line
2nd Corridor Metro Line

SYSTEM OF TRACTION AND POWER TARIFF

The power requirements of a metro system are determined by peak-hour demands of power for traction and auxiliary applications. Broad estimation of auxiliary and traction power demand is made based on the following requirements:-

- (i) Specific energy consumption of rolling stock – 75KWh/1000 GTKM
- (ii) Regeneration by rolling stock – 30%
- (iii) Elevated station load – initially 200KW, which will increase to 400 KW in the year 2041
- (iv) Underground Station load – initially 2000 kW, which will increase to 2500 kW in the year 2041
- (v) Depot auxiliary load - initially 1500 KW, which will increase to 2500 KW in the year 2041

Keeping in view of the train operation plan and demand of auxiliary and traction power requirements projected for the year 2016, 2021, 2031 and 2041 are summarized in **Table below**:

Table : Power Demand Estimation (MVA)

Corridor		Year			
		2016	2021	2031	2041
North-South Corridor – 1 Automotive Sqre to KHAPRI. [19.658 kms ; 15 elevated Stations & 2 at Grade Station].	Traction	4.32	5.01	5.84	7.16
	Auxiliary	7.72	7.84	9.14	11.49
	Total	12.04	12.85	14.98	18.65
East-West Corridor – 2 Prajapati Nagar to Lokmanya Nagar [18,557 kms ; 19 Elevated Stations].	Traction	4.24	4.57	5.73	7.01
	Auxiliary	8.34	8.46	9.88	12.48
	Total	12.58	13.03	15.61	19.49

SELECTION OF TRACTION SYSTEM

On techno-economic consideration, it is recommended to adopt 25 KV single phase AC Traction. In addition, it has the following merits.

- Lower initial cost.
- Lower operating and maintenance cost as in case of 25 KV ac traction the
- regeneration is up to 30% and the line losses are around 0.5% in comparison to D.C. losses up to 6 – 7%.
- A.C. system poses lesser Fire hazards as current levels are much lower than D.C.
- There are no current problems and hence the corrosion is controlled.

SOURCES OF POWER SUPPLY

The high voltage power supply network of Nagpur City has only 220kV and 132kV network on the periphery of the city to cater to various types of demand in vicinity of the proposed corridor. 220/132 kV sub stations are far away from the alignment and therefore, it involves substantial cable and it's laying cost.

Keeping in view the reliability requirements, two input sources of 220 kV or 132KV Voltage level are normally considered for each corridor. Therefore, to achieve the desired reliability, two Receiving Sub Stations (132/33/25 kV or 220/33/25 KV) are proposed to be set up for each Corridor – 1 & Corridor – 2. The intersection of the two corridors will be at Sitaburdi station (Elevated station of Corridor – 1).

It is proposed to avail power supply for traction as well as auxiliary services from the following grid sub-stations at 220/132kV through cable feeders.

Sources of Power Supply

Corridor	Grid sub-station (with Input voltage)	Location of RSS of Metro Authority	Approx. length of cables
North-South Corridor – 1 Automotive Sqre to Khapri Station.	1. 132 KV Uppalwadi Grid Sub-station.	2 x 132 KV bays near Automotive station	7 route km, 132 kV (Double Circuit cables).
	2. Proposed 220 KV Butibori Grid Sub-station.	2 x 220 KV bays at Khapri Station	4 route km, 220kV (Double Circuit cables).
East-West Corridor – 2 Prajapati Nagar to Lokmanya Nagar.	3. LILO of proposed 132 KV Pardi-Jattarodi ckt.	2 X132 KV bays near Prajapati Nagar station	4 route km, 132 kV (Double Circuit Cables).
	LILO of proposed 132 KV Hingna – Lendra Ckt.	2 x 132 KV bays near Suhash Nagar station	10 route km, 132 kV (Double Circuit Cables).

As the power supply is available at 220 KV and 132 KV levels that too at a substantial distance from the alignment, one sub-station of each line to be considered with one set of transformers and add another set as the traffic grows.
The above sub-stations are being considered as a conventional sub-station. In case a 220 KV or 132KV GIS is to be provided, there will be an additional cost of Rs. 20 Crores or 15 Crores per sub-station respectively.

Power Demand Projection for various sources

Corridor	Input Source / Receiving Sub Station (RSS)	Peak Demand – Normal (MVA)				Peak Demand – Emergency (MVA)			
		2016	2021	2031	2041	2016	2021	2031	2041
North-South Corridor – 1 Automotive Sqre to Khapari	**At Depot near Khapri station**								
	Traction	2.60	2.75	3.50	4.30	4.32	4.65	5.84	7.16
	Auxiliary	4.62	4.70	5.54	6.89	7.72	7.84	9.14	11.49
	Sub – Total (A)	7.22	7.45	9.04	11.19	**12.04**	**12.50**	**14.98**	**18.65**
	Near automotive station								
	Traction	1.72	1.90	2.34	2.86	04.32	04.65	05.84	07.16
	Auxiliary	3.10	3.14	3.60	4.60	07.72	07.84	09.14	11.49
	Sub – Total (B)	4.82	5.04	5.94	7.46	**12.04**	**12.50**	**14.98**	**18.65**
	TOTAL (A + B)	**12.04**	**12.49**	**14.98**	**18.65**				
East-West Corridor – 2 Prajapati Nagar to Lokmanya Nagar .	**Near Subhash Nagar station**								
	Traction	2.54	2.77	3.43	4.21	4.21	4.57	5.73	7.01
	Auxiliary	5.00	5.06	5.98	7.48	7.48	8.46	9.88	12.48
	Total	7.54	7.83	9.41	11.69	**12.58**	**13.03**	**15.61**	**19.49**
	Near Prajapati Nagar station								
	Traction	1.70	1.80	2.30	2.80	4.21	4.57	5.73	7.01
	Auxiliary	3.34	3.40	3.90	5.00	7.48	8.46	9.88	12.48
	Total	5.04	5.20	6.20	7.80	**12.58**	**13.03**	**15.61**	**19.49**
	TOTAL (A + B)	**12.58**	**13.03**	**15.61**	**19.49**				

The 220 kV or 132 KV power supply will be stepped down to 25kV single phase for traction purposes at the RSS of Nagpur Metro and the 25kV traction supply will be fed to the OHE at viaduct through cable feeders. For feeding the auxiliary loads, the 220/33 kV or 132/33 KV power supply received will be stepped down to 33 kV and will be distributed along the alignment through 33kV Ring main cable network. These cables will be laid along the viaduct and tunnel walls. If one RSS trips on fault or input supply failure, train services can be maintained from the other RSS. In case of total grid failure, all trains may come to a halt, but station lighting & other essential services can be catered to by stand-by DG sets. Therefore, while the proposed scheme is expected to ensure adequate reliability, it would cater to emergency situations as well.

The 220 kV or 132 KV cables will be laid through public pathways of Maharasthra Grid Sub-stations to RSS of Metro Authority. For corridor – 1, one substation near Automotive station shall be provided with 2nos. (one as standby) 132/25 kV, 10 MVA single-phase traction Transformers for feeding Traction and 132/33 KV, 15 MVA three phase Transformers for feeding auxiliary loads and other near Khapri Depot shall be provided with 2nos. (one as standby) 220/25 kV, 10 MVA single-phase traction Transformers for feeding Traction and 220/33 KV, 15 MVA three phase Transformers for feeding auxiliary loads. For corridor – 2, one RSS near Subhash Nagar and another RSS near Prajapati Nagar station shall be provided with 2nos. (one as standby) 132/25 kV, 10MVA single phase traction Transformers for feeding Traction supply and 132/33 KV, 15 MVA three phase Transformers for feeding auxiliary loads. Interconnection will be provided at 33KV & 25KV level to meet emergency requirement at Sitaburdi in case of failure of two RSS of any one corridor. The capacity of transformers may be reviewed considering the load requirement/distribution of both the corridors at the time of detailed design. Conventional Outdoor type 132 kV Switchgear is proposed for RSS's to be located in approx. 100 X 100 m (10000 sq. mtr.) land plot and for 220 KV Conventional Outdoor type switchgear is proposed for RSS to be located in 120 x 100 m (12000 sq.mtr.). The availability of land in the depot area may not be a constraint. The land at Automative station, Subhash Nagar and near Prajapati Nagar station to be allocated. Requirement of land for 220 KV GIS substation will be approx. 70 X 80 m (5600 sq. m) and for 132 KV GIS substation land requirement will be approx. 60 X 70 m (4200 sq. m) but the cost of substation works will increase by nearly Rs. 20 Crore and 15 Crores respectively. 220/132 kV Grid sub stations are far away from the alignment and therefore, it involves approx. Rs.20 Crores extra cable and it's laying cost.

AUXILIARY SUPPLY ARRANGEMENTS FOR STATIONS & DEPOT

Auxiliary sub-stations (ASS) are envisaged to be provided at each station (2 ASS's for Underground stations and 1 ASS for elevated station) for stepping down 33 kV supply to 415 V for auxiliary applications. A separate ASS is required at depot. The station ASS's will be located at mezzanine or platform level inside a room. The auxiliary load requirements have been assessed at 250kW for elevated / at-grade stations which is likely to increase up to 400 KW in the year 2041 and 2000 kW for Underground Station which is likely to increase up to 2500 KW in the year 2041. In order to meet the requirement of auxiliary power two dry type cast resin transformers (33/0.415kV) of 500kVA capacity are proposed to be installed at the elevated stations (one transformer as standby) and two transformer of 2.5 MVA at each underground ASS. For Property Development within the footprints of the station, a provision to add a third transformer at a later date may be kept at an elevated station.

VARIOUS PANELS AT ASS

There is total 13 panels at every ASS. They are as follows:

1. MDB (main distribution board): A distribution board is the main electrical supply system for any commercial or residential entity. The main cable comes into the distribution board and then via circuit breakers get distributed in the secondary circuit such as lights ang bugs. The capacity of CB at Nagpur metro ASS is 800A for 2.5MVA transformer and 400A for 400KVA transformer.

2. APFC1 and

3. APFC 2 (automatic power factor correction): APFC or automatic power factor control panels are mainly used for improvement of power factor. APFC panels are needed because in in industry most of the load is inductive in nature which results in lagging power factor that is why there is loss and wastage of energy which results in high power bills and heavy penalties from electricity boards.

4. MLP (main lighting panel): main lighting panel performs the function of switching or controlling lights and lighting circuits. MLF contains total lighting load of the whole station.

5. ELP (emergency lighting panel): apart from MLP, ELP contains only the lighting load which is needed for emergency conditions such as sign boards, emergency lighting systems, etc.

5. EPP (essential power panel): emergency power panel provides uninterrupted power supply to the most important equipments so that they can work properly without failure during emergency conditions

7. AMF (auto main failure): it is sometimes also called an automatic transfer switch. It is normally connected to the generator set to control the generator set function, automatically detecting a power cut and causing the generator to start and support the load

8. Air conditioning power panel: It controls the load of air conditioning units that are used for cooling of electrical systems such as UPS rooms. At metro station 3 units of 18 tones each are installed which are operated in combination of two sets operating at a time. They are equipped with VRV (variable refriginal value) system.

9. Escalator power panel: This panel deals with the load of escalators and control their movement by providing supply to escalator drive which is a VVF(variable voltage variable frequency) drive.

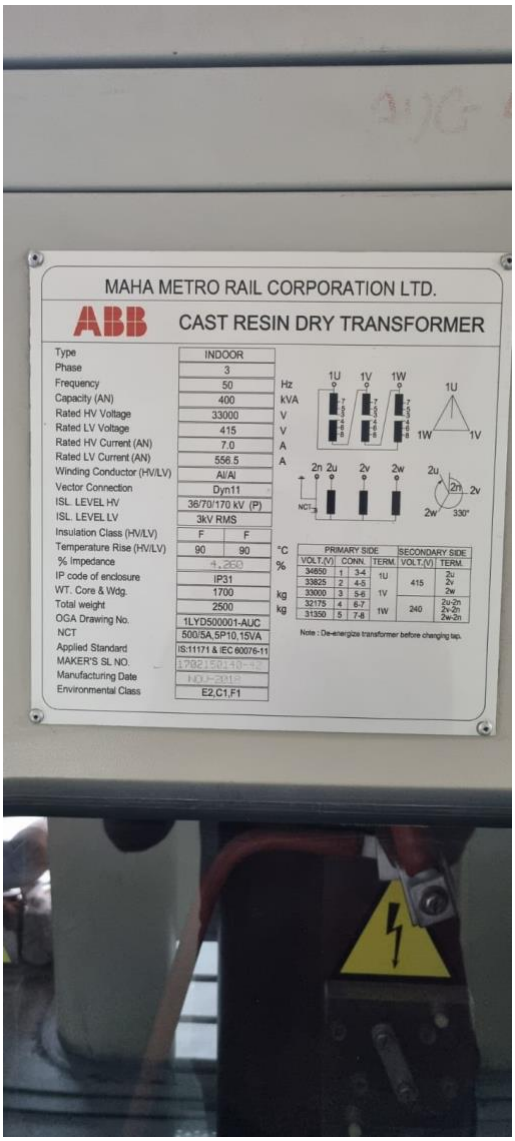
10.DPP (domestic pump panel): pump panels control electric motors that power mechanical pumps. A pump control panel includes power components to control the pump motor, sensors to protect the pump, and pilot devices for operator control.

11.FPP (fire pump panel): The component in this panel receives signal from alarm device which is a multi-sensor (smoke and fire detector) and activates motor control devices to provide power to fire pumps and monitor its performance

12.UPS (uninterrupted power supply) input panel and

13.UPS output panel: UPS is typically used to protect equipment's such as computers, data centers, telecommunication apparatus, or there electrical equipment's where an unexpected power outage could cause injuries, fatalities, serious disruption to business or loss of date

Cast resin dry type transformer



Cast Resin Dry Type Specification. A dry type of transformer is a transformer that does not use liquid as insulation for its winding or core. Instead, the windings and core are kept within a sealed cast epoxy resin. Cast resin dry type transformers are used in high moisture areas.

Cast resin transformers are a popular choice for use in commercial, industrial and residential sites. These power tranformers require practically no maintenance and have a much lower environmental impact than traditional oil-immersed transformers.

For more than 45 years, DuPont™ Nomex® has been the material of choice for dry type transformer insulation.

Dry transformers are best used in industrial, commercial, and even utility applications. This is because they can comfortably meet both small and medium voltage needs.

ENERGY SAVING MEASURES

Energy charges of any metro system constitute a substantial portion of its operation & maintenance (O & M) costs. Therefore, it is imperative to incorporate energy saving measures in the system design itself. The auxiliary power consumption of metros is generally more than the traction energy consumed by train movement during initial years of operation. Subsequently, traction power consumption increases with increase in train frequency/composition in order to cater more traffic. The proposed system of Nagpur Metro includes the following energy saving features:

- Modern rolling stock with 3-phase VVVF drive and lightweight stainless-steel coaches has been proposed, which has the benefits of low specific energy consumption and almost unity power factor.
- Rolling stock has regeneration features and it is expected that 30% of total traction energy will be regenerated and fed back to 25kV ac OHE to be consumed by nearby trains.
- Effective utilization of natural light is proposed. In addition, the lighting system of the stations will be provided with different circuits (33%, 66% & 100%) and the relevant circuits can be switched on based on the requirements (day or night, operation or maintenance hours etc).
- Machine-room less type lifts with gearless drive have been proposed with 3-phase VVVF drive. These lifts are highly energy efficient.
- The proposed heavy-duty public services escalators will be provided with a 3-phase VVVF drive, which is energy efficient & improves the power factor. Further, the escalators will be provided with infrared sensors to automatically reduce the speed (to idling speed) when not being used by passengers.
- The latest state of art and energy efficient electrical equipment (e.g., transformers, motors, light fittings etc) has been incorporated in the system design.

ELECTRIC POWER TARIFF

The cost of electricity is a significant part of Operation & Maintenance (O&M) charges of the Metro System, which constitutes about 25 – 35% of total annual working cost. Therefore, it is the key element for the financial viability of the project. The annual energy consumption is assessed to be about 36 million units in initial years (2016), which will increase to about 56 Million Units by year 2041 for Corridor – 1 and about 31 million units in initial years (2016), which will increase to 52 Million Units by year 2041 for Corridor – 2. In addition to ensuring optimum energy consumption, it is also necessary that the electric power tariff be kept at a minimum in order to contain the O& M costs. Therefore, the power tariff for this Corridor should be at effective rate of purchase price (at 132/220 kV voltage level) plus nominal administrative charges i.e. on a no profit no loss basis. This is expected to be in the range of Rs. 5.00 per unit with Rs.125/KVA/month fixed charges. It is proposed that Government of Maharashtra will take necessary steps to fix power tariff for Nagpur Metro at “No Profit No Loss” basis. Financial analysis has been carried out based on this tariff for the purpose of finalizing the DPR. Similar approach is being pursued for Delhi Metro.

Nagpur metro is green metro

More than 65% of ElectriCities of all metro stations & metro bhavan are dependent on solar energy. After completion of whole work of Nagpur metro, it will be the greenest metro of nation India, by using more than 85% of electricity from solar energy.

Nagpur Metro Rail Corporation Limited (NMRCL) is installing energy efficient

HVAC systems and LED lights and solar pipe based lighting in Nagpur metro

stations. Sewage treatment plant is also planned to generate waster

drinking purposes

1.Airport Metro station

2.South airport metro station

3.Metro Bhavan Nagpur