Volume-XVI

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MMRDA

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MUMBAI METROPOLITAN REGION DEVELOPMENT AUTHORITY

STRABAG

JV of STRABAG Infrastructure & Safety Solutions GmbH and STRABAG AG

Mumbai Trans Harbour Link Project, Package-4

Design, Supply, Installation, Testing and Commissioning of Intelligent Transport System (ITS), Toll Management System, Electrical works, Highway and Bridge streetlighting system, Construction of Toll Plazas and Administrative Buildings including Command Control Centre

Bid Documents

IFB No.: MMRDA/ENG1/0002561

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Technical Proposal

Mobilization Schedule

Catalogue and Drawing

TMS & ATMS Datasheets

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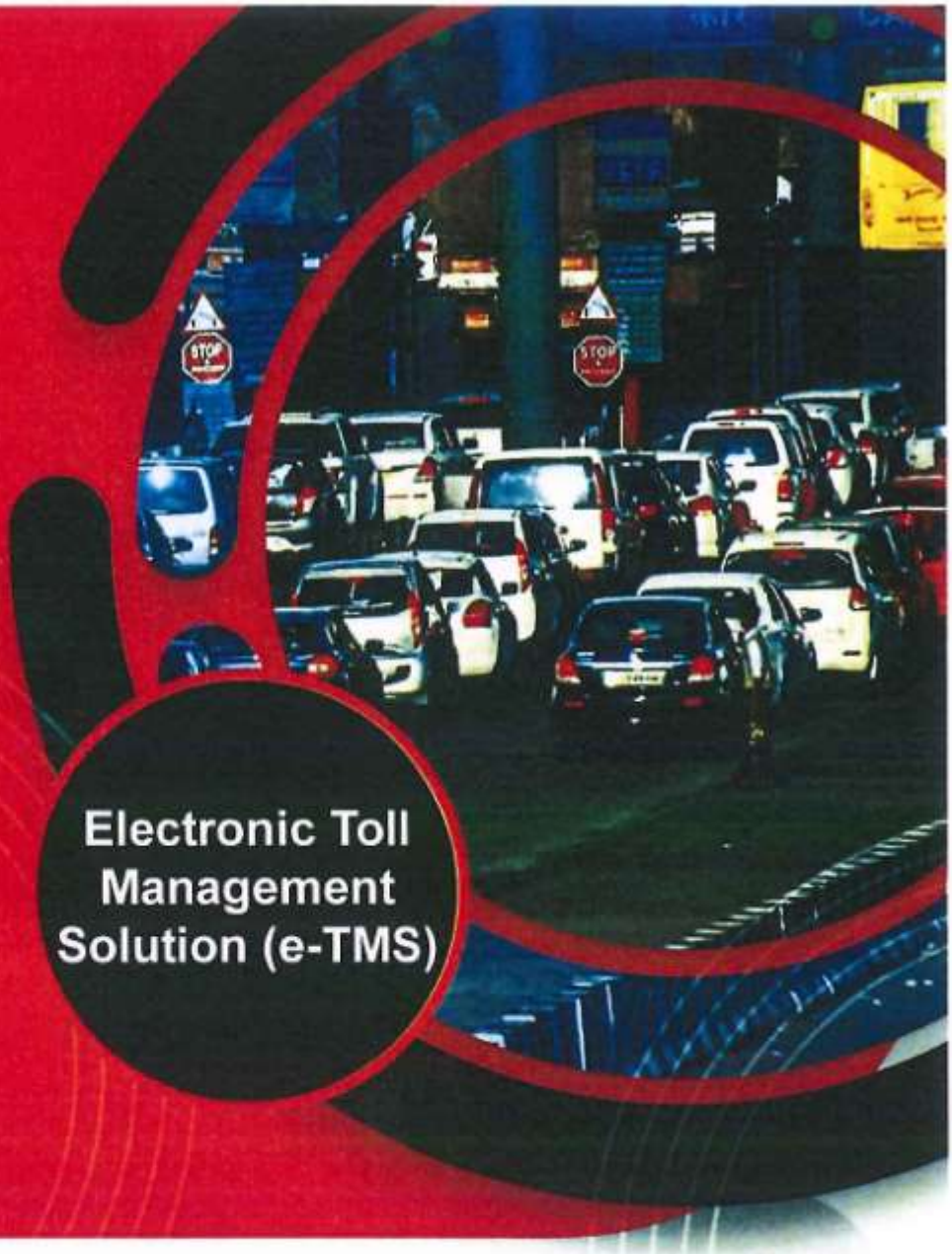

Electronic Toll Management Solution (e-TMS)

An Electronic Toll Management Solution (e-TMS) is a wireless system that automatically collects the toll charge or usage fee for vehicles using toll roads, bridges, tunnels, and HOV lanes. It is a faster alternative that has replaced toll booths, where the driver used to pay manually via cash.

The system is equipped with an automated radio transponder device that detects the vehicle that passes an embedded toll license plate reader device and generates radio signals. Further, it transmits back the identified registered number of the vehicle and charges toll charge from the user via electronic payment mode.

EFKON India's **e-TMS** helps in all electronic toll collection in free-flow traffic or automated payments at conventional toll plazas, high-occupancy vehicles (HOV) lanes, toll bridges, tunnels, etc. We design, implement, and maintain an optimal solution to meet our clients' tolling needs.

Our in-house toll management solutions help in smooth toll collection via smart cards, RFID technology (FASTag), and manually. We provide leakage and tampered proof electronic toll collection with theft identification. It also comes with an Automatic Vehicle Classifier (AVC) of 99% high accuracy, queue length monitoring system, and User Fair Display (UFD) for toll lanes.

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Key features

- AVC enabled with 99% accuracy
- Hybrid ETC lanes both manual and Touch n Go
- Queue length monitoring system with transaction mapping
- Supports multiple transaction types including FASTag
- User Fair Display (UFD) for toll lanes
- In-house built solutions with theft detection

Advantage of using EFKON's AVC

- Generates revenue without leakages
- Better traffic management and control
- Cashless and tampered-proof electronic toll collection
- Smooth toll collection with low transaction costs
- Reduced congestion at interchange junctions
- Well-equipped toll plazas at every interchange
- A hassle-free and seamless experience for users

Why EFKON?

- 19 years of domain expertise and seasoned cross-functional teams
- Strong presence in the growth markets (highways and smart cities)
- End-to-end traffic management system products
- Track record of award-winning successful project executions

Hyderabad Outer Ring Road (ORR) - Case Study

Implemented Toll Management Solutions (TMS) for the Outer Ring Road (ORR), Hyderabad, India which led to improved traffic flow and decongestion on the existing significant arterials between the outer suburbs of Greater Hyderabad. EFKON India installed the Toll Management Systems (TMS) at 19 interchanges of the ORR with 157 Manual and Touch 'n Go lanes and 23 Electronic Toll Collection (ETC) lanes to maintain mainline traffic flow and smooth toll collection.

Our key clients include

NHAI · TATA (TATA Group) · DND FLYWAY · hmda (HYDERABAD ORR) · JAYPEE Group · PGGPL · HMCL · GVK · SVBTC · ESSEL Infra

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EFKON – A Global Leader in Intelligent Traffic Management Systems

EFKON India is a pioneer in bringing innovative products for Intelligent Traffic Management ... 2001. It is a wholly-owned subsidiary of STRABAG, a leading infrastructure company with revenue of € 15.57 Billion (2019). EFKON ... end-to-end solutions for

- Advanced Traffic Management System for Smart Highways and Smart Cities
- Intelligent Revenue Collection and Assurance Systems for Smart Highways and Smart Cities
- Intelligent Transport Management Systems for Logistics and Fleet Operations

For more information, please visit www.efkonindia.com

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The number of vehicles on highways is ever increasing and managing them has become a significant concern. It is of the prime importance of road authorities to provide real-time and precise information to road users about the road and traffic conditions, toll management, incidents, and weather updates. This will ensure a smooth, safe, and efficient traffic movement on highways.

A **Highway Traffic Management System (HTMS)** helps to intelligently integrate multiple technologies to improve highway tolling needs, safe and secure flow of vehicle traffic, and continuous updates on untoward situations and weather conditions.

EFKON's advanced HTMS solutions provide an effective and secure road management system for collecting and delivering data concerning road status, toll management, accidents, congestions as well as environmental information like weather updates, road temperature, or wind speed. We offer products that are based on our own-developed technologies and solutions portfolio for electronic enforcement, toll collection, and traffic telematics.

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Our HTMS product portfolio includes

Toll Management Systems (TMS) helps in all electronic toll collection in free-flow traffic or automated payments at conventional toll plazas, high-occupancy vehicles (HOV) lanes, toll bridges, tunnels, etc. We design, implement and maintain an optimal solution to meet our clients' tolling needs with support of Smart cards and FASTag.

Automatic Number Plate Recognition (ANPR) system is based on artificial intelligence, providing a robust and ready-to-integrate system, capturing diverse types of license plates. Its usage ranges from monitoring traffic activities such as speed enforcement, detection of theft, hot listed/wanted/stolen vehicles, electronic toll collection to various other traffic enforcement applications.

Electronic Enforcement Systems (EES) suite incorporates traffic surveillance and enforcement products that provide valuable insights to stakeholders, contribute to improving safety and security on highways, thereby saving lives and property and enhancing the ease of commute. Its key components are:

Speed Violation Detection (SVD) system is a robust and ready-to-integrate system for identifying vehicles not adhering to the permissible speed limits on the highways. Easy integration with e-challan systems enables automated processing of violations without the need for manual intervention. Our EES can also detect commuters who are riding two-wheelers without helmets. Violations like triple-and quadruple riding are also offenses which can be identified by our systems and make the violator liable for penalty and fine.

Video Incident Detection System (VIDS) helps to ensure safety on highways and generate e-Challans for violators on roads. Some of the violation the system can detect includes no-helmet riding, triple riding, reverse movement, blocking left free lane, stopped vehicle, etc. It can also detect weather conditions like smoke, fire, etc.

Automated Vehicle Classifier (AVC) a profiler-based system that ensures accurate vehicle detection and classification offering outstanding performance. Our solution helps in accurately identifying and classifying vehicles to collect the appropriate toll amount.

Additionally, our HTMS also includes solutions for Emergency Call Box, integration with Command and Control Centre, Video Message Systems, and Environmental Systems.

Advantage of using EFKON's HTMS

- Efficient toll management
- Accurate vehicle detection and classification
- Improved highway road safety
- Accident detection and incident management
- Speed detection and control
- Improved flow of vehicle traffic

Why EFKON?

- 19 years of domain expertise and seasoned cross-functional teams
- Strong presence in the growth markets (highways and smart cities)
- End-to-end traffic management system products
- Track record of award-winning successful project executions

Our key clients include

Yamuna Expressway · Greater Noida Expressway · NHAI · Hyderabad ORR

EFKON – A Global Leader in Intelligent Traffic Management Systems

EFKON India is a pioneer in bringing innovative products for Intelligent Traffic Management [illegible] 01. It is a wholly owned subsidiary of STRABAG, a leading infrastructure company with revenue of € 15.97 Billion (2019). EFKON [illegible] end-to-end solutions for

- Advanced Traffic Management System for Smart Highways and Smart Cities
- Intelligent Revenue Collection and Assurance Systems for Smart Highways and Smart [illegible]
- Intelligent Transport Management Systems for Logistics and Fleet Operations

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Technology has been advancing for ages, and there is development in almost every domain. There is, however, one commonly seen pain point that everyone goes through every day, the traffic. In present-day times, the number of vehicles has increased drastically. However, in contrast, the capabilities of roads and transportation ecosystems remain underdeveloped and, as a result, causing traffic congestions and jams, road accidents, increase in pollution levels in new age metro cities and towns.

An Intelligent Traffic Management System (ITMS) enables users to be better informed and to make safer, more efficient, coordinated, and smarter use of transport networks. It is defined as an advanced application that aims to provide innovative solutions related to different modes of transportation and traffic management.

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EFKON's **innovative and intelligent traffic management systems** make road management significantly less manual, reduce human-interventions, and more accurate. Our significant know-how on all traffic and transport technologies for building smarter, safer, and more efficient solutions has helped us deliver outstanding business value for our clients on service, security, reliability, and accuracy parameters. EFKON's ITMS creates a perfect platform for addressing traffic-related issues faced by traffic management authorities, in terms of predicting an optimum route, reducing average waiting time, traffic congestion, travel cost, and the extent of air pollution. The system aims at using artificial intelligence algorithms for predicting optimum routes based upon traffic mobilization patterns, vehicle categorization, accident occurrences, and levels of precipitation.

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Our ITMS product portfolio includes

Automatic Number Plate Recognition (ANPR) system is based on artificial intelligence, providing a robust and ready-to-integrate system, capturing diverse types of license plates. It's usage ranges from monitoring traffic activities such as red-light adherence and speed enforcement, detection of theft, hot listed/wanted/stolen vehicles, electronic toll collection to various other traffic enforcement applications

Electronic Enforcement Systems (EES) suite incorporates traffic surveillance and enforcement products that provide valuable insights to stakeholders, contribute to improving safety and security on roads, thereby saving lives and property and enhancing ease of commute. Its key components are:

Red Light Violation Detection (RLVD) system is a fully automated electronic monitoring system identifying vehicles jumping the red light, stopping after the stop line, and over the zebra-crossing. This system is easy to integrate with e-Challan solutions.

Speed Violation Detection (SVD) system is a robust and ready-to-integrate system for identifying vehicles not adhering to the permissible speed limits on the roads.

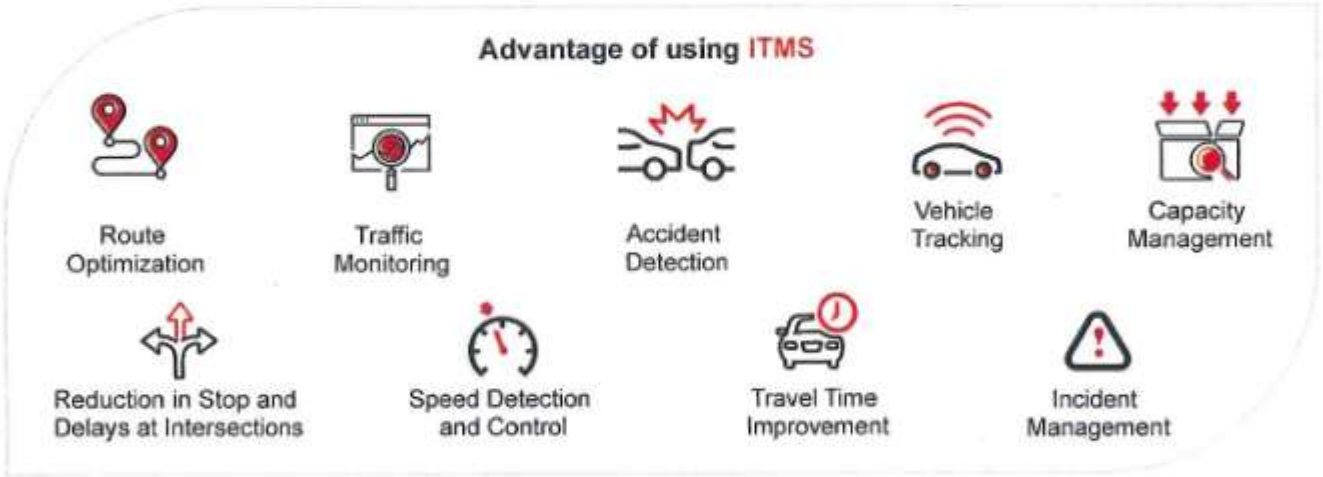
Easy integration with e-challan systems enables automated processing of violations without the need for manual intervention. Our EES can also detect commuters who are riding two-wheelers without helmets. Violations like triple-and quadruple riding are also offenses which can be identified by our systems and make the violator liable for penalty and fine.

Adaptive Traffic Control System (ATCS) enables traffic signals to work in adaptive (fully synchronized), vehicle actuated (local optimization), and fixed timing modes to maximize vehicular throughput and reduce congestion.

Other systems such as Emergency Call Box (ECB) and Public Address Systems (PAS), City ERP, Video Management Systems (VMS), etc. complement the core solutions outlined above to provide a comprehensive and robust ITMS solution

Video Incident Detection System (VIDS) helps to ensure safety on highways and generate e-Challans for violators on roads. Some of the violation the system can detect includes no-helmet riding, triple riding, reverse movement, blocking left free lane, stopped vehicle, etc.

Advantage of using ITMS



Why EFKON?

- 18 years of domain expertise and seasoned cross-functional teams
- Strong presence in the growth markets (highways and smart cities)
- End-to-end traffic management system products
- Track record of award-winning successful project executions

Our key clients include

EFKON – A Global Leader in Intelligent Traffic Management Systems

EFKON India is a pioneer in bringing innovative products for Intelligent Traffic Management [illegible] 21. It is a wholly-owned subsidiary of STRABAG, a leading infrastructure company with revenue of € 15.67 Billion (2019). EFKON [illegible] to-end solutions for

- Advanced Traffic Management System for Smart Highways and Smart Cities
- Intelligent Revenue Collection and Assurance Systems for Smart Highways and Smart [illegible]
- Intelligent Transport Management Systems for Logistics and Fleet Operators

For more information, please visit www.efkonindia.com

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EFKON INDIA

EMERGENCY CALLING BOX (ETH1100)

EFKON - A Global Leader in Intelligent Traffic Management Systems

Efkon GmbH is a fully owned subsidiary of Strabag SE , A leading infrastructure company with € 13.5 bn Turnover . Efkon GmbH is a global leader in providing end to-end solutions for :

- Advanced traffic management system – for Smart Highway and Smart Cities .
- Intelligent Revenue collection and Assurance system – for Smart Highway and Smart Cities .
- Intelligent Transport Management system – for Logistics Management & Fleet operation.

Efkon India is pioneer to bring innovative solutions for ITS Industry in Indian market since 2001. Efkon India has 700+ Engineers working in R&D, Project execution, operation management for Government as well as Private customers.

EFKON'S EMERGENCY CALL BOX SYSTEM PROVIDES A DEDICATED, RELIABLE AND SAFE COMMUNICATION LINK BETWEEN THE USER AND THE OPERATOR AT THE CONTROL ROOM, MAKING IT RELIABLE FOR EMERGENCY SITUATIONS. ECB BEING ONE OF THE MAJOR COMPONENTS OF HIGHWAY MANAGEMENT SYSTEM IT PROVIDES REAL TIME HELP TO ROAD USERS UPON ANY EMERGENCY.

CUSTOMER BENEFITS

- Two way communication with Control room
- Negligible running cost
- Robust design
- Stainless steel cover
- Easy installation
- Low maintenance cost
- Call button with visual indicators
- Ethernet Connectivity via Fiber
- Single button suitable for Emergency Calling

KEY FEATURES

- Audibility in noisy environments
- Background noise filter
- Weather resistant
- Battery backup of 72 ++ hours – Fully solar operated, no requirement of raw power
- Audio and LED indication for call connected, calling, call not completed
- Call-recording facility
- Optical signal regeneration at every ECB
- Automatic call-forwarding to predefined mobile numbers
- Special fibre bypass switch for fail safe – reduced dependency on the series connection of ECB

PROCESS FLOW

The control centre is provided with ECB central unit and ECB workstation along with telephone set. Any call made from an ECB is received in a centralized manner at the ECB workstation in the Traffic Control Centre (TCC). All conversions between the calling ECB and TCC operator are recorded and can be played back providing an exhaustive report generation facility.

TECHNICAL SPECIFICATIONS

Description	Item	Specification
	Protection class	IP65
	Environmental conditions	0 - +50 °C
	Reliability and maintainability	MTBF: 50,000 hours , MTTR: 0.5 hours
	Power requirements	12 V ±10% DC
	Power consumption	12 W
General	ECB battery	Latest Li-Ion type battery
	Operation type	Hands free
	Noise level	Audible operation with 95 db noise level
	Call indicator	Led indicator
	Type	Water resistant
Speaker	Max power	15W
Microphone	Type	Dynamic microphone
Network	Protocol	TCP/IP, UDP/IP, SNMP

004276

EFKON INDIA

ECB MANAGEMENT SOFTWARE (ETH1100)

EFKON - A Global Leader in Intelligent Traffic Management Systems

Efkon AG is a fully owned subsidiary of STRABAG SE, a leading infrastructure company with € 12 bn turnover. Efkon AG is a global leader in providing end-to-end solutions for:

- Intelligent Revenue Collection & Assurance System – for Smart Highways
- Advanced Traffic Management System – for Smart Highways & Smart Cities
- Intelligent Lighting System – for Smart Highways & Smart Cities
- Intelligent Transport Management System – for On Road & Off Road Applications

EFKON India has been providing Intelligent Transportation Solution to Indian market since 2001 and has 500+ engineers working in Research & Development, Execution of Operations & Maintenance of leading Government & Private Institutes in India.

EFKON'S EMERGENCY CALL BOX BACK END SOFTWARE PROVIDES A DEDICATED, RELIABLE AND SAFE COMMUNICATION LINK BETWEEN CONTROL ROOM OPERATOR & FIELD ECB, MAKING IT RELIABLE FOR EMERGENCY SITUATIONS. ECB BEING ONE OF THE MAJOR COMPONENTS OF SMART CITY & HIGHWAY MANAGEMENT SYSTEM IT PROVIDES REAL TIME HELP TO ROAD USERS IN EMERGENCY.

CUSTOMER BENEFITS

- Hands-free emergency call management service.
- All emergency call boxes are connected to a central server.
- VOIP system to attend the calls.
- Direct routing to Emergency Services
- All emergency call boxes are plotted on map for quick access.

KEY FEATURES

- Call Recording of all Calls.
- Easy to use GUI.
- live site map help in pinpointing exact location and problem.
- Optical signal regeneration at every ECB.
- Automatic call-forwarding to predefined mobile numbers.
- Quick retrieval and playback of recorded conversations.
- Quick monitoring of field ECB devices.

The control centre is provided with ECB central unit and ECB workstation along with telephone set. Any call made from an ECB is received in a centralized manner at the ECB workstation in the Control Centre. All conversation between the calling ECB and control room operator is recorded and can be played back as and when required.

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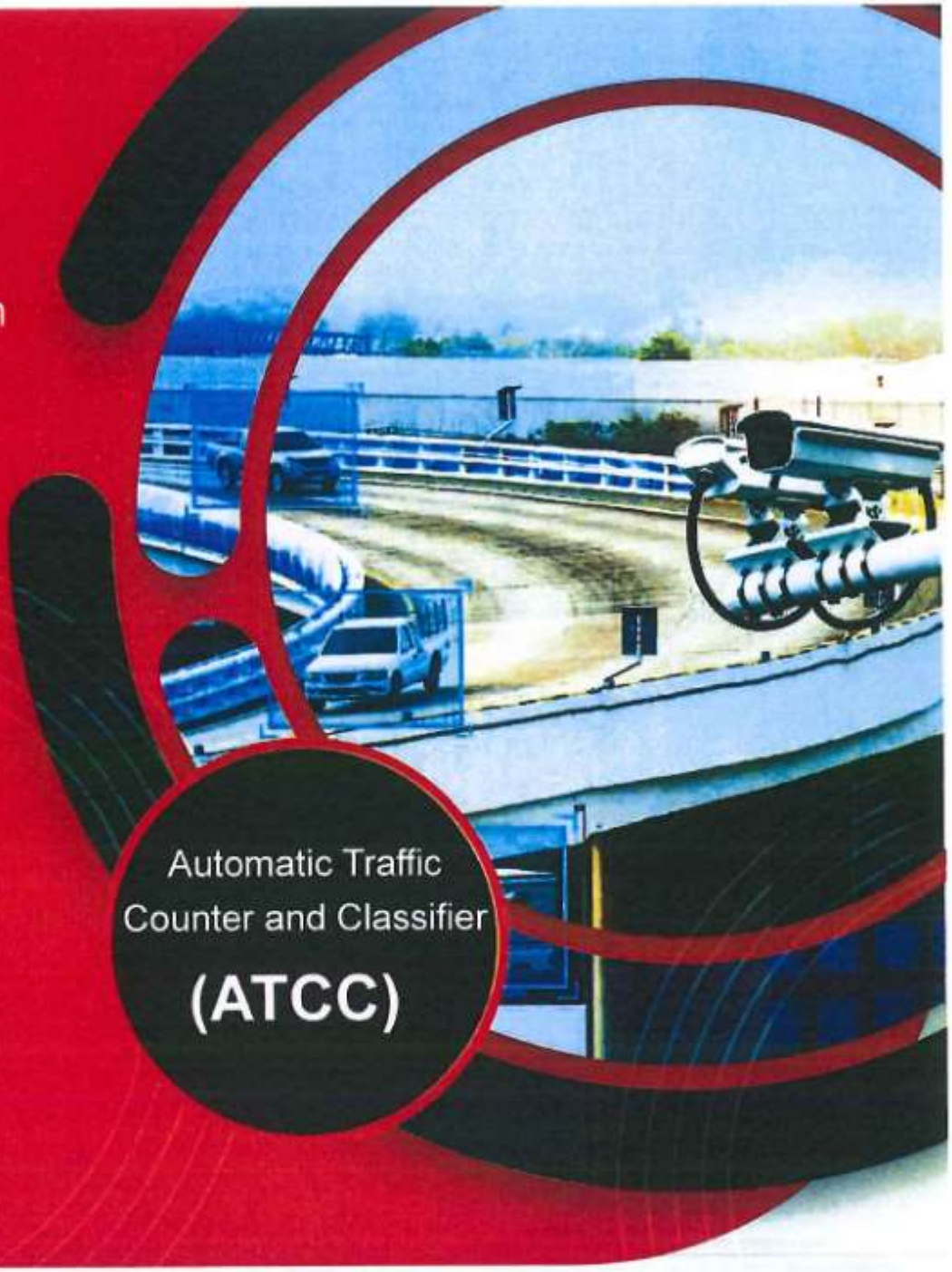
EFKON



Automatic Traffic Counter and Classifier (ATCC)

Collecting real-time, reliable, and precise vehicle flow information is crucial for instant management of traffic on roads. To maximize the capacity of city roads as well as highways, continuous vehicle monitoring, counting, and classification efforts need to be carried out to understand seasonal, day-of-the-week, and time-of-the-day traffic volume patterns. Automatic Traffic Counter and Classifier (ATCC) monitors the real-time traffic flow of a road section, keeps count of vehicles, and classify them according to their pre-defined classes.

Overview

EFKON's Video-based Automatic Traffic Counter and Classifier (ATCC) is a standalone ATCC system based on neural network/map matching technique. It gathers real-time traffic data, including vehicle count, classification, traffic volume, average traffic speed, time headway, direction of travel and occupancy. Our system can count and classify vehicles up to five classes:

- **Motorcycles/two-wheelers**
- **Trucks/buses**
- **Light Motor Vehicle (LMV)**
- **Light Commercial Vehicle (LCV)**
- **Others (MAVs, OSVs, machine equipment vehicles, etc.**

Contact Us

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frontdesk@efkonindia.com

www.efkonindia.com

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How the ATCC system works?

Below is the process flow of EFKON's ATCC system:

Vehicle Detection → Vehicle Separation → Template Matching → Confidence Factor → Vehicle Class Determination

Key Features

- Free flow traffic count and classification, operates 24X7
- Cover up to four lanes of traffic
- Neural Network based classification
- Fully customized reporting system to meet unique business requirements
- Applications across traffic signal design, toll enforcement/free-flow tolling, infrastructure planning, violation detection (vehicle coming from the opposite direction)
- Can detect
  - Parallel vehicles
  - Bi-directional vehicle detection either from left or right side
- Low false classification rate

Advantage of using EFKON's ATCC

- High accuracy level of 95% (traffic count, vehicle classification)
- A complete IP video-based solution: mobile and non-intrusive solution
- Real-time video analysis
- Highly cost-effective solution
- Easy validation of traffic data
- Easy integration with third party software

Why EFKON?

- 18 years of domain expertise and seasoned cross-functional teams
- Strong presence in the growth markets (highways and smart cities)
- End-to-end traffic management system products
- Track record of award-winning successful project executions

Our key clients include

Yamuna Expressway · Greater Noida Expressway · Hyderabad ORR · Varanasi Smart City Limited

EFKON – A Global Leader in Intelligent Traffic Management Systems

EFKON India is a pioneer in bringing innovative products for Intelligent Traffic Management and ... It is a wholly owned subsidiary of STRABAG, a leading infrastructure company with revenue of € 15.67 Billion (2019). EFKON ... end-to-end solutions for

- Advanced Traffic Management System for Smart Highways and Smart Cities
- Intelligent Revenue Collection and Assurance Systems for Smart Highways and Smart ...
- Intelligent Transport Management Systems for Logistics and Fleet Operations

For more information, please visit www.efkonindia.com

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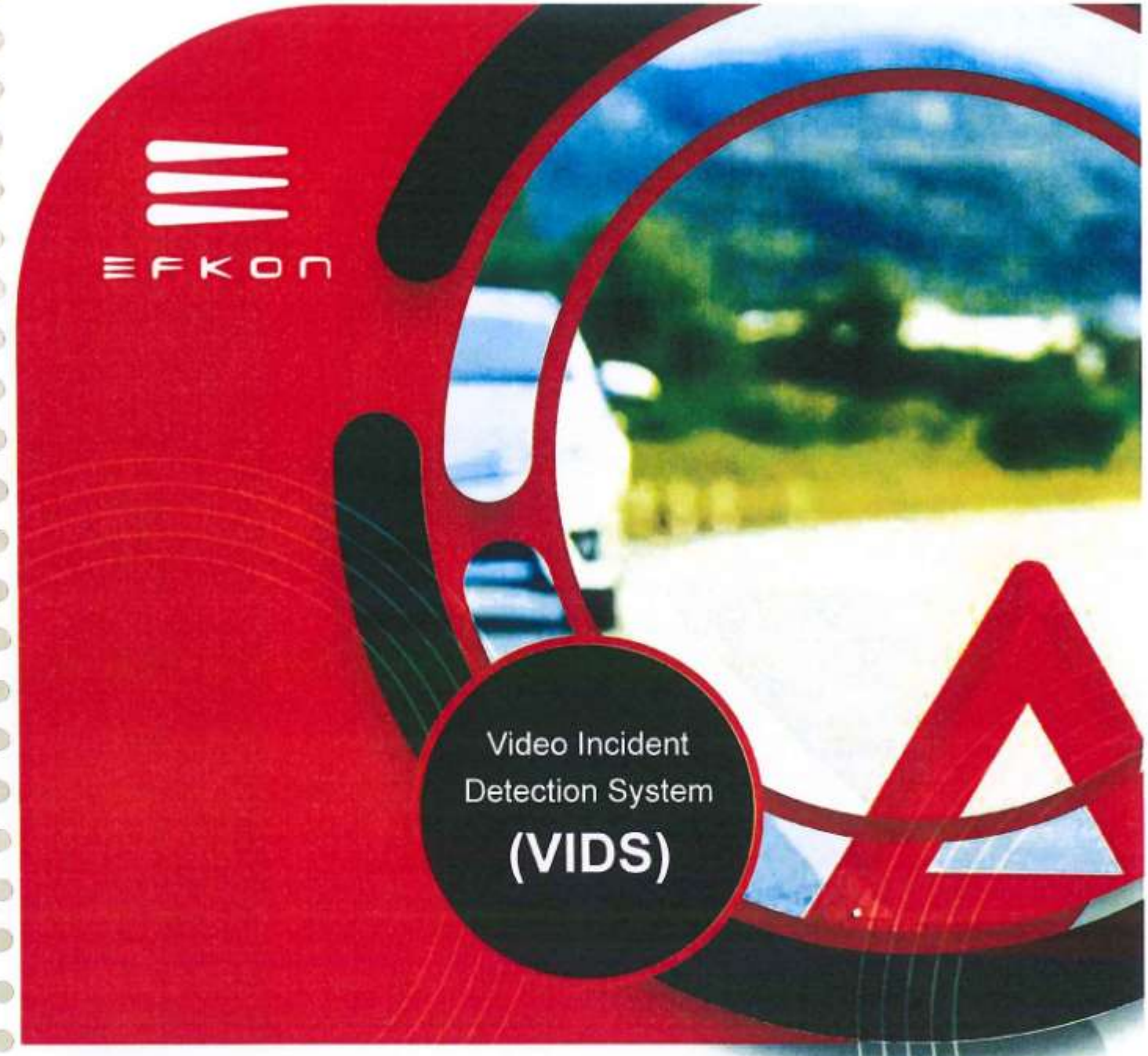

An efficient traffic management system depends on how fast incidents are detected, verified, and resolved. Video analysis is a well-established technology for traffic incident monitoring. Through real-time analysis of camera images, a wide variety of incidents can be detected and lives can be saved. Video Incident Detection Systems (VIDS) consists of a network of cameras that automatically detect events and ensure appropriate responses.

Overview

EFKON's Video Incident Detection System (VIDS) provides accurate and reliable vehicle tracking and automatic incident detection for highways and expressways. The system helps providing safety on highways and generate e-Challans for violators on roads. To make our roads safer and ensuring a smooth traffic flow, our VIDS can detect

- Stalled/stopped vehicles
- Vehicles coming from the opposite direction,
- Pedestrian crossing,
- Over speeding and under speeding
- Crowd gathering
- Weather status like normal conditions, smoke or fog
- Acceleration/deacceleration
- Traffic status like congestion, dense, delay, stop and go, normal, etc.
- No helmets and triple riding

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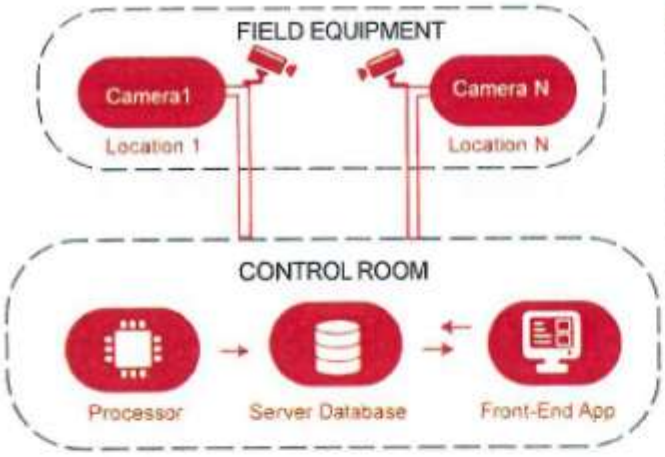

How the VIDS system works?

The VIDS cameras mounted on highway structures monitors the respective stretch. Dedicated algorithms monitoring the video signals turn the traffic data into actionable business intelligence. This traffic data is transmitted continuously to the technical control room, unusual activity detected by the system is validated and confirmed, to take required action depending upon the incident type.

Key Features

- Monitor traffic density and alert road users
- Automatic detection of traffic flow, congestion, and density
- Easy integration with systems for automatic challan generation (for most violations)
- Alert concerned authorities (police, ambulance, road clearing services, etc.) for immediate actions
- Maximum number of lanes covered – 4

Advantage of using EFKON's VIDS system

High accuracy of violation detection ~ 95%

Low installation cost, hence, highly cost-effective

Efficient and reliable

24X7 real-time intelligent monitoring of road

Faster response time to accidents thereby reducing fatalities

Why EFKON?

- 18 years of domain expertise and seasoned cross-functional teams
- Strong presence in the growth markets (highways and smart cities)
- End-to-end traffic management system products
- Track record of award-winning successful project executions

Our key clients include

Yamuna Expressway · Greater Noida Expressway · Hyderabad ORR · Pune Solapur Expressway · Aligarh Smart City Limited · Tumakuru Smart City Limited · Varanasi Smart City Limited

EFKON – A Global Leader in Intelligent Traffic Management Systems

EFKON India is a pioneer in bringing innovative products for Intelligent Traffic Management [illegible] 2001. It is a wholly owned subsidiary of STRABAG, a leading infrastructure company with revenue of € 15.67 Billion (2019). EFKON [illegible] end-to-end solutions for:

- Advanced Traffic Management System for Smart Highways and Smart Cities
- Intelligent Revenue Collection and Assurance Systems for Smart Highways and Smart [illegible]
- Intelligent Transport Management Systems for Logistics and Fleet Operations

For more information, please visit www.efkonindia.com

STRABAG Infrastructure & Safety Solutions GmbH

EFKON

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EFKON INDIA

VIDEO MANAGEMENT SYSTEM (Ver.1)

EFKON - A Global Leader in Intelligent Traffic Management Systems

Efkon GmbH is a fully owned subsidiary of Strabag SE, A leading infrastructure company with € 13.5 bn Turnover. Efkon GmbH is a global leader in providing end to-end solutions for:

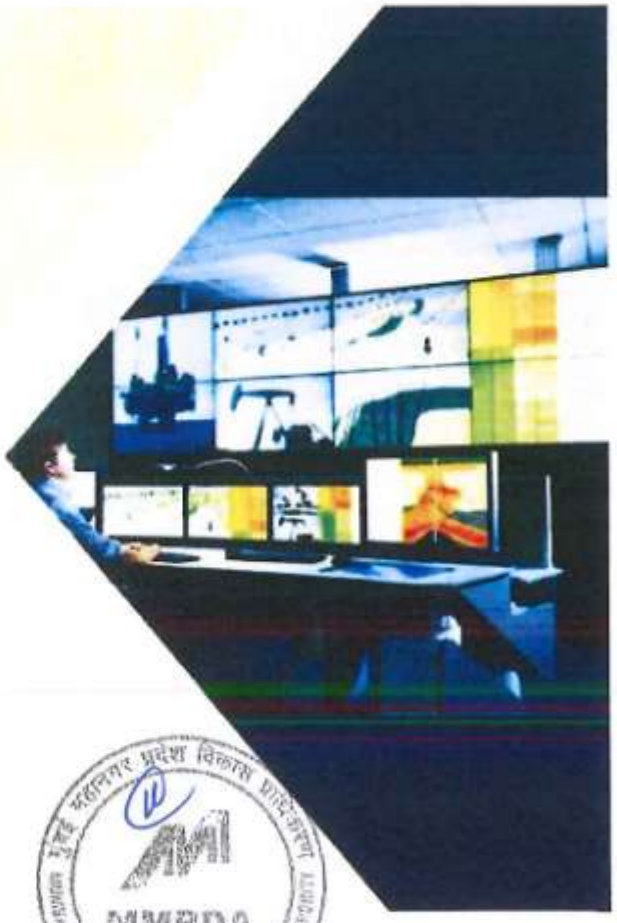
- Advanced traffic management system – for Smart Highway and Smart Cities.
- Intelligent Revenue collection and Assurance system – for Smart Highway and Smart Cities.
- Intelligent Transport Management system – for Logistics Management & Fleet operation.

Efkon India is pioneer to bring innovative solutions for ITS Industry in Indian market since 2001. Efkon India has 700+ Engineers working in R&D, Project execution, operation management for Government as well as Private customers.

EFKON 'S VIDEO MANAGEMENT SYSTEM PROVIDES A WAY TO VIEW ALL CITY LIVE STATUS WITH VER.1 VIDEO MANAGEMENT SOLUTION. HIGHLY SCALABLE VIDEO MANAGEMENT SOFTWARE WHICH IS SUITABLE TO SUPPORT AND MONITOR LARGE NUMBER OF CAMERAS AND IT IS IDEAL SOLUTION FOR LARGE SCALE MONITORING AND RECORDING.

CUSTOMER BENEFITS

- Multiple users can securely and simultaneously access live or recorded video with proper login credentials.
- Flexible rule-based system.
- Powerful Video Management
- Software with central management for Smart Cities.
- Recording of video with high performance.
- Supports PTZ operation, recording playback option.
- Grid based system to view multiple cameras at once.



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KEY FEATURES

- Intelligent PTZ and multi-view
- Advanced Intelligent Video Surveillance
- Playback, Search, Export and Secure Data.
- Supports live Video Streams
- Supports Central Management of Cameras, Servers and Clients
- Backup / Export Video Encryption
- Support clustered server environment & supports inbuilt mechanism for high availability and failover
- System provides remote users with rich functionality as below:
  - Monitoring of live video from cameras on the surveillance system
  - Browsing recordings from storage systems
  - Creating and switching between multiple of display.
  - Monitoring of video from selected cameras in greater magnification and/ or higher quality
  - Getting quick overview of sequences with detected motion
  - Quick overviews of detected alerts or events
  - Quick search on selected areas of video recording for motion
- Advanced encryption/ authentication.
- Supports transcode and multiple stream profiles: flexible video compression, display, storage and retrieval.
- System supports rule initiated actions such as:
  - Start and Stop recording
  - Set non-default live frame rate
  - Send notifications via email
  - Pop-up video on designated client monitor
- Supports multiple brands of IP cameras & ONVIF profile

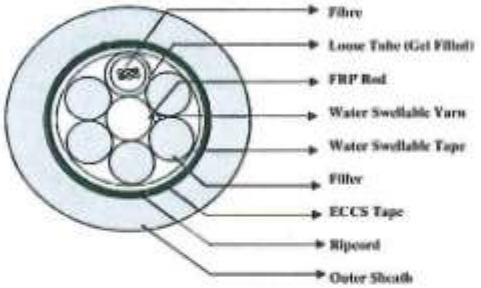
TECHNICAL SPECIFICATIONS

- Capable of displaying videos in 3 monitors simultaneously.
  - AVI Files
  - M-JPEG
  - MPEG-4
  - MP4 export
- Supports H.265, H.264, MPEG-4, M-JPEG Compression Format
- Supports below operations
  - Adding / Updating an IP device
  - Updating basic device parameters
  - Adding/ removing channels and output signals
  - Updating / Removing an IP channel
  - Enabling/ disabling an IP channel
  - Refreshing an IP device (in case of firmware upgrade)
  - Multicast at multiple aggregation points
- Supports different logs
  - System Log
  - Audit Log
  - Alert Log
  - Event Log

004284

HFCL Limited
(Formerly Himachal Futuristic Communications Ltd)

01/06F SM Multitube Armoured OFC



Cable Construction Details		
Parameter	**Dimension**	**Type, Color**
Number of Fiber per tube	4/6	Color Bl Or G Br W Wh
Number of Loose Tubes	1	Color Bl
Loose Tube ID/OD	1.4/2.0 ± 0.1 mm	PBT
Central Strength Member	2.1 ± 0.1 mm	FRP Rod
Number of Fillers	3	HDPE - Black
Moisture barrier	-	Water Swellable Yarn
Core Wrapping	-	Water Swellable Tape
Armouring	-	ECCS Tape
Outer Sheath	1.5 mm (Nominal)	HDPE – Black
Number of Ripcords	2	Polyester
Overall Cable Diameter	11.0 ± 0.5 mm	
Cable Weight	115.0 ± 10 kg/km	

Optical Fibre Characteristics		
Fibre Type		G.652D (OS2)
Attenuation (cable)	at 1310 nm	≤ 0.36 dB/km
	at 1550 nm	≤ 0.25 dB/km
Chromatic Dispersion	1285 - 1330 nm	≤ 3.5 ps/nm.km
	1550 nm	≤ 18 ps/nm.km
Zero Dispersion Wavelength		1300 - 1322 nm
Zero Dispersion Slope		≤ 0.092 ps/nm2.km
Polarization Mode Dispersion		≤ 0.2 ps/√km
Cut-off Wavelength	λ_{cc}	≤ 1260 nm
Mode Field Diameter	at 1310 nm	9.2 ± 0.4 µm
	at 1550 nm	10.4 ± 0.5 µm
Core Cladding Concentricity Error		≤ 0.6 µm
Cladding Diameter		125 ± 1.0 µm
Cladding Non-circularity		≤ 1.0 %
Coating Diameter	(Uncolored)	245 ± 10 µm

Cable Mechanical Characteristics	
Tensile Strength	1500 N
Crush Resistance	2000 N
Impact	15 N.m
Torsion	± 180 °
Minimum Bend Radius	Under Tension : 20 x D
	Under No Tension : 10 x D

Packing	Wooden Drums
Drum Length	1000 m

Temperature Performance	
Installation	- 20 °C to + 70 °C
Operation	- 20 °C to + 70 °C
Storage	- 20 °C to + 70 °C

Printing Details	*As per customer requirement*

Document No.:HFCL/EFK/L/081221/001 Rev.: 00
Dated: 08.12.21

www.hfcl.com

STRABAG Infrastructure & Safety Solutions GmbH

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004285

Certificate of Compliance

CE

We hereby declare that the technical file of product complied with the requirement of directives Low voltage directive 2006/95/EC & 305/2011/EU of the European parliament and of the council of 9 March 2011 (the construction products regulation of CPR)

Certificate No.: CE-4480

Name : **EFKON INDIA PRIVATE LIMITED**

Address : **14th FLOOR SUPREMUS E WING, 1405 - 1408, I THINK TECHNO CAMPUS, KANJURMARG EAST, KANJURMARG, MUMBAI CITY, MAHARASHTRA - 400042**

Product : **VARIABLE MESSAGE SIGNAGE DISPLAY**

The Certification body has performed an audit of the above products quality system covering the design, manufacture and final inspection of the certified products. The quality system has been assessed, approved and is subject to continuous surveillance according to the directive Low voltage directive 2006/95/EC & 305/2011/EU of the European parliament and of the council of 9 March 2011 (the construction products regulation of CPR)

This certificate is issued under the following conditions:

1. It applies only to the quality system maintained in the manufacture of above referenced models and it does not substitute the design or type-examination procedures, if requested.
2. The certificate remains valid until the manufacturing conditions or the quality systems are changed.
3. The certificate validity is conditioned by positive results or surveillance audits.
4. The CE mark as shown above can be used, after completion of an EC Declaration of conformity and compliance with all relevant EC Directives. The statement is based on a single evaluation of one sample of above-mentioned product.

Validity of this certificate can be verified at www.rbscert.com/verify

Date of initial registration	25th Feb 2021
Date of this certificate	25th Feb 2021
Recertification due	24th Feb 2024

(Subject to the company maintaining its System to the required standard)

Validity of this Certificate is subject to Annual Surveillance audits to be done successfully on or before 365 days from date of this certificate (In case if Surveillance Audit is not allowed to be conducted, this certificate shall be Suspended / Withdrawal). Also Verification of the certificate can be verified at www.rbscert.com

This Certificate of Registration remains the Property of RBS Certification Pvt. Ltd. and shall be returned immediately upon request

Email - info@rbscert.com website - www.rbscert.com

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VERIFIED • TRUST SEAL

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Director

2225

004286

Certificate of Compliance

Certificate No.: UR-4481

In compliance with regulation 305/2011 /EU of the European parliament and of the council of 9 march 2011(the construction products regulation or CPR), this certificate applies to the construction products.

VARIABLE MESSAGE TRAFFIC SIGNAGE DISPLAY

Identified as shown in Annexure 1
By

EFKON INDIA PRIVATE LIMITED

14th FLOOR SUPREMUS E WING, 1405 - 1408, I THINK TECHNO CAMPUS, KANJURMARG EAST, KANJURMARG, MUMBAI CITY, MAHARASHTRA – 400042

This certificate attests that all provisions concerning the assessment and verification of constancy of performance at system as per standard.

EN 12966:2014+A1:2018

Are applied and that

The product fulfil all the prescribed requirements.

This certificate is issued on 25/2/2021 and will remain valid as long as the harmonised standard remains valid or the manufacturing conditions in the plant or the factory production control itself are not modified significantly.

Validity of this certificate can be verified at www.rbscert.com/verify

Validity of this Certificate is subject to Annual Surveillance audits to be done successfully on or before 365 days from date of this certificate (In case if Surveillance Audit is not allowed to be conducted, this certificate shall be Suspended / Withdrawal).
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Director

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004287

Certificate of Compliance | Annexure 1

Annexure to Certificate No:- UR- 4481

PRODUCT TYPE: VMS containing up to a 30(W) x 6(H) matrix (size: 9760 mm x 1120 mm) of fkon-VMS modules.

Product standard: EN 12966-1:2005 + A1:2009

METHOD	LABORATORY TEST		CONFORMITY
EN 60598-1	Impact test		Compliant
EN 60068-2-64	Vibration test		Compliant
EN ISO 9227	Corrosion test		Compliant
EN 60529	Degrees of protection provided by enclosures (IP –class)		P2 (IP54)
EN 60068-2-14	Change of temperature test		T2
EN 60068-2-30	Damp heat cycling test		Compliant
EN 12966-1	Optical performance (luminance)	Luminance	Red, green, blue, yellow and white: L3, L3(*), L3(T)
		Luminance ratio	Red, green, blue, yellow and white: R3
		Beam width	Red, green, blue, yellow and white: B6
		Uniformity	Compliant
	Chromaticity co-ordinates	Colour	Red, green, blue, yellow and white: C2
EN 12899-1	Assessment of calculation report referring to the variable message signs (VMS) frame		PAF1, WL9, DSL0, PL0, TDB2, TDT2

Validity of this Certificate is subject to Annual Surveillance audits to be done successfully on or before 365 days from date of this certificate (In case if Surveillance Audit is not allowed to be conducted: this certificate shall be Suspended / Withdrawn). Also Verification of the certificate can be verified at www.rbscert.com

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Director

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004288

光勝光電 LITE-MAX

LITE-MAX OPTOELECTRONICS Co., LTD.

DATA SHEET

光勝光電科技(惠州)有限公司
LITE-MAX OPTOELECTRONICS Co., LTD.

產 品 承 認 書
APPROVED SHEET

品 名 Product	R05圓形红管
產品型號 Part No	LM-R05ARCD-SX
樣品編號 Sample No	---

隨本承認書提供該產品的設計及技術參數
Provide the product's design and technical character with the file.

核 准 Approved By	審 核 Check By	擬 定 Prepared By
廖志平	--	陈映廷

客戶承認 Customer Approved	核 准 Approved By	工 程 Engineer	品 保 Q.C

2228

光勝光電科技（惠州）有限公司

LITE-MAX OPTOELECTRONICS CO. , LTD.

DATA SHEET

LM-R05ARCD-SX

004290

L·MAX 光勝光電 LITE-MAX

DATA SHEET

LITE-MAX OPTOELECTRONICS Co., LTD.

Part No:

LM-R05ARCD-SX

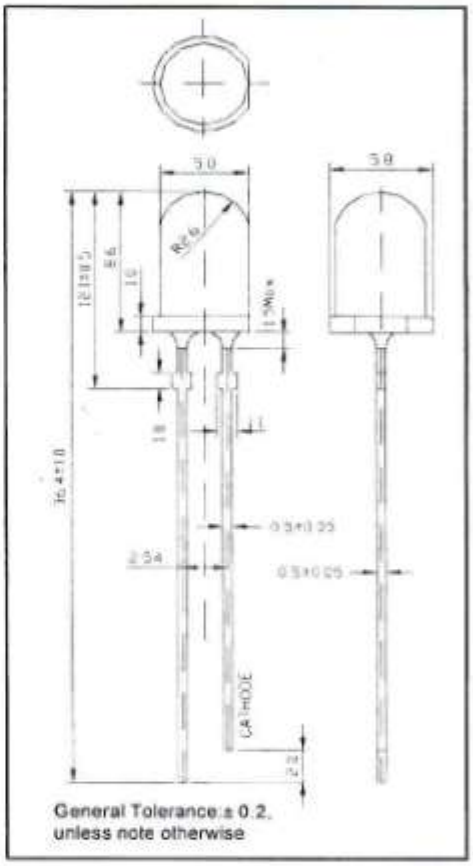
Features

* High intensity LED lamp
* Ø5mm round shape
* UV resistant epoxy

Applications

* LED Screen
* Illumination

Package Dimensions



Unit : mm

Tolerance are±0.2,unless note otherwise

Absolute Maximum Ratings (Ta=25℃)

Parameter	Symbol	Max	Unit
Power Dissipation	P_D	100	mW
Peak Forward Current *	I_{FM}	100	mA
Continuous Forward Current	I_F	20	mA
Reverse Voltage	V_R	5	V
Operating Temperature Range	Topr	-25℃ to +80℃	
Storage Temperature Range	Tstg	-40℃ to +100℃	
Lead Soldering Temperature	Tsol	260	℃

* Duty ratio max 1/10 Pulse Width max. 0.1ms;

△ At the position of 4mm from the bottom of the package within 5 seconds.

Electrical Optical Characteristics (Ta=25℃ , @IF=20mA)

Part No.	Material	Lens	Emitting Color	Forward Voltage (v)		Luminous Intensity (mcd)		Dominant Wavelength(nm)		Viewing Angle (2θ1/2)
				Min	Max	Min	Max	Min	Max	
LM-R05ARCD-SX	AlGaInP	Water Clear			2.6	6000	10400	620	630	23°

2230

BIN Table : (Test at 20mA)

VF (v)	
Color	Range
Red	1.8-2.6
0.2V 分档	

IV (mcd)	
Code	Range
25	6000-7200
26	7200-8600
27	8600-10400

Wd (nm)	
Code	Range
R2	620-625
R3	625-630

Error range :

- Luminous Intensity (IV) ±10%, Forwerd Voltage (VF) ±0.1, Wavelength (Wd) ±1nm

Caution in ESD :

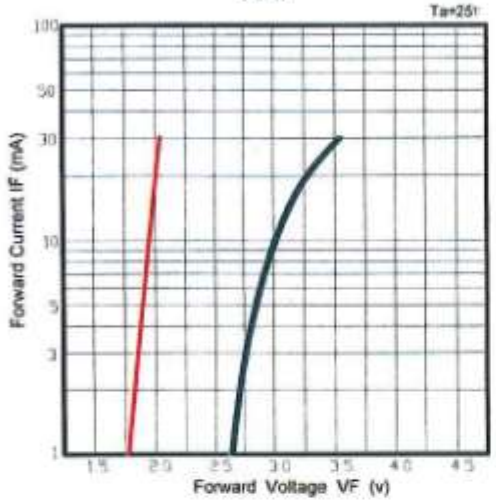
1. Static Electricity and surge damages the LEDs. It is recommended to use a wrist band or anti-electrostatic glove when handling the LEDs. All devices · Equipment and machinery must be properly grounded.
2. When inspecting own final products on which LEDs were mounted, It is easy to find static-damaged LEDs by light emission test at lower current (below 1mA is recommended) .
3. Damaged LEDs will show some unusual characteristics such as leak current remarkably increases, starting forward voltage becomes lower, or the LEDs get unlighted at the low current.

LITE-MAX 光勝光電

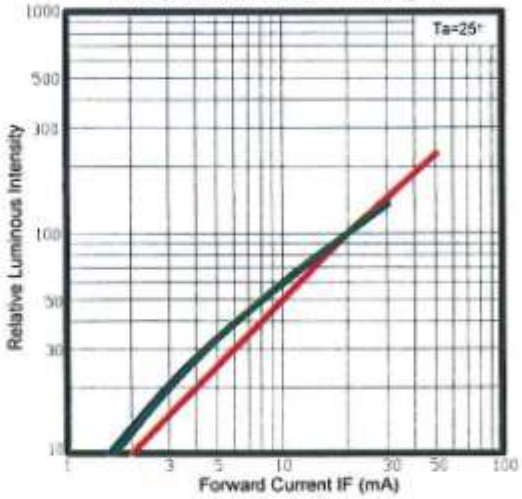
DATA SHEET

LITE-MAX OPTOELECTRONICS Co., LTD.

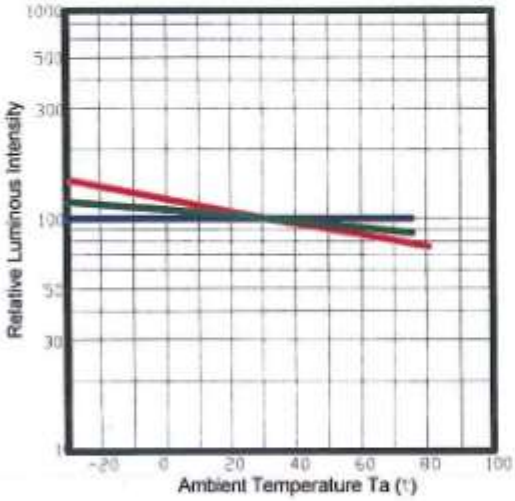
VF-IF



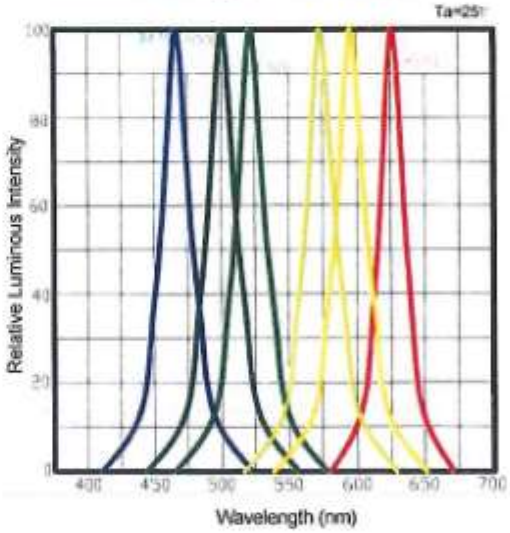
Relative Luminous Intensity-Ta



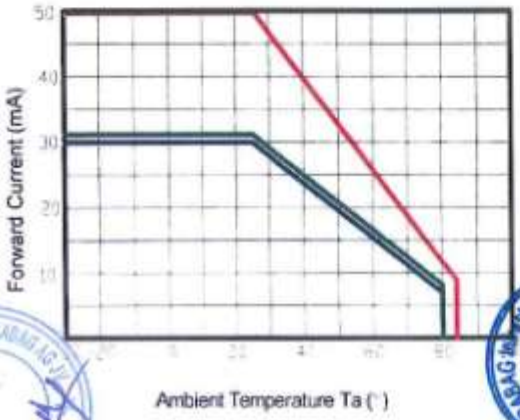
Relative Luminous Intensity-Ta



Wavelength Characteristics



IF-Ta



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LITE-MAX 光勝光電 LITE-MAX

DATA SHEET

LITE-MAX OPTOELECTRONICS Co., LTD.

Reliability Test

Classification	Test Item	Test Conditions	Sample Size	Num of Damaged	Reference Standard
Endurance Test	Operating Life	I_F=30mA 1000Hrs	22	0	MIL-STD-750:1026 MIL-STD-202:107D JIS C 7021:B-4
	High Temp. High Humidity Storage	60±5℃ 90%±5 RH 500Hrs	100	0	MIL-STD-202:103D JIS C 7021:B-11
	Hi-Temp. Storage	100±5℃ 1000Hrs	100	0	MIL-STD-750:2031 MIL-STD-202:210A JIS C 7021:B-10
	Low-Temp. Storage	-30±5℃ 1000Hrs	100	0	JIS C 7021:B-12
Environmental Test	Temperature Cycling	-30±5℃ 30min Room Temp. 5min 100±5℃ 30min 100 Cycles	100	0	MIL-STD-750:1051 MIL-STD-202:107D JIS C 7021:A-4
	Thermal Shock	-30±5℃ 5min 100±5℃ 5min 100 Cycles	100	0	MIL-STD-750:1051 MIL-STD-202:107D JIS C 7021:A3
	Solderability	230±5℃ Dwell Time≤5sec	22	0	MIL-STD-202:208D MIL-STD-750:2026 MIL-STD-883:2003 JIS C 7021:A-2
	Solder Resistance	260±5℃ 10±1sec	22	0	MIL-STD-750:2031 MIL-STD-202:210A JIS C 7021:A-1

Criteria for Judging The Damage:

Item	Symbol	Test Conditions	Criteria for Judgment	
			Min	Max
Forward Voltage	VF	I_F=20mA	_	U.S.L*1.1
Reverse Current	I_R	V_R=5V	_	U.S.L*2.0
Luminous Intensity	Iv	I_F=20mA	L.S.L*0.7	

PS: U.S.L. :Upper Standard Level L.S.L. : Lower Standard Level

004294

L·MAX 光勝光電 LITE-MAX

LITE-MAX OPTOELECTRONICS Co., LTD.

DATA SHEET

L·MAX 光勝光電科技(惠州)有限公司
LITE-MAX OPTOELECTRONICS Co., LTD.

產 品 承 認 書
APPROVED SHEET

品 名 Product	R05圓形藍管
產品型號 Part No	LM-R05BCD-SX
樣品編號 Sample No	---

隨本承認書提供該產品的設計及技術參數
Provide the product's design and technical character with the file.

核 准 Approved By	審 核 Check By	擬 定 Prepared By
廖志平	--	陈映廷

客戶承認 Customer Approved	核 准 Approved By	工 程 Engineer	品 保 Q.C

MMRDA 2234

光勝光電科技（惠州）有限公司

LITE-MAX OPTOELECTRONICS CO. , LTD.

DATA SHEET

LM-R05BCD-SX

MMRDA

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L·MAX 光勝光電 LITE-MAX

DATA SHEET

LITE-MAX OPTOELECTRONICS Co., LTD.

Part No:

LM-R05BCD-SX

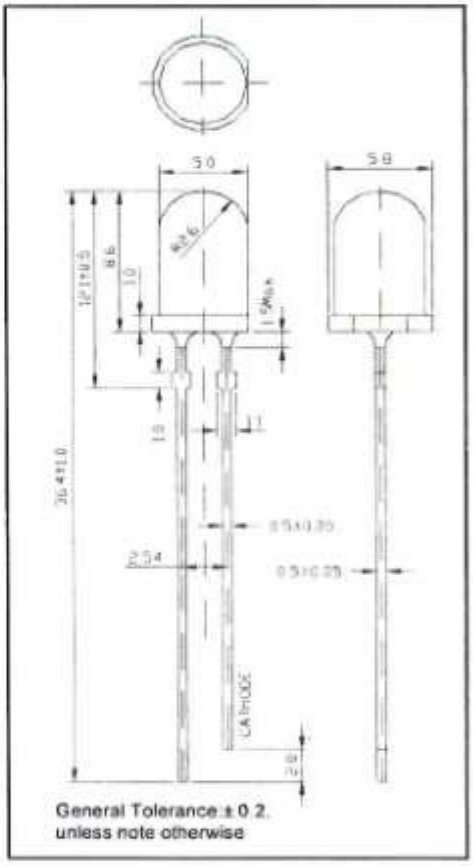
Features

* High intensity LED lamp
* Ø5mm round shape
* UV resistant epoxy

Applications

* LED Screen
* Illumination

Package Dimensions



Unit : mm

Tolerance are±0.2,unless note otherwise

Absolute Maximum Ratings (Ta=25℃)

Parameter	Symbol	Max	Unit
Power Dissipation	P_D	100	mW
Peak Forward Current *	I_{FM}	100	mA
Continuous Forward Current	I_F	20	mA
Reverse Voltage	V_R	5	V
Operating Temperature Range	Topr	-25℃ to +80℃	
Storage Temperature Range	Tstg	-40℃ to +100℃	
Lead Soldering Temperature	Tsol	260	℃

* Duty ratio max 1/10 Pulse Width max. 0.1ms;

△ At the position of 4mm from the bottom of the package within 5 seconds.

Electrical Optical Characteristics (Ta=25℃ , @IF=20mA)

Part No.	Material	Lens	Emitting Color	Forward Voltage (v)		Luminous Intensity (mcd)		Dominant Wavelength(nm)		Viewing Angle ($2\theta_{1/2}$)
				Min	Max	Min	Max	Min	Max	
LM-R05BCD-SX	InGaN	Colored Diffuse			3.6	3500	6000	465	475	23°

L·MAX 光勝光電 LITE-MAX

DATA SHEET

LITE-MAX OPTOELECTRONICS Co., LTD.

BIN Table : (Test at 20mA)

VF (v)	
Color	Range
Blue	2.8-3.6
0.2V 分档	

IV (mcd)	
Code	Range
12	3500-4200
13	4200-5040
14	5040-6000

Wd (nm)	
Code	Range
B2	465-470
B3	470-475

Error range :

- Luminous Intensity (IV) ±10%, Forwerd Voltage (VF) ±0.1, Wavelength (Wd) ±1nm

Caution in ESD :

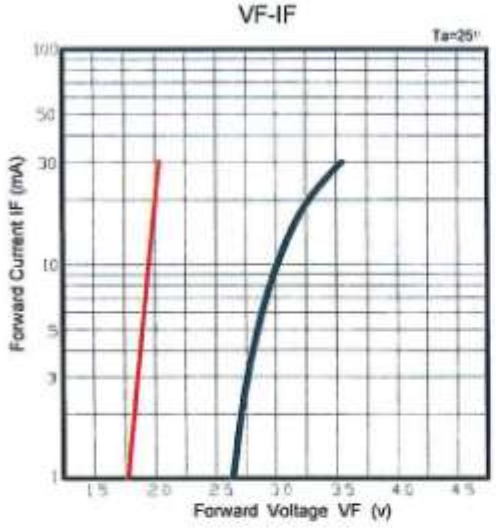
1. Static Electricity and surge damages the LEDs. It is recommended to use a wrist band or anti-electrostatic glove when handling the LEDs. All devices、Equipment and machinery must be properly grounded.
2. When inspecting own final products on which LEDs were mounted, It is easy to find static-damaged LEDs by light emission test at lower current (below 1mA is recommended).
3. Damaged LEDs will show some unusual characteristics such as leak current remarkably increases, starting forward voltage becomes lower, or the LEDs get unlighted at the low current.

LITE-MAX 光勝光電 LITE-MAX

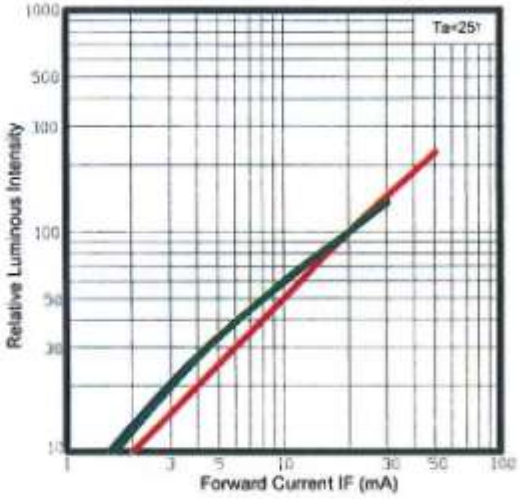
DATA SHEET

LITE-MAX OPTOELECTRONICS Co., LTD.

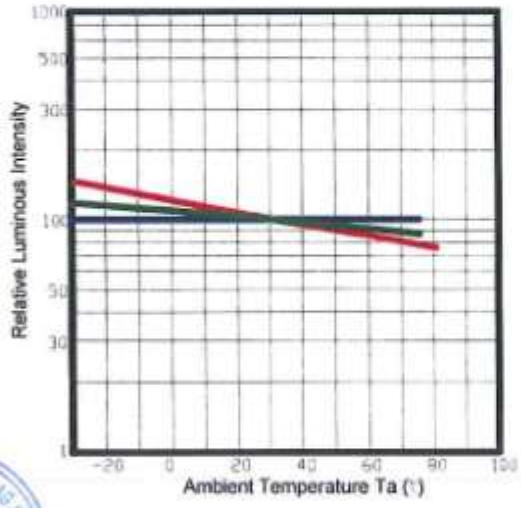
VF-IF



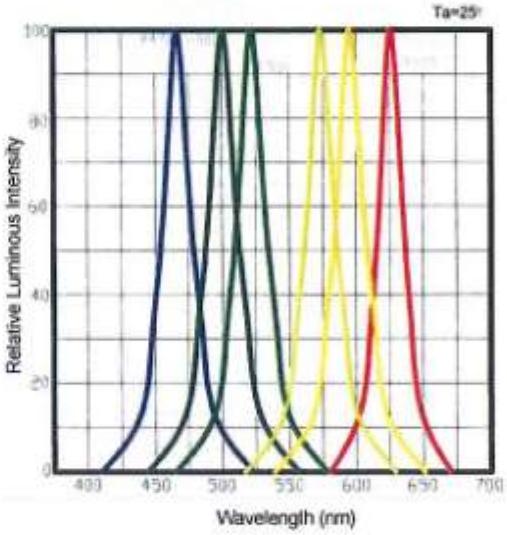
Relative Luminous Intensity-Ta



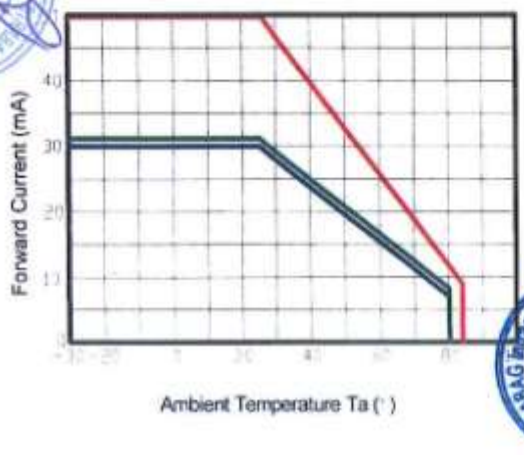
Relative Luminous Intensity-Ta



Wavelength Characteristics



IF-Ta



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LITE-MAX 光勝光電 LITE-MAX

DATA SHEET

LITE-MAX OPTOELECTRONICS Co., LTD.

Reliability Test

Classification	Test Item	Test Conditions	Sample Size	Num of Damaged	Reference Standard
Endurance Test	Operating Life	I_F=30mA 1000Hrs	22	0	MIL-STD-750:1026 MIL-STD-202:107D JIS C 7021:B-4
	High Temp. High Humidity Storage	60±5℃ 90%±5 RH 500Hrs	100	0	MIL-STD-202:103D JIS C 7021:B-11
	Hi-Temp. Storage	100±5℃ 1000Hrs	100	0	MIL-STD-750:2031 MIL-STD-202:210A JIS C 7021:B-10
	Low-Temp. Storage	-30±5℃ 1000Hrs	100	0	JIS C 7021:B-12
Environmental Test	Temperature Cycling	-30±5℃ 30min Room Temp. 5min 100±5℃ 30min 100 Cycles	100	0	MIL-STD-750:1051 MIL-STD-202:107D JIS C 7021:A-4
	Thermal Shock	-30±5℃ 5min 100±5℃ 5min 100 Cycles	100	0	MIL-STD-750:1051 MIL-STD-202:107D JIS C 7021:A3
	Solderability	230±5℃ Dwell Time≤5sec	22	0	MIL-STD-202:208D MIL-STD-750:2026 MIL-STD-883:2003 JIS C 7021:A-2
	Solder Resistance	260±5℃ 10±1sec	22	0	MIL-STD-750:2031 MIL-STD-202:210A JIS C 7021:A-1

Criteria for Judging The Damage:

Item	Symbol	Test Conditions	Criteria for Judgment	
			Min	Max
Forward Voltage	VF	I_F=20mA	_	U.S.L*1.1
Reverse Current	I_R	V_R=5V	_	U.S.L*2.0
Luminous Intensity	Iv	I_F=20mA	L.S.L*0.7	_

PS. U.S.L.:Upper Standard Level L.S.L.:Lower Standard Level

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光勝光電 LITE-MAX

LITE-MAX OPTOELECTRONICS Co., LTD.

DATA SHEET

光勝光電科技(惠州)有限公司
LITE-MAX OPTOELECTRONICS Co., LTD.

產 品 承 認 書
APPROVED SHEET

品 名 Product	R05圓形绿管
產品型號 Part No	LM-R05FCD-SX
樣品編號 Sample No	---

隨本承認書提供該產品的設計及技術參數
Provide the product's design and technical character with the file.

核 准 Approved By	審 核 Check By	擬 定 Prepared By
廖志平	--	陈映廷

客戶承認 Customer Approved	核 准 Approved By	工 程 Engineer	品 保 Q.C

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光勝光電
LITE-MAX

DATA SHEET

光勝光電科技（惠州）有限公司

LITE-MAX OPTOELECTRONICS CO. , LTD.

DATA SHEET

LM-R05FCD-SX

LITE-MAX 光勝光電 LITE-MAX

LITE-MAX OPTOELECTRONICS Co., LTD.

DATA SHEET

Part No:

LM-R05FCD-SX

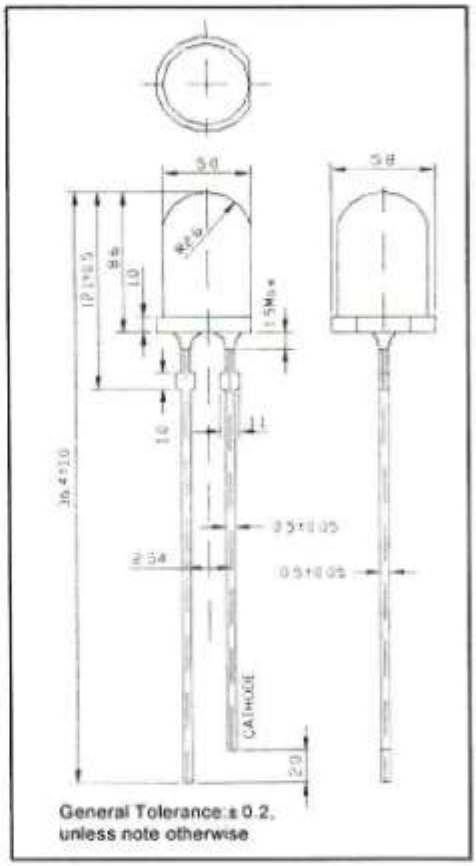
Features

* High intensity LED lamp
* Ø5mm round shape
* UV resistant epoxy

Applications

* LED Screen
* Illumination

Package Dimensions



Unit : mm

Tolerance are±0.2,unless note otherwise

Absolute Maximum Ratings (Ta=25℃)

Parameter	Symbol	Max	Unit
Power Dissipation	P_D	100	mW
Peak Forward Current *	I_{FP}	100	mA
Continuous Forward Current	I_F	20	mA
Reverse Voltage	V_R	5	V
Operating Temperature Range	Topr	-25℃ to +80℃	
Storage Temperature Range	Tstg	-40℃ to +100℃	
Lead Soldering Temperature	Tsol	260	℃

* Duty ratio max 1/10 Pulse Width max. 0.1ms;

△ At the position of 4mm from the bottom of the package within 5 seconds.

Electrical Optical Characteristics (Ta=25℃ , @IF=20mA)

Part No.	Material	Lens	Emitting Color	Forward Voltage (v)		Luminous Intensity (mcd)		Dominant Wavelength(nm)		Viewing Angle (2θ1/2)
				Min	Max	Min	Max	Min	Max	
LM-R05FCD-SX	InGaN	Colored Diffuse	Green		3.6	11000	20000	520	530	23°

L·MAX 光勝光電 LITE-MAX

DATA SHEET

LITE-MAX OPTOELECTRONICS Co., LTD.

BIN Table : (Test at 20mA)

VF (v)	
Color	Range
Green	2.8-3.6
0.2V 分档	

IV (mcd)	
Code	Range
30	11000-13200
31	13200-16000
32	16000-20000

Wd (nm)	
Code	Range
F2	520-525
F3	525-530

Error range :

- Luminous Intensity (IV) ±10%, Forwerd Voltage (VF) ±0.1, Wavelength (Wd) ±1nm

Caution in ESD :

1. Static Electricity and surge damages the LEDs. It is recommended to use a wrist band or anti-electrostatic glove when handling the LEDs. All devices · Equipment and machinery must be properly grounded.
2. When inspecting own final products on which LEDs were mounted, It is easy to find static-damaged LEDs by light emission test at lower current (below 1mA is recommended) .
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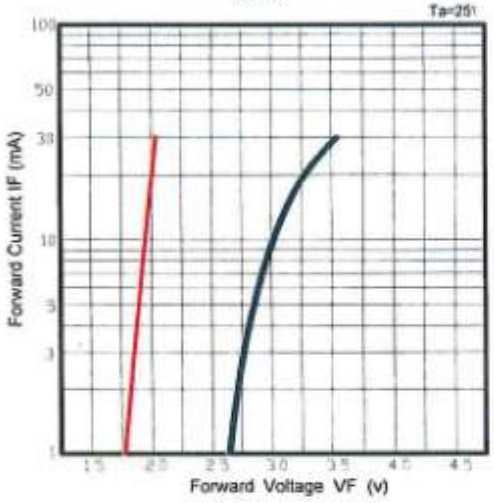
LITE-MAX 光勝光電 LITE-MAX

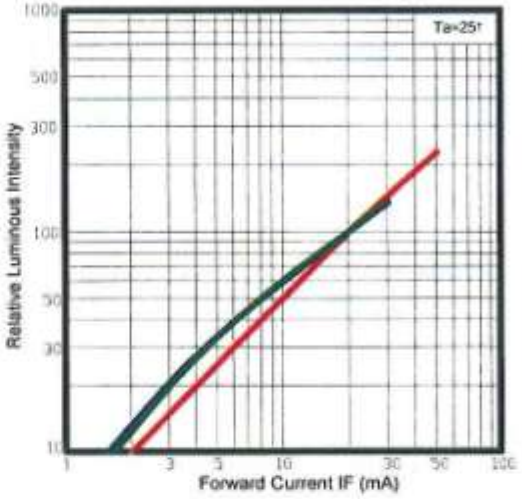
DATA SHEET

LITE-MAX OPTOELECTRONICS Co., LTD.

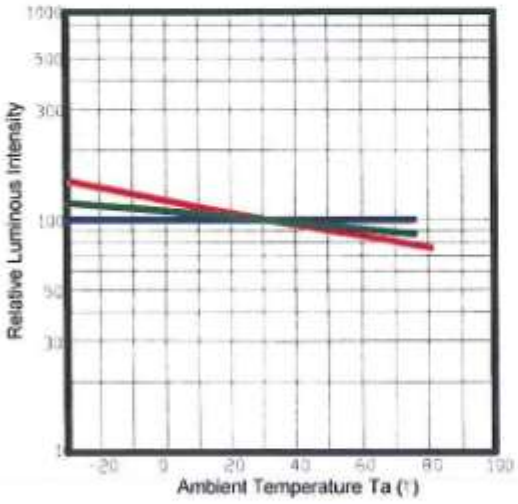
VF-IF



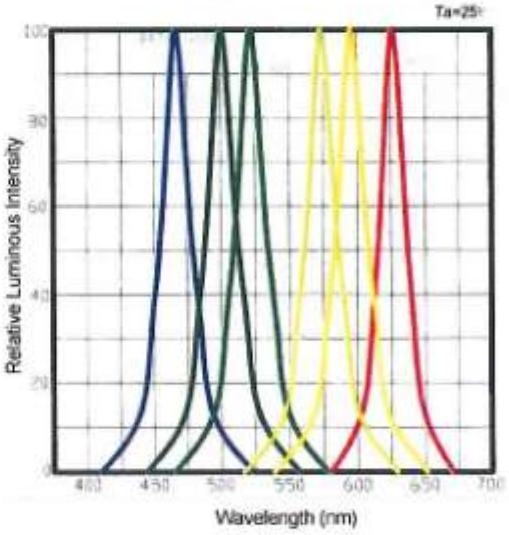
Relative Luminous Intensity-Ta



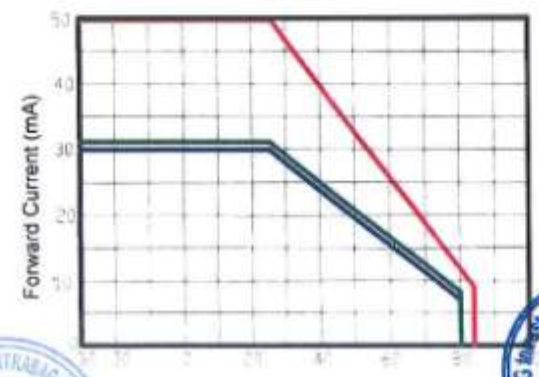
Relative Luminous Intensity-Ta



Wavelength Characteristics



IF-Ta



Reliability Test

Classification	Test Item	Test Conditions	Sample Size	Num of Damaged	Reference Standard
Endurance Test	Operating Life	I_F=30mA 1000Hrs	22	0	MIL-STD-750:1026 MIL-STD-202:107D JIS C 7021:B-4
	High Temp. High Humidity Storage	60±5℃ 90%±5 RH 500Hrs	100	0	MIL-STD-202:103D JIS C 7021:B-11
	Hi-Temp. Storage	100±5℃ 1000Hrs	100	0	MIL-STD-750:2031 MIL-STD-202:210A JIS C 7021:B-10
	Low-Temp. Storage	-30±5℃ 1000Hrs	100	0	JIS C 7021:B-12
Environmental Test	Temperature Cycling	-30±5℃ 30min Room Temp. 5min 100±5℃ 30min 100 Cycles	100	0	MIL-STD-750:1051 MIL-STD-202:107D JIS C 7021:A-4
	Thermal Shock	-30±5℃ 5min 100±5℃ 5min 100 Cycles	100	0	MIL-STD-750:1051 MIL-STD-202:107D JIS C 7021:A3
	Solderability	230±5℃ Dwell Time≤5sec	22	0	MIL-STD-202:208D MIL-STD-750:2026 MIL-STD-883:2003 JIS C 7021:A-2
	Solder Resistance	260±5℃ 10±1sec	22	0	MIL-STD-750:2031 MIL-STD-202:210A JIS C 7021:A-1

Criteria for Judging The Damage:

Item	Symbol	Test Conditions	Criteria for Judgment	
			Min	Max
Forward Voltage	VF	I_F=20mA	_	U.S.L*1.1
Reverse Current	I_R	V_R=5V	_	U.S.L*2.0
Luminous Intensity	Iv	I_F=20mA	L.S.L*0.7	

PS: U.S.L. :Upper Standard Level L.S.L. :Lower Standard Level

EFKON INDIA

VARIABLE MESSAGE SIGN BOARD (P123015RGB)

EFKON - A Global Leader in Intelligent Traffic Management Systems

Efkon GmbH is a fully owned subsidiary of Strabag SE , A leading infrastructure company with € 13.5 bn Turnover . Efkon GmbH is a global leader in providing end to-end solutions for :

- Advanced traffic management system – for Smart Highway and Smart Cities .
- Intelligent Revenue collection and Assurance system – for Smart Highway and Smart Cities .
- Intelligent Transport Management system – for Logistics Management & Fleet operation.

Efkon India is pioneer to bring innovative solutions for ITS Industry in Indian market since 2001. Efkon India has 700+ Engineers working in R&D, Project execution, operation management for Government as well as Private customers.

VARIABLE MESSAGING DISPLAY COMMUNICATE IMPORTANT INFORMATION & GUIDANCE ABOUT TRAFFIC, DIVERSIONS ETC. TO THE CITIZENS / PUBLIC ON THE ROAD. VMD CAN ALSO BE USED FOR SHOWING EMERGENCY/DISASTER RELATED MESSAGES AS AND WHEN REQUIRED.

CUSTOMER BENEFITS

- Clear visibility with ultra bright LED Technology
- Display legible from distance of more than 100mtrs.
- Anti-glare front screen visible from all angles.
- Robust design can withstand extreme temperatures.
- User friendly software to display information.

TECHNICAL SPECIFICATIONS

GENERAL	
Input Voltage	230 VAC, 50Hz
DISPLAY	
Matrix Configuration	Full Matrix (LED)
Color	RGB
Board size	3000mm(W) x1500mm(H) X 200(D) mm
Pixel Pitch	P12
Character Height	300 mm
Language	English and Hindi
Viewing Angle	0 to 10° as per B6
Viewing Distance	150 Mtrs
OPTICAL SPECIFICATION	
Luminance Class/ Ratio	L3
Contrast Ratio	R3
Beam Width, Brightness	B6
COMMUNICATION	
Interfaces	Ethernet
Communication	Capable of wireless connectivity with 3G up gradable to 4G
MECHANICAL	
Housing Material	Aluminum, 2mm thick
Paint Coating	Black, 100% anti glare
Maintenance Access	Rear
Mounting Types	Gantry/Cantilever Mount
Sensors	Door, Temperature
LED	Full Color
ENVIRONMENTAL	
Working Temperature	0°~ +55° C
Working Humidity	10% to 95%
Environmental protection	IP65 from front IP54 from rear

004308

EFKON INDIA

VARIABLE MESSAGE CONTROL ROOM SOFTWARE (VMS1.6)

EFKON - A Global Leader in Intelligent Traffic Management Systems

Efkon AG is a fully owned subsidiary of STRABAG SE, a leading infrastructure company with € 12 bn turnover. Efkon AG is a global leader in providing end-to-end solutions for:

- Intelligent Revenue Collection & Assurance System – for Smart Highways
- Advanced Traffic Management System – for Smart Highways & Smart Cities
- Intelligent Lighting System – for Smart Highways & Smart Cities
- Intelligent Transport Management System – for On Road & Off Road Applications

EFKON India has been providing Intelligent Transportation Solution to Indian market since 2001 and has 500+ engineers working in Research & Development, Execution of Operations & Maintenance of leading Government & Private Institutes in India.

VARIABLE MESSAGING DISPLAY COMMUNICATE IMPORTANT INFORMATION & GUIDANCE ABOUT TRAFFIC, DIVERSIONS ETC. TO THE CITIZENS / PUBLIC ON THE ROAD. VMD CAN ALSO BE USED FOR SHOWING EMERGENCY/DISASTER RELATED MESSAGES AS AND WHEN REQUIRED.

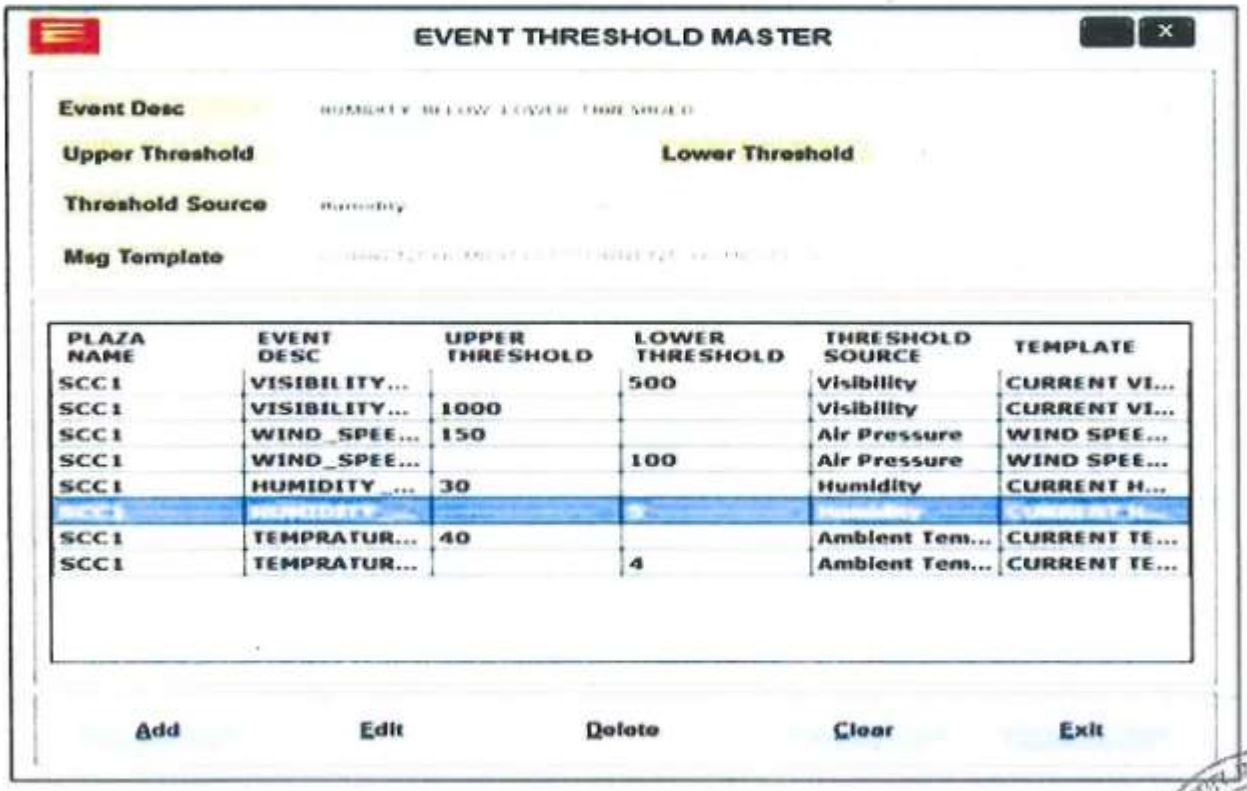
CUSTOMER BENEFITS

- Board Selection and Connection
- Graphics/pictogram Selection
- Manual Message Creation in GTG
- Message Lookup from Library
- Entering graphics/pictograms and text messages
- Rule Based Message Scheduling
- Priority Based Message Scheduling

MMRDA

2248

- Schedule control
- Unknown message retrieval
- Monitoring the sign
- Brightness adjustments
- Date/Time settings
- Log File use
- Default message settings
- Light Sensor readings
- Temp Sensor readings
- Power Supply Pass/Fail readings
- Comm. Failure messages



Catalogues and Drawings

MEP

004311

STRABAG Infrastructure & Safety Solutions GmbH

STRABAG

DECLARATION FOR - TECHNICAL DATA SHEETS/CATALOGUES

We have enclosed catalogues/data sheets of the equipments for one of the approved /proposed make in line with tender requirement. After award of order during detail engineering stage we will submit the data sheets and catalogues of the final approved vendor meeting the tender requirement.

The capacities/ratings and quantities of all equipment are indicative based on the details available in the tender documents and the same shall be updated as per actual load requirements during detailed engineering and design stage as per actual site conditions inline with the contract requirement subject to approval by Engineer/Employer.

STRABAG Infrastructure & Safety Solutions GmbH

MMRDA

STRABAG Infrastructure & Safety Solutions GmbH
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1210 Wien/Österreich
www.strabag-sss.com

Tel +43 1 90199-0
Fax +43 1 90199-19
sss-office@strabag.com

Raiffeisenlandesbank Oberösterr. AG
IBAN AT91 3400 0000 0014 1317
BIC/SWIFT RZOOAT2LXXX

Sitz: Wien, Handelsgericht Wien, FN 79688p, UID Nr. ATU14764502

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NEPTUNE
COMPANY
PROFILE
Celebrating
over 25 years
of excellence
www.neptuneindia.com

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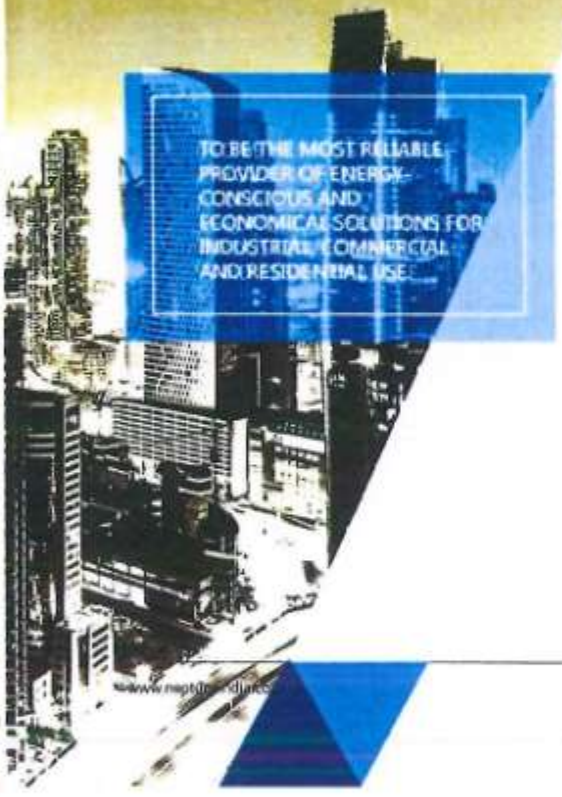
About NEPTUNE



Established in the Year 1989, Neptune has established itself as among the most reliable providers of energy & access management solutions for industrial, commercial and residential use. Through collaboration with global conglomerates, the company has been instrumental in bringing globally renowned technologies and advanced products to the subcontinent. Not only this has contributed immensely towards the growth of the region over the last three decades but in the process, has also made Neptune Group an absolute powerhouse in energy management and access control solutions.

Today, the organization has split its core business activities into two major business units- Neptune India, which deals with Energy Management & Power Quality & Distribution Solutions and Neptune Automatic- the Parking Management & Access Automation division of the firm. From Marketing, Innovation and Production to Quality Assurance, Installation and After-Sales Support, Neptune has continually excelled as a company in all departments, boasting a team of over 500 dedicated employees, 35000+ installations, world-class manufacturing units and an extremely reliable network of partners across the globe.

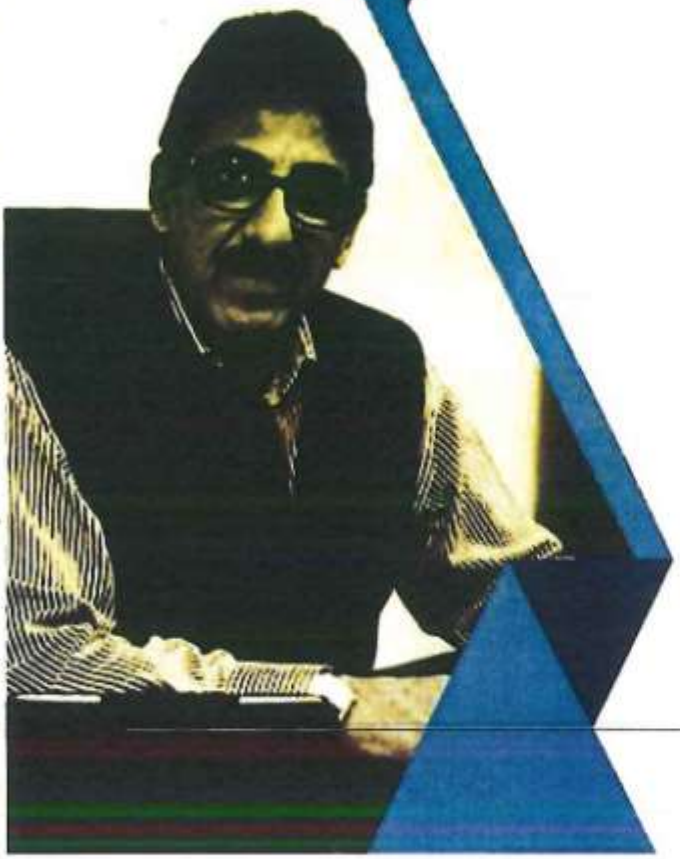
Today, the Neptune Group is celebrating over 25 years of excellence, with focus & passion for "Innovative Energy Management Solutions" and "Intuitive Access Automation & Parking Management Solutions".

STRABAG Infrastructure & Safety Solutions GmbH

MMRDA

NEPTUNE

NEPTUNE GROUP



Deepak Kapoor

The Founder, The Visionary and The Leader!

The creditable growth and the success of Neptune has been distinctively possible under the visionary and Inspirational attitude of Deepak Kapoor, the Chairman of Neptune Group.

From an idea on paper to a tangible business entity, Mr. Kapoor, with an intense vision, strong ambitions and positive energy, founded Neptune India – a company dedicated to saving energy and improving power quality. The idea was simple yet brilliant... not only he wanted to become a successful businessman but also work on something that will contribute towards the growth of the nation and hence improve the lives of billions of people. As the company continued to demonstrate its commitment to an Energy Efficient future, the dedication and progressive motivation inspired extensive growth.

In the year 2005, he introduced FAAC India (now known as Neptune Automatic), a subsidiary of the well-known global automation giant FAAC. Leveraging on our established brand reputation, professional expertise and trusted partner network, Neptune Automatic took the Indian Access Automation and Parking Management industry by storm. The quality of products, matched by ever-reliable services of Neptune, was something that was never seen before in the country.

For his remarkable achievements, Mr. Kapoor is the recipient of the prestigious Price Water House Coopers' 'Brands and Leaders Award' and has also been quoted multiple times by various media outlets. An article published in his honour can be found in the 12th edition of 'AsiaOne' business & news magazine.

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Collaboration & Joint Ventures

Neptune understands the fact that success is not achieved by a single person or an entity on its own. A company's true success story has thousands of supporting characters that contribute towards its growth and are very much responsible for the state of strength that it is in today. Over the years, Neptune has collaborated with many reputed organizations across the globe and is thankful for their guidance, trust & confidence in our services. We currently have joint ventures with following global energy and technology firms:

- **Bals Elektrotechnik**, Germany [Industrial plugs & sockets, enclosures, customized distribution panels]
- **Ducati Energia** S.p.A., Italy [Power factor controllers, capacitors, power analysers, energy management systems, harmonic filters and power factor solutions]
- **Elsteel**, Denmark [LV switchboards, techno modular switchboards (TTA)]
- **ABB** ArTu K Systems (TTA)
- **FAAC** S.p.A. Italy [access automation products]
- **TiSO** (Pedestrian Gates & Road Blocking Systems)

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Business Units

The Neptune Group, the Renowned Pioneers in Introducing, world renowned technologically advanced Products into the Indian subcontinent, has selectively compiled these collaboration with global conglomerates into four business units:

SMART ENERGY MANAGEMENT

Improved Energy Efficiency, Greater User Convenience and Increased ROI

POWER DISTRIBUTION MANAGEMENT

Enhanced Power Quality, Reduced Downtime and Better Equipment Lifetime.

POWER QUALITY MANAGEMENT

Impeccable Protection, Effective Monitoring and Higher Cost Savings

SECURITY & ACCESS MANAGEMENT

Maximum Safety, Superior User Experience and Remarkable Operational Efficiency

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NEPTUNE

NEPTUNE GROUP

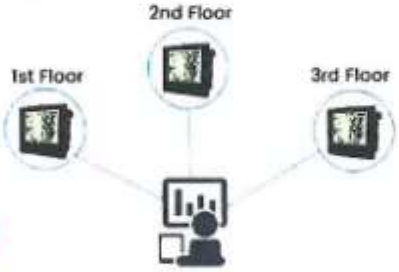
SMART ENERGY MANAGEMENT

Smart Energy Management

As new technologies modernize our day to day operations, the demand for effective energy management solutions and improved energy efficiency is also increasing. Neptune's Smart Energy Management Solutions are revolutionizing traditional business models by offering new capabilities - from reductions in carbon footprint to improvements in integrated resource planning and higher asset utilization.

We work with our clients to identify & manage opportunities that are capable of delivering smart energy management. Our proprietary Energy Management System is a high-performance application used by thousands of electrical grid operators in India to monitor and optimize the performance of their system.

Neptune India also offers energy meters, power analyzers & data loggers, in partnership with 'Ducati Energia S.p.A.' (Italy), that allow our clients to effectively manage their energy demands, set objectives & measurable targets and easily identify their key energy users. All our micro-controller based smart products are compliant with applicable IS /IEC standards and our highly secure proprietary security algorithms provide effective shield against frauds & hacking.



DUCATI energia

Multi Source Energy Meter

VIF Meter

Power Analyzers

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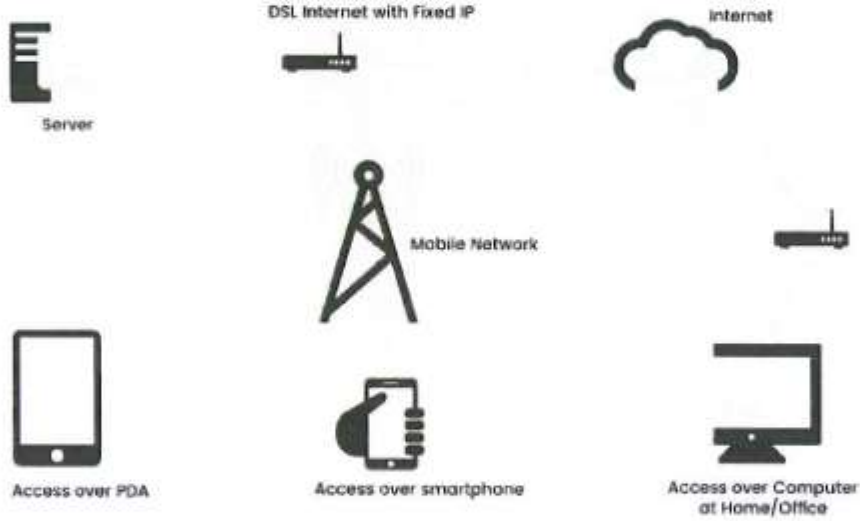
SMART ENERGY MANAGEMENT

How does Energy Management System work?

System Architecture



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NEPTUNE

NEPTUNE GROUP

Power Distribution Management

Neptune offers a remarkable range of power distribution management solutions for commercial, residential, utility and industrial markets. The business unit has a wide-ranging portfolio of superior quality LV Switchboards and Industrial Plugs & Sockets.

Our LV Switchboards are manufactured in collaboration with 'Elsteel' (Denmark) and are ideal for protection & management of electrical equipment, monitoring various energy parameters and efficient power distribution.

LV Switchboards

ABB

MODULAR ELSTEEL ENCLOSURES

Power Control Centre

Motor Control Centre

Local Distribution

Feeder Pillars

Mains / DG Synchronizing

APFC Panels

STRABAG Infrastructure & Safety Solutions GmbH

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NEPTUNE

NEPTUNE GROUP

Power Distribution Management

Neptune India has a fantabulous gamut of high-grade industrial plugs and sockets that has found application in various sectors such as agriculture & chemical industry, airports, construction sites and water treatment plants. Our stellar range of products (in partnership with 'Bals Elektrotechnik', Germany) include Surface/Panel Mounting Socket Outlets, industrial Plugs, GT Connectors, Variaboxes and Domestic AC/Industrial outlets.

Industrial Plugs & Sockets

Bals

VARIABOX

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NEPTUNE

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POWER QUALITY MANAGEMENT

Power Quality Management

Electric supply is among the most essential & basic services needed to support our industrial world. From power generation & transmission to distribution & usage, all are undergoing significant changes due to heavy energy demands of today's modern society. These changes affect electrical quality and Neptune understands that a superior level of power quality & stability is necessary for reliable functioning of equipment & systems.

A high level of power quality can only be guaranteed with reliable partners like the Neptune Group. This is particularly true for harmonic distortions, created by non-linear loads that account for largest group of loads in the modern world. Neptune offers an array of harmonic mitigation solutions (line & load, passive, active & hybrid filters), including one of the best THD reductions in the market today, thus increasing productivity and system efficiency.

Detuned-Tuned Harmonic Filtration Systems

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Power Quality Management

Neptune India also offers Power Factor Correction units, in partnership with 'Ducati', as part of its Power Quality Management Portfolio. Our range of products include Power Factor Controllers, Capacitors and Thyristors, which are perfect in scenarios where efficient power supply is a must. These ensure zero downtimes, increased productivity & continuity, smoother power supply, improved power factor and hence higher quality of power.

Power Factor Correction

DUCATI energia





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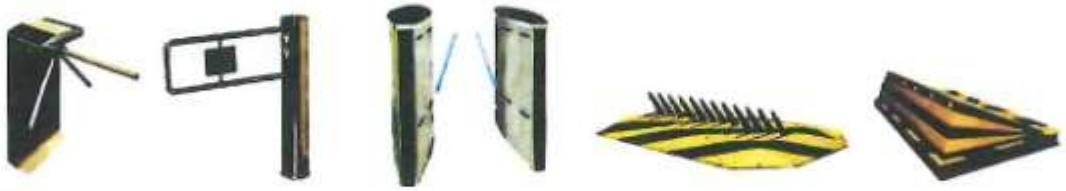
Security & Access Management

Neptune's Security & Access Management portfolio consists of entry automation systems, access control & parking management solutions and are the key pillars of our 'Neptune Automatic' business unit. We are currently the official sole distribution partners of FAAC Access Automation (B.U) in India and offer an impressive range of innovative & versatile products such as automatic doors, boom barriers & security bollards and parking management systems.

Neptune's Access Automation solutions include swing/slide door automation, automatic boom barriers and high security bollards. These allow for increased safety, user comfort & employee productivity and are ideal for areas such as airports, parking lots, VIP residences, embassies, places of interest and banks.

Access Automation

TSO



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NEPTUNE

NEPTUNE GROUP

Security & Access Management

Neptune Automatic's Parking Management portfolio chiefly includes our proprietary parking management system, automated pay stations and entry/exit stations. Neptune's Parking Management solutions allow for a fully automated parking experience where a user can pre-book his/her parking space using our app, get directions, know the real-time availability and pay for parking via multiple payment options.

Parking Management

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NEPTUNE GROUP

Parking Management in Security Automation

LPR (License Plate Recognition)

Major Access

Simple & Easy PC or Laptop

Real Time Information Of Parking Space

Automatic Communication With Mobile App

Parking Reservation by App

Collection System

Multi Level Parking

Multiple Entries And Exits

STRABAG Infrastructure & Safety Solutions GmbH

MMRDA

004326

NEPTUNE

Neptune Group

Corporate & Mktg. Office

A-11, Sector-53, Noida - 201301, India

Tel: 0120 429 5500, 429 7900

E: enquiry@neptuneindia.com

www.neptuneindia.com

STRABAG Infrastructure & Safety Solutions GmbH

MIARDA

2266

004327

SUPERNOVA
ENGINEERS LTD.
An ISO 9001 : 2015 Certified Company

REGISTERED OFFICE
SUPERNOVA ENGINEERS LIMITED
B Wing, F-2, First Floor, Shapath Hexa, Opp. Gujarat High Court,
S.G.Highway, Ahmedabad - 380 060. Gujarat. INDIA.
Call - +91 79-66111136/37/38/39/40
Email - marketing@supernovagenset.com, inquiry@supernovagenset.com
Web - www.supernovagenset.com

Branches

BENGALURU	[illegible]
CHENNAI	[illegible]
COIMBATORE	[illegible] Coimbatore - 641 018, Tel : 0422 4959404
DELHI-UP	702, 7th Floor, DLF Star Tower, [illegible] Sector 30, Gurugram, Haryana-122002
HYDERABAD	[illegible] Secunderabad - 500 003, Tel : [illegible]
MUMBAI	1605 Dev Corpora, Opposite Korum Mall, Cadbury Junction, Eastern Express High Way, Thane West, Mumbai, Pin Code: 400 602
PATNA	[illegible] Patna - 800 001, Tel : [illegible]
RANCHI	502, [illegible] Ranchi - 834 001, Tel : [illegible]
INDORE	206, 2nd Floor, Royal Ratan Building, M.G.Road, Indore-452001 (M.P.), Tel : 8893566446

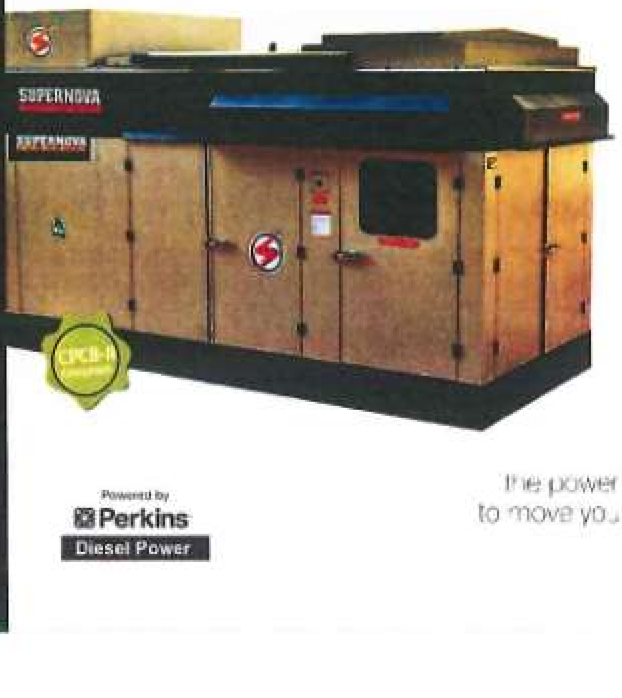
MFG. FACILITIES

RAIPUR-MEHSANA	[illegible] Village Rajpur, Tal. Kadi, Dist. Mehsana, North Gujarat. Tel : [illegible]
SILVASSA	Survey No. [illegible] Tel : [illegible]

SUPERNOVA
Power Up

SUPERNOVA
Euro Series

400 kVA to 625 kVA
6250 kVA when paralleled



Powered by
Perkins
Diesel Power

the power
to move you

2267

SUPERNOVA | Perkins Diesel Power

Rating Table

TECHNICAL DATA

GENSET MODEL (1500RPM (50Hz) 3 Ph., 415V, 0.8 PF)	SP 400*	SP 500*	SP 625*
Rated kVA / Rated kWe	400kVA / 320kWe	500kVA / 400kWe	625kVA / 500kWe
Engine Model	2206D-E13TAG3	2506D-E15TAG2	2806D-E18TAG1A
Engine bhp	492	607	724
Type	4 STROKE WATER COOLED 1500 RPM DIESEL ENGINE		
No. of Cylinder & Arrangement	6 VERTICAL IN LINE		
Governor	ELECTRONIC		
Fuel System	DIRECT INJECTION SYSTEM WITH UNIT INJECTORS		
Bore X Stroke (mm x mm)	130x157	137x171	145x183
Compression Ratio	[illegible]	17:1	16:01
Starting System	24V DC ELECTRIC		
Lead Acid TYPE Battery	2Nos. 180 AH		
Fuel day Tank Capacity (Ltrs)	700	890	890
Coolant Capacity incl Radiator (ltrs)	57	48	57
Lube Oil Capacity incl Oil Filters (Ltrs)	40	62	71
Lube Oil Specification	API CI-4 15W/40		
Recommended Fuel Specification	ASTM D975 No 2-D or BS2869 Class A2 or BSEN 590		
Overall D.G. Set Dimensions in mm			
Length	5550	5600	5600
Width	2000	2200	2200
Height	2800	3025	3025
Total Weight incl. (Approx.) Acoustic Enclosure (in kgs)	5600	7200	7450

*SUPPLY WITH ACOUSTIC ENCLOSURE AS PER CPCB-II NORMS

STRABAG Infrastructure & Safety Solutions GmbH

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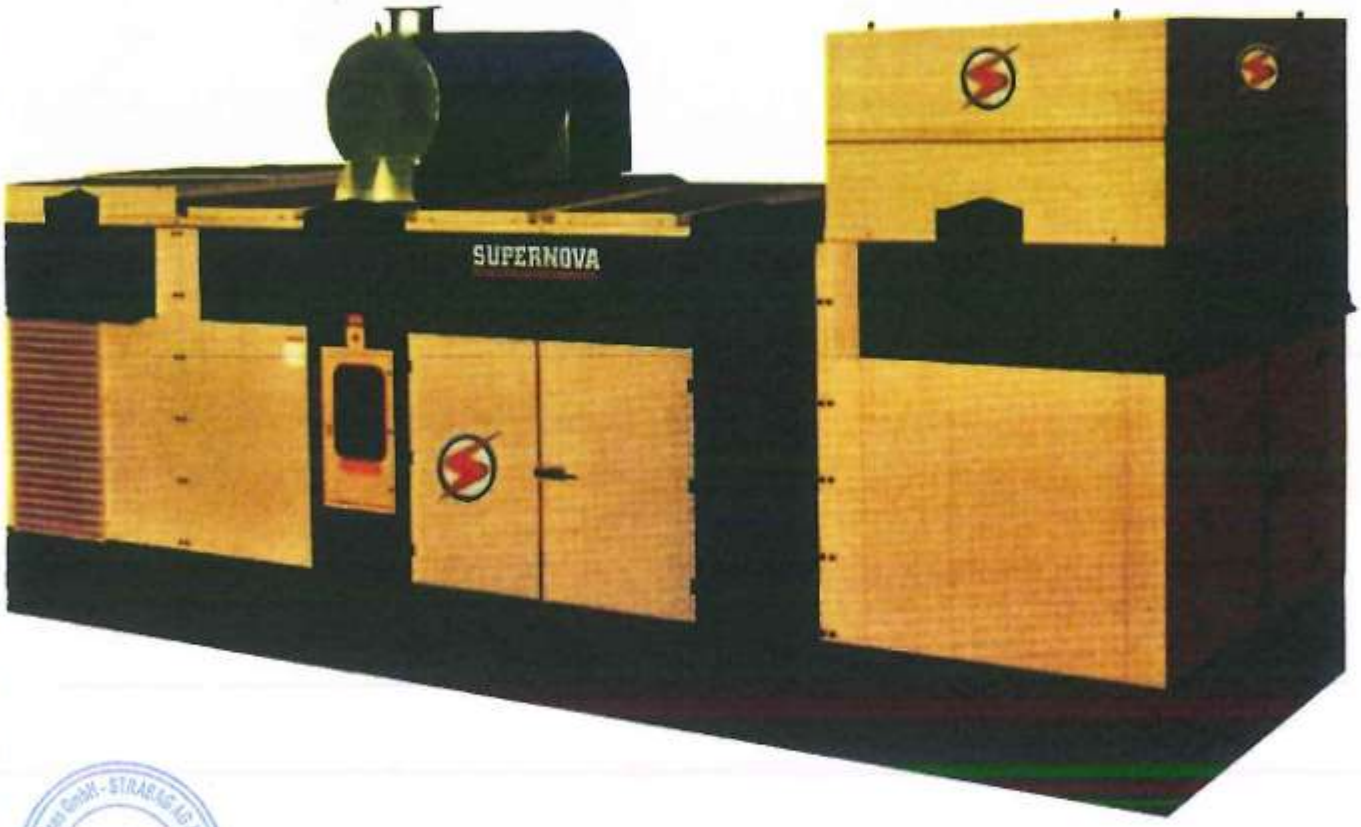
SUPERNOVA
Power Up

SUPERNOVA
Euro Series

750 kVA to 2500 kVA
25000 kVA when paralleled



Powered by
Perkins
Diesel Power

zero
compromise
decision

2269

SUPERNOVA | Perkins Diesel Power

Supernova Diesel Electric Gensets are powered by Perkins Diesel Engines [illegible] from 400KVA to 2500KVA. Each Supernova Diesel Electric Genset is manufactured under stringent [illegible] process and undergoes in-house testing. Engine performance corresponds to ISO 3046, BS 5514 and DIN 6271. The technical data applies to an engine operating on a fuel with a calorific value of 42.7 MJ/Kg (10200 Kcal/Kg) and a density of 0.86 Kg/Liter and as per BS 2869 Part 2 1998 Class A2 or ASTM D975D2. AC Generator performance corresponds to IEC 34, IS 4722.

The unmatched fuel efficiency and ease of maintenance are the [illegible] factors which makes them preferred choice of customers.

Salient Features

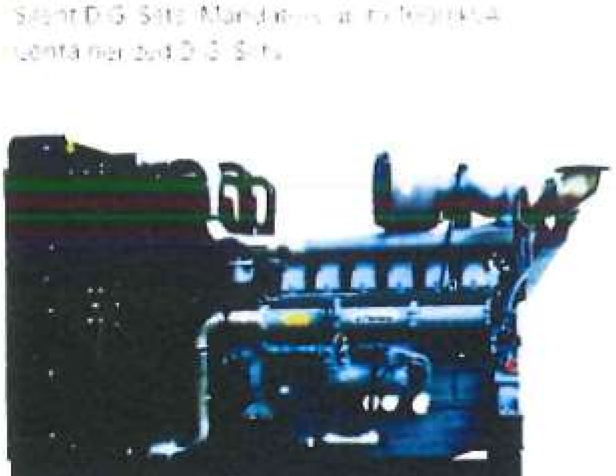
- Market leading power density
- No deration in power output up to 50 Deg. C
- In line cylinder configuration engine up to 1125KVA (Prime)
- Vee cylinder configuration engine up to 2250KVA (Prime)
- Excellent Power to weight ratio
- High block load capability due to split exhaust system
- Average loading of Engine is 80% as against industries standard up to [illegible]
- Commonality of component over the entire series of Engine
- Unit injection system with electronic governor to optimized fuel consumption
- Low Operating and maintenance cost
- Service interval 500 hrs / 1 Year
- Coolant change interval 3 years / 6000hrs
- Designed to provide excellent service access for Easy of Maintenance
- Compact size for easier transportation and installation

Standard Scope Comprising Of

Diesel Engine, AC Generator, Base frame, Standard Control Panel, Radiator, Silencer, Battery & Battery Cables, AVM's, First Fill of Lube Oil, First Fill of Coolant, D.G. Set Controller, Fuel tank, Wiring Harness, Sensors

Types for D.G. Sets

- Open Type D.G Sets [illegible]
- Silent D.G. Sets [illegible]
- Containerized D.G. Sets



[illegible]

[illegible]

RATING [illegible]

PRIME POWER [illegible] standard power for continuous [illegible] supplying electrical [illegible] number of hours [illegible] power. This is as per the BS 5 [illegible]

STAND BY POWER [illegible]

POWER [illegible]

Engine [illegible] BS 5514, SAE [illegible]

2270

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Rating Table

GENSET MODEL (4 stroke water cooled) (1500RPM (50Hz) 3 Ph., 415V, 0.8 PF)	SP 750 EP	SP 810	SP 910	SP 1010	SP 1125/SP 1250 (S)*
Rated kVA / Rated kW	**750kVA / 600kWe**	**810kVA / 648kWe**	**910kVA / 728kWe**	**1010kVA / 808kWe**	**1125kVA / 900kWe 1250kVA / 1000kWe**
Engine Model	4006D-E23TAG2	4008D-E30TAG1	4008D E30TAG2	4008 30TAG2	4008 30TAG3
Engine Bhp	895	965	1071	1206	1336 / 1481
No. of Cylinder & Arrangement	6 VERTICAL IN-LINE		8 VERTICAL IN-LINE		
Governor			ELECTRONIC		
Fuel System			DIRECT INJECTION SYSTEM WITH UNIT INJECTORS		
Bore X Stroke (mm x mm)			160 x 190		
Compression Ratio		12.8:1			13:1
Starting System			24V DC ELECTRIC		
Lead Acid TYPE Battery			2 Nos. 180 AH		
Fuel day Tank Capacity (Ltrs)			990		
Coolant Capacity incl.Radiator (Ltrs)	120			143	
Lube.Oil Capacity incl Oil Filters (Ltrs)	113.4			153	
Lube.Oil Specification			API CI4 15W/40		
Bare D.G. Set Dimen (LxWxH) in mm		NA		4700 x 2100 x 2560	
Dry Weight (Approx.) DG Set Only (in kgs)		NA		8500	
Overall D.G. Set Dimen (LxWxH) in mm	7000 x 2150 x 2518		7200 x 2600 x 2950		
Total Wgt. incl. (Appr.) Acou. Encl. (in kgs)	10500		12500		

GENSET MODEL (4 stroke water cooled) (1500RPM (50Hz) 3 Ph., 415V, 0.8 PF)	SP 1250	SP 1500	SP 1700	SP 1850	SP 2000	SP 2250	SP 2500 (S)*
Rated kVA / Rated kW	**1250kVA / 1000kWe**	**1500kVA / 1200kWe**	**1700kVA / 1360kWe**	**1850kVA / 1480kWe**	**2000kVA / 1600kWe**	**2250kVA / 1800kWe**	**2500kVA / 2000kWe**
Engine Model	4012-46TAG0A	4012-46TAG2A	4012-46TAG3A	4016-61TRG1	4016-61TRG2	4016-61TRG3	4016-61TRG3
Engine Bhp	1497	1785	2006	2208	2377	2647	2925
No. of Cylinder & Arrangement		12VEE			16VEE		
Governor				ELECTRONIC			
Fuel System				DIRECT INJECTION SYSTEM WITH UNIT INJECTORS			
Bore X Stroke (mm x mm)				160 x 190			
Compression Ratio	13.6:1			13:1			
Starting System				24V DC ELECTRIC			
Lead Acid TYPE Battery				4 Nos. 180 AH			
Fuel day Tank Capacity (Ltrs)				990			
Coolant Capacity incl Radiator (Ltrs)		210			550		
Lube.Oil Capacity incl.Oil Filters (Ltrs)		177			213		
Lube.Oil Specification				API CI4 15W/40			
Bare D.G. Set Dimen (LxWxH) in mm		5400 x 2200 x 2650			5800 x 3000 x 3400		
Dry Weight (Approx.) DG Set Only (in kgs)	11700	12000	12400	16500	17500	17900	18900
Overall D.G. Set Dimen (LxWxH) in mm		9112 x 2600 x 3760		10363x3300x3200	10363x3300x3945	10363 x 3300 x 4340	
Total Wgt. incl. (Appr.) Acou. Encl. (in kgs)	19000	19300	24200	26400	27460	29630	30000

NOTE: CONTINUOUS DEVELOPMENTS IN THE PRODUCT ENTITLES US TO CHANGE TECHNICAL SPECIFICATIONS, DIMENSIONS, SCOPE OF WORK, ETC.
*DG SET ARE STAND BY RATED. STAND BY MODEL ARE ALSO AVAILABLE IN OTHER RATINGS. PLEASE CONTACT US FOR MORE DETAILS

STRAG Infrastructure & Safety Solutions GmbH

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SUPERNOVA
ENGINEERS LTD.
An ISO 9001 : 2015 Certified Company

REGISTERED OFFICE
SUPERNOVA ENGINEERS LIMITED
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S.G.Highway, Ahmedabad – 380 060. Gujarat, INDIA.
Call - +91 79-66111136/37/38/39/40
Email - marketing@supernovagenset.com, inquiry@supernovagenset.com
Web - www.supernovagenset.com

Branches

BENGALURU	: #203, 1AA Cross, 2nd Main, East of NGEF, Kasturi Nagar, Bangalore - 560 043.
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COIMBATORE	: No.81, Dr. Nanjappa Road, Chenny's Chamber, Coimbatore - 641 018
DELHI/HARYANA	: 702, 7th Floor, DLF Star Tower, Opp. Exit-8 on Delhi-Jaipur Highway, Sector-30, Gurugram, Haryana - 122 002
HYDERABAD	: 6 & 7, Premises No. 1-7-319, 3rd Floor, Panchsheel Towers, Park Lane, Secunderabad - 500 003
INDORE	: 206, 2nd Floor, Royal Ratan Building, 7 M G Road, Indore 452001 (MP)
LUCKNOW	: 2nd Floor, D5, Sector E, Lda Colony, Hindnagar, Kanpur Rd, Lucknow-226012
MOHALI	: Office No. 2, 3rd Floor, SCF-29, Above Capital Finance Bank, Phase-V, SAS Nagar, District-Mohali
MUMBAI	: 204/205, Agrawal Arcade - VI, Nr. Juhinagar Rly Station, Sector-I, Nerul, Navi Mumbai-Pune Road, Navi Mumbai - 400 706
PATNA	: B-22, Luv Kush Tower, Exhibition Road Crossing, Patna - 800 001
RANCHI	: 502, Estate Plaza, Kantatoali, Old HB Road, Behind Mangal Tower, Ranchi - 834 001

MFG. FACILITIES

RAJPUR-MEHSANA	: 1470/1, Village Rajpur, Tal, Kadi, Dist. Mehsana,North Gujarat
SILVASSA	: Survey No. 263/3/2/1, Silvassa Dadra Nagar Haveli

Authorised Dealer for SUPERNOVA

2272

004333

PRODUCT-DETAILS

E1.2N 1000 Ekip G Hi-Touch LSIG 3p F F

E1.2N 1000 Ekip G Hi-Touch LSIG 3p F F

General Information

Extended Product Type	E1.2N 1000 Ekip G Hi-Touch LSIG 3p F F
Product ID	1SDA070810R1
EAN	8015644746605
Catalog Description	E1.2N 1000 Ekip G Hi-Touch LSIG 3p F F
Long Description	C.BREAKER SACE EMAX2 E1.2N 1000 FIXED THREE-POLE WITH FRONT TERMINALS AND SOLID-STATE RELEASE IN AC EKIP/G/HI-TOUCH-LSIG R 1000 FITTED WITH: 4 AUXILIARY CONTACT AND C.BREAKER IN POSITION OPEN-CLOSED

Ordering

EAN	8015644746605
Minimum Order Quantity	1 piece
Customs Tariff Number	85362090

Dimensions

Product Net Width	210 mm
Product Net Height	296 mm
Product Net Depth / Length	183 mm
Product Net Weight	14 kg

Container Information

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Package Level 1 Units	1 piece
Package Level 1 Width	270 mm
Package Level 1 Height	350 mm
Package Level 1 Depth / Length	330 mm
Package Level 1 Gross Weight	16 kg
Package Level 1 EAN	8015644746605

Environmental

RoHS Status	Following EU Directive 2011/65/EU and Amendment 2015/863 July 22, 2019

Additional Information

Current Type	AC
Electrical Durability	Ue =< 440 V 8000 cycle Ue = 500 ... 690 V 8000 cycle 30 cycles per hour
Mechanical Durability	20000 cycle 60 cycles per hour
Number of Poles	3
Power Loss	78 W
Product Main Type	SACE Emax 2
Product Name	Air Circuit Breaker
Product Type	Air Circuit Breaker
Rated Service Short-Circuit Breaking Capacity, in % of Icu (I_{cs})	100 %
Rated Current (I_n)	1000 A
Rated Voltage (U_r)	690 V
Rated Impulse Withstand Voltage (U_{imp})	acc. to IEC 60947-2 12 kV
Rated Insulation Voltage (U_i)	AC 1000 V
Rated Operational Voltage	690 V AC
Rated Service Short-Circuit Breaking Capacity (I_{cs})	(220 V AC) 66 kA (230 V AC) 66 kA (380 V AC) 66 kA (400 V AC) 50 kA (415 V AC) 50 kA (440 V AC) 50 kA (500 V AC) 50 kA (660 V AC) 50 kA (690 V AC) 50 kA
Rated Short-time Withstand Current (I_{cw})	for 1 s 50 kA for 3 s 30 kA
Rated Ultimate Short-Circuit Breaking Capacity (I_{cu})	(400 V AC) 66 kA (415 V AC) 66 kA (440 V AC) 66 kA (500 V AC) 50 kA (525 V AC) 50 kA (690 V AC) 50 kA
Rated Uninterrupted Current (I_u)	1000 A
Release	Ekip G Hi-Touch LSIG
Release Type	EL
Short-Circuit Performance Level	N
Standards	IEC

Sub-type	E1.2
Terminal Connection Type	Front
Version	F

Certificates and Declarations (Document Number)

Data Sheet, Technical Information	1SDC200023D0209
Declaration of Conformity - CE	9AKK106713A5546
Environmental Information	Not Available
Instructions and Manuals	1SDH000999R0002
Instructions and Manuals (Part 2)	1SDH001316R1002

Classifications

ETIM 4	EC000228 - Power circuit-breaker for trafo/generator/installation prot.
ETIM 5	EC000228 - Power circuit-breaker for trafo/generator/installation prot.
ETIM 6	EC000228 - Power circuit-breaker for trafo/generator/installation prot.
ETIM 7	EC000228 - Power circuit-breaker for trafo/generator/installation protection
Object Classification Code	Q
WEEE Category	5. Small Equipment (No External Dimension More Than 50 cm)

Categories

Low Voltage Products and Systems → Circuit Breakers → Air Circuit Breakers → Emax 2

STRABAG Infrastructure & Safety Solutions GmbH

MMRDA

004336

PRODUCT-DETAILS

E1.2N 1250 Ekip Hi-Touch LSIG 4p WMP

E1.2N 1250 Ekip Hi-Touch LSIG 4p WMP

General Information

Extended Product Type	E1.2N 1250 Ekip Hi-Touch LSIG 4p WMP
Product ID	1SDA072829R1
EAN	8015644766795
Catalog Description	E1.2N 1250 Ekip Hi-Touch LSIG 4p WMP
Long Description	MOVING PART FOR C.BREAKER SACE EMAX2 E1.2N 1250 FOUR-POLE WITH SOLID-STATE RELEASE IN AC EKIP/HI-TOUCH-LSIG R 1250 FITTED WITH: 4 AUXILIARY CONTACT AND C.BREAKER IN POSITION OPEN-CLOSED

Ordering

EAN	8015644766795
Minimum Order Quantity	1 piece
Customs Tariff Number	85362090

Dimensions

Product Net Width	348 mm
Product Net Height	363.5 mm
Product Net Depth / Length	271 mm
Product Net Weight	20 kg

Container Information

STRABAG Infrastructure & Safety Solutions GmbH

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Package Level 1 Units	1 piece
Package Level 1 Width	350 mm
Package Level 1 Height	350 mm
Package Level 1 Depth / Length	330 mm
Package Level 1 Gross Weight	23 kg
Package Level 1 EAN	8015644766795

Environmental

RoHS Status	Following EU Directive 2011/65/EU and Amendment 2015/863 July 22, 2019

Additional Information

Current Type	AC
Electrical Durability	Ue =< 440 V 8000 cycle Ue = 500 ... 690 V 6500 cycle 30 cycles per hour
Mechanical Durability	20000 cycle 60 cycles per hour
Neutral Pole Current ([% Iu])	100 %
Number of Poles	4
Power Loss	244 W
Product Main Type	SACE Emax 2
Product Name	Air Circuit Breaker
Product Type	Air Circuit Breaker
Rated Service Short-Circuit Breaking Capacity, in % of Icu (I_{cs})	100 %
Rated Current (I_n)	1250 A
Rated Voltage (U_r)	690 V
Rated Impulse Withstand Voltage (U_{imp})	acc. to IEC 60947-2 12 kV
Rated Insulation Voltage (U_i)	AC 1000 V
Rated Operational Voltage	690 V AC
Rated Service Short-Circuit Breaking Capacity (I_{cs})	(220 V AC) 66 kA (230 V AC) 66 kA (380 V AC) 66 kA (400 V AC) 50 kA (415 V AC) 50 kA (440 V AC) 50 kA (500 V AC) 50 kA (660 V AC) 50 kA (690 V AC) 50 kA
Rated Short-time Withstand Current (I_{cw})	for 1 s 50 kA for 3 s 30 kA
Rated Ultimate Short-Circuit Breaking Capacity (I_{cu})	(400 V AC) 66 kA (415 V AC) 66 kA (440 V AC) 66 kA (500 V AC) 50 kA (525 V AC) 50 kA (690 V AC) 50 kA
Rated Uninterrupted Current (I_u)	1250 A
Release	Ekip Hi-Touch LSIG
Release Type	EL
Short-Circuit	N

Performance Level	
Standards	IEC
Sub-type	E1.2
Version	W

Certificates and Declarations (Document Number)

Data Sheet, Technical Information	1SDC200023D0209
Declaration of Conformity - CE	9AKK106713A5546
Environmental Information	Not Available
Instructions and Manuals	1SDH000999R0002
Instructions and Manuals (Part 2)	1SDH001316R1002

Classifications

ETIM 4	EC000228 - Power circuit-breaker for trafo/generator/installation prot.
ETIM 5	EC000228 - Power circuit-breaker for trafo/generator/installation prot.
ETIM 6	EC000228 - Power circuit-breaker for trafo/generator/installation prot.
ETIM 7	EC000228 - Power circuit-breaker for trafo/generator/installation protection
Object Classification Code	Q
WEEE Category	5. Small Equipment (No External Dimension More Than 50 cm)

Categories

Low Voltage Products and Systems → Circuit Breakers → Air Circuit Breakers → Emax 2

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PRODUCT-DETAILS

E2.2S/E9 2000 Ekip Hi-Touch LSIG 4p WMP

E2.2S/E9 2000 Ekip Hi-Touch LSIG 4p WMP

General Information

Extended Product Type	E2.2S/E9 2000 Ekip Hi-Touch LSIG 4p WMP
Product ID	1SDA104460R1
EAN	8015644065409
Catalog Description	E2.2S/E9 2000 Ekip Hi-Touch LSIG 4p WMP
Long Description	MOVING PART FOR C.BREAKER SACE EMAX2 E2.2S 2000 FOUR-POLE WITH SOLID-STATE RELEASE IN AC EKIP/HI-TOUCH-LSIG R 2000 FITTED WITH: 4 AUXILIARY CONTACT AND C.BREAKER IN POSITION OPEN-CLOSED 900V

Ordering

Minimum Order Quantity	1 piece
Customs Tariff Number	85362090
Country of Origin	Italy (IT)

Popular Downloads

Data Sheet, Technical Information	1SDC200023D0209
Instructions and Manuals	1SDH001000R0002

Dimensions

Product Net Width	407 mm

STABAG Infrastructure & Safety Solutions GmbH

MMRDA

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Product Net Height	425 mm
Product Net Depth / Length	383 mm
Product Net Weight	55 kg

Technical

Rated Impulse Withstand Voltage (U_{imp})	acc. to IEC 60947-2 12 kV
Rated Insulation Voltage (U_i)	AC 1000 V
Rated Operational Voltage	900 V AC
Rated Short-Circuit Making Capacity (I_{cm})	(800 V AC) 105 kA (900 V AC) 105 kA
Rated Short-time Withstand Current (I_{cw})	for 1 s 50 kA for 3 s 50 kA
Power Loss	450 W
Standards	IEC
Number of Poles	4
Mechanical Durability	25000 cycle 60 cycles per hour

Environmental

RoHS Status	Following EU Directive 2011/65/EU and Amendment 2015/863 July 22, 2019
Environmental Information	ROHS, REACH

Certificates and Declarations (Document Number)

Declaration of Conformity - CE	9AKK107680A4888
Environmental Information	ROHS, REACH
Instructions and Manuals	1SDH001000R0002
Instructions and Manuals (Part 2)	1SDH001316R1002

Container Information

Package Level 1 Units	1 piece
Package Level 1 Width	515 mm
Package Level 1 Depth / Length	515 mm
Package Level 1 Height	610 mm
Package Level 1 Gross Weight	53 kg
Package Level 1 EAN	8015644065409

Classifications

Object Classification Code	Q
ETIM 6	EC000228 - Power circuit-breaker for trafo/generator/installation prot.
ETIM 7	EC000228 - Power circuit-breaker for trafo/generator/installation protection

STRABAG Infrastructure & Safety Solutions GmbH

MMRDA

2280

ETIM 8	EC000228 - Power circuit-breaker for trafo/generator/installation protection
WEEE Category	5. Small Equipment (No External Dimension More Than 50 cm)

Categories

Low Voltage Products and Systems → Circuit Breakers → Air Circuit Breakers → Emax 2

Low Voltage Products and Systems → Industries → Solar power → 800V AC

KEI

Wires and Cables

ONE STOP SOLUTION FOR WIRES AND CABLES

TECHNICAL HANDBOOK

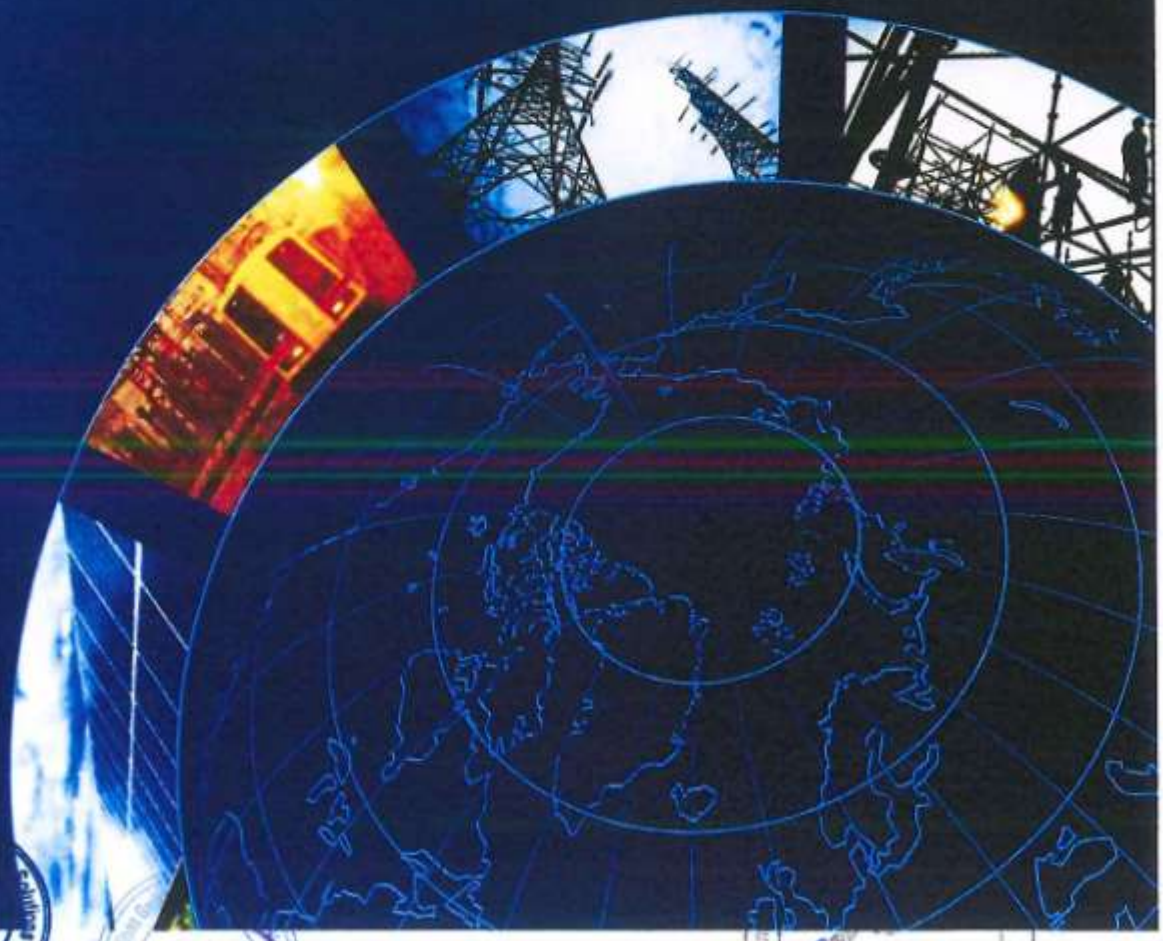

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Chart: Cable Selection Guide (Material Comprison Chart) Handling & Storage

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KEI
Wires and Cables

Corporate Information

Board of Directors
Mr. Anil Gupta, Chairman-cum-Managing Director
Mrs. Archana Gupta, Director
Mr. Pawan Kr. Bhalotia, Director
Mr. K G Somani, Director
Mr. Vijay Bhushan, Director
Mr. Vikram Bhartia, Director
Mr. Rajeev Gupta, Executive Director & CFO (Finance)

Bankers
Dena Bank
Punjab National Bank
ING Vysya Bank
State Bank of Hyderabad
ICICI Bank Ltd
Standard Chartered Bank
State Bank of Patiala
State Bank of Bikaner & Jaipur
Indian Overseas Bank
Corporation Bank
DCB Bank Limited
IDBI Bank Limited
Lakshmi Vilas Bank Ltd
State Bank of India
Bank of India

Year of Establishment
1968

Type of Company
PUBLIC LIMITED

Income Tax (PAN) No.
AAACK0251C

CIN No: L74899DL1992PLC051527

PF Regd. No:

Delhi	DL-2330
Bhiwadi	RJ/8348 Dt.26.12.1996
Silvassa	GJ/VAPI/45769 Dt.9.11.2001
Chopanki	RJ/19828 Dt. 12/09/2008

Factory Regd. No.

Bhiwadi	RJ/22219
Silvassa	GJ/1472
Chopanki	RJ/28507

Excise Regd. No.

Bhiwadi	AAACK0251CXM002
Silvassa	AAACK0251CXM003
Chopanki	AAACK0251CXM004

Factory Area

Bhiwadi	52447 sq. mtrs. (Covered)
Silvassa	14595 sq. mtrs. (Covered)
Chopanki	19188 sq. mtrs. (Covered)
Total Built-up area	102260 sq. mtrs.

TIN No.

Bhiwadi	08600850088-Dt. 18/1/1996
Silvassa	26900003620-Dt. 31/12/1999
Chopanki	08600850088-Dt. 18/1/1996

Organization Strength — Total Nos. 3580

Managerial	460
Supervisory	204
Office Staff	266
Workmen	2650

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KEI at a Glance

Business

Established with the vision of changing the landscape of the electrical cable & wire industry in India, KEI has been a leader in the cables and wires industry for over 40 years. With a sharp focus on quality and service, the Company has been able to overcome challenges by adopting latest business practices and innovations in technology to deliver maximum value to its customers. Over the years, KEI has carved a niche for itself in the market. Its superior quality and service resonates the trust that its customers have placed in the Company. Backed by state-of-the-art technology and infrastructure, KEI, today, has a vast product portfolio ranging EHV, HT, LT and specialized Power, Control and Instrumentation cables along with vast range of Rubber Cables.

History

Established in 1968 as a partnership firm under the name Krishna Electrical Industries, with the prime focus of manufacturing cables for the Department of Telecommunications (DoT), the firm was later converted into a public limited company under the abbreviated trade name KEI Industries Limited. In the following years, KEI acquired Matchless Status as a company engaged in the manufacture of stainless steel wires and other electrical wires and cables. In 2010 KEI set foot into the manufacturing of EHV cables (up to 220 kV) in collaboration with Brugg Cables, a century old Swiss company. Since then, KEI has continuously received the Superbrand Award for Industry and Consumer Validation, each year. Also, KEI has been continuously rated for good corporate governance by CARE, since 2007.

Verticals & Clientele

KEI supplies a range of cables to a number of industries such as power, petrochemical, cement, steel, infrastructure telecommunication and fertilizer industries, among others. KEI is a registered vendor for both Indian and overseas EPC contractors like ABB, Siemens, BHEL, Areva, Alstom and McDermott to name a few and is registered as a vendor for more than 200 large Indian companies encompassing almost all industrial sectors.

Services

In addition to electrical cable and wire manufacturing, KEI has diversified its operations and now has a fully established EPC Division to execute turnkey projects for various utilities. KEI offers a comprehensive range of services, including engineering, consultancy and project management, ranging from conceptualising to commissioning for core sectors like Power (including renewable energy), Railways, Refineries, Petrochemicals, Mining, Cement, Steel, etc. It provides end-to-end customer solutions from engineering to designing, supply and installation of products.

Manufacturing

KEI has created a large infrastructure by strategically locating its three manufacturing units over a built-up area of 1022e0 sq. mtrs. presently however further expansion plans are in pipeline. KEI has three manufacturing units located at Bhiwadi, Chopanki and Silvassa. The current capacity stands at 48,00,000 kg per annum for stainless steel wire division, 9,500 km per annum for HT cables, 35,000 km per annum for LT power cables, 18,000 km per annum for control cables, 10,000 km per annum for instrumentation cables, 6,000 km per annum for rubber cable and 5,00,000 km per annum for house wires/flexible wires. To meet the increased demand for its products emanating from the power, industrial, infrastructure and housing and construction sectors, the company has planned a capacity expansion program for all of its products.

Exports

The company enjoys a presence across almost 60 countries. Algeria, Mozambique, Russia, Yemen, Australia, Bangladesh, Canada, Congo, Cyprus, Ethiopia, France, Ghana, Germany, Italy, Iran, Iraq, Indonesia, Japan, Kenya, Mauritius, Mexico, Nigeria, New Zealand, Philippines, Qatar, Sri Lanka, Saudi Arabia, Singapore, South Africa, Switzerland, Tanzania, UAE, Uganda, UK, USA, Vietnam, West Indies & Zambia. The company drives almost 20% of its revenue from the overseas market.

Performance

Financial Performance of the Company

Particulars	01.04.15 to 31.03.16 (₹ in Lakh)	01.04.15 to 31.03.16 ($ in Million)	01.04.14 to 31.03.15 (₹ in Lakh)	01.04.14 to 31.03.15 ($ in Million)	01.04.13 to 31.03.14 (₹ in Lakh)	01.04.13 to 31.03.14 ($ in Million)	01.04.12 to 31.03.13 (₹ in Lakh)
Sales & Other Income	233,092.74	388.49	203,333.55	338.89	162,018.64	270.03	166,070.75
Profit Before Interest, Depreciation & Taxes	24,760.45	41.26	19,786.24	32.98	15,432.05	25.72	17,287.46
Less: Financial Charges	12,697.46	21.16	12,039.49	20.07	11,153.06	18.59	10,925.37
Less: Depreciation	2,528.61	4.21	2,458.49	4.10	2,097.35	3.50	2,044.48
Profit Before Tax	9,534.38	15.89	5,287.95	8.81	2,181.64	3.63	4,307.61
Provision for Taxation							
- Current Tax	3,289.59	5.48	1113.27	1.86	459.97	0.77	850.98
- Deferred Tax	1,270.75	2.12	750.15	1.25	547.10	0.91	822.85
- Provision Earlier Years	(0.03)	(0.00)	(0.42)	0.00**	14.49	0.02	0.38
Profit After Tax	4,220.22	10.37	3,424.95	5.71	1,160.08	1.93	2,633.70

Note: The dollar rate considered for conversion is $1= (INR 60

** Values appearing as 0 due to conversion

KEI Product Range

KEI has been a pioneer in design and manufacture of high-performance cables and wires. Its vast portfolio ,apart from EHV cables up to 400 kV, MV (medium voltage) and HT cables also includes control and instrumentation cables, rubber cables, thermocouple cables, zero halogen cables, braided cables, single and multi core flexible cables, housewire and stainless steel wires. By actively responding to changing customer demands and expectations, the company has expanded its distribution network and strengthened existing industrial product vertical.

KEI's Product Range

- EHV Cables up to 400 kV
- HT Cables up to 33 kV- Dry Cured Process
- LT Power Cables-Copper / Aluminium Conductor PVC, XLPE & EPR
- LT Control Cables-Copper PVC, XLPE & EPR
- Screened / Unscreened Type PVC/PE/EPR/XLPE Instrumentation Cables
- Flexible & Housewires (Single & Multicore)
- Elastomeric (Rubber) Cables
- Railway Signaling Cables
- Fire Survival, Zero Halogen Cables
- Dry Filled Telephone Cables
- Automatic Cables
- Welding Cables
- Submersible Cables / Winding Cables
- Ship Wiring Cable
- Mining Cable-Rubber as per IS 14494 & PVC
- Cables for Offshore Installation
- Cables for Defence
- AB Cables

ISO CERTIFICATES

DNV

DNV BUSINESS ASSURANCE

MANAGEMENT SYSTEM CERTIFICATE

Certificate No. 98090-2011-AE-IND-RvA Rev. 01

This is to certify that

KEI Industries Ltd

at

Unit 1: 919, 920, 922, RIICO Industrial Area, Phase III, Bhiwadi - 301 019, District Alwar, Rajasthan, INDIA
Unit 2: 99/2/7, Madhuban Industrial Estate, Rakholi, Silvassa - 396 230, Dadra & Nagar Haveli, INDIA
Unit 3: 280 - 284, Chopanki Industrial Area, Bhiwadi - 301 019, District Alwar, Rajasthan, INDIA

has been found to conform to the Environmental Management System Standard:

ISO 14001:2004

This certificate is valid for the following scope:

MANUFACTURE AND SUPPLY OF ALL TYPE OF CABLES, WIRES & CONDUCTORS VIZ. HT / EHV & LT POWER, CONTROL, INSTRUMENTATION, THERMOCOUPLES, ELASTOMERIC CABLES, WINDING & FLEXIBLE WIRES AND STAINLESS STEEL WIRES FOR WIDE RANGE OF APPLICATIONS

Initial certification date: 30 June 2011

This certificate is valid until: 29 June 2017

The audit has been performed under the supervision of

Balwant Rai
Lead Auditor

Place and date of issue: Chennai, 17 June 2014

for the Accredited Unit: DNV Business Assurance ... B.V., The Netherlands

Sivadasan Madiyath
Management Representative

RvA
MGMT SYS
RvA C 074

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DNV BUSINESS ASSURANCE

MANAGEMENT SYSTEM CERTIFICATE

Certificate No: 1385-2007-AQ-IND-RvA Rev. 04

This is to certify that

KEI Industries Ltd

at

Regd. Office: D - 90, Okhla Industrial Area, Phase I, New Delhi - 110 020, INDIA
Unit 1: 919, 920, 922, RIICO Industrial Area, Phase III, Bhiwadi - 301 019, District: Alwar, Rajasthan, INDIA
Unit 2: 90 / 2 / 7, Madhuban Industrial Estate, Rakholi, Silvassa - 396 230, Dadra & Nagar Haveli, INDIA
Unit 3: 280 - 284, Chopanki Industrial Area, Bhiwadi - 301 019, District: Alwar, Rajasthan, INDIA

has been found to conform to the Quality Management System Standard

ISO 9001:2008

This certificate is valid for the following scope

MANUFACTURE AND SUPPLY OF ALL TYPE OF CABLES, WIRES & CONDUCTORS VIZ. HT / EHV & LT POWER, CONTROL, INSTRUMENTATION, THERMOCOUPLES, ELASTOMERIC CABLES, WINDING & FLEXIBLE WIRES AND STAINLESS STEEL WIRES FOR WIDE RANGE OF APPLICATIONS

Initial certification date
12 December 2000

This certificate is valid until
29 June 2017

Place and date of issue
Chennai, 17 June 2014

for the Accredited Unit:
DET NORSKE VERITAS CERTIFICATION B.V.
The Netherlands

MGMT SYS
RvA C 374

The validity has been performed under the supervision of

Balwant Rai
Lead Auditor

Sivadasan Madhvath
Management Representative

Lack of fulfilment of conditions as set out in the Certification Agreement & the assessment for the certificate may render this Certificate invalid.

DNV BUSINESS ASSURANCE

MANAGEMENT SYSTEM CERTIFICATE

Certificate No: 989581-2011-HSO-IND-DNV Rev. 01

This is to certify that

KEI Industries Ltd

at

Unit 1: 919, 920, 922, RIICO Industrial Area, Phase III, Bhiwadi - 301 019, District: Alwar, Rajasthan, INDIA
Unit 2: 90 / 2 / 7, Madhuban Industrial Estate, Rakholi, Silvassa - 396 230, Dadra & Nagar Haveli, INDIA
Unit 3: 280 - 284, Chopanki Industrial Area, Bhiwadi - 301 019, District: Alwar, Rajasthan, INDIA

has been found to conform to the Occupational Health and Safety Management System Standard:

OHSAS 18001:2007

This certificate is valid for the following scope

MANUFACTURE AND SUPPLY OF ALL TYPE OF CABLES, WIRES & CONDUCTORS VIZ. HT / EHV & LT POWER, CONTROL, INSTRUMENTATION, THERMOCOUPLES, ELASTOMERIC CABLES, WINDING & FLEXIBLE WIRES AND STAINLESS STEEL WIRES FOR WIDE RANGE OF APPLICATIONS

Initial Certification date
30 June 2011

This Certificate is valid until
29 June 2017

Place and date of issue
Chennai, 17 June 2014

for the Certifying Unit
DNV BUSINESS ASSURANCE INDIA PVT. LTD.
MUMBAI, INDIA

DET NORSKE VERITAS
1864

The validity has been performed under the supervision of

Balwant Rai
Lead Auditor

Sivadasan Madhvath
Management Representative

Lack of fulfilment of conditions as set out in the Certification Agreement & the assessment for the certificate may render this Certificate invalid.

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NABL

National Accreditation Board for Testing and Calibration Laboratories

(An Autonomous Body under Department of Science & Technology, Govt. of India)

CERTIFICATE OF ACCREDITATION

KEI INDUSTRIES LTD. (QUALITY ASSURANCE LABORATORY)

has been assessed and accredited in accordance with the standard

ISO/IEC 17025:2005

"General Requirements for the Competence of Testing & Calibration Laboratories"

for its facilities at

SP-919, 920, 922, RIICO Industrial Area, Bhiwadi, Alwar, Rajasthan

in the discipline of

ELECTRICAL TESTING

(To see the scope of accreditation of this laboratory, you may also visit NABL website www.nabl-india.org)

Certificate Number T-1616

Issue Date 18/06/2015

Valid Until 17/06/2017

This certificate remains valid for the Scope of Accreditation as specified in the annexure subject to continued satisfactory compliance to the above standard & the additional requirements of NABL.

Signed for and on behalf of NABL

N. Venkateswaran
Program Manager

Anil Relia
Director

Prof. Ashutosh Sharma
Chairman

2287

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DNV·GL

Certificate No
E-14121
File No
827.20
Job Id
262.1-002361-2

TYPE APPROVAL CERTIFICATE

This is to certify:
That the Low Voltage Cable

with type designation(s)
BFOU (i) S3/S7 250 V, BFOU (c) S4/S8 250 V, BFCU(i) & (c) 250V. ,

Issued to
KEI Industries Ltd.
Mumbai DELHI, India

is found to comply with
Det Norske Veritas' Rules for Classification of Ships, High Speed & Light Craft and Det Norske Veritas' Offshore Standards
IEC 60092-376 (2003-05)
IEC 60331-21 (1999-04)
IEC 60332-3-22 (2009-02)
IEC 60754-1 (2011-11)
IEC 60754-2 (2011-11)
IEC 61034-1/2 (2013-07/2013-09)
NEK TS 606 (2009-05) (S-types only)

Application :
Instrumentation and communication.
Fire resistant. Flame retardant Cat. A. Halogen free. Low smoke. Mud resistant.

Type	Voltage class (V)	Temp. class (°C)
BFOU (i) S3/S7 250 V	250	90
BFOU (c) S4/S8 250 V	250	90
BFCU(i) & (c) 250V	250	90

This Certificate is valid until **2018-12-31**.
Issued at **Høvik** on **2015-03-23**

DNV GL local station: **Mumbai**

Approval Engineer: **Ludovico Gullifa**

for **DNV GL**

Marit Laumann
Head of Section

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DNV·GL

Certificate No.
6-14122
File No.
827.20
Job Id
262.1-002361-2

TYPE APPROVAL CERTIFICATE

This is to certify:
That the Low Voltage Cable

with type designation(s)
RFOU (i) S1/S5 250 V, RFOU (c) S2/S6 250V, RFCU(i) & (c),

Issued to
KEI Industries Ltd.
Mumbai DELHI, India

is found to comply with
Det Norske Veritas' Rules for Classification of Ships, High Speed & Light Craft and Det Norske Veritas' Offshore Standards
IEC 60092-376 (2003-05)
IEC 60332-3-22 (2009-02)
IEC 60754-1 (2011-11)
IEC 60754-2 (2011-11)
IEC 61034-1/2 (2013-07/2013-09)
NEK TS 606 (2009-05) (S-types only)

Application :
Instrumentation and communication.
Flame retardant Cat. A. Halogen free. Low smoke. Mud resistant.

Type	Voltage class (V)	Temp. class (°C)
RFOU (i) S1/S5 250 V	250	90
RFOU (c) S2/S6 250V	250	90
RFCU(i) & (c)	250	90

This Certificate is valid until **2018-12-31**
Issued at **Høvik** on **2015-03-23**

DNV GL local station: **Mumbai**

Approval Engineer: **Ludovico Gullifa**

for **DNV GL**
Marit Laumann
Head of Section

DNV·GL

Certificate No.
6-14123
File No.
827.10
Job Id
262.1-002361-2

TYPE APPROVAL CERTIFICATE

This is to certify:
That the Electric Power Cable

with type designation(s)
BFOU PS/P12 0,6/1 kV, BFCU 0,6/1kV, BFOU VFD 0,6/1 kV,

Issued to
KEI Industries Ltd.
Mumbai DELHI, India

is found to comply with
Det Norske Veritas' Rules for Classification of Ships, High Speed & Light Craft and Det Norske Veritas' Offshore Standards
IEC 60092-353 (2011-08)
IEC 60331-21 (1999-04)
IEC 60332-3-22 (2009-02)
IEC 60754-1 (2011-11)
IEC 60754-2 (2011-11)
IEC 61034-1/2 (2013-07/2013-09)
NEK TS 606 (2009-05) (P-types only)

Application :
General power and lighting.
Fire resistant. Flame retardant Cat. A. Halogen free. Low smoke. Mud resistant.

Type	Voltage class (kV)	Temp. class (°C)
BFOU PS/P12 0,6/1 kV	0,6/1	90
BFCU 0,6/1kV	0,6/1	90
BFOU VFD 0,6/1 kV	0,6/1	90

This Certificate is valid until **2018-12-31**
Issued at **Høvik** on **2015-03-23**

DNV GL local station: **Mumbai**

Approval Engineer: **Ludovico Gullifa**

for **DNV GL**
Marit Laumann
Head of Section

KEI WIRES & CABLES

DNV·GL

TYPE APPROVAL CERTIFICATE

Certificate No:
E-14124
File No.
827.10
Job Id:
262.1-002361-2

This is to certify:
That the Electric Power Cable

with type designation(s)
RFOU P1/P8 0,6/1 kV, RFCU 0,6/1 kV, RFOU-VFD 0,6/1 kV,

Issued to
KEI Industries Ltd.
Mumbai DELHI, India

is found to comply with
Det Norske Veritas' Rules for Classification of Ships, High Speed & Light Craft and Det Norske Veritas' Offshore Standards
IEC 60092-353 (2011-08)
IEC 60332-3-22 (2009-02)
IEC 60754-1 (2011-11)
IEC 60754-2 (2011-11)
IEC 61034-1/2 (2013-07/2013-09)
NEK TS 606 (2009-05) (P-types only)

Application :
General power and lighting.
Flame retardant Cat. A. Halogen free. Low smoke. Mud resistant.

Type	Voltage class (kV)	Temp. class (°C)
RFOU P1/P8 0,6/1 kV	0,6/1	90
RFCU 0,6/1 kV	0,6/1	90
RFOU-VFD 0,6/1 kV	0,6/1	90

This Certificate is valid until **2018-12-31**
Issued at **Høvik** on **2015-03-23**

DNV GL local station: **Mumbai**

Approval Engineer: **Ludovico Gullifa**

for DNV GL

Marit Laumann
Head of Section

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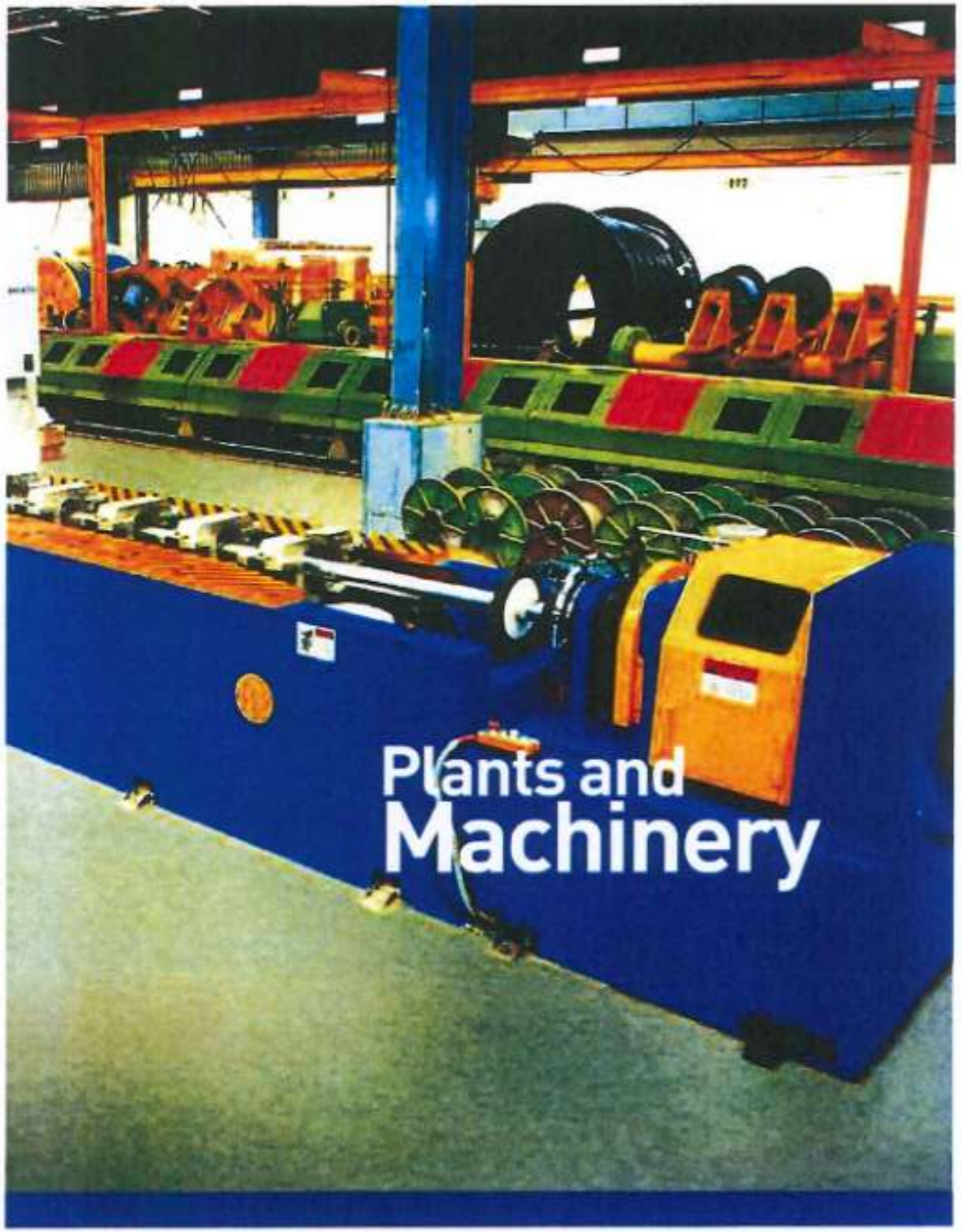


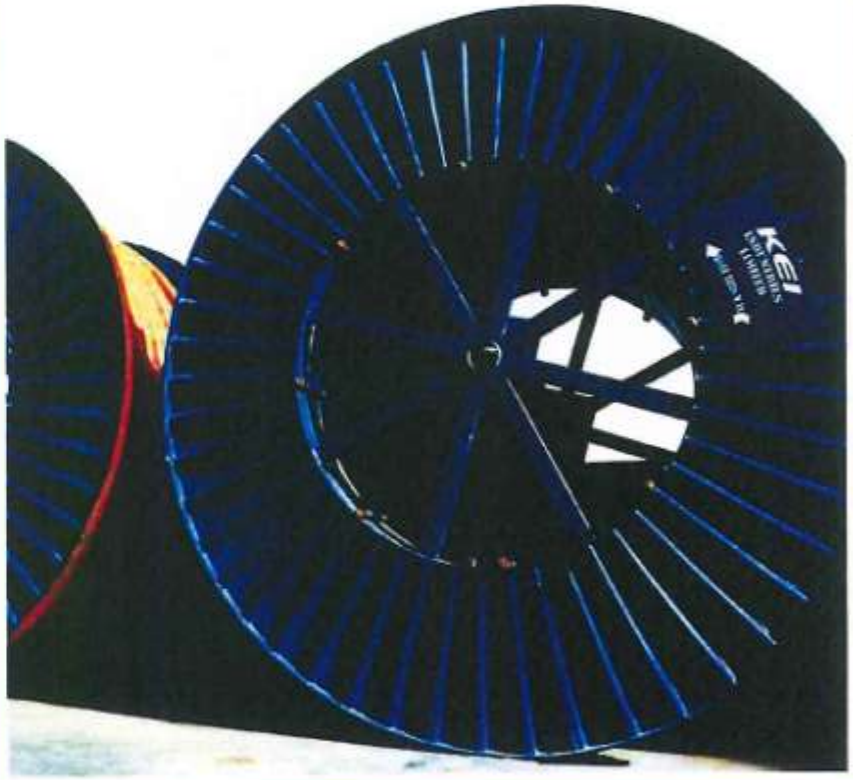
004343

LIST OF PLANT MACHINERY, CHOPANKI

SR.	NAME OF MACHINE	MAKE/COUNTRY
1	WIRE DRAWING MACHINE WITH ONLINE NIEHOFF ANNEALER (RBD) (CU)	1/ RBD CU /NIEHOFF
2	WIRE DRAWING MACHINE(RBD) (AL)	2/ AL/ Indian
3	DUAL HEAD WIRE DRAWING MACHINE WITH ONLINE NIEHOFF ANNEALER	1/ Dual Wire/ NIEHOFF
4	HIGH SPEED BUNCHING MACHINE WITH 630MM PAYOFF SPOOL	1/ Buncher NIEHOFF,India
5	7-BOBBIN BOW TWISTER -I	1/ Indian
6	7 BOBBIN STRANDING MACHINE	1/Indian
7	37 (1+6+12+18) BOBBIN STRANDING MACHINE	2/ 19 & 37/Indian
8	61 (1+6+12+18+24) BOBBIN STRANDING MACHINE	1/ 61/ CHINA
9	45 MM COMPLETE EXTRUSION LINE	1/Indian
10	60 B SCREENING MACHINE	1/ Indian
11	60+120 MM COMPLETE DUAL EXTRUSION LINE FOR BI-COLOUR	1/ Indian
12	100 MM COMPLETE EXTRUSION LINE	1/Indian
13	LEAD EXTRUDER	1/Sweden
14	150 MM COMPLETE EXTRUSION LINE	1/Indian
15	7 BOBBIN BOW TWISTER-II	1/Indian
16	DRUM TWISTER	1/Indian
17	3+1 LAYING UP MACHINE	1/Indian
18	1+6 LAYING UP MACHINE	1/Indian
19	48 BOBBIN ARMOURING MACHINE - I	1/Indian
20	48 BOBBIN ARMOURING MACHINE-II	1/Indian
21	60 BOBBIN ARMOURING MACHINE	1/Indian
22	96 BOBBIN ARMOURING MACHINE	1/Indian
23	SPOOLING MACHINE-I	8/ Indian
24	CABLE REWINDING MACHINE - I	5/ Indian
25	BOILER	2/ Indian
26	WATER TANK FOR CURING/HV TEST	1/Indian
27	E.O.T. CRANE - I	4/Indian
28	COMPRESSOR - I	3/Indian
29	AIR DRYER UNIT	1/Indian
30	D.G. SET - I (500 KVA)	1/Indian
31	D.G. SET - II (1110 KVA)	1/USA
32	RO SYSTEM	1/Indian
33	WATER SOFTNER	1/Indian
34	COOLING TOWERS - I	2/ Indian
35	MOBILE CRANE	1/Indian
36	FORK LIFTER	1/Indian
37	UPS	1/Indian
38	CCV LINE 90MM+200MM+90MM	1/German

LIST OF PLANT MACHINERY, CHOPANKI

SR.	NAME OF MACHINE	MAKE/COUNTRY
39	33 B Laying up machine	1/Indian
40	60+175MM COMPLETE DUAL EXTRUSION LINE FOR BI-COLOUR	1/Indian
41	ALUMINIUM CORRUGATION	1/Imported
42	SHIELDING MACHINE	1
43	NITROGEN GENERATOR	1/Indian
44	WATER CHILLER	3/Indian
45	GOODS LIFT	2/ Indian
46	PASSENGER LIFT	1/Indian
47	EOT CRANE	3/5,6,7/ Indian
48	PORTABLE CRANE	1/Indian



LIST OF PLANT MACHINERY, (RUBBER PLANT) BHIWADI

SR.	NAME OF MACHINE	NO. OF MACHINES/ CAPACITY/ MAKE
1	KNEADER	2/ 35 LTRS / India
2	TWO ROLL MILL	2/ 14"X36" / India
3	TWO ROLL MILL	1/ 16"X42" / India
4	TWO ROLL MILL	1/ 11"X22" / India
5	HOT FEED EXTRUDER	1/ 75MM/ India
6	HOT FEED EXTRUDER	1/ 115MM, India
7	COLD FEED EXTRUDER	1/ 120MM, India
8	SILICONE EXTRUDER	1/ 65MM/ India
9	PVC EXTRUDER	1/ 65MM/ India
10	CV LINE	1/ 90MM/ French
11	CV LINE	1/ 60MM/ Imported
12	CCV LINE	1/ 90+120MM/ Imported
13	TAPING HEAD (HORIZONTAL)	1/ 3 HEAD, India
14	TAPING HEAD (HORIZONTAL)	2/ 1 HEAD, India
15	TAPING HEAD	1/ 2 HEAD, India
16	CABLE REWINDER M/C + INKJET PRINTING M/C	2/ Willet UK
17	37 BOBBIN STRANDING /LAYING MACHINE	1/ 560MM/ India
18	7 BOBBIN MACHINE	1/ 560mm India
19	BUNCHER	1/ 630mm India
20	BUNCHER	2/ 560mm India
21	BUNCHER	2/ 400mm India
22	BRAIDING M/C	4/ 16 CARRIER, Imported
23	BRAIDING M/C	1/ 24 CARRIER, Imported
24	BRAIDING M/C	1/ 16 CARRIER, India
25	BRAIDING M/C	2/ 36 CARRIER, India
26	BRAIDING M/C	4/ 24 CARRIER/ USA
27	BRAIDING M/C	1/ 24 CARRIER, India
28	BRAIDING M/C	1/ 16 CARRIER, India
29	BRAIDING M/C	1/ 16 CARRIER, Imported
30	BRAIDING M/C	1/ 24 CARRIER, Imported
31	SPOOLING M/C	3/ 20"/24" / India
32	SPOOLING M/C	1/ 20"/24"/25" / India
33	SPOOLING M/C	1/ 25" / India
34	VULCANIZING CHAMBER	1/ 8'X6' / India
35	VULCANIZING CHAMBER	1/ 8'X12' / India
36	VULCANIZING CHAMBER	1/ 2.7X4.5 MTR, India
37	VERTICAL LAPPING	2/ 2HEAD/ Imported
38	VERTICAL LAPPING	1/ 3HEAD/ Imported

LIST OF PLANT MACHINERY, (RUBBER PLANT) BHIWADI

SR.	NAME OF MACHINE	NO. OF MACHINES/ CAPACITY/ MAKE
39	STEAM BOILER	1/ 2000 L/HR./ India
40	PAIR TWISTER	1/ 560MM/ India
41	SLITTING MACHINE	1/ 1MTR/ India
42	BOBBIN REWINDER WARDWELL	1/ 2 HEAD/ USA
43	BOBBIN REWINDER	1/ 2 HEAD/ Imported
44	BOBBIN REWINDER SHIDHANA	1/ 1 HEAD/ India
45	BOBBIN REWINDER-4 KEI	4/ 1 HEAD/ India
46	BANBURY INTERMIX	1/ 35 LIT/ India

LIST OF PLANT MACHINERY (SP-922) CONTROL DIVISION BHIWADI

SR.	NAME OF MACHINE	NO. OF MACHINES/ CAPACITY/ MAKE
1	Wire Drawing	1/ 2-wire/17-die/ Niehaff (Germany)
2	Wire Drawing	2/ 1-wire/17-die/ India
3	Buncher	2/ 8 bobbin/630mm/ India
4	Buncher	2/ 7 bobbin/630mm/ India
5	Buncher	6/ 7 bobbin/400mm/ India
6	Buncher	1/ 7 bobbin/250mm/ India
7	Buncher	1/ 8 bobbin/400mm/ India
8	Buncher	1/ 9 bobbin/400mm/ India
9	Buncher	1/ 10 bobbin/400mm/ India
10	Extruder-Insulation	2/ 60mm+38 Dual/ India
11	Extruder-Insulation	1/65mm/ India
11	Extruder-Insulation	1/ 50mm/ India
14	Pair Twist Buncher	4/ 630mm/ India
15	Shielding	5/ 630mm/ India
16	Laying	1/ 1+3/560mm/ India
17	Laying	1/ 1+6/400mm/ India
18	Roller Twister-630	1/ 630mm/ France
19	Laying	1/ 12+18/630mm/ India
20	Laying	1/ 19/630mm/ India
21	Laying	1/ 14/600mm/ India
22	Laying	1/ 12+18/400mm/ India
23	Drum Twister	1/ 1600mm/ India
24	Extruder	1/ 80mm/ India
25	Extruder	1/ 90mm/ India
26	Armouring	1/ 42 bobbin/400mm/ India
27	Armouring	1/ 64 bobbin/400mm/ India
28	Armouring	1/ 48 bobbin/400mm/ India

LIST OF PLANT MACHINERY (SP-922) CONTROL DIVISION BHIWADI

SR.	NAME OF MACHINE	NO. OF MACHINES/ CAPACITY/ MAKE
29	Armouring	1/ Double head taping m/c/ India
30	Armouring	1/ 24 bobbin/400mm/ India
31	Armouring	1/ 40 bobbin/400mm/ India
32	Extruder	1/ 120mm/ India
33	Extruder	1/ 80mm/ India
34	Extruder	1/ 45mm/ India
35	Extruder	1/ 50mm/ India
36	Cable Rewinder	5/ 2200mm/ India
37	Cable Rewinder (tape)	1/ 2200mm/ India
39	GI Rewinder	13/ 400mm/ India
40	Core Rewinder	10/ 630mm/ India
41	Auto Core Rewinder	4/ 630mm/ India
42	Conductor Rewinder	4/ 630mm/ India
CONDUCTOR DIVISION		
1	RBD (AL)	2/ RBD- 13 Die/ Indian
2	RBD (AL)	2/ RBD- 11 Die/ Indian
3	RBD (CU) with Annealer	1/ RBD -11 Die with Annealer CU/ Germany
4	Wire Drawing (Cu.)	1/ 16 Die/CU/ Indian
5	Wire Drawing (Cu.)	1/ 19 Die/CU/ Indian
6	Wire Drawing (AL)	1/ 17-Die/ AL/ Indian
7	61 -Str. Machine	2/ 61-bobbin/ Indian
8	97 -Str. Machine	1/ 97-bobbin/ Indian
9	37 -Str. Machine	2/ 37-bobbin/ Indian
10	19 -Str. machine	1/ 19-bobbin/ Indian
11	Skip	1/ 7-bobbin/ Indian
12	Tubular	1/ 7-bobbin/200mm/ Indian
13	Wire Rewinder	2/ 630mm/ Indian
14	Conductor Rewinder	1/ 2200mm/ Indian
15	Tinning machine	1/ Italian
UTILITY DIVISION		
1	DG set	1/ 1110 kVA/ Cummins (India)
2	DG set	1/ 1010 kVA/ Cummins (India)
3	Compressor	3/ 18.5 kW/100 CFM/ ELGI (India)
4	Goods lift	2/ 7.5 ton/ Real (India)
5	Goods lift	1/ 2.0 ton/ Globe (India)
6	Passenger Lift	1/ 680 kg/ KONE (India)

LIST OF PLANT MACHINERY (SP-919) CONTROL CABLE BHIWADI

SR.	NAME OF MACHINE	NO. OF MACHINES/ CAPACITY/ MAKE
1	CU-Std 16*-1	3/ 400mm/ India
2	65MM EXT	1/ 65mm/ India
3	65MM EXT-2	1/ 66 mm/ India
4	Pair Twister-1	2/ 400mm/ India
5	Laying 3+1	1/ 4B/530 mm/ India
6	Shielding 1+1	2/ 560 mm/ India
7	Laying - 12 B.	1/ 630 mm/ India
8	Laying - 19 B.	1/ 630 mm/ India
9	40B Arm	1/ 400 mm/ India
10	24B Arm	1/ 400 mm/ India
11	100 MM EXT	2/ 100 mm/ India
12	Cable Rewinder	18 Numbers

LIST OF PLANT MACHINERY, HT & EHV BHIWADI

SR.	NAME OF MACHINE	NO. OF MACHINE/ M/C SIZE/CAPACITY/ MAKE
1	CCV LINE	1/ 65+150+90 MM/ Germany
2	SID PLAS LINE	1/ 60+120+80 MM/ India
3	COPPER TAPING MACHINE	10 Numbers
4	DOUBLE STEEL TAPE	—
5	DRUM TWISTER	1/ 3150 MM/ India
6	LAYING MACHINE	1/ 1600 MM / (3+1)/ India
7	EXTRUDER	1/ 120 MM/ India
8	ARMOURING MACHINE	1/ 64B / 560 MM/ India
9	ARMOURING MACHINE	1/ 54B / 560 MM/ India
10	ARMOURING MACHINE	1/ 80B / 560 MM/ India
11	ARMOURING MACHINE	1/ 80B / 560 MM/ Imported
12	EXTRUDER	1/ 120+45 MM/ India
13	EXTRUDER	1/ 150MM/ India
14	EXTRUDER	1/ 120MM/ India
15	CABLE REWINDING MACHINE	05 Number
16	ELECTRIC OVER HEAD TRAVELLING (CRANE)	3/ 15 TON/ India
17	ELECTRIC OVER HEAD TRAVELLING (CRANE)	2/ 10 TON/ India
18	MATERIAL LIFTS	2/ 3 TON/ India
19	D.G. SET	1/ 1250 kVA/ India
20	D.G. SET	1/ 500 kVA/ India
21	BOILER	1/ 600KG/Hr/ India
22	NITROGEN GENERATOR	1/ 40 NM^3/Hr/ India
23	COMPRESSOR	3/ 57 M3/Hr/ India
24	UPS	4/ 250 kVA/ India
25	PASSENGER LIFT	1/ 450 KG/ Beacon

LIST OF PLANT MACHINERY, LT CABLE BHIWADI

SR.	NAME OF MACHINE	NO. OF MACHINES/ CAPACITY/ MAKE
1	AL. WIRE DRAWING MACHINE	1/ 11 DIE/ Niehoff (India)
2	[illegible]LER - I	1/ 07B (500MM)/ India
3	[illegible]/C	1/ 33B (500MM)/ India
4	[illegible] - M/C	1/ 43B(630MM)/ India
5	65-MM EXT. - I	2/ 65MM/ India
6	100MM EXT.	1/ 100MM/ India
7	120-MM EXT. - I	2/ 120MM/ India
8	150MM EXT.	1/ 150MM/ India
9	(3+1) - LAYING - I	1/ 3+1 , 48"/ India
10	DRUM TWISTER	1/ 3+1,84"/ India
11	36-B M/C (ARM.)	1/ 32B (500MM)/ India
12	48-B (ARM.) M/C	1/ 48B (400MM)/ India
13	54-B (ARM.) M/C	1/ 54MM (500MM)/ India
14	72-B (ARM.) M/C	1/ 72B (500MM)/ India
15	FURNACE	1/ 90KW/ India
16	WATER TANK &LPE CURRING	2/ 2.5X2.6X2.1M/ India
17	BOILER - I (KUMAR)	1/ 600KG/ India
18	PROGRESSIVE LENGTH MARKING	3/ 0000TO 9999/ India
19	E.O.T	3/ 7.5TON/ India
20	E.O.T	1/ 03TON/ India
21	E.O.T - (CARRYMORE)	1/ 05TON/ India
22	LIFT	1/ 02TON/ India
23	COMPRESSOR - I st (SCREW)	1/ 105CFM/ India
24	COMPRESSOR - II nd	2/ 80CFM/ India
25	D.G. 500 kVA	1/ 500 kVA/ India
26	UPS - I st	2/ 250 kVA/ India
27	CABLE REWINDER	7/(2200mm/2600mm/2200mm, 500mm)/ India
28	G.I. SPOOLING M/C.	8/ 500MM/ India
29	AL. STRIP M/C	1/ 500MM/ India
M/C IN MAINTENANCE		
1	LATH M/C -I st	2/ 6FEET/ India
2	SHAPPER M/C	1/ 02FEET/ India
3	DRILLING M/C (VERTICAL)	1/ 22MM / India
4	BANCH GRIENDER M/C	1/ 215MM/ India
5	WELDING M/C -I	3/ 300AMP/ India
6	POWER HACKSAW	1/ 12"/ India
7	HAND GRIENDER M/C	1/ 7"/ India

LIST OF TESTING & MEASURING INSTRUMENTS, SILVASSA

SR.	NAME OF THE INSTRUMENT	NO. OF EQUIPMENTS	MAKE/MODEL	RANGE
1	Kelvin double Bridge	1	Osaw	0-1100hms
2	Million Megohmmeter	1	Sivananda/LS-3B	10-10^6MW
3	Million Megohmmeter	1	Sivananda/LS-3BD	10-10^6MW
4	H.V. Megaohm box (IR)	1	Sigma	2MW - 200W
5	Cold chamber	1	Audiotronics	RT to - 15deg
6	Cold chamber	1	Audiotronics	RT to - 45deg
7	Spark tester	1	RE	0 - 10 kV
8	Spark tester	3	RE	0 - 15 kV
9	H.V. Tester	1	RE	0-5Kv/0-10 kV
10	H.V. DC Tester	1	RE	0 - 3 kV
11	High Voltage Test Set	1	RE (AC)	0-6Kv / 0-12 kV
12	Tensile testing m/c.	1	Presto	0 - 2500N
13	Tensile testing m/c.	1	KMI 1.5G	0 - 50KN
14	Tensile testing m/c.	1	KMI 1.3D	0 - 200N
15	Hotset test Apparatus (Temp. Controler)	1	S.A. Associates	0-5000 C
16	Digital temp. controller (Thermal stability)	1	West	0-400 DC
17	Digital temp. controller (Water bath)	1	Narang	0-400 DC
18	Digital temp. controller (Water bath-2)	1	Audiotronics	0-199.9 DC
19	Oxygen Index / Temp. Index (Temp.controler)	1	S.A. Associates	0-400 DC
20	Weighing Balace	1	Presca/303	0-300Gr.
21	Air flow meter (Flame test -IEC-332/III)	1	S.A. Associates	0-81.19psi
22	Glass flow meter (Flame test -IEC-332/III)	1	S.A. Associates	0-11.9psi
23	Pressure Gauge (Flame test -IEC-332/III)	1	Manometer	0 to 4.2 Kg/cm2
24	Pressure Gauge (Flame test -IEC-332/III)	1	Manometer	0 to 2.1 Kg/cm2
25	Vaccum Gauge (WATER ABSORBTION TEST)	1	Manometer	(-)760mm Hg
26	Digital temp. controller (Vaccume Oven))	1	PT-100	0-200DC
27	Micro-ohmmeter	2	Agronic-53c	1999MW-19.99KW
28	Glass Thermometer	1	ZEAL	-10 to 110degC
29	Glass Thermometer	1	JRM	-10 to 360degC
30	Glass Thermometer	1	JRM	-10 to 250degC
31	Glass Thermometer	1	Venus	190 to 210degC
32	Glass Thermometer	1	JRM	-10 to 110degC
33	Ageing in Air Oven	1		0 to 300degC
34	Air Oven	1	Shivki	0 to 200degC
35	Ageing Oven (Temp. Controller)	1	West	0 to 200degC
36	Hcl gas test apparatus(TEMP CONTROLER)	1	S.A. Associates	0-1000degC
37	Slip gauge	1	USSR	0.5 to 100mm
38	Vernier Caliper (DIGITAL)	1	Mitutoyo	0 - 150mm

LIST OF TESTING & MEASURING INSTRUMENTS, SILVASSA

SR.	NAME OF THE INSTRUMENT	NO. OF EQUIPMENTS	MAKE/MODEL	RANGE
40	Vernier Caliper (DIGITAL)	1	Mitutoyo	0 - 150mm
41	Micrometer	1	Mitutoyo	0 - 25mm
42	Density test apparatus	1	S.A. Associates	
43	Fire Resistance Test Apparatus	1	-	-
44	Swedish Chimmney test Apparatus	1		
45	Dumbell Cutting Die	1		-
46	Stop watch	1	Racer	0 - 15min
47	Colourfastness to Daylight Exposure	1	-	-
48	Torsion testing M/C.	1	Presto	60 / 30 / 45
49	Hot Deformation test apparatus	1	S.A. Associates	-
50	Purity test	1	S.A. Associates	

LIST OF MAJOR TEST EQUIPMENT, BHIWADI

SR.	NAME OF EQUIPMENT	NO. OF EQUIPMENTS	MODEL/TYPE/YEAR OF MAKE	RANGE
1	UNIVERSAL HEATING OVEN	1	NSW, DELHI	0- 250°C
2	UNIVERSAL HEATING OVEN	1	JOHRI SCIENTIFIC	0- 250°C
3	HEATING OVEN	2	SA ASSOCIATE	0- 250°C
4	HOT SET TEST OVEN	3	SA ASSOCIATE	0- 250°C
5	VACUUM OVEN	1	JOHRI	0 -100°C / 0 -760 mmHg
6	UNIVERSAL HEATING OVEN	2	S.A. ASSOCIATE	0 to 250°C
7	VACUUM OVEN	1	S.A. ASSOCIATE	0 to 150°C / 0 - 999 mbar
8	THERMAL STABILITY TEST APP.	3	S.A. ASSOCIATE	0-300°C
9	MILLION MEGOHM METER	2	SIVANANDA	10 M-ohms to106 M-ohms
10	AGEING OVEN (4 Cell)	2	S.A. ASSOCIATE	0 -250°C
11	TENSILE TESTING MACHINE	1	KML, AHEMD.	0 to 2500 N
12	AGEING OVEN (4 CELL)	2	S.A. ASSOCIATE	0 -400°C
13	AGEING OVEN (4 CELL)	2	S.A. ASSOCIATE	0 to 250°C
14	TENSILE TESTING MACHINE	1	KML, AHEMD.	0 to 2500 N
15	TENSILE TESTING MACHINE	1	KML, AHMD.	0 - 500 N
16	TENSILE TESTING MACHINE	1	KML, AHEMD.	0 to 25000 N
17	DIGITAL WEIGHING BALANCE	1	AMAN	220 gm
18	DIGITAL WEIGHING BALANCE	1	SANSUI	6 kg
19	DIGITAL WEIGHING BALANCE	1	AFCOSET	0.00001 to 180 gms.
20	TORSION TESTING MACHINE	1	S.A. ASSOCIATE	0 To 999 turns
21	MICROMETER	1	MITUTOYO	0 to 25 mm
22	DEEP FREEZER	1	S.A. ASSOCIATE	-40 TO 30°C
23	CONDITIONING CHAMBER	1	S.A. ASSOCIATE	5 - 50°C / 0-99.9Rh %
24	WATER BATH (01)	2	JOHRI SCIENTIFIC	0 -200°C
25	WATER BATH (Big)	1	SA ASSOCIATE	0 -199.9°C
26	WATER BATH	1	S.A. ASSOCIATE	0 -100°C
27	KELVIN DOUBLE BRIDGE	1	OSAW	0.2 micro-ohm to 11 ohm
28	SENIOR KELVIN BRIDGE	1	OSAW	0.02 micro-ohm to 1.1 ohm
29	D.C.HIGH VOLTAGE TESTER	1	RE, DELHI	0-5 kV (D.C)
30	H.V. TESTER (FIRE SURVIVAL)	1	R.E.	0-1200 VOLTS
31	H.V. TESTER (A.C.) (W.I.)	1	R.E	0-15/30 kV/22KVA
32	H.V. TESTER (A.C.) (L.T.)	1	R.E.	0-5/10 kV/50KVA
33	H.V. TESTER (A.C.) (Rubber)	1	R.E.	0-6/12 kV/ 50 kvA
34	H.V. TESTER (A.C.) (Control)	1	BILLIONIX	0-7.5/15 kV/60KVA
35	H.V. TESTER (A.C.) (H.T)	1	R.E.	0-5/10 kV/22KVA

LIST OF MAJOR TEST EQUIPMENT, BHIWADI

SR.	NAME OF EQUIPMENT	NO. OF EQUIPMENTS	MODEL/TYPE/YEAR OF MAKE	RANGE
36	DIGITAL VERNIER CALLIPER	2	MITUTOYO	0-150 mm
37	DIGITAL VERNIER CALLIPER	2	MITUTOYO	0-300 mm
38	MEGGOHM BOX	1	SIGMA	20 MOHM - 200GOHM
40	DIGITAL MICROMETER	1	MITUTOYO	0 - 25 mm
41	MICROMETER (Pointed)	2	MITUTOYO	0- 25 mm
42	DIGITAL MICROMETER	1	MITUTOYO	0 - 25 mm
43	MICROMETER	1	MITUTOYO	0- 25 mm
44	SMOKE DENSITY MEASUREMENT TEST APPARATUS	1	S.A. ASSOCIATES	0 - 100 %
45	THERMOMETER	2	ZEAL	10 TO 250°C
46	STANDARD CAPACITANCE BOX	1	SIGMA	0.1mFf to 3.3 uF
47	STANDARD RESISTANCE BOX	1	SIGMA	0.001 Ohm to 1Kohm
48	STANDARD RESISTANCE	1	OSAW	0.1 Ohm
49	O2 & TEMP. INDEX TEST APPARATUS	1	S.A. ASSOCIATE	0 - 400°C
50	SMOKE DENSITY TEST APPARATUS	1	SA ASSOCIATE	0 TO 4.2 kg/cm²
51	ACID GAS GENERATION TEST APP.	1	S.A. ASSOCIATE	0-1000 degC
52	FLOWMETER FOR HCL GAS GENERATION TEST APPARATUS	1	IEPL	43 to430 sccm
53	FLAMMABILITY TEST APPARATUS	1	S.A. ASSOCIATE	---
54	FLAMMABILITY TEST APPARATUS	1	S.A. ASSOCIATE	0-1200 Deg C
55	FLAMMABILITY TEST APPARATUS (as per IEC 332-1(i) & IS-10810-Pt-42)	1	S.A. ASSOCIATE	1.7 TO 17.05 LPM 8.98 TO 89.77 LPM
56	SWEDISH CHIMNEY TEST APP.	1	---	0 -1200°C
57	L-C-R-Q METER	1	APLAB	L - uH to H , C - pf-uf , R- ohm to M-ohm.
58	SINE SQUARE OSCILLATOR	1	TESTRONIX	1 KHz to 1000KHz / 0.3 - 30V
59	SOLID STATE AC MICROVOLTMETER	1	SYSTRONICS	AC voltage 0 microV to 500V ,-120db to 56db
60	DIGITAL D.C. MICROVOLT AMMETER	1	TESTRONEX	0-1000V / 1000 mA
61	kV METER	1	SIGMA	0 -10 kV
62	OIL BATH	1	SCIENTIFIC TRADERS	0 - 400°C
63	AIR & OXY. BOMB TEST APP.	1	JOHRI SCIENTIFIC	R.Temp-180 Deg.C
64	OZONE RESISTANCE TEST APPARATUS	1	SA ASSOCIATE	0-180 Deg C
65	TEMPRATURE INDICATOR	1	AUDIOTRONICS	0-1200 Deg C
66	MEASURING TAPE	1	PLASTIKA	15 Meter
67	STEEL SCALE	1	KRISTEEL	0 - 150 mm
68	STEEL SCALE	1	KRISTEEL	0 - 300 mm
69	STEEL SCALE	1	OMEGA	0 - 1000 mm

LIST OF MAJOR TEST EQUIPMENT, BHIWADI

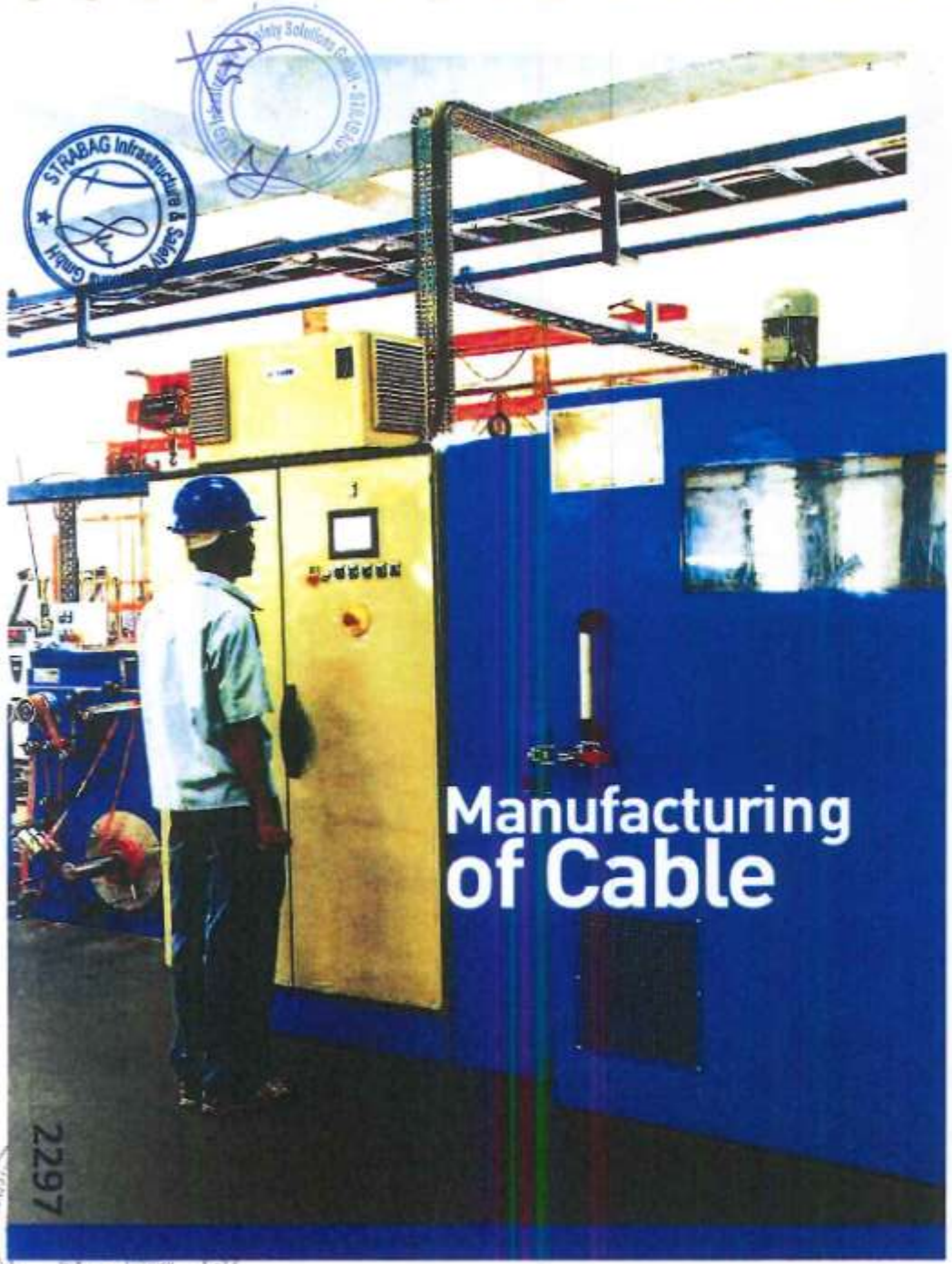
SR.	NAME OF EQUIPMENT	NO. OF EQUIPMENTS	MODEL/TYPE/YEAR OF MAKE	RANGE
70	IMPEDANCE METER	1	SIVANANDA	0 Ohm to19.99K-ohm
71	PROFILE PROJECTOR(MICROMETER)	1	MITUTOYO	0-25MM
72	HIGH PRECISION HIGH VOLTAGE CAPACITANCE BRIDGE	1	WELLGAIN CABLE SYSTSEM LTD.	10nf to 1000pf
73	PARTIAL DISCHARGE DETECTOR	1	DIELEC-JIATE	0 pc to 250 pc with multiplier
74	H.V. TESTER	1	POWERLITE	0.1 kV TO 75 kV
75	H. V.ETESTER (Series Resonance System)	1	DIELEC-JIATE	0 - 250 kV
76	IMPULSE VOLTAGE GENERATOR	1	DIELEC-JIATE	0 - 500 kV
77	HEATING CYCLE INSTRUMENT	1	DIELEC-JIATE	0 - 110 DegC
78	DIGITAL MICRO-OHM METER	3	Agronic-53C	199.9u-ohmto19.99k-ohm
79	BURRETE	1	BOROSIL	0.1ml to 50 ml
80	MEASURING CYLINDER	1	BOROSIL	1ml to 50 ml
81	MEASURING CYLINDER	1	BOROSIL	2ml to 250 ml
82	MEASURING CYLINDER	1	BOROSIL	5ml to 500 ml
83	MEASURING CYLINDER	1	BOROSIL	10ml to 1000 ml
84	MEASURING CYLINDER	1	BOROSIL	0.5ml to 25 ml
85	MEASURING CYLINDER	1	BOROSIL	1ml to 100 ml
86	MEASURING PIPETTE	1	BOROSIL	1 ml
87	MEASURING PIPETTE	1	BOROSIL	20 ml
88	MEASURING PIPETTE	1	BOROSIL	0.1 ml to 10 ml
89	DIGITAL STOP WATCH	2	RACER	0 - 24 Hours
90	DRY & WET THERMOMETER	1	DIMPLE	-10 TO 50°C
91	UV RADIATION TEST APPARATUS	1	SA Associate	0 - 200°C

LIST OF TESTING / QUALITY CONTROL INSTRUMENT & EQUIPMENTS, CHOPANKI

SR.	DESCRIPTION OF THE INSTUMENT	NO. OF EQUIPMENTS	MFG/COUNTRY
1	UNIVERSAL HEATING OVEN	3	S.A. ASSOCIATE, INDIA
2	SHRINKAGE TEST OVEN with Dail Indicator	1	S.A. ASSOCIATE, INDIA
3	VACUUM OVEN	1	S.A. ASSOCIATE, INDIA
4	THERMAL STABILITY TEST APP.	1	S.A. ASSOCIATE, INDIA
5	AGEING OVEN (4 Cell)	3	S.A. ASSOCIATE, INDIA
6	DEEP FREEZER	1	S.A. ASSOCIATE, INDIA
7	CONDITIONING CHAMBER	1	S.A. ASSOCIATE, INDIA
8	Oxygen &Temp. INDEX TEST (ASTM-D -2863)	1	S.A. ASSOCIATE, INDIA
9	SMOKE DENSITY TEST APPARATUS (ASTM-D -2843)	1	S.A. ASSOCIATE, INDIA
10	ACID GAS GENERATION TEST APP. (IEC-754-1 & 2)	1	S.A. ASSOCIATE, INDIA
11	FLAMMABILITY TEST APPARATUS (IEEE-383)	1	S.A. ASSOCIATE, INDIA
12	SWIDISH CHIMNEY TEST APP.(SS-4241475)	1	S.A. ASSOCIATE, INDIA
13	DIGITAL TEMPERATURE INDICATOR	1	
14	STEEL SCALE	1	NA
15	MILLION MEGOHM METER IN STEPS, 500V	2	SIVANANDA, INDIA
16	TENSILE TESTING MACHINE 500N, 1000N & 2500N	1	CANON TENSILE M/c, INDIA
17	TENSILE TESTING MACHINE 2kN 5kN, 10kN	1	CANON TENSILE M/c, INDIA
18	ROLLING BALL MILL	1	S.A. ASSOCIATE, INDIA
19	HYDRAULLIC PRESS	1	JOHRI SCIENTIFIC, INDIA
20	DUMB-BELL CUTTING PRESS	1	S.A. ASSOCIATE, INDIA
21	TENSILE TESTING MACHINE	1	CANON TENSILE M/c, INDIA
22	DIGITAL MICROHM METER	2	AGRONIC-53C, INDIA
23	VERNIER CALLIPER	3	MITUTOYO, JAPAN
24	L-C-R-Q METER	1	APLAB, INDIA
25	KELVIN DOUBLE BRIDGE WITH SPOT REFLECTING GALVANOMETER	1	OSAW, INDIA
26	DIGITAL WEIGHING BALANCE	1	PRECISA INDIA
27	DIGITAL WEIGHING BALANCE	1	SANSUI, INDIA
28	GLASS THERMOMETER (GT-01)	1	GERA, INDIA
29	GLASS THERMOMETER (GT-02)	1	GERA, INDIA
30	AC H.V.TESTER 12kV/50kVA	1	RE, INDIA
31	DIGITAL VERNIER CALLIPER	3	MITUTOYO, JAPAN
32	DIGITAL MICROMETER	2	MITUTOYO, JAPAN
33	DIAL VERNIER CALLIPER	1	MITUTOYO, JAPAN
34	BALL POINT MICROMETER	1	MITUTOYO, JAPAN
35	ANALOG MICROMETER	1	MITUTOYO, JAPAN
36	DIGITAL BALL TYPE MICROMETER	1	MITUTOYO, JAPAN
37	WATER BATH (John Scientific) WB-1	1	(JOHRI SCIENTIFIC), INDIA

LIST OF TESTING / QUALITY CONTROL INSTRUMENT & EQUIPMENTS, CHOPANKI

SR.	DESCRIPTION OF THE INSTUMENT	NO. OF EQUIPMENTS	MFG/COUNTRY
38	WATER BATH (S.A. ASSOCIATE) WB-II	1	S.A. ASSOCIATE, INDIA
39	PROFILE PROJECTOR	1	BANBROS, INDIA
40	TORSION TESTING MACHINE	1	S.A. ASSOCIATE, INDIA
41	FLAMMABILITY TEST APPARATUS (IEC 332-II	1	S.A. ASSOCIATE, INDIA
42	DIGITAL WEIGHING BALANCE	1	SANSUI, INDIA
43	P.D. DETECTER (JFD-3) WITH SHIELDED ROOM	1	DIELEC - JIATE
44	SERIES RESONANCE HV TEST SET (1200kVA / 120kV)	1	DIELEC - JIATE, CHINA
45	PARTIAL DISCHARGE DETECTOR (DIELEC)	1	DIELEC - JIATE, CHINA
46	SERIES RESONANCE HV TEST SET (1200kVA / 120kV)	1	DIELEC - JIATE, CHINA
47	5 kV MEGGER and 10kV DIGITAL MEGGER	1	MEGGER, INDIA
48	PI STEEL SCALE (DIA-METRIC TAPE)	1	MICRONIX, INDIA
49	DIGITAL/ANALOUGE STOP WATCH	1	RACER
50	DIGITAL VERNIER CALLIPER	1	MITUTOYO, JAPAN
51	HVDC TESTER	1	JOHRI SCIENTIFIC, INDIA
52	WATER BATH	1	JOHRI SCIENTIFIC, INDIA
53	SERIES RESONANCE HV TEST SET (375kV/10000kVA)	1	HIPOTRONICS, USA
54	DIGITAL PARTIAL DISCHARGE DETECTOR (MTRONICX)	1	MTRONICX, HVTS, GERMANY
55	FULLY AUTOMATIC CONTROLLED TAN DELTA MEASUREMENT	1	MTRONICX, HVTS, GERMANY
56	TAN DELTA & CAPACITANCE MEASUREMENT BRIDGE QS 30A	1	WELLGAIN CABLES SYSTEMS
57	IMPULSE VOLTAGE TEST SYSTEM 2000kV/200kJ	1	WELLGAIN CABLES SYSTEMS
58	HEATING CYCLE INSTRUMENT 7000A/OPEN MOUTH TYPE	1	DIELEC - JIATE
59	HV TESTER (PROLONG HV TEST) 450 kV/225kVA	1	DIELEC - JIATE
60	HVDC & SURGE GENERATOR SET 0-32kV-400mA (4 STEPS)	1	TECHNO-INSTRUMENTS,INDIA
61	SHIELDING ROOM FOR EHV CABLES	1	DIELEC - JIATE
62	TGA (THERMOGRAVIMETRIC ANALYSER)	1	TA INSTRUMENTS, UK
63	DSC (DIFFERENTIAL SCANNING CALORIMETER)	1	TA INSTRUMENTS, UK
64	SPECTROMETER	1	PERKIN ELMERS
65	OPTICAL MICROSCOPE, MEASUREMENT SOFTWARE ASSITED (100X TO 1000X MAGNIFICATION IN FOUR STEPS)	1	DWINTER INDIA
66	ODR RHEOMETER	1	FUTURE FOUNDATIONS, INDIA
67	TAPE EXTRUSION EXTRUDER	1	SILICON, INDIA
68	GLASS THERMOMETER (GT-03) 150 deg. C	1	GERA, INDIA
69	GLASS THERMOMETER (GT-04) 250 deg. C	1	GERA, INDIA
70	TENSILE TESTING MACHINE 50KN (AUTOMATIC)	1	INSTRON, UK
71	UNIVERSAL HEATING OVEN	1	S.A. ASSOCIATE, INDIA
72	COLD ELONGATION TEST APPRATUS	1	S.A. ASSOCIATE, INDIA
73	CABLE QUICKY FOR THICKNESS MEASUREMENTS (AUTOMATIC)	1	S.A. ASSOCIATE, INDIA



MANUFACTURING OF EHV CABLES 66 kV TO 400 kV XLPE

KEI Industries Limited is equipped with the Cable Development Technologies to ensure manufacturing of cables up to and including 400 kV. At the Chopanki plant the company is into manufacturing of cables up to 400 kV and the Bhiwadi Plant is capable of manufacturing cables upto 132 kV by Dry Cooled Process. The 220 kV cables are Type & PQ tested at FGH Lab (Germany). KEI is equipped and accredited to manufacture cables to all national & international level.

Our Chopanki Plant which commenced its production in 2008 and equipped with state-of-art machines including testing equipments to meet Indian as well as international standards to produce cables and including 400 kV.

KEI is equipped to manufacture EHV Cables using most modern machines & equipments at both the plants, received from M/s Troester (Germany). The plant endowed with special features. Rotating Caterpillers &Truss System for Eccentricity / Ovality Control at Chopanki.

- Single point Triple extrusion process prevents micro contaminants from outside atmosphere
- Dry cure & dry cooling process provides increased electrical stress bearing strength
- Online insulation thickness monitoring & control by Sikora X-ray unit
- Separate rooms with positive pressure for Insulation & semiconducting compound & vacuum feeding / Gravity Feeding at Chopanki for EHV
- Super clean / Tree retardant XLPE compound (Borealis, Dow, Hanwa etc.)

We manufacture EHV Cables as per requirements of clients with Poly-Al tape, Corrugated Al / Corrugated Cu / Lead Alloy as well as with world renowned and tried process i.e. continuous extrusion.

Al-Corrugated sheath has following advantages:

High Flexibility
Lesser Weight
Lesser Cost
Environment Friendly

Cu-Corrugated sheath has following advantages:

Very high flexibility
Short circuit rating is very high & thin sheath as compared to Al can serve

Advantages of Lead extruded sheathed cables:

Lead has superior corrosion resistant properties in any environment than Aluminium
Lead sheathed cables can follow bending with ease
Lead sheathed cables provide radial water barrier
Lead sheathed cables are easily solderable/welded
Life of lead is more than 30 to 40 years
Lead is very dense & easily fusible
Shares the fault current with metallic screen in cable
Chemical resistant behavior

A TYPICAL CROSS SECTION OF EHV CABLES:

1. Stranded compacted plain Copper/Aluminium Conductor & Milliken Conductor for higher sizes above 1000 sq. mm &upto 2500 sq. mm (copper) & 3000 sq. mm (aluminium) (Water tight conductors with water blocking tapes/yarn is another option)
2. Semi Conducting Tape (Optional)
3. Extruded Semi-Conducting Layer (Conductor Screen)
4. XLPE Insulation (Super Clean Compound / Tree retardant)
5. Extruded Semi-conducting Layer (Insulation Screen)
6. Semi-conducting Water Blocking Tape
7. Extruded Lead Alloy E sheath / Aluminium Corrugated Sheath / Copper Corrugated Sheath / AluminiumLaminated Tapes
8. Semi-conducting Water Blocking Tape
9. Metallic Screen (Copper wires)
10. Counter open Helix with Copper Tape
11. Non-conducting Water Blocking Tape
12. Extruded Inner Sheath
13. Aluminium Wire Armour
14. Outer Sheath
15. Graphite Coating / Extruded Semi-conductive layer

complete solution for EHV Cables. Please send your requirements to us and we shall offer you our best solutions.
ring department takes following into account-

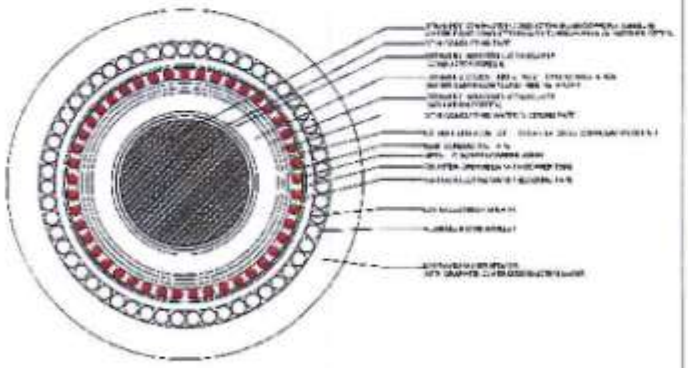
- Supply of cable
- Selecting and recommending best routes for installation of the system
- Designing cables
- Manufacture of cables at their own plants (No out sourcing)
- Inspection at our plants
- Dispatch cables to site
- Take up installation of cables at site including termination and jointing etc.
- Final testing after installation & Complete Routine / Acceptance / Type testing In-house / MAH before dispatch from plant
- Charging of system
- Guarantee / warranty for the system and service after installation for many years

FOR CABLE DESIGN WE REQUIRE THE FOLLOWING:-

i. System voltage
ii. Operating frequency
iii. Type of earthing
iv. Fault current level and duration
v. Lightning impulse level
vi. Normal loading
vii. Cyclic emergency loading with duration
viii. Max. air temperature
ix. Ground thermal resistivity
x. Route length requirements and allowable max. voltage drop per km
xi. Terminations types
xii. Site limitations & installation conditions & Drum handling System / Unloading system for longer length

Based on above and site visit, best cable solution can be designed and offered

A Typical Cross Sectional Drawing of EHV XLPE Cable



KEI INDUSTRIES LTD — EHV , Single core, XLPE Cable

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HT CABLES

KEI manufactures HT XLPE cables conforming to National and International Standards at Bhiwadi plant.

KEI has State-of-the-art HT / EHV Cable plant with German technology.

We have two CCV line with a Single point triple extrusion and computerized sophisticated control and monitoring systems. The CCV line at Bhiwadi was imported from Machinenbau Scholz GMBH & Co KG, and CCV line at Chopanki supplied by paul Troester Germany. Both manufacturers are renowned in CCV line technology and have supplied more than 300 lines world over.

HT plant is complete with heavy duty machines for wire drawing and conductor making, laying up, armouring, sheathing and packing.

The process commences with a compacted circular conductor Milliken Conductor being fed from the pay off stands into the extruder on elevated platform. The conductor passes through extruder's crosshead, it is covered first with semiconducting screen layer then the XLPE insulation, followed by the outer semiconducting core screen. This crosshead is specially designed to feed three compounds from three extruders at one point described as Singe-point Triple extrusion.

Thereafter, the extruded core enters and passes through vulcanizing line known as CCV line (Continuous Catenary Vulcanising) and the XLPE insulated core is cured in the process. In CV line inert atmosphere is maintained by the Nitrogen gas which is at high pressure and high temperature.

This process is popularly known as Single-point Triple extrusion CDCC (Completely Dry Cured and Dry Cooled Curing) Process.

Over the cured core a copper screening is provided by lapping of copper tape or for special requirements a layer of copper wires is provided. Core is tested for Partial Discharge and then as per requirement; the cores are laid up with fillers, provided with inner sheath, armoured and sheathed. Sheath can be of PVC, HDPE, FRLS, ZHFR, PCP or CSP compound. Seamless Lead "Alloy E" Sheath is extruded for moisture barrier, necessary for EHV Cables and Submarine Cables before Inner Sheath.

KEI's manufacturing plant and process ensures great XLPE cables for the new age Power sector and industry. Our modern plant takes full advantage of the new generation XLPE compounds which offer fast curing and superior electrical parameters, dimensional control and higher productivity. The Sikora X-Ray units at both the plants and Rotating Caterpillar & Tross System provides excellent eccentricity and ovality control for higher thickness.

Triple Extrusion and CDCC process ensure contamination free cores. All three layers are bonded and core has least eccentricity and ovality. Insulation itself is free of micro-voids and with negligible moisture content.

To control the manufacturing process the line has been provided with many sophisticated instruments and servo controls all monitored by the computer. Important systems are:

X-Ray Non-touch sensors of SIKORA make for thickness and dimensional control. This system continuously measures the dimensions of insulated cores. Unit has capability to measure multilayer dimensions in all directions and record and analyse the data on line.

CCV tube has a Touch Less Sag control system. This ensures no marks/lines on core unlike older lines.

For EHV Cables conductor pre-heater, core rotation and de-gasification facilities have been provided.

Computerised control system ensures optimum efficiency, fast start up, synchronized operations of compound feeds, three extruders, CCV line gas temperature zones, pay off and take-up.

Nevertheless, KEI XLPE cables compare better than those produced with older plants when checked for Micro-voids, Moisture content, PD levels, dielectric strength.

We have strict quality plan and fully-equipped testing laboratory to ensure cables of best quality are produced as per the design and specifications prescribed. Cables have been type tested as per International Standards.

Inventory and production plans are controlled by BANN ERP system. This ensures reliable and prompt delivery and operational efficiency.

KEI offers a variety of designs to suit different installations viz. Aerial Bunched cables, Water tight construction, Stainless steel armouring for Offshore and Ship installation, etc.

We have many satisfied customers from many countries and diverse industries.

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CAPACITANCE

*Approximate Capacitane for Single core & Multi core cables in microfarad per Km at 50 Hz

NOMINAL SIZE OF CONDUCTOR (IN SQMM)	1.9 / 3.3kV (E) OR 3.3 / 3.3 kV (UE)		3.8 / 6.6kV(E)	6.35/11kV(E) OR 6.6/6.6kV(UE)	11/11kV(UE)	12.7/22kV(E)	19/33kV(E)
	UNARMOURED	ARMOURED					
25	0.230	0.210	0.220	0.180	0.140	-	-
35	0.270	0.240	0.250	0.210	0.150	0.140	-
50	0.300	0.270	0.270	0.220	0.160	0.160	0.120
70	0.340	0.310	0.310	0.250	0.190	0.170	0.140
95	0.390	0.350	0.350	0.290	0.210	0.190	0.150
120	0.430	0.390	0.380	0.310	0.220	0.210	0.160
150	0.490	0.420	0.430	0.340	0.240	0.230	0.180
185	0.520	0.460	0.450	0.360	0.260	0.260	0.180
240	0.590	0.510	0.510	0.410	0.290	0.270	0.200
300	0.670	0.570	0.540	0.460	0.320	0.300	0.230
400	0.760	0.630	0.570	0.520	0.360	0.340	0.250
500	0.770	0.680	0.570	0.560	0.390	0.360	0.270
630	0.810	0.690	0.640	0.630	0.430	0.400	0.290
800	0.860	0.740	0.730	0.710	0.490	0.450	0.330
1000	0.880	0.740	0.800	0.780	0.530	0.490	0.360

REACTANCE

*Approximate Reactance for Multi core cables in Ohms per Km at 50 Hz

NOMINAL SIZE OF CONDUCTOR (IN SQMM)	1.9 / 3.3kV (E) OR 3.3 / 3.3 kV (UE)	3.8 / 6.6kV(E)	6.35/11kV(E) OR 6.6/6.6kV(UE)	11/11kV(UE)	12.7/22kV(E)	19/33kV(E)
25	0.0981	0.1090	0.1160	0.1380	-	-
35	0.0940	0.1050	0.1110	0.1240	0.1270	-
50	0.0878	0.0989	0.1050	0.1170	0.1200	0.1345
70	0.0862	0.0945	0.1000	0.1110	0.1140	0.1260
95	0.0813	0.0909	0.0959	0.1079	0.1090	0.1210
120	0.0785	0.0878	0.0925	0.1030	0.1050	0.1170
150	0.0769	0.0851	0.0894	0.0987	0.1000	0.1130
185	0.0755	0.0838	0.0879	0.0968	0.0990	0.1100
240	0.0737	0.0813	0.0850	0.0932	0.0952	0.1060
300	0.0725	0.0798	0.0823	0.0897	0.0915	0.1000
400	0.0712	0.0788	0.0799	0.0864	0.0883	0.0971

APPROXIMATE REACTANCE FOR SINGLE CORE CABLES IN OHM PER KM AT 50 Hz (CABLES LAID IN TREFOIL TOUCHING FORMATION)

NOMINAL SIZE OF CONDUCTOR (IN SQMM)	UNARMOURED					ARMOURED				
	1.9/3.3 KV (E) OR 3.3/3.3 kV (UE)	3.8/6.6 KV (E)	6.35/11 KV (E) OR 6.6/6.6 kV (UE)	11/11 KV (UE)	12.7/22 KV (E)	19/33 KV (E)	1.9/3.3 KV (E) OR 3.3/3.3 kV (UE)	3.8/6.6 KV (E)	6.35/11 KV (E) OR 6.6/6.6 kV (UE)	11/11 KV (UE)	12.7/22 KV (E)	19/33 KV (E)
25	0.1170	0.1230	0.1380	0.1390	-	-	0.1300	0.1330	0.1370	0.1470	-	-
35	0.1110	0.1170	0.1220	0.1330	0.1350	-	0.1230	0.1270	0.1310	0.1400	0.1420	-
50	0.1040	0.1110	0.1140	0.1260	0.1280	0.1460	0.1170	0.1200	0.1240	0.1340	0.1360	0.1479
70	0.0988	0.1050	0.1100	0.1190	0.1290	0.1330	0.1120	0.1140	0.1180	0.1270	0.1290	0.1400
95	0.0957	0.1010	0.1050	0.1150	0.1170	0.1270	0.1060	0.1080	0.1120	0.1210	0.1260	0.1360
120	0.0920	0.1020	0.1010	0.1100	0.1120	0.1220	0.1020	0.1040	0.1090	0.1180	0.1190	0.1293
150	0.0887	0.0936	0.0973	0.1060	0.1080	0.1170	0.0979	0.1010	0.1050	0.1130	0.1150	0.1240
185	0.0871	0.0919	0.0963	0.1040	0.1060	0.1160	0.0959	0.0993	0.1040	0.1110	0.1120	0.1219
240	0.0840	0.0894	0.0926	0.1010	0.1010	0.1110	0.0929	0.0969	0.0997	0.1070	0.1080	0.1170
300	0.0815	0.0869	0.0896	0.0961	0.0977	0.1060	0.0900	0.0936	0.0936	0.1020	0.1040	0.1130
400	0.0797	0.0850	0.0860	0.0925	0.0939	0.1030	0.0880	0.0917	0.0926	0.0984	0.0997	0.1100
500	0.0788	0.0838	0.0845	0.0905	0.0918	0.0994	0.0865	0.0900	0.0884	0.0959	0.0969	0.1063
630	0.0766	0.0819	0.0828	0.0875	0.0893	0.0960	0.0851	0.0876	0.0879	0.0941	0.0953	0.1039
800	0.0762	0.0778	0.0798	0.0855	0.0866	0.0925	0.0831	0.0858	0.0844	0.0920	0.0922	0.0976
1000	0.0758	0.0769	0.0787	0.0836	0.0851	0.0907	0.0820	0.0844	0.0845	0.0898	0.0904	0.0966

CURRENT RATINGS

KEI Recommendations for Current Ratings:

The Current rating of power cables is defined by the maximum intensity of current (amperes) which can flow continuously through the cable under permanent loading conditions, without any risk of damaging the cable or deterioration of its electrical properties.

The current ratings in the tables are valid for one circuit in a three phase system under conditions specified. For grouping cables correction factors must be used.

The current carrying capacities mentioned in KEI technical data are intended as a guide, to assist operating engineers in selecting cables for safety and reliability.

- Max. Conductor Temperature : 90° C
- Ambient Ground Temperature : 30° C
- Ambient Air Temperature : 40° C
- Thermal resistivity of soil : 150°C cm/W
- Depth of laying (to the highest point of the cables laid direct in the ground)
  3.3, 6.6 & 11 kV Cables : 90 cm
  22 and 33 kV Cables : 105 cm
- Max. Conductor Temperature for Short Circuit : 250° C

To obtain the maximum current carrying capacity of a cable operating at different conditions from the standard, various rating factors are to be multiplied, as follows :-

Ia = Ks k in amperes

Ia : Current rating at actual operating conditions (amperes)

Is : Current rating at standard operating conditions (amperes)

K : Rating factor, as applicable

RATING FACTORS

1) For Air And Ground Temperature

a) Rating Factors For Variation In Ambient Air Temperature

Air Temperature, 0°C	25	30	35	40	45	50	55	60
Rating Factor (Maximum Conductor Temperature 90°C)	1.16	1.11	1.06	1.0	0.94	0.88	0.81	0.74

b) Rating Factors For Variation In Ground Temperature For Cables Laid Direct In The Ground

Ground Temperature, 0°C	15	20	25	30	35	40	45	50
Rating Factor (Maximum Conductor Temperature 90°C)	1.12	1.08	1.04	1.0	0.96	0.91	0.87	0.82

2) Rating Factors For Variation In Ground Temperature For Cables In Ducts

Ground Temperature, 0°C	15	20	25	30	35	40	45	50
Rating Factor (Maximum Conductor Temperature 90°C)	1.12	1.08	1.04	1.0	0.96	0.91	0.87	0.82

3) Rating Factors For Depth Of Laying For Cables Laid Direct In The Ground

Depth of Laying	3.3, 6.6 & 11 kV Cables	22 & 33 kV Cables
mm		
900	1.0	-
1050	0.99	1.0
1200	0.97	0.99
1500	0.95	0.97
1800	0.94	0.95
2000	0.93	0.94
2500	0.91	0.92
3000 or above	0.90	0.91

GROUP RATING FACTORS

FOR SINGLE CORE CABLES

A) Group Rating Factors For Three Core Cables, In Horizontal Formation Laid Direct In The Ground

Number of Cables in Group	Spacing between trefoil group centres				
	Touching	200	400	600	800
2	0.79	0.86	0.90	0.92	0.94
3	0.67	0.77	0.82	0.86	0.89
4	0.61	0.72	0.79	0.83	0.87
5	0.56	0.68	0.76	0.81	0.85
6	0.53	0.65	0.74	0.80	0.84
7	0.50	0.63	0.72	0.78	0.83
8	0.48	0.61	0.71	0.78	-
9	0.46	0.60	0.70	0.77	-
10	0.44	0.59	0.69	-	-
11	0.43	0.58	0.69	-	-
12	0.42	0.57	0.68	-	-

B) Cables laid on Racks / Trays in covered trench with removable covers where air circulation is restricted, Trefoils are separated by two cable diameter horizontally and the trays are in tiers having 300 mm distance.

No. Racks / Trays in Tiers	No. of Trefoils in Horizontal Formation		
	1	2	3
1	0.95	0.90	0.88
2	0.90	0.85	0.83
3	0.88	0.83	0.81
6	0.86	0.81	0.79

C) As above B, but cables laid in open air.

1	1	0.98	0.96
2	1	0.95	0.93
3	1	0.94	0.92
6	1	0.93	0.90

FOR MULTI CORE CABLES

A) Cables laid inside concrete trench with removable covers, on cable trays where air circulation is restricted. The Cables spaced by one cable diameter and trays are in tiers spaced by 300 mm. The clearance Between the wall and the cable is 25 mm.

No. of cables trays in tier	Distance between Trefoils				
	1	2	3	4	9
1	0.95	0.90	0.88	0.85	0.84
2	0.90	0.85	0.83	0.81	0.80
3	0.88	0.83	0.81	0.79	0.78
6	0.86	0.81	0.79	0.77	0.76

B) Cable laid on cable trays exposed to air, the cables spaced by one cable diameter and trays are in tiers spaced by 300 mm. The clearance of the cable from the wall is 25 mm.

No. of cables trays in tier	No. of cables				
	1	2	3	6	9
1	1	0.98	0.90	0.75	0.73
2	1	0.95	0.76	0.71	0.69
3	1	0.94	0.74	0.70	0.68
6	1	0.93	0.72	0.68	0.66

C) Cables laid on cable trays exposed to air, the cables touching and trays are in tiers spaced by 300 mm. The clearance between the wall and the cable is 25 mm.

No. of cables trays	No. of cables per tray				
	1	2	3	6	9
1	1	0.84	0.80	0.75	0.73
2	1	0.80	0.76	0.71	0.69
3	1	0.78	0.74	0.70	0.68
6	1	0.76	0.72	0.68	0.66

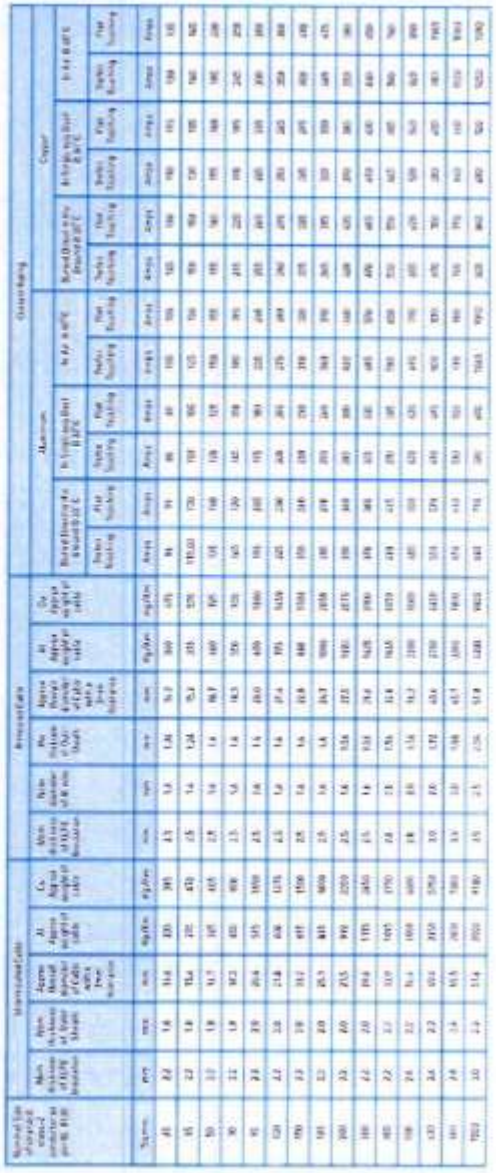
D) Cables laid direct in ground in horizontal formation.

No. of cables in Group	Distance of cables			
	Touching	15cm	30cm	45 cm
2	0.79	0.82	0.87	0.90
3	0.69	0.75	0.79	0.83
4	0.62	0.69	0.74	0.79
5	0.58	0.65	0.72	0.76
6	0.54	0.61	0.69	0.75

SINGLE CORE COMPACTED ALUMINIUM & COPPER CONDUCTOR, XLPE INSULATED, UNARMOURED & ARMOURED CABLE, Al & Cu/XLPE/Al WIRE/PVC CONFIRMING TO IS: 7098 (PART-2)

Voltage Grade : 1.9/3.3 kV (Unscreened) (E)

WEIGHT & DIMENSIONS



SINGLE CORE COMPACTED ALUMINIUM & COPPER CONDUCTOR, XLPE INSULATED, UNARMOURED & ARMOURED CABLE, Al & Cu/XLPE/Al WIRE/PVC CONFORMING TO IS: 7098 (PART-2)

Voltage Grade : 3.3/3.3 kV (Screened) (UE)

WEIGHT & DIMENSIONS

Nominal Size of stranded class-2 conductor as per IS: 8130	Unarmoured Cable: Nom. thickness of XLPE insulation	Unarmoured Cable: Nom. thickness of outer sheath	Unarmoured Cable: Approx. overall diameter of cable with ±2mm tolerance	Unarmoured Cable: Al Approx. weight of cable	Unarmoured Cable: Cu Approx. weight of cable	Armoured Cable: Nom. thickness of XLPE insulation	Armoured Cable: Nom. diameter of Al wire	Armoured Cable: Min. thickness of outer sheath	Armoured Cable: Approx. overall diameter of cable with ±2mm tolerance	Armoured Cable: Al Approx. weight of cable	Armoured Cable: Cu Approx. weight of cable	Current Rating Aluminium: Buried direct in the ground @30°C Trefoil touching	Buried direct in the ground @30°C Flat touching	In single way duct @30°C Trefoil touching	In single way duct @30°C Flat touching	In Air @40°C Trefoil touching	In Air @40°C Flat touching	Current Rating Copper: Buried direct in the ground @30°C Trefoil touching	Buried direct in the ground @30°C Flat touching	In single way duct @30°C Trefoil touching	In single way duct @30°C Flat touching	In Air @40°C Trefoil touching	In Air @40°C Flat touching
Sq.mm.	mm	mm	mm	Kg/Km	Kg/Km	mm	mm	mm	mm	Kg/Km	Kg/Km	Amps	Amps	Amps	Amps	Amps	Amps	Amps	Amps	Amps	Amps	Amps	Amps
25	2.2	1.8	15.6	310	450	2.5	1.6	1.40	21.4	510	670	96	99	96	97	145	155	125	130	110	115	150	150
35	2.2	1.8	16.6	350	550	2.5	1.6	1.4	22.4	555	770	115	118	109	115	165	180	150	130	130	137	180	165
50	2.2	2	17.7	425	700	2.5	1.6	1.4	23.7	610	950	135	145	120	120	150	155	155	160	155	160	195	200
70	2.2	2	19.3	500	950	2.5	1.6	1.6	25.3	706	1150	165	158	165	158	190	195	215	220	190	195	245	250
95	2.2	2.0	21.6	600	1150	2.5	1.6	1.6	27.8	835	1400	195	205	175	180	235	248	255	260	225	235	300	310
120	2.2	2.0	22.8	700	1555	2.5	1.6	1.6	28.6	915	1630	225	230	200	206	275	280	290	295	255	265	355	360
150	2.2	2.2	24.4	820	1655	2.5	1.6	1.56	30.2	1125	1950	225	240	220	225	295	320	325	335	280	295	405	410
185	2.2	2.0	26.1	935	1955	2.5	1.6	1.56	32.1	1250	2200	285	270	250	260	350	370	385	375	320	320	460	475
240	2.2	2.2	28.5	1145	2450	2.5	2.0	1.56	35.1	1550	2900	320	300	285	300	430	440	420	435	370	385	550	560
300	2.2	2.2	30.4	1355	3000	2.5	2.0	1.56	37.6	1775	3175	370	380	320	335	495	510	470	485	410	420	620	650
400	2.2	2.2	35.4	1650	3900	2.6	2.0	1.72	41.2	2115	4000	420	475	370	395	580	605	530	570	465	480	740	760
500	2.4	2.2	38.8	2030	4900	2.6	2.0	1.72	44.4	2575	5250	480	555	420	435	690	775	600	610	520	536	855	895
630	2.4	2.4	42.6	2450	6000	3.0	2.0	1.88	48.8	3075	6850	550	598	470	492	802	850	670	720	560	602	990	1025
800	2.8	2.6	47.8	3050	7500	3.5	2.5	2.04	55	3700	8400	610	665	530	555	930	968	745	790	640	624	1120	1168
1000	3.0	2.6	54	3700	9200	3.5	2.5	2.2	61	4400	10400	680	745	580	618	1055	1090	880	860	675	700	1250	1294

SINGLE CORE COMPACTED ALUMINIUM & COPPER CONDUCTOR, XLPE INSULATED, UNARMOURED & ARMOURED CABLE, Al & Cu/XLPE/Al WIRE/PVC CONFORMING TO IS: 7098 (PART-2)

Voltage Grade : 3.8/6.6 kV (E)

WEIGHT & DIMENSIONS

Nominal Size of stranded class-2 conductor as per IS: 8130	Unarmoured Cable: Nom. thickness of XLPE insulation	Unarmoured Cable: Nom. thickness of outer sheath	Unarmoured Cable: Approx. overall diameter of cable with ±2mm tolerance	Unarmoured Cable: Al Approx. weight of cable	Unarmoured Cable: Cu Approx. weight of cable	Armoured Cable: Nom. diameter of Al wire	Armoured Cable: Min. thickness of outer sheath	Armoured Cable: Approx. overall diameter of cable with ±2mm tolerance	Armoured Cable: Al Approx. weight of cable	Armoured Cable: Cu Approx. weight of cable	Current Rating Aluminium: Buried direct in the ground @30°C Trefoil touching	Buried direct in the ground @30°C Flat touching	In single way duct @30°C Trefoil touching	In single way duct @30°C Flat touching	In Air @40°C Trefoil touching	In Air @40°C Flat touching	Current Rating Copper: Buried direct in the ground @30°C Trefoil touching	Buried direct in the ground @30°C Flat touching	In single way duct @30°C Trefoil touching	In single way duct @30°C Flat touching	In Air @40°C Trefoil touching	In Air @40°C Flat touching
Sq.mm.	mm	mm	mm	Kg/Km	Kg/Km	mm	mm	Kg/Km	Kg/Km	Kg/Km	Amps	Amps	Amps	Amps	Amps	Amps	Amps	Amps	Amps	Amps	Amps	Amps
25	2.8	1.8	18.0	300	475	1.6	1.40	23.4	470	640	99	100	97	95	115	122	125	130	118	125	130	155
35	2.8	2.0	19.6	400	610	1.6	1.4	21.6	525	760	115	120	105	105	140	145	150	155	135	140	180	180
50	2.8	2.0	20.3	470	730	1.6	1.4	22.9	650	875	140	142	122	125	180	170	160	160	155	160	215	220
70	2.8	2.0	23.1	550	950	1.6	1.4	24.5	675	1050	170	175	150	155	210	215	215	225	190	190	250	270
95	2.8	2.0	24.8	600	1200	1.6	1.4	26.9	800	1325	200	205	175	180	170	240	260	267	227	235	320	330
120	2.8	2.0	31.2	700	1481	1.6	1.4	31.5	900	1550	230	235	200	205	285	300	298	300	255	269	385	395
150	2.8	2.0	34.8	895	1700	1.6	1.56	34.0	1005	1800	255	260	225	232	320	345	325	330	280	285	430	440
185	2.8	2.0	36.2	1020	2025	1.6	1.56	31.7	1150	2220	286	295	255	260	365	385	370	380	315	330	495	510
240	2.8	2.2	31.4	1000	2550	2.0	1.56	34.4	1350	2800	330	340	290	300	435	470	425	430	370	380	560	600
300	3.0	2.2	32.9	1425	3135	2.0	1.56	35.6	1455	3150	375	385	325	335	520	540	475	490	415	425	620	690
400	3.3	2.2	37.6	1750	4000	2.0	1.72	41	2000	4300	425	440	370	380	610	630	500	530	465	480	700	730
500	3.5	2.4	41.2	2150	4950	2.0	1.72	44.3	2400	5270	480	495	415	430	720	750	610	610	520	540	810	870
630	3.5	2.6	44.8	2555	6175	2.0	1.88	50.2	2900	6475	535	545	470	480	810	882	670	680	575	580	1000	1040
800	3.5	2.6	49.5	3100	7650	2.5	2.04	57.8	3580	8125	618	635	520	555	918	962	770	760	630	650	1150	1140
1000	3.6	2.8	53.6	3850	9450	2.5	2.2	56.6	4150	10250	675	680	550	580	1036	1080	780	810	670	670	1280	1320

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MMRDA

SINGLE CORE COMPACTED ALUMINIUM & COPPER CONDUCTOR, XLPE INSULATED, UNARMOURED & ARMOURED CABLE CONFORMING TO IS: 7098 (PART-2)

Voltage Grade : 6.35 / 11kV (E), 6.6/6.6 kV (UE)

WEIGHT & DIMENSIONS

Nominal Size of Stranded class-2 conductor as per IS: 8130	Unarmoured Cable					Round Wire Armoured Cable				
	Nom. thickness of XLPE Insulation	Nom. thickness of Outer Sheath	Approx. Overall diameter of Cable with a 3mm tolerance	Al Approx. weight of cable	Cu Approx. weight of cable	Nom. diameter of Al wire	Min. thickness of Outer Sheath	Approx. Overall diameter of Cable +/- 2mm tolerance	Al Approx. weight of cable	Cu Approx. weight of cable
Sq.mm	mm	mm	mm	Kg/km	Kg/km	mm	mm	mm	Kg/km	Kg/km
35	3.6	2.0	21.8	450	650	1.6	1.6	23.2	520	733
50	3.6	2.0	23.3	541	808	1.6	1.6	24.3	600	875
70	3.6	2.0	24.7	635	1008	1.6	1.6	25.9	675	1050
95	3.6	2.0	27.4	731	1270	1.6	1.6	29.8	800	1100
120	3.6	2.1	28.8	825	1550	1.6	1.56	28.6	900	1555
150	3.6	2.0	30.2	925	1750	1.6	1.58	30.6	1035	1815
185	3.6	2.2	30.2	1050	2100	2.0	1.58	32.5	1150	2300
240	3.6	2.2	33.9	1250	2650	2.0	1.70	35.9	1470	2800
300	3.6	2.2	37.8	1500	3150	2.0	1.72	38.0	1800	3312
400	3.6	2.2	38.8	1800	4050	2.0	1.72	40.6	2100	4350
500	3.6	2.4	41.6	2150	5000	2.0	1.72	44.6	2450	5325
630	3.6	2.4	45.8	2550	6150	2.5	1.80	49.6	3050	6450
800	3.6	2.6	49.3	3050	7600	2.5	2.06	54.3	3500	8250
1000	3.6	2.8	55.6	3650	9100	2.5	2.20	58.6	4050	9570

Nominal Size	Current Rating – Aluminium: Buried Direct in the Ground @30°C		In Single way Duct @30°C		In Air @40°C		Current Rating – Copper: Buried Direct in the Ground @30°C		In Single way Duct @30°C		In Air @40°C	
	Trefoil Touching	Flat Touching	Trefoil Touching	Flat Touching	Trefoil Touching	Flat Touching	Trefoil Touching	Flat Touching	Trefoil Touching	Flat Touching	Trefoil Touching	Flat Touching
Sq.mm	Amps	Amps	Amps	Amps	Amps	Amps	Amps	Amps	Amps	Amps	Amps	Amps
35	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
50	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
70	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
95	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
120	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
150	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
185	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
240	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
300	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
400	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
500	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
630	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
800	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1000	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

SINGLE CORE COMPACTED ALUMINIUM & COPPER CONDUCTOR, XLPE INSULATED, UNARMOURED & ARMOURED CABLE CONFORMING TO IS: 7098 (PART-2)

Voltage Grade : 11/11 kV (UE)

WEIGHT & DIMENSIONS

Nominal Size of Stranded class-2 conductor as per IS: 8130	Unarmoured Cable					Armoured Cable				
	Nom. thickness of XLPE Insulation	Nom. thickness of Outer Sheath	Approx. Overall diameter of Cable with a 3mm tolerance	Al Approx. weight of cable	Cu Approx. weight of cable	Nom. diameter of Al wire	Min. thickness of Outer Sheath	Approx. Overall diameter of Cable +/- 2mm tolerance	Al Approx. weight of cable	Cu Approx. weight of cable
Sq.mm	mm	mm	mm	Kg/km	Kg/km	mm	mm	mm	Kg/km	Kg/km
35	5.5	2.0	25.0	690	801	1.6	1.5	27.4	759	932
50	5.5	2.0	26.3	870	955	1.6	1.56	28.8	833	1105
70	5.5	2.0	27.9	975	1150	1.6	1.56	30.4	952	1310
95	5.5	2.0	29.6	970	1520	1.6	1.56	32.1	1018	1600
100	5.5	2.0	31.6	1050	1750	2.0	1.56	34.3	1220	1920
150	5.5	2.2	32.8	1150	2080	2.0	1.72	35.7	1400	2200
185	5.5	2.1	34.7	1375	2380	2.0	1.56	37.6	1550	2600
240	5.5	2.2	37.1	1500	2850	2.0	1.72	40.3	1900	3150
300	5.5	2.2	39.8	1900	3350	2.0	1.72	42.6	2150	3550
400	5.5	2.4	42.8	1850	4350	2.5	1.88	46.0	2525	4450
500	5.5	2.6	45.8	2450	5250	2.5	1.88	49.0	2935	5250
630	5.5	2.6	49.6	2800	6450	2.5	1.84	53.7	3450	7800
800	5.5	2.8	54.6	3300	8050	2.5	2.2	58.5	4100	8050
1000	5.5	2.8	59.6	4350	9850	2.5	2.20	63.8	4800	10200

Nominal Size	Current Rating – Aluminium: Buried Direct in the Ground @30°C		In Single way Duct @30°C		In Air @40°C		Current Rating – Copper: Buried Direct in the Ground @30°C		In Single way Duct @30°C		In Air @40°C	
	Trefoil Touching	Flat Touching	Trefoil Touching	Flat Touching	Trefoil Touching	Flat Touching	Trefoil Touching	Flat Touching	Trefoil Touching	Flat Touching	Trefoil Touching	Flat Touching
Sq.mm	Amps	Amps	Amps	Amps	Amps	Amps	Amps	Amps	Amps	Amps	Amps	Amps
35	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
50	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
70	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
95	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
100	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
150	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
185	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
240	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
300	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
400	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
500	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
630	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
800	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1000	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

SINGLE CORE COMPACTED ALUMINIUM & COPPER CONDUCTOR, XLPE INSULATED, UNARMOURED & ARMOURED CABLE CONFORMING TO IS: 7098 (PART-2)

Voltage Grade : 12.7/22 kV (E)

WEIGHT & DIMENSIONS

Nominal Size of stranded class-2 conductor as per IS: 8130	Unarmoured Cable					Round Wire Armoured Cable				
	Nom. thickness of XLPE insulation	Nom. thickness of outer sheath	Approx. overall diameter of cable with ± 2mm tolerance	Al Approx weight of cable	Cu Approx weight of cable	Nom. diameter of Al wire	Min. thickness of outer sheath	Approx. overall diameter of cable with ± 2mm tolerance	Al Approx weight of cable	Cu Approx weight of cable
Sq.mm	mm	mm	mm	Kg/km	Kg/km	mm	mm	mm	Kg/km	Kg/km
35	6.0	2.0	26.2	650	900	1.6	1.56	30.2	820	1050
50	6.0	2.0	27.2	725	1000	1.6	1.56	29.6	920	1175
70	6.0	2.0	28.9	825	1225	1.6	1.56	31.2	1030	1400
95	6.0	2.0	30.0	975	1500	2.0	1.56	33.7	1120	1650
120	6.0	2.2	32.4	1000	1750	2.0	1.56	35.7	1300	2000
150	6.0	2.2	33.8	1200	2050	2.0	1.56	36.5	1470	2350
185	6.0	2.2	35.3	1375	2400	2.0	1.56	38.4	1600	2650
240	6.0	2.2	38.1	1550	2900	2.0	1.72	41.2	1900	3200
300	6.0	2.2	40.2	1775	3450	2.0	1.72	43.1	2150	3800
400	6.0	2.4	43.8	2150	4450	2.5	1.88	47.0	2625	4850
500	6.0	2.4	47.2	2550	5350	2.5	2.04	51.2	3000	5820
630	6.0	2.4	50.8	3000	6500	2.5	2.20	54.9	3450	6900
800	6.0	2.6	55.0	3650	8100	2.5	2.2	59.5	4100	8600
1000	6.0	2.8	57.2	4200	9450	2.5	2.36	61.7	4850	10500

Nominal Size	Current Rating											
	Aluminium						Copper					
	Buried Direct in the Ground @ 30°C		In Single way Duct @ 30°C		In Air @ 40°C		Buried Direct in the Ground @ 30°C		In Single way Duct @ 30°C		In Air @ 40°C	
	Trefoil Touching	Flat Touching	Trefoil Touching	Flat Touching	Trefoil Touching	Flat Touching	Trefoil Touching	Flat Touching	Trefoil Touching	Flat Touching	Trefoil Touching	Flat Touching
Sq.mm	Amps	Amps	Amps	Amps	Amps	Amps	Amps	Amps	Amps	Amps	Amps	Amps
35	115	120	165	185	145	165	150	155	146	150	165	190
50	135	140	145	125	155	175	175	180	165	160	220	230
70	165	170	165	150	215	220	215	220	195	195	275	285
95	200	205	190	180	260	270	255	265	220	237	345	345
120	225	230	210	208	300	305	290	300	255	260	390	403
150	250	258	230	225	345	350	320	335	280	290	440	450
185	285	290	255	275	395	405	360	375	315	325	505	510
240	331	335	295	310	470	470	420	430	360	375	590	590
300	370	380	320	335	535	540	475	482	405	417	680	678
400	422	435	350	376	621	633	538	522	475	465	780	774
500	475	485	406	420	700	730	598	600	530	520	920	900
630	530	574	445	459	821	830	660	669	581	570	1030	1041
800	655	670	598	520	855	850	720	700	620	620	1170	1190
1000	695	690	560	540	1075	1058	800	780	690	680	1290	1340

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SINGLE CORE COMPACTED ALUMINIUM & COPPER CONDUCTOR, XLPE INSULATED, UNARMOURED & ARMOURED CABLE CONFORMING TO IS: 7098 (PART-2)

Voltage Grade : 19/33 kV (E)

WEIGHT & DIMENSIONS

Nominal Size of stranded class-2 conductor as per IS: 8130	Unarmoured Cable					Armoured Cable				
	Nom. thickness of XLPE insulation	Nom. thickness of outer sheath	Approx. overall diameter of cable with ± 2mm tolerance	Al Approx weight of cable	Cu Approx weight of cable	Nom. diameter of Al wire	Min. thickness of outer sheath	Approx. overall diameter of cable with ± 2mm tolerance	Al Approx weight of cable	Cu Approx weight of cable
Sq.mm	mm	mm	mm	Kg/km	Kg/km	mm	mm	mm	Kg/km	Kg/km
120	8.8	2.2	38.2	1400	2250	2.0	1.72	41.6	1580	2400
150	8.8	2.2	39.6	1500	2550	2.0	1.72	42.8	1850	2700
185	8.8	2.4	41.9	1800	2750	2.0	1.72	44.7	2000	3050
240	8.8	2.4	44.3	1900	3200	2.0	1.88	47.2	2250	3800
300	8.8	2.4	46.8	2150	3850	2.5	2.04	50.9	2700	4400
400	8.8	2.6	49.8	2400	4850	2.5	2.04	54.1	3000	5300
500	8.8	2.8	53.0	3000	5850	2.5	2.20	57.4	3400	6300
630	8.8	2.8	56.8	3500	7000	2.5	2.20	61.2	4150	7850
800	8.8	3.0	61.5	4100	8600	2.5	2.36	65.6	4500	9300
1000	8.8	3.2	67.2	4850	10600	3.15	2.52	72.5	5300	11050

Nominal Size	Current Rating											
	Aluminium						Copper					
	Buried Direct in the Ground @ 30°C		In Single way Duct @ 30°C		In Air @ 40°C		In Single way Duct @ 30°C		In Single way Duct @ 30°C		In Air @ 40°C	
	Trefoil Touching	Flat Touching	Trefoil Touching	Flat Touching	Trefoil Touching	Flat Touching	Trefoil Touching	Flat Touching	Trefoil Touching	Flat Touching	Trefoil Touching	Flat Touching
Sq.mm	Amps	Amps	Amps	Amps	Amps	Amps	Amps	Amps	Amps	Amps	Amps	Amps
120	285	280	195	240	303	318	290	300	277	303	398	403
150	318	307	229	270	329	351	325	330	290	300	448	455
185	403	390	305	255	364	413	365	375	370	305	510	518
240	331	335	305	290	410	471	420	428	380	372	570	638
300	372	380	340	325	531	560	476	480	487	475	655	658
400	425	438	393	375	620	670	538	510	475	462	738	750
500	475	480	470	420	700	736	596	600	545	530	868	880
630	540	556	429	473	826	800	670	620	580	570	1020	1022
800	610	614	718	532	903	916	710	800	678	630	1178	1148
1000	690	648	749	750	1095	1049	780	760	667	660	1200	1325

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THREE CORE, ALUMINIUM & COPPER CONDUCTOR, XLPE INSULATED, ARMOURED CABLE CONFORMING TO IS: 7098 (PART-2)

Voltage Grade : 1.9/3.3 kV (Unscreened) (E)

WEIGHT & DIMENSIONS

Nominal Size of stranded class 2 conductor as per IS 8130	Form of conductor shape	Nom. thickness of XLPE Insulation	Min thickness of PVC Inner sheath	Strip Armoured Cable					Round Wire Armoured Cable					Current Rating					
				Nom. Dimension of Armour strip	Min thickness of Outer sheath	Approx Overall diameter of Cable with ±2mm tolerance	Al Approx weight of cable	Cu Approx weight of cable	Nom. Dimension of Armour wire	Min thickness of Outer sheath	Approx Overall diameter of Cable with ±2mm tolerance	Al Approx weight of cable	Cu Approx weight of cable	Aluminium: Buried Directly in the Ground @ 30°C	Aluminium: In Single way Ducts @ 30°C	Aluminium: In Air @ 40°C	Copper: Buried Directly in the Ground @ 30°C	Copper: In Single way Ducts @ 30°C	Copper: In Air @ 40°C
Sq.mm	△	mm	mm	mm x mm	mm	mm	Kg/Km	Kg/Km	mm	mm	mm	Kg/Km	Kg/Km	Amps	Amps	Amps	Amps	Amps	Amps
25	Shaped	2.2	[illegible]	4x0.8	[illegible]	[illegible]	[illegible]	[illegible]	1.6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
35	Shaped	2.2	[illegible]	4x0.8	[illegible]	[illegible]	[illegible]	[illegible]	1.6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
50	Shaped	2.2	[illegible]	4x0.8	[illegible]	[illegible]	[illegible]	[illegible]	2.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
70	Shaped	2.2	[illegible]	4x0.8	[illegible]	[illegible]	[illegible]	[illegible]	2.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
95	Shaped	2.2	[illegible]	4x0.8	[illegible]	[illegible]	[illegible]	[illegible]	2.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
120	Shaped	2.2	[illegible]	4x0.8	[illegible]	[illegible]	[illegible]	[illegible]	2.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
150	Shaped	2.2	[illegible]	4x0.8	[illegible]	[illegible]	[illegible]	[illegible]	2.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
185	Shaped	2.2	[illegible]	4x0.8	[illegible]	[illegible]	[illegible]	[illegible]	2.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
240	Shaped	2.2	[illegible]	4x0.8	[illegible]	[illegible]	[illegible]	[illegible]	2.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
300	Shaped	2.2	[illegible]	4x0.8	[illegible]	[illegible]	[illegible]	[illegible]	2.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
400	Shaped	2.2	[illegible]	4x0.8	[illegible]	[illegible]	[illegible]	[illegible]	3.15	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

THREE CORE, ALUMINIUM & COPPER CONDUCTOR, XLPE INSULATED, ARMOURED CABLE CONFORMING TO IS: 7098 (PART-2)

Voltage Grade : 3.3/3.3 kV (Screened) (UE)

WEIGHT & DIMENSIONS

Nominal Size of stranded class 2 conductor as per IS 8130	Form of conductor shape	Nom. thickness of XLPE Insulation	Min thickness of PVC Inner sheath	Strip Armoured Cable					Round Wire Armoured Cable					Current Rating					
				Nom. Dimension of Armour strip	Min thickness of Outer sheath	Approx Overall diameter of Cable with ±2mm tolerance	Al Approx weight of cable	Cu Approx weight of cable	Nom. Dimension of Armour wire	Min thickness of Outer sheath	Approx Overall diameter of Cable with ±2mm tolerance	Al Approx weight of cable	Cu Approx weight of cable	Aluminium: Buried Directly in the Ground @ 30°C	Aluminium: In Single way Ducts @ 30°C	Aluminium: In Air @ 40°C	Copper: Buried Directly in the Ground @ 30°C	Copper: In Single way Ducts @ 30°C	Copper: In Air @ 40°C
Sq.mm	○	mm	mm	mm x mm	mm	mm	Kg/Km	Kg/Km	mm	mm	mm	Kg/Km	Kg/Km	Amps	Amps	Amps	Amps	Amps	Amps
25	Circular	2.2	[illegible]	4x0.8	[illegible]	[illegible]	[illegible]	[illegible]	2.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
35	Circular	2.2	[illegible]	4x0.8	[illegible]	[illegible]	[illegible]	[illegible]	2.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
50	Circular	2.2	[illegible]	4x0.8	[illegible]	[illegible]	[illegible]	[illegible]	2.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
70	Circular	2.2	[illegible]	4x0.8	[illegible]	[illegible]	[illegible]	[illegible]	2.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
95	Circular	2.2	[illegible]	4x0.8	[illegible]	[illegible]	[illegible]	[illegible]	2.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
120	Circular	2.2	[illegible]	4x0.8	[illegible]	[illegible]	[illegible]	[illegible]	2.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
150	Circular	2.2	[illegible]	4x0.8	[illegible]	[illegible]	[illegible]	[illegible]	2.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
185	Circular	2.2	[illegible]	4x0.8	[illegible]	[illegible]	[illegible]	[illegible]	2.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
240	Circular	2.2	[illegible]	4x0.8	[illegible]	[illegible]	[illegible]	[illegible]	2.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
300	Circular	2.2	[illegible]	4x0.8	[illegible]	[illegible]	[illegible]	[illegible]	3.15	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
400	Circular	2.2	[illegible]	4x0.8	[illegible]	[illegible]	[illegible]	[illegible]	3.15	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

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THREE CORE, ALUMINIUM & COPPER CONDUCTOR, XLPE INSULATED, ARMOURED CABLE CONFORMING TO IS: 7098 (PART-2)

Voltage Grade : 3.8/6.6 kV (E)

WEIGHT & DIMENSIONS

Nominal Size of stranded compact conductor as per IS 8130	Form of conductor strand	Nom. thickness of XLPE Insulation	Min. thickness of PVC inner sheath	Strip Armoured Cable: Nom. Dimension of Strip Armour	Strip Armoured Cable: Min. Thickness of Outer sheath	Strip Armoured Cable: Approx Overall diameter of Cable with ±2mm tolerance	Strip Armoured Cable: Al Approx weight of cable	Strip Armoured Cable: Cu Approx weight of cable	Round Wire Armoured Cable: Nom. Dimension of RW Armour wire	Round Wire Armoured Cable: Min Thickness of Outer sheath	Round Wire Armoured Cable: Approx Overall diameter of Cable with ±2mm tolerance	Round Wire Armoured Cable: Al Approx weight of cable	Round Wire Armoured Cable: Cu Approx weight of cable	Current Rating Aluminium: Buried Direct in the Ground @ 30°C	Current Rating Aluminium: In Single way Buried Duct @ 30°C	Current Rating Aluminium: In Air @ 40°C	Current Rating Copper: Buried Direct in the Ground @ 30°C	Current Rating Copper: In Single way Buried Duct @ 30°C	Current Rating Copper: In Air @ 40°C
Sq.mm.	Ω	mm	mm	mm x mm	mm	mm	Kg/km	Kg/km	mm	mm	mm	Kg/km	Kg/km	Amps	Amps	Amps	Amps	Amps	Amps
25	Circular	2.8	[illegible]	4x0.8	1.50	36.8	[illegible]	[illegible]	2.0	1.52	38.6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
35	Circular	2.8	[illegible]	4x0.8	1.52	39.1	[illegible]	[illegible]	2.0	1.52	41.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
50	Circular	2.8	[illegible]	4x0.8	1.72	41.6	[illegible]	[illegible]	2.0	1.80	44.2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
70	Circular	2.8	[illegible]	4x0.8	1.80	45.2	[illegible]	[illegible]	2.0	1.80	47.6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
95	Circular	2.8	[illegible]	4x0.8	1.90	48.7	[illegible]	[illegible]	2.5	2.04	52.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
120	Circular	2.8	[illegible]	4x0.8	2.04	52.3	[illegible]	[illegible]	2.5	2.20	56.1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
150	Circular	2.8	[illegible]	4x0.8	2.20	55.6	[illegible]	[illegible]	2.5	2.20	59.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
185	Circular	2.8	[illegible]	4x0.8	2.20	59.4	[illegible]	[illegible]	2.5	2.36	64.6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
240	Circular	2.8	[illegible]	4x0.8	2.36	65.3	[illegible]	[illegible]	3.15	2.52	70.3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
300	Circular	3.0	[illegible]	4x0.8	2.52	71.0	[illegible]	[illegible]	3.15	2.68	76.8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
400	Circular	3.3	[illegible]	4x0.8	2.84	79.3	[illegible]	[illegible]	4.0	3.00	85.8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

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THREE CORE, ALUMINIUM & COPPER CONDUCTOR, XLPE INSULATED, ARMOURED CABLE CONFORMING TO IS: 7098 (PART-2)

VOLTAGE GRADE : 6.35/11 kV (E) OR 6.6/6.6 kV (UE)

WEIGHT & DIMENSIONS

Nominal Size of stranded compact conductor as per IS 8130	Form of conductor strand	Nom. thickness of XLPE Insulation	Min. thickness of PVC inner sheath	Strip Armoured Cable: Nom. Dimension of Strip Armour	Strip Armoured Cable: Min. Thickness of Outer sheath	Strip Armoured Cable: Approx Overall diameter of Cable with ±2mm tolerance	Strip Armoured Cable: Al Approx weight of cable	Strip Armoured Cable: Cu Approx weight of cable	Round Wire Armoured Cable: Nom. Dimension of RW Armour wire	Round Wire Armoured Cable: Min Thickness of Outer sheath	Round Wire Armoured Cable: Approx Overall diameter of Cable with ±2mm tolerance	Round Wire Armoured Cable: Al Approx weight of cable	Round Wire Armoured Cable: Cu Approx weight of cable	Current Rating Aluminium: Buried Direct in the Ground @ 30°C	Current Rating Aluminium: In Single way Buried Duct @ 30°C	Current Rating Aluminium: In Air @ 40°C	Current Rating Copper: Buried Direct in the Ground @ 30°C	Current Rating Copper: In Single way Buried Duct @ 30°C	Current Rating Copper: In Single way Buried Duct @ 30°C
Sq.mm.	Ω	mm	mm	mm x mm	mm	mm	Kg/km	Kg/km	mm	mm	mm	Kg/km	Kg/km	Amps	Amps	Amps	Amps	Amps	Amps
35	Circular	3.6	[illegible]	4x0.8	1.72	41.7	[illegible]	[illegible]	2.0	1.80	43.3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
50	Circular	3.6	[illegible]	4x0.8	1.80	45.3	[illegible]	[illegible]	2.5	2.05	48.8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
70	Circular	3.6	[illegible]	4x0.8	1.88	48.5	[illegible]	[illegible]	2.5	2.04	53.1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
95	Circular	3.6	[illegible]	4x0.8	2.04	52.5	[illegible]	[illegible]	2.5	2.20	56.9	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
120	Circular	3.6	[illegible]	4x0.8	2.20	56.3	[illegible]	[illegible]	2.5	2.20	59.6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
150	Circular	3.6	[illegible]	4x0.8	2.20	59.5	[illegible]	[illegible]	2.5	2.36	62.8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
185	Circular	3.6	[illegible]	4x0.8	2.36	63.5	[illegible]	[illegible]	3.15	2.52	68.3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
240	Circular	3.6	[illegible]	4x0.8	2.52	68.8	[illegible]	[illegible]	3.15	2.68	73.3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
300	Circular	3.6	[illegible]	4x0.8	2.68	74.6	[illegible]	[illegible]	4.0	2.84	78.3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
400	Circular	3.6	[illegible]	4x0.8	2.84	80.3	[illegible]	[illegible]	4.0	3.00	85.7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

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THREE CORE, ALUMINIUM & COPPER CONDUCTOR, XLPE INSULATED, ARMOURED CABLE CONFORMING TO IS: 7098 (PART-2)

VOLTAGE GRADE : 11/11 kV (UE)

WEIGHT & DIMENSIONS

Nominal Size of stranded, shaped conductor as per IS: 8130	Type of conductor strand	Nom. thickness of XLPE insulation	Min. thickness of PVC inner sheath	Strip Armoured Cable					Round Wire Armoured Cable					Current Rating					
				Nom. Dimension of Strip Armour	Min. Thickness of Outer sheath	Approx. Overall diameter of Cable with a 3mm tolerance	Al Approx. weight of cable	Cu Approx. weight of cable	Nom. Dimension of RW Round wire	Min. Thickness of Outer sheath	Approx. Overall diameter of Cable with a 3mm tolerance	Al Approx. weight of cable	Cu Approx. weight of cable	Aluminium: Buried Direct in the Ground at 30°C	Aluminium: In Single way ducts at 30°C	Aluminium: In Air at 40°C	Copper: Buried Direct in the Ground at 30°C	Copper: In Single way ducts at 30°C	Copper: In Air at 40°C
Sq.mm.	U	mm	mm	mm x mm	mm	mm	Kg/Km	Kg/Km	mm	mm	mm	Kg/Km	Kg/Km	Amps	Amps	Amps	Amps	Amps	Amps
35	Circular	3.3	0.5	4x0.8	2.24	51.3	2590	3650	3.5	2.20	55.5	4450	4950	115	97	125	140	125	165
50	Circular	3.3	0.6	4x0.8	2.20	54.0	2690	4150	3.5	2.28	57.4	4590	5400	130	115	150	170	150	195
70	Circular	3.3	0.6	4x0.8	2.28	57.1	3150	4950	3.5	2.36	61.5	5150	6300	160	140	190	210	180	205
95	Circular	3.3	0.6	4x0.8	2.36	61.3	4200	5900	3.15	2.52	64.7	6450	8550	190	165	210	250	215	275
120	Circular	3.3	0.7	4x0.8	2.36	64.6	4850	6950	3.15	2.52	70.0	7100	9750	215	190	245	280	245	325
150	Circular	3.3	0.7	4x0.8	2.52	67.8	5200	7850	3.15	2.68	74.0	7660	10450	245	210	275	310	270	360
185	Circular	3.3	0.7	4x0.8	2.68	72.2	5915	9150	3.15	2.84	74.5	8580	11600	275	235	315	350	305	430
240	Circular	3.3	0.7	4x0.8	2.84	77.4	6990	10850	3.55	3.00	83.9	9680	13700	315	275	365	410	350	500
300	Circular	3.3	0.7	4x0.8	3.0	80.2	7850	12800	4.0	3.00	89.0	11950	16400	355	310	410	455	395	580
400	Circular	3.3	0.7	4x0.8	3.0	85.1	9540	16150	4.0	3.00	94.0	13450	20800	400	350	500	510	440	650

THREE CORE, ALUMINIUM & COPPER CONDUCTOR, XLPE INSULATED, ARMOURED CABLE CONFORMING TO IS: 7098 (PART-2)

VOLTAGE GRADE : 12.7/22 kV (E)

WEIGHT & DIMENSIONS

Nominal Size of stranded, shaped conductor as per IS: 8130	Type of conductor strand	Nom. thickness of XLPE insulation	Min. thickness of PVC inner sheath	Strip Armoured Cable					Round Wire Armoured Cable					Current Rating					
				Nom. Dimension of Strip Armour	Min. Thickness of Outer sheath	Approx. Overall diameter of Cable with a 3mm tolerance	Al Approx. weight of cable	Cu Approx. weight of cable	Nom. Dimension of RW Round wire	Min. Thickness of Outer sheath	Approx. Overall diameter of Cable with a 3mm tolerance	Al Approx. weight of cable	Cu Approx. weight of cable	Aluminium: Buried Direct in the Ground at 30°C	Aluminium: In Single way ducts at 30°C	Aluminium: In Air at 40°C	Copper: Buried Direct in the Ground at 30°C	Copper: In Single way ducts at 30°C	Copper: In Air at 40°C
Sq.mm.	U	mm	mm	mm x mm	mm	mm	Kg/Km	Kg/Km	mm	mm	mm	Kg/Km	Kg/Km	Amps	Amps	Amps	Amps	Amps	Amps
35	Circular	6.0	0.6	4x0.8	2.36	53.8	2750	3750	3.5	2.20	57.6	4430	5550	110	98	130	140	125	165
50	Circular	6.0	0.6	4x0.8	2.20	56.5	3510	4850	3.5	2.36	60.2	4800	5750	130	115	155	170	150	200
70	Circular	6.0	0.6	4x0.8	2.36	60.7	3900	5350	3.5	2.36	63.5	5500	6900	160	140	190	205	180	245
95	Circular	6.0	0.7	4x0.8	2.36	63.7	4550	6750	3.15	2.52	65.7	6950	8250	190	170	230	245	215	300
120	Circular	6.0	0.7	4x0.8	2.52	67.8	5100	7550	3.15	2.68	72.8	7450	9400	215	190	265	275	245	345
150	Circular	6.0	0.7	4x0.8	2.68	70.2	7450	8650	3.15	2.68	74.3	8100	9650	240	215	300	305	275	390
185	Circular	6.0	0.7	4x0.8	2.84	74.4	6300	9850	3.15	2.84	77.6	8750	10850	270	240	330	345	315	395
240	Circular	6.0	0.7	4x0.8	2.84	80.8	7300	11300	4.0	3.00	83.7	11200	15250	315	275	400	395	355	510
300	Circular	6.0	0.7	4x0.8	3.00	83.7	8150	13300	4.0	3.00	91.4	12350	17950	350	310	455	440	395	585
400	Circular	6.0	0.7	4x0.8	3.00	91.2	9450	16700	4.0	3.00	97.2	14250	21100	395	355	530	495	440	660

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THREE CORE, ALUMINIUM & COPPER CONDUCTOR, XLPE INSULATED, ARMOURED CABLE CONFORMING TO IS: 7098 (PART-2)

Voltage Grade : 19/33 kV (E)

WEIGHT & DIMENSIONS

Nominal size of conductor	Shape of conductor	Nom. thickness of XLPE insulation	Min. thickness of PVC inner sheath	Strip Armoured Cable					Round Wire Armoured Cable					Current Rating					
				[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Aluminium			Copper		
														[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Sq.mm	V	mm	mm	mm x mm	mm	mm	kg/km	kg/km	mm	mm	mm	kg/km	kg/km	Amps	Amps	Amps	Amps	Amps	Amps
50	Circular	8.8	0.7	4x0.8	[illegible]	69.9	[illegible]	[illegible]	[illegible]	[illegible]	73.9	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
70	Circular	8.8	0.7	4x0.8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
95	Circular	8.8	0.7	4x0.8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	81.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
120	Circular	8.8	0.7	4x0.8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
150	Circular	8.8	0.7	4x0.8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
185	Circular	8.8	0.7	4x0.8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
240	Circular	8.8	0.7	4x0.8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
300	Circular	8.8	0.7	4x0.8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
400	Circular	8.8	0.7	4x0.8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

PVC AND XLPE LT POWER CABLES

KEI INDUSTRIES LIMITED is manufactures LT Power Cables with PVC or XLPE insulation of voltage grade upto 3.3 kV conforming to various Indian and International Standard Specifications. KEI also manufactures other types of cables as listed at the end of this catalogue.

CROSS LINKED POLYETHYLENE (XLPE)

XLPE means cross-linked polyethylene or vulcanized polyethylene. The basic material is low density polyethylene. Polyethylene is a thermoset material consisting of long chain of hydrocarbon molecules. At elevated temperature, these molecules tend to move relative to one another so that the material becomes increasingly deformable and eventually melts at the temperature around 110°C.

By means of process similar to the vulcanization of rubber, the polyethylene molecules can be cross-linked. The process of cross-linking or vulcanization consists of producing chemical bonds at interval between the long molecular chain to give a "ladder" effect which prevents slippage between molecules. As a result of cross-linking the material becomes heat resistant and does not soften at higher temperatures. Further it has better resistance to stress cracking and good resistance to ageing in hot air. With [illegible] of structure there is no adverse effect on electrical properties.

Advantages of KEI XLPE CABLES

- ✓ Dielectric losses are very small
- ✓ Higher current carrying capacity
- ✓ Higher short circuit rating 250°C as against 160 °C for PVC
- ✓ KEI XLPE can retain flexibility down upto - 40°C
- ✓ Jointing and termination is easy
- ✓ Light in weight
- ✓ They are not prone to fatigue damages due to vibrations or loading cycles
- ✓ Has better resistance to most chemicals, oils, acids, etc.
- ✓ Can be installed along cable routes without elevation limitations

Comparison of main properties between PVC and XLPE Insulation

Characteristics	Unit	PVC	XLPE
Permitivity (50 Hz, 20° C)	----	4-6	2.3
Dielectric Loss Factor (50 Hz, 20° C)	----	0.05-0.07	0.0004
Volume Resistivity (Insulation Resistance) (27° C)	Ohm-cm (min)	10^{13}	10^{14}
Maximum Conductor Temperature during continuous operation	Deg C	70	90
Maximum Conductor Temperature during short circuit	Deg C	160	250
Tensile Strength	N/mm² (min)	12.5	12.5
% Elongation at break	----	Excellent	Medium
Flexibility at 10° C	----	Poor	Good
Resistance to abrasion	----	Medium	Good

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RATING FACTORS (PVC)

The current ratings in Table – 1 & 2 based on the normal conditions of installation as described below:

1. Maximum condr. temperature 70° C
2. Ambient air temperature 40° C
3. Ground temperature 30° C
4. Depth of laying (for cable laid directly in ground) 75 cm (1.1 kV)
5. Thermal resistivity of soil 150° C cm/watt
6. Thermal resistivity of cable 650° C cm/watt
7. Max. short-circuit conductor temperature 160° C
8. Max. Ambient Air Temperature 55° C
9. Min Ambient Air temperature -15° C

Installation method and Rating factors are given in tables 1 to 6

Table 1

Rating for variations in ground temperature for cables laid directly in ground and in ducts

Ground temperature (°C)	15	20	25	30	35	40	45	50	55
Rating factor	1.17	1.12	1.06	1.0	0.94	0.87	0.79	0.70	0.60

Table 2

Rating factors for variation in ambient air temperature

Air temperature (°C)	25	30	35	40	45	50	55
Rating factor	1.25	1.14	1.09	1.0	0.90	0.80	0.69

Table 3

Rating factors of groups of twin and multicore cables laid directly in ground in horizontal formation

No. of cables	Rating factor for axial spacing				
	Touching	15 cm	30 cm	45 cm	60 cm
2 cables	0.78	0.81	0.85	0.88	0.90
3 cables	0.68	0.71	0.77	0.81	0.83
4 cables	0.61	0.65	0.72	0.76	0.79
6 cables	0.53	0.58	0.66	0.71	0.76
8 cables	0.48	0.54	0.62	0.67	0.72

Table 4

Rating Factors of groups of Twin and Multicore cables laid directly in Ground in Tier formation

No. of cables	Rating factor for axial spacing				
	Touching	15 cm	30 cm	45 cm	60 cm
4 cables	0.60	0.67	0.73	0.76	0.78
6 cables	0.51	0.57	0.63	0.67	0.69
8 cables	0.45	0.51	0.57	0.59	0.61

Table 5

Rating factors for variation in depth of laying in ground

Depth of laying (cms)	75	90	105	120	150	150 & above
Rating factor upto 25 sq. mm.	1.00	0.99	0.98	0.97	0.96	0.95

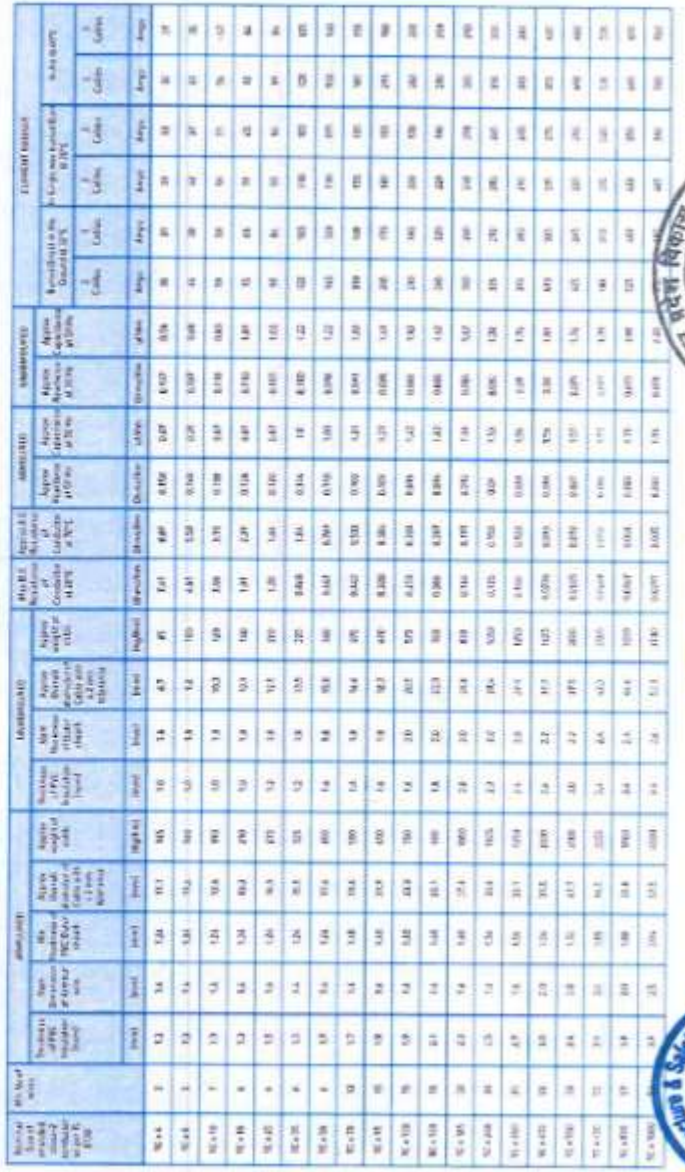
Table 6

Group rating factors for cables installed in Ground, separated by more than 7 cms.

No. of cables	1	2	3	4	5	6
Single core D.C. cables & multicore power cables	1.0	0.90	0.80	0.75	0.70	0.65
Single core A.C. cables	1.0	0.80	0.75	0.70	0.65	0.60

1 CORE, ALUMINIUM CONDUCTOR, PVC INSULATED, ARMOURED & UNARMOURED POWER CABLES

FOR WORKING VOLTAGES UP TO AND INCLUDING 1100 V



1 CORE, COPPER CONDUCTOR, PVC INSULATED, ARMOURED & UNARMOURED POWER CABLES

FOR WORKING VOLTAGES UP TO AND INCLUDING 1100 V

Nominal Size of stranded conductor as per IS 8130	No. of wires	ARMOURED: Thickness of PVC Insulation (nom)	Nom. Dimension of Armour wire	Min Thickness of PVC Outer sheath	Approx Overall diameter of Cable with ±2mm tolerance	Approx weight of cable	UNARMOURED: Thickness of PVC Insulation (nom)	Min thickness of Outer sheath	Approx Overall diameter of Cable with ±2mm tolerance	Approx weight of cable	Max D.C. Resistance of Conductor at 20°C	Approx A.C. Resistance of Conductor at 70°C	ARMOURED: Approx Reactance at 50 Hz	Approx Capacitance at 50 Hz	UNARMOURED: Approx Reactance at 50 Hz	Approx Capacitance at 50 Hz	CURRENT RATINGS: Buried Direct in the Ground at 30°C, 2 Cables	3 Cables	In Single way Ducts at 30°C, 2 Cables	3 Cables	In Air at 40°C, 2 Cables	3 Cables
		(mm)	(mm)	(mm)	(mm)	(kg/km)	(mm)	(mm)	(mm)	(kg/km)	Ohm/km	Ohm/km	Ohm/km	µF/km	Ohm/km	µF/km	Amps	Amps	Amps	Amps	Amps	Amps
1C x 4	7	1.0	1.4	1.24	11.1	165	1.0	1.8	8.7	100	4.61	5.53	0.139	0.49	0.137	0.56	46	39	42	39	43	35
1C x 6	7	1.0	1.4	1.24	11.6	200	1.0	1.8	9.2	124	3.08	3.70	0.186	0.50	0.127	0.60	57	48	54	48	56	42
1C x 10	7	1.0	1.4	1.24	12.6	240	1.0	1.8	10.2	171	1.83	2.20	0.136	0.67	0.119	0.80	75	63	70	61	75	68
1C x 16	6	1.0	1.4	1.24	13.5	310	1.0	1.8	10.9	238	1.15	1.38	0.128	0.68	0.110	0.91	96	85	92	83	98	82
1C x 25	6	1.2	1.4	1.24	14.9	425	1.2	1.8	12.3	336	0.727	0.87	0.130	0.87	0.105	1.05	123	110	120	110	125	110
1C x 35	6	1.2	1.4	1.24	15.9	535	1.2	1.8	13.3	435	0.524	0.63	0.116	1.00	0.100	1.22	150	135	140	125	155	135
1C x 50	6	1.4	1.6	1.24	17.4	700	1.4	1.8	15.0	595	0.387	0.464	0.110	1.00	0.098	1.22	180	160	165	150	190	165
1C x 70	12	1.4	1.6	1.40	19.6	950	1.4	1.8	16.8	825	0.268	0.322	0.104	1.21	0.091	1.42	220	190	205	185	235	205
1C x 95	15	1.6	1.6	1.40	21.7	1200	1.6	1.8	18.7	1125	0.193	0.232	0.101	1.29	0.086	1.47	265	230	240	210	275	250
1C x 120	18	1.6	1.6	1.40	23.3	1450	1.6	2.0	20.1	1350	0.153	0.185	0.096	1.42	0.086	1.62	300	255	270	240	315	280
1C x 150	18	2.1	1.6	1.40	25.1	1750	1.8	2.0	21.9	1550	0.124	0.150	0.096	1.52	0.085	1.62	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1C x 185	30	[illegible]	1.6	1.40	[illegible]	[illegible]	2.0	2.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1C x 240	34	[illegible]	1.6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1C x 300	34	[illegible]	1.6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1C x 400	53	[illegible]	2.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1C x 500	53	[illegible]	2.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1C x 630	53	[illegible]	2.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1C x 800	53	[illegible]	2.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1C x 1000	53	[illegible]	2.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

2 CORE, ALUMINIUM CONDUCTOR, PVC INSULATED, ARMOURED & UNARMOURED POWER CABLES

FOR WORKING VOLTAGES UP TO AND INCLUDING 1100 V

Nominal Cross Sectional Area	No. of wires	Thickness of PVC Insulation (nom)	Min thickness of PVC Inner Sheath	ARMOURED: Nominal Dimension of Armour, Strip	Wire	Min thickness of PVC Outer sheath, Strip	Wire	Approx Overall diameter of Cable with ±2mm tolerance, Strip	Wire	Approx Net Wt of Cable, Strip	Wire	UNARMOURED: Nom thickness of PVC Outer sheath	Approx Overall diameter of Cable with ±2mm tolerance	Approx weight of cable	Max D.C. Resistance of Conductor at 20°C	Approx A.C. Resistance of Conductor at 70°C	Approx Reactance at 50Hz	Approx Capacitance at 50Hz	CURRENT RATINGS: Buried Direct in the Ground at 30°C	In Single way Buried Duct 30°C	In Air at 40°C
Sq mm	No's	mm	mm	mm x mm	mm	mm	mm	mm	mm	kg/km	kg/km	mm	mm	kg/km	Ohm/km	Ohm/km	Ohm/km	µF/km	Amps	Amps	Amps
2C x 1.5	1	0.8	0.3	—	1.4	—	1.26	—	10.0	—	390	1.8	12.2	160	18.1	21.7	0.124	0.16	18	16	16
2C x 2.5	1	0.9	0.3	—	1.4	—	1.24	—	15.2	—	420	1.8	13.0	200	12.1	14.5	0.119	0.15	25	21	20
2C x 4	3	1.0	0.3	—	1.4	—	1.28	—	16.8	—	520	1.8	15.0	250	7.41	8.87	0.116	0.16	32	27	27
2C x 6	3	1.0	0.3	—	1.4	—	1.28	—	17.8	—	600	1.8	16.0	280	4.61	5.53	0.110	0.19	40	34	35
2C x 10	7	1.0	0.3	—	1.4	—	1.28	—	19.8	—	780	1.8	16.0	350	3.08	3.70	0.100	0.22	55	45	47
2C x 16	6	1.0	0.3	4 x 0.8	1.4	1.4	1.4	18.8	20.4	525	675	1.8	16.8	320	1.91	2.29	0.097	0.23	70	59	58
2C x 25	6	1.2	0.3	4 x 0.8	1.4	1.4	1.4	20.9	22.4	650	850	2.0	20.6	410	1.20	1.44	0.097	0.32	90	76	78
2C x 35	6	1.2	0.3	4 x 0.8	1.4	1.4	1.4	21.8	23.4	750	1000	2.0	21.6	525	0.868	1.04	0.087	0.37	110	92	94
2C x 50	6	1.4	0.3	4 x 0.8	1.4	1.4	1.56	24.3	26.2	925	1200	2.0	23.9	675	0.641	0.769	0.085	0.33	130	115	125
2C x 70	12	1.4	0.3	4 x 0.8	1.6	1.56	1.56	26.7	28.3	1100	1400	2.0	26.8	825	0.443	0.532	0.080	0.44	160	140	150
2C x 95	15	1.6	0.4	4 x 0.8	2.0	1.56	1.56	30.2	32.6	1400	1900	2.2	27.9	1050	0.320	0.384	0.079	0.44	190	170	185
2C x 120	15	1.6	0.4	4 x 0.8	2.0	1.56	1.72	33.7	35.4	1600	2150	2.2	33.6	1275	0.253	0.304	0.077	0.49	215	190	215
2C x 150	15	1.8	0.4	4 x 0.8	2.0	1.72	1.72	35.6	37.8	1950	2550	2.4	35.7	1550	0.206	0.247	0.077	0.49	240	210	250
2C x 185	30	2.0	0.5	4 x 0.8	2.0	1.88	1.88	39.1	41.5	2250	3150	2.6	38.5	1850	0.164	0.197	0.077	0.49	275	240	275
2C x 240	30	2.2	0.5	4 x 0.8	2.5	2.04	2.04	42.5	45.9	2850	3750	2.6	42.8	2300	0.125	0.150	0.077	0.59	320	275	325
2C x 300	30	2.4	0.6	4 x 0.8	2.5	2.20	2.20	48.5	51.5	3500	4425	2.8	48.1	2850	0.100	0.120	0.076	0.52	355	305	365
2C x 400	53	2.6	0.6	4 x 0.8	3.15	2.36	2.52	54.6	58.1	4300	6250	3.0	53.6	3700	0.0778	0.093	0.076	0.53	400	345	420

STRABAG Infrastructure & Safety Solutions GmbH

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MUMBAI METROPOLITAN REGION DEVELOPMENT AUTHORITY

2 CORE COPPER PVC ARMOURED & UNARMOURED POWER CABLES

FOR WORKING VOLTAGES UP TO AND INCLUDING 1100 V

No. of Cores & Cross sectional Area	Min. No. of wires	Thickness of PVC Insulation (nom)	Min. Thickness of PVC Inner Sheath	ARMOURED: Nominal Dimension of Armour		Min. Thickness of PVC Outer Sheath		Approx Overall diameter of Cable with ±2mm tolerance		Approx. Weight of Cable		UNARMOURED: Nom. thickness of PVC Outer sheath	Approx Overall diameter of Cable with ±2mm tolerance	Approx weight of cable	Max D.C. Resistance of Conductor at 20°C	Approx A.C. Resistance of Conductor at 70°C	Approx Reactance at 50Hz	Approx Capacitance at 50Hz	CURRENT RATINGS: Buried Direct in the Ground @ 30°C	In Single way Ducts @ 30°C	In Air @ 40°C
				Strip	Wire	Strip	Wire	Strip	Wire	Strip	Wire										
Sq mm	No's	mm	mm	mm	mm	mm	mm	mm	mm	Kg/Km	Kg/Km	mm	mm	Kg/Km	Ohm/Km	Ohm/Km	Ohm/Km	µF/Km	Amps	Amps	Amps
2C x 1.5	1	0.8	0.3	—	1.4	—	1.24	—	14.3	—	410	1.8	12.2	185	12.1	14.52	0.104	0.76	23	29	30
2C x 2.5	1	0.9	0.3	—	1.4	—	1.24	—	15.4	—	477	1.8	13.0	245	7.41	8.89	0.101	0.75	32	37	29
2C x 4	1	1.0	0.3	—	1.4	—	1.24	—	16.8	—	556	1.8	15.0	300	4.61	5.53	0.096	0.76	47	35	35
2C x 6	1	1.0	0.3	—	1.4	—	1.24	—	17.8	—	659	1.8	16.0	337	3.08	3.70	0.110	0.31	50	44	45
2C x 10	1	1.0	0.3	—	1.4	—	1.24	—	19.8	—	855	1.8	18.0	475	1.83	2.20	0.086	0.42	70	58	60
2C x 16	6	1.0	0.3	4 x 0.8	1.4	1.4	1.4	19.8	26.4	510	859	1.8	16.6	500	1.15	1.38	0.077	0.21	96	75	78
2C x 25	6	1.2	0.3	4 x 0.8	1.4	1.4	1.4	20.9	22.6	960	1104	2.0	20.4	725	0.727	0.872	0.077	0.42	115	97	101
2C x 35	6	1.2	0.3	4 x 0.8	1.6	1.4	1.4	21.8	23.6	1138	1109	2.0	21.4	915	0.524	0.629	0.077	0.37	140	122	125
2C x 50	6	1.4	0.3	4 x 0.8	1.6	1.4	1.56	24.3	26.0	1503	1756	2.0	22.9	1205	0.387	0.464	0.094	0.27	162	145	155
2C x 70	12	1.4	0.3	4 x 0.8	1.6	1.56	1.56	26.2	28.7	1953	2250	2.0	24.8	1670	0.268	0.322	0.092	0.46	202	181	195
2C x 95	15	1.6	0.4	4 x 0.8	2.0	1.56	1.72	29.2	32.4	2524	2881	2.2	27.9	2150	0.193	0.232	0.093	0.44	240	215	230
2C x 120	18	1.6	0.4	4 x 0.8	2.0	1.56	1.72	31.3	34.4	3118	3513	2.2	31.6	2851	0.153	0.184	0.087	0.49	275	245	265
2C x 150	18	1.8	0.4	4 x 0.8	2.0	1.72	1.72	35.4	37.8	3698	4203	2.4	33.2	3250	0.124	0.149	0.080	0.49	310	278	305
2C x 185	30	2.0	0.5	4 x 0.8	2.0	1.88	1.88	38.7	41.5	4655	5356	2.6	38.5	3950	0.0991	0.119	0.087	0.49	350	310	350
2C x 240	34	2.2	0.5	4 x 0.8	2.5	2.04	2.04	42.8	45.9	5934	6655	2.6	42.8	5050	0.0754	0.090	0.087	0.59	405	355	470
2C x 300	34	2.4	0.6	4 x 0.8	2.5	2.20	2.20	46.7	50.9	6933	8025	2.8	46.1	6150	0.0601	0.072	0.086	0.72	450	395	445
2C x 400	53	2.6	0.7	4 x 0.8	3.15	2.36	2.52	52.6	56.8	8803	10252	3.2	52.5	8150	0.0470	0.056	0.085	0.75	490	475	550

3 CORE, ALUMINIUM CONDUCTOR, PVC INSULATED, ARMOURED & UNARMOURED POWER CABLES

FOR WORKING VOLTAGES UP TO AND INCLUDING 1100 V

No. of Cores & Cross sectional Area	Min. No. of wires	Thickness of PVC Insulation (nom)	Min. Thickness of PVC Inner Sheath	ARMOURED: Nominal Dimension of Armour		Min. Thickness of PVC Outer Sheath		Approx Overall diameter of Cable with ±2mm tolerance		Approx weight of cable		UNARMOURED: Nom. thickness of PVC Outer sheath	Approx Overall diameter of Cable with ±2mm tolerance	Approx weight of cable	Max D.C. Resistance of Conductor at 20°C	Approx A.C. Resistance of Conductor at 70°C	Approx Reactance at 50Hz	Approx Capacitance at 50Hz	CURRENT RATINGS: Buried Direct in the Ground @ 30°C	In Single way Ducts @ 30°C	In Air @ 40°C
				Strip	Wire	Strip	Wire	Strip	Wire	Strip	Wire										
Sq mm	No's	mm	mm	mm	mm	mm	mm	mm	mm	Kg/Km	Kg/Km	mm	mm	Kg/Km	Ohm/Km	Ohm/Km	Ohm/Km	µF/Km	Amps	Amps	Amps
3C x 1.5	1	0.8	0.3	—	1.4	—	1.25	—	14.3	—	420	1.8	12.1	175	18.1	21.72	0.104	0.66	16	16	15
3C x 2.5	1	0.9	0.3	—	1.4	—	1.24	—	15.8	—	330	1.8	14.0	225	12.1	14.52	0.111	0.65	21	18	18
3C x 4	1	1.0	0.3	—	1.4	—	1.24	—	15.6	—	358	1.8	15.0	295	7.41	8.89	0.115	0.47	28	23	23
3C x 6	1	1.0	0.3	—	1.4	—	1.24	—	18.6	—	625	1.8	16.8	325	4.61	5.53	0.110	0.47	35	30	30
3C x 10	1	1.0	0.3	—	1.4	—	1.4	—	20.3	—	710	1.8	19.0	405	3.08	3.70	0.100	0.54	46	39	40
3C x 16	6	1.0	0.3	4 x 0.8	1.4	1.4	1.4	19.6	20.2	620	730	1.8	17.6	275	1.91	2.29	0.097	0.76	48	39	57
3C x 25	6	1.2	0.3	4 x 0.8	1.6	1.4	1.4	20.3	22.9	720	900	2.0	20.1	575	1.20	1.44	0.097	0.84	76	62	70
3C x 35	6	1.2	0.3	4 x 0.8	1.6	1.4	1.4	20.1	21.3	900	1128	2.0	22.1	555	0.868	1.04	0.093	0.98	92	77	84
3C x 50	6	1.4	0.3	4 x 0.8	1.6	1.56	1.56	24.4	28.8	1156	1460	2.0	27.7	950	0.641	0.769	0.096	1.02	115	90	105
3C x 70	12	1.4	0.4	4 x 0.8	2.0	1.56	1.56	29.4	30.8	1600	2050	2.2	29.2	1506	0.443	0.531	0.091	1.10	131	115	130
3C x 95	15	1.6	0.4	4 x 0.8	2.0	1.56	1.72	30.8	35.2	1800	2650	2.2	33.4	1400	0.320	0.384	0.090	1.20	160	140	155
3C x 120	15	1.6	0.4	4 x 0.8	2.0	1.72	1.72	35.5	36.6	2700	2800	2.4	36.6	1750	0.253	0.304	0.087	1.31	185	155	180
3C x 150	15	1.8	0.5	4 x 0.8	2.0	1.88	1.88	40.1	42.5	3400	3800	2.6	39.5	2150	0.206	0.247	0.087	1.41	210	175	205
3C x 185	30	2.0	0.5	4 x 0.8	2.5	1.88	2.04	44.2	47.8	3700	4200	2.6	44.0	2850	0.164	0.197	0.088	1.31	235	200	240
3C x 240	30	2.2	0.6	4 x 0.8	2.5	2.20	2.20	50.3	50.9	4400	3750	2.8	44.9	3550	0.125	0.150	0.087	1.34	275	235	280
3C x 300	30	2.4	0.6	4 x 0.8	2.5	2.36	2.36	55.0	58.4	4900	4900	3.0	54.1	4450	0.100	0.120	0.086	1.41	305	260	310
3C x 400	53	2.6	0.7	4 x 0.8	3.15	2.52	2.68	62.0	60.7	6000	8000	3.4	62.8	7200	0.0778	0.093	0.085	1.43	335	290	355

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3 CORE, COPPER CONDUCTOR, PVC INSULATED, ARMOURED & UNARMOURED POWER CABLES

FOR WORKING VOLTAGES UP TO AND INCLUDING 1100 V

No. of Cores & Cross sectional Area	Min. No. of wires	Thickness of PVC Insulation (nom)	Min. Thickness of PVC Inner Sheath	ARMOURED: Nominal Dimension of Armour		Min Thickness of PVC Outer sheath		Approx Overall diameter of Cable with ± 2 mm tolerance		Approx weight of cable		UNARMOURED: Nom. Thickness of PVC Outer Sheath	Approx Overall diameter of Cable with ± 2 mm tolerance	Approx weight of cable	Max D.C. Resistance of Conductor at 20°C	Approx A.C. Resistance of Conductor at 70°C	Approx Reactance at 50 Hz	Approx Capacitance at 50 Hz	CURRENT RATINGS: Buried Direct in the Ground @ 30°C	In Single way Ducts (Duct) @ 30°C	In Air @ 40°C
				Strip	Wire	Strip	Wire	Strip	Wire	Strip	Wire										
Sq.mm	Nos	mm	mm	mm	mm	mm	mm	mm	mm	Kg/Km	Kg/Km	mm	mm	kg/km	Ohm/km	Ohm/km	Ohm/km	µF/km	Amps	Amps	Amps
3C x 1.5	7	0.8	0.3	—	1.4	—	1.24	—	16.5	—	450	1.8	12.7	235	12.1	14.5	0.100	0.16	21	17	17
3C x 2.5	7	0.9	0.3	—	1.4	—	1.24	—	15.8	—	525	1.8	14.0	330	7.41	8.89	0.099	0.17	27	24	24
3C x 4	7	1.0	0.3	—	1.4	—	1.24	—	17.8	—	623	1.8	15.4	356	4.61	5.53	0.096	0.47	36	32	30
3C x 6	7	1.0	0.3	—	1.4	—	1.24	—	18.4	—	737	1.8	16.9	435	3.08	3.70	0.110	0.47	45	38	39
3C x 10	7	1.0	0.3	—	1.4	—	1.4	—	21.2	—	968	1.8	19.0	575	1.83	2.20	0.102	0.56	60	50	53
3C x 16	6	1.0	0.3	4 x 0.8	1.4	1.4	1.4	18.6	20.2	850	1028	1.8	17.8	750	1.15	1.38	0.097	0.70	77	64	66
3C x 25	6	1.2	0.3	4 x 0.8	1.6	1.4	1.4	21.2	22.9	1000	1400	2.0	20.1	1020	0.727	0.872	0.097	0.80	99	81	73
3C x 35	6	1.2	0.3	4 x 0.8	1.6	1.4	1.4	23.3	23.7	1950	1600	2.0	22.7	1320	0.524	0.629	0.087	0.86	120	99	110
3C x 50	6	1.4	0.3	4 x 0.8	1.6	1.56	1.56	26.6	26.8	2010	2200	2.0	23.9	1850	0.387	0.465	0.094	1.00	146	120	135
3C x 70	12	1.4	0.4	4 x 0.8	2.0	1.56	1.56	27.9	30.6	2183	3150	2.2	28.3	2150	0.268	0.322	0.090	1.16	175	153	165
3C x 95	15	1.6	0.4	4 x 0.8	2.0	1.56	1.72	30.8	34.2	3700	4150	2.2	33.1	3100	0.193	0.232	0.090	1.20	210	185	200
3C x 120	18	1.6	0.4	4 x 0.8	2.0	1.72	1.72	35.0	39.6	4250	5004	2.2	36.4	3550	0.153	0.184	0.087	1.20	240	192	230
3C x 150	18	1.8	0.5	4 x 0.8	2.5	1.88	1.88	40.1	42.5	5180	5950	2.4	39.5	4800	0.124	0.149	0.087	1.20	270	225	265
3C x 185	30	2.0	0.5	4 x 0.8	2.5	1.88	2.04	44.2	47.8	6250	7604	2.6	45.0	5600	0.0991	0.119	0.087	1.20	300	255	305
3C x 240	34	2.2	0.6	4 x 0.8	2.5	2.20	2.20	50.3	50.7	8000	9700	2.8	49.4	7600	0.0754	0.0906	0.087	1.26	350	295	355
3C x 300	34	2.4	0.6	4 x 0.8	2.5	2.36	2.36	55.0	56.6	10000	11450	3.0	54.1	9100	0.0601	0.072	0.086	1.41	390	335	420
3C x 400	53	2.6	0.7	4 x 0.8	3.15	2.52	2.68	62.6	65.7	13070	15303	3.4	61.8	11101	0.047	0.056	0.086	1.45	435	368	470

3.5 CORE, COPPER CONDUCTOR, PVC INSULATED, ARMOURED POWER CABLES

FOR WORKING VOLTAGES UP TO AND INCLUDING 1100 V

No. of Cores & Cross sectional Area	Min. No. of wires (Phase/Neutral)	Thickness of PVC Insulation (nom) (Phase/Neutral)	Min. thickness of PVC Inner Sheath	Nominal Dimension of Armour		Min Thickness of PVC Outer sheath		Approx Overall diameter of Cable with ± 2 mm tolerance		Approx weight of cable		Max D.C. Resistance of Conductor at 20°C	Approx A.C. Resistance of Conductor at 70°C	Approx Reactance at 50 Hz	Approx Capacitance at 50 Hz	CURRENT RATINGS: Buried Direct in the Ground @ 30°C	In Single way Ducts (Duct) @ 30°C	In Air @ 40°C
				Strip	Wire	Strip	Wire	Strip	Wire	Strip	Wire							
Sq.mm	Nos	mm	mm	mm x mm	mm	mm	mm	mm	mm	Kg/Km	Kg/Km	Ohm/km	Ohm/km	Ohm/km	µF/km	Amps	Amps	Amps
3.5C x 25/16	6/6	1.0/0.8	0.3	4 x 0.8	1.6	1.4	1.4	23.9	25.4	1800	1900	0.727	0.872	0.097	0.86	99	81	90
3.5C x 35/16	6/6	1.2/1.0	0.3	4 x 0.8	1.6	1.4	1.4	26.8	24.6	1900	2100	0.524	0.629	0.097	0.98	120	99	110
3.5C x 50/25	6/6	1.4/1.2	0.4	4 x 0.8	1.6	1.56	1.56	28.6	31.0	2350	2850	0.387	0.465	0.094	1.00	145	120	135
3.5C x 70/35	12/6	1.4/1.2	0.4	4 x 0.8	2.0	1.56	1.56	32.5	36.8	3100	3450	0.268	0.322	0.09	1.16	175	150	165
3.5C x 95/50	15/6	1.6/1.4	0.5	4 x 0.8	2.0	1.72	1.72	36.2	38.9	4100	4300	0.193	0.232	0.09	1.2	210	175	200
3.5C x 120/70	18/12	1.6/1.4	0.5	4 x 0.8	2.0	1.72	1.88	38.3	42.1	5050	5900	0.153	0.184	0.087	1.21	240	195	230
3.5C x 150/70	18/12	1.8/1.4	0.5	4 x 0.8	2.0	1.88	1.88	44.5	46.6	6050	6900	0.124	0.149	0.087	1.21	270	225	265
3.5C x 185/95	30/15	2.0/1.6	0.5	4 x 0.8	2.5	2.04	2.04	48.6	52.2	7600	8450	0.0991	0.119	0.087	1.21	300	255	305
3.5C x 240/120	34/18	2.2/1.6	0.6	4 x 0.8	2.5	2.2	2.36	53.2	58.9	9450	10500	0.0754	0.090	0.087	1.36	345	295	355
3.5C x 300/150	34/18	2.4/1.8	0.6	4 x 0.8	3.15	2.36	2.52	59.7	64.7	11550	12300	0.0601	0.072	0.086	1.41	390	335	420
3.5C x 400/185	53/30	2.6/2.0	0.7	4 x 0.8	3.15	2.68	2.68	69.6	73.4	14650	15250	0.047	0.056	0.086	1.45	435	368	470

3.5 CORE, COPPER CONDUCTOR, PVC INSULATED, UNARMOURED POWER CABLES

FOR WORKING VOLTAGES UP TO AND INCLUDING 1100 V

No. of Cores & Cross sectional Area	Min. No. of wires (Phase/Neutral)	Thickness of PVC Insulation (nom) (Phase/Neutral)	Min. thickness of PVC Inner Sheath	Nom. thickness of PVC Outer sheath	Approx Overall diameter of Cable with ± 2 mm tolerance	Approx weight of cable	Max D.C. Resistance of Conductor at 20°C	Approx A.C. Resistance of Conductor at 70°C	Approx Reactance at 50 Hz	Approx Capacitance	CURRENT RATINGS: Buried Direct in the Ground @ 30°C	In Single way Ducts (Duct) @ 30°C	In Air @ 40°C
Sq.mm	Nos	mm	mm	mm	mm	Kg/km	Ohm/km	Ohm/km	Ohm/km	µF/km	Amps	Amps	Amps
3.5C x 25/16	6/6	1.0/0.8	0.3	2.0	20.6	1150	0.727	0.872	0.097	0.86	99	81	90
3.5C x 35/16	6/6	1.2/1.0	0.3	2.0	23.4	1420	0.524	0.629	0.097	0.98	120	99	110
3.5C x 50/25	6/6	1.4/1.2	0.3	2.0	27.1	2000	0.387	0.465	0.094	1.00	145	120	135
3.5C x 70/35	12/6	1.4/1.2	0.4	2.2	30.3	2800	0.268	0.322	0.090	1.16	175	150	165
3.5C x 95/50	15/6	1.6/1.4	0.5	2.2	35.1	3500	0.193	0.232	0.090	1.2	210	180	200
3.5C x 120/70	18/12	1.6/1.4	0.5	2.4	37.1	4200	0.153	0.184	0.087	1.21	240	195	230
3.5C x 150/70	18/12	1.8/1.4	0.5	2.6	42.3	5400	0.124	0.149	0.087	1.21	270	225	265
[illegible]	[illegible]	2.0/1.6	0.5	2.8	46.3	6500	0.0991	0.119	0.087	1.21	[illegible]	[illegible]	305
[illegible]	[illegible]	2.2/1.6	0.6	3.0	53.2	8400	0.0754	0.090	0.087	1.36	[illegible]	[illegible]	355
[illegible]	[illegible]	2.4/1.8	0.6	3.2	[illegible]	10500	0.0601	0.072	0.086	1.41	390	335	420
[illegible]	[illegible]	2.6/2.0	0.7	3.4	[illegible]	[illegible]	0.047	0.056	0.086	1.45	435	[illegible]	[illegible]

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KEI WIRES & CABLES

3.5 CORE, ALUMINIUM CONDUCTOR, PVC INSULATED, ARMOURED POWER CABLES

FOR WORKING VOLTAGES UP TO AND INCLUDING 1100 V

No. of Cores & Cross Sectional Area	Min. No. of wires (main/neutral)	Thickness of PVC Insulation (main/neutral)	Min. thickness of PVC Inner Sheath	Nominal Dimension of Armour		Min. Thickness of PVC Outer Sheath		Approx. Overall diameter of cable with ± 2 mm tolerance		Approx. weight of cable		Max. D.C. Resistance of Conductor at 20°C	Approx. A.C. Resistance of Conductor at 70°C	Approx. Reactance at 50 Hz	Approx. Capacitance at 50 Hz	CURRENT RATINGS		
				Strip	Wire	Strip	Wire	Strip	Wire	Strip	Wire					Buried Direct in the Ground at 30°C	In Single way Ducts at 30°C	In Air at 40°C
Sq mm	Nos	mm	mm	mm x mm	mm	mm	mm	mm	mm	(kg/km)	(kg/km)	Ohm/km	Ohm/km	Ohm/km	µF/km	Amps	Amps	Amps
3.5C x 25/16	6/6	1.2/1.0	0.3	4 x 0.8	1.4	1.40	1.40	23.8	25.4	430	1150	1.20	1.44	0.097	0.84	76	63	70
3.5C x 35/16	6/6	1.2/1.0	0.3	4 x 0.8	1.6	1.40	1.40	24.8	26.5	1000	1300	0.868	1.11	0.097	0.88	83	77	86
3.5C x 50/25	6/6	1.4/1.2	0.3	4 x 0.8	1.6	1.56	1.56	26.4	30.0	1300	1800	0.641	0.822	0.094	1.02	100	92	105
3.5C x 70/35	12/6	1.4/1.2	0.4	4 x 0.8	2.0	1.56	1.56	28.5	30.8	1450	2400	0.443	0.530	0.090	1.16	121	115	131
3.5C x 95/50	15/6	1.6/1.4	0.4	4 x 0.8	2.0	1.56	1.72	30.2	36.9	2075	2720	0.320	0.384	0.090	1.20	147	142	155
3.5C x 120/70	15/12	1.6/1.4	0.5	4 x 0.8	2.0	1.72	1.88	29.3	42.7	2150	3210	0.253	0.306	0.087	1.31	167	155	185
3.5C x 150/70	15/12	1.8/1.4	0.5	4 x 0.8	2.0	1.88	1.88	44.0	46.4	3150	3700	0.206	0.247	0.087	1.31	190	175	210
3.5C x 185/95	30/15	2.0/1.6	0.6	4 x 0.8	2.5	2.04	2.36	49.8	52.7	3440	4830	0.164	0.199	0.087	1.31	215	200	248
3.5C x 240/120	30/15	2.2/1.6	0.6	4 x 0.8	2.5	2.20	2.52	55.2	56.9	4080	5710	0.125	0.150	0.087	1.44	251	235	289
3.5C x 300/150	30/30	2.4/1.8	0.6	4 x 0.8	3.15	2.36	2.52	55.7	61.7	5180	7690	0.100	0.120	0.086	1.61	281	240	315
3.5C x 400/185	53/30	2.6/2.0	0.7	4 x 0.8	3.15	2.68	2.68	68.6	72.3	6850	9330	0.0778	0.094	0.086	1.65	321	290	365

3.5 CORE, ALUMINIUM CONDUCTOR, PVC INSULATED, UNARMOURED POWER CABLES

FOR WORKING VOLTAGES UP TO AND INCLUDING 1100 V

No. of Cores & Cross sectional Area	Min. No. of wires (main/neutral)	Thickness of PVC Insulation (main/neutral)	Min. thickness of PVC Inner Sheath	Min. Thickness of PVC Outer sheath	Approx. Overall diameter of Cable with ± 2 mm tolerance	Approx. weight of cable	Max. D.C. Resistance of Conductor at 20°C	Approx. A.C. Resistance of Conductor at 70°C	Approx. Reactance at 50 Hz	Approx. Capacitance at 50 Hz	CURRENT RATINGS		
											Buried Direct in the Ground @ 30°C	In Single way ducted (Duct @ 30°C)	In Air @ 40°C
Sq mm	Nos	mm	mm	mm	mm	kg/km	Ohm/km	Ohm/km	Ohm/km	µF/km	Amps	Amps	Amps
3.5C x 25/16	6/6	1.2/1.0	0.3	1.8	20.6	610	1.20	1.44	0.097	0.84	76	63	70
3.5C x 35/16	6/6	1.2/1.0	0.3	1.8	22.6	750	0.868	1.062	0.097	0.88	97	77	86
3.5C x 50/25	6/6	1.4/1.2	0.3	2.0	27.2	1021	0.641	0.768	0.094	1.02	110	95	105
3.5C x 70/35	12/6	1.4/1.2	0.4	2.2	30.2	1350	0.443	0.530	0.090	1.16	135	115	130
3.5C x 95/50	15/6	1.6/1.4	0.4	2.2	35.9	1700	0.320	0.383	0.090	1.20	165	142	155
3.5C x 120/70	15/12	1.6/1.4	0.5	2.4	39.1	2100	0.253	0.306	0.087	1.31	185	155	180
3.5C x 150/70	15/12	1.8/1.4	0.5	2.4	43.6	2500	0.206	0.248	0.087	1.31	210	175	205
3.5C x 185/95	30/15	2.0/1.6	0.6	2.6	48.3	3025	0.164	0.197	0.087	1.31	235	200	240
3.5C x 240/120	30/15	2.2/1.6	0.6	3.0	55.3	3850	0.125	0.150	0.087	1.44	270	235	280
3.5C x 300/150	30/30	2.4/1.8	0.6	3.2	59.8	4700	0.100	0.120	0.086	1.61	305	265	315
3.5C x 400/185	53/30	2.6/2.0	0.7	3.4	68.6	6125	0.0778	0.094	0.086	1.65	335	290	365

4 CORE ALUMINIUM PVC ARMOURED & UNARMOURED POWER CARLES

FOR WORKING VOLTAGES UP TO AND INCLUDING 1100 V

No. of Cores & Cross sectional Area	Min. No. of wires	Thickness of PVC Insulation (main)	Min. thickness of PVC Inner Sheath	ARMOURED								UNARMOURED			Max. D.C. Resistance of Conductor at 20°C	Approx. A.C. Resistance of Conductor at 70°C	Approx. Reactance at 50 Hz	Approx. Capacitance at 50 Hz	CURRENT RATINGS		
				Nominal Dimension of Armour		Min. Thickness of PVC Outer sheath		Approx. Overall diameter of cable with ± 2 mm tolerance		Approx. weight of cable		Nominal thickness of Outer Sheath	Overall Diameter (Approx) ± 2 mm	Net Weight of Cable (Approx)					Buried Direct in the Ground @ 30°C	In Single way ducted (Duct @ 30°C)	In Air @ 40°C
				Strip	Wire	Strip	Wire	Strip	Wire	Strip	Wire										
Sq mm	Nos	mm	mm	mm x mm	mm	mm	mm	mm	mm	(kg/km)	(kg/km)	mm	mm	kg/km	Ohm/km	Ohm/km	Ohm/km	µF/km	Amps	Amps	Amps
4C x 1.5	1	0.8	0.3	-	1.4	-	1.24	-	15.6	-	450	1.8	10.6	200	18.1	21.7	0.128	0.16	15	14	13
4C x 2.5	1	0.9	0.3	-	1.4	-	1.24	-	16.8	-	520	1.8	11.8	250	12.1	14.5	0.118	0.15	20	18	18
4C x 4	1	1.0	0.3	-	1.4	-	1.24	-	18.8	-	605	1.8	12.8	325	7.41	8.89	0.116	0.17	28	25	23
4C x 6	1	1.0	0.3	-	1.6	-	1.24	-	20.0	-	750	1.8	14.2	380	4.61	5.53	0.112	0.17	35	32	30
4C x 10	7	1.0	0.3	4 x 0.8	1.6	1.4	1.4	19.6	21.8	910	950	1.8	20.6	475	3.08	3.70	0.103	0.56	46	39	40
4C x 16	6	1.0	0.3	4 x 0.8	1.6	1.4	1.4	22.2	24.8	925	1020	2.0	21.8	500	1.91	2.29	0.097	0.76	60	50	51
4C x 25	6	1.2	0.3	4 x 0.8	1.6	1.4	1.4	23.6	23.6	910	1150	2.0	22.2	780	1.20	1.44	0.097	0.80	76	67	70
4C x 35	6	1.2	0.3	4 x 0.8	1.6	1.4	1.56	25.9	27.8	1100	1620	2.0	22.5	855	0.868	1.06	0.097	0.88	92	77	86
4C x 50	6	1.4	0.4	4 x 0.8	2.0	1.56	1.56	30.3	31.3	1470	1895	2.2	26.6	1110	0.641	0.769	0.091	1.02	110	95	105
4C x 70	12	1.4	0.4	4 x 0.8	2.0	1.56	1.56	30.5	30.8	1960	2050	2.2	33.7	1520	0.443	0.532	0.091	1.16	135	115	130
4C x 95	15	1.6	0.4	4 x 0.8	2.0	1.72	1.72	36.2	45.6	2300	2950	2.4	36.9	1925	0.320	0.384	0.09	1.20	165	140	155
4C x 120	15	1.6	0.5	4 x 0.8	2.0	1.88	1.88	41.7	43.7	2755	3350	2.4	41.1	2355	0.253	0.306	0.087	1.31	190	155	180
4C x 150	15	1.8	0.5	4 x 0.8	2.5	1.88	2.04	45.7	48.4	3250	4400	2.6	44.5	2820	0.206	0.247	0.087	1.31	210	175	205
4C x 185	30	2.0	0.6	4 x 0.8	2.5	2.04	2.2	50.3	53.8	4000	5020	2.8	50.0	3625	0.164	0.197	0.087	1.31	235	200	240
4C x 240	30	2.2	0.6	4 x 0.8	2.5	2.36	2.36	56.9	61.1	5050	6455	3.0	54.4	4325	0.125	0.150	0.087	1.36	270	235	280
4C x 300	30	2.4	0.7	4 x 0.8	3.15	2.52	2.68	62.9	65.8	6150	8000	3.4	60.1	5400	0.100	0.120	0.086	1.41	305	265	315
4C x 400	53	2.6	0.7	4 x 0.8	3.15	2.84	2.84	70.8	75.4	7650	10100	3.6	70.5	6850	0.0778	0.094	0.086	1.65	335	295	365

COMPANY PROFILE

STRABAG Infrastructure & Safety Solutions GmbH

Safety Solutions GmbH - STRABAG AG

मुंबई महानगर प्रदेश विकास प्राधिकरण MUMBAI METROPOLITAN REGION DEVELOPMENT AUTHORITY MMRDA

4 CORE, COPPER CONDUCTOR, PVC INSULATED, ARMOURED & UNARMOURED POWER CABLES

FOR WORKING VOLTAGES UP TO AND INCLUDING 1100 V

Nominal Cross sectional Area	No. of wires	Thickness of PVC insulation	Min. thickness of PVC inner sheath	ARMOURED: Nominal dimension of armour (Strip)	(Wire)	Min. thickness of PVC outer sheath (Strip)	(Wire)	Approx. overall diameter (Strip)	(Wire)	Approx. weight of cable (Strip)	(Wire)	UNARMOURED: Nominal thickness of outer sheath	Overall diameter	Net weight of cable	Max. D.C. resistance at 20°C	Approx. A.C. resistance at 70°C	Approx. reactance	Approx. capacitance	CURRENT RATINGS: Buried	In single way duct	In air
Sq.mm	Nos	mm	mm	mm x mm	mm	mm	mm	mm	mm	Kg/Km	Kg/Km	mm	mm	Kg/Km	Ohm/Km	Ohm/Km	Ohm/Km	µF/Km	Amps	Amps	Amps
4C x 1.5	[illegible]	[illegible]	[illegible]	-	[illegible]	-	[illegible]	-	[illegible]	-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4C x 2.5	[illegible]	[illegible]	[illegible]	-	[illegible]	-	[illegible]	-	[illegible]	-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4C x 4	[illegible]	[illegible]	[illegible]	-	[illegible]	-	[illegible]	-	[illegible]	-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4C x 6	[illegible]	[illegible]	[illegible]	-	[illegible]	-	[illegible]	-	[illegible]	-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4C x 10	[illegible]	[illegible]	[illegible]	4 x 0.8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4C x 16	[illegible]	[illegible]	[illegible]	4 x 0.8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4C x 25	[illegible]	[illegible]	[illegible]	4 x 0.8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4C x 35	[illegible]	[illegible]	[illegible]	4 x 0.8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4C x 50	[illegible]	[illegible]	[illegible]	4 x 0.8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4C x 70	[illegible]	[illegible]	[illegible]	4 x 0.8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4C x 95	[illegible]	[illegible]	[illegible]	4 x 0.8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4C x 120	[illegible]	[illegible]	[illegible]	4 x 0.8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4C x 150	[illegible]	[illegible]	[illegible]	4 x 0.8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4C x 185	[illegible]	[illegible]	[illegible]	4 x 0.8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4C x 240	[illegible]	[illegible]	[illegible]	4 x 0.8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4C x 300	[illegible]	[illegible]	[illegible]	4 x 0.8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4C x 400	[illegible]	[illegible]	[illegible]	4 x 0.8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

RATING FACTORS (XLPE)

The current ratings in Table - 1 & 2 based on the normal conditions of installation as described below:

1. Maximum condc. temperature 90° C
2. Ambient air temperature 40° C
3. Ground temperature 30° C
4. Depth of laying (for cable laid directly in ground) 75 cm (1.1 kV)
5. Thermal resistivity of soil 150° C cm/w
6. Max-short-circuit conductor temperaure 250° C cm/w
7. Max Ambient Air temperature 55° C

Installation method and Rating factors are given in tables 1 to 4

Table 1

Rating for variations in ground temperature for cables laid directly in ground and in ducts

Ground temperature °C	15	20	25	30	35	40	45	50
Rating Factor	1.12	1.08	1.03	1.00	0.96	0.91	0.87	0.82

Table 2

Rating Factors for Variation in Ambient Air Temperature

Air temperature °C	25	30	35	40	45	50	55
Rating Factor	1.14	1.10	1.04	1.00	0.95	0.90	0.84

Table 3

Rating Factors of groups of cables laid directly in Ground in Horizontal formation

No. of Cables	Rating factor for Axial spacing			
	Touching	15 cm	30 cm	45 cm
2 cables	0.79	0.82	0.87	0.90
3 cables	0.69	0.75	0.79	0.83
4 cables	0.62	0.69	0.74	0.79
5 cables	0.58	0.65	0.72	0.76
6 cables	0.54	0.61	0.69	0.75

Table 4

Rating Factors for Variation in Depth of laying in Ground

Depth of laying	Size		
	Upto 25 mm²	25 to 300 mm²	Above 300 mm²
75 cm	1.00	1.00	1.00
90 cm	0.99	0.98	0.97
105 cm	0.98	0.97	0.96
120 cm	0.97	0.96	0.95
150 cm	0.96	0.94	0.92
Above 180 cm	0.95	0.93	0.91

1 CORE, ALUMINIUM CONDUCTOR, XLPE INSULATED, ARMOURED & UNARMOURED POWER CABLES

FOR WORKING VOLTAGES UP TO AND INCLUDING 1100 V

Nominal Size of stranded conductor	Min No. of wires	ARMOURED					UNARMOURED				Max D.C. Resistance of Conductor at 20°C	Approx A.C. Resistance of Conductor at 90°C	ARMOURED		UNARMOURED		CURRENT RATING					
		Thickness of XLPE Insulation (Nom)	Nom. Dimension of Armour wire	Min Thickness of PVC Outer sheath	Approx Overall Diameter of Cable	Approx weight of cable	Thickness of XLPE Insulation (Nom)	Nom. Thickness of Outer sheath	Approx Overall Diameter of Cable	Approx weight of cable			Approx Reactance at 50 Hz	Approx Capacitance at 50 Hz	Approx Reactance at 50 Hz	Approx Capacitance at 50 Hz	Buried Direct in the Ground @ 30°C		In Single way buried Duct @ 30°C		In Air @ 40°C	
Sq mm	Nos	mm	mm	mm	mm	kg/km	mm	mm	mm	kg/km	Ohm/km	Ohm/km	Ohm/km	µF/km	Ohm/km	µF/km	2 Cables (Amps)	3 Cables (Amps)	2 Cables (Amps)	3 Cables (Amps)	2 Cables (Amps)	3 Cables (Amps)
1C x 4	[illegible]	-	-	-	-	-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-	-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1C x 4	[illegible]	-	-	-	-	-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-	-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1C x 6	[illegible]	-	-	-	-	-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-	-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1C x 6	[illegible]	-	-	-	-	-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-	-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1C x 10	[illegible]	-	-	-	-	-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1C x 10	[illegible]	-	-	-	-	-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1C x 16	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1C x 25	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1C x 35	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1C x 50	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1C x 70	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1C x 95	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1C x 120	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1C x 150	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1C x 185	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1C x 240	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1C x 300	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1C x 400	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1C x 500	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1C x 630	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1C x 800	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1C x 1000	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

1 CORE, COPPER CONDUCTOR, XLPE INSULATED, ARMOURED & UNARMOURED POWER CABLES

FOR WORKING VOLTAGES UP TO AND INCLUDING 1100 V

Nominal Size of stranded conductor	Min No. of wires	ARMOURED					UNARMOURED				Max D.C. Resistance of Conductor at 20°C	Approx A.C. Resistance of Conductor at 90°C	ARMOURED		UNARMOURED		CURRENT RATING					
		Thickness of XLPE Insulation (Nom)	Nom. Dimension of Armour wire	Min Thickness of PVC Outer sheath	Approx Overall Diameter of Cable	Approx weight of cable	Thickness of XLPE Insulation (Nom)	Nom. Thickness of Outer sheath	Approx Overall Diameter of Cable	Approx weight of cable			Approx Reactance at 50 Hz	Approx Capacitance at 50 Hz	Approx Reactance at 50 Hz	Approx Capacitance at 50 Hz	Buried Direct in the Ground @ 30°C		In Single way buried Duct @ 30°C		In Air @ 40°C	
Sq mm	Nos	mm	mm	mm	mm	kg/km	mm	mm	mm	kg/km	Ohm/km	Ohm/km	Ohm/km	µF/km	Ohm/km	µF/km	2 Cables (Amps)	3 Cables (Amps)	2 Cables (Amps)	3 Cables (Amps)	2 Cables (Amps)	3 Cables (Amps)
1C x 4	[illegible]	-	-	-	-	-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-	-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1C x 4	[illegible]	-	-	-	-	-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-	-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1C x 6	[illegible]	-	-	-	-	-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-	-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1C x 6	[illegible]	-	-	-	-	-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-	-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1C x 10	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1C x 16	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1C x 25	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1C x 35	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1C x 50	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1C x 70	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1C x 95	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1C x 120	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1C x 150	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1C x 185	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1C x 240	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1C x 300	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1C x 400	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1C x 500	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

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MUMBAI METROPOLITAN REGION DEVELOPMENT AUTHORITY
MMRDA

2315

2 CORE, ALUMINIUM CONDUCTOR, XLPE INSULATED, ARMOURED POWER CABLES

FOR WORKING VOLTAGES UP TO AND INCLUDING 1100 V

No. of Cores & Cross sectional Area	Min No. of wires	Thickness of XLPE Insulation (nom)	Min thickness of PVC Inner Sheath	Nominal Dimension of Armour		Min Thickness of PVC Outer Sheath		Approx Overall diameter of Cable with ... Armouring		Approx weight of cable		Max D.C. Resistance of Conductor at 20°C	Approx A.C. Resistance of Conductor at 90°C	Approx Reactance at 50Hz	Approx Capacitance at 50Hz	CURRENT RATINGS		
				Strip	Wire	Strip	Wire	Strip	Wire	Strip	Wire					Rated Direct in the Ground @ 30°C	In Single way Ducted Duct @ 30°C	In Air @ 40°C
Sq.mm	Nos	mm	mm	mm x mm	mm	mm	mm	mm	mm	Kg/Km	Kg/Km	Ohm/Km	Ohm/Km	Ohm/Km	µF/Km	Amps	Amps	Amps
2C x 4	1	0.7	0.3	—	1.4	—	1.24	—	14.9	—	405	7.41	9.48	0.0927	0.465	42	34	36
2C x 4	3	0.7	0.3	—	1.4	—	1.24	—	15.4	—	405	7.41	9.48	0.0921	0.365	42	35	38
2C x 6	1	0.7	0.3	—	1.4	—	1.24	—	15.9	—	455	4.61	5.20	0.0880	0.391	55	45	51
2C x 6	3	0.7	0.3	—	1.4	—	1.24	—	16.6	—	455	4.61	5.90	0.0886	0.387	55	45	54
2C x 10	1	0.7	0.3	—	1.4	—	1.24	—	17.4	—	550	3.08	3.94	0.0837	0.281	69	57	66
2C x 10	7	0.7	0.3	—	1.6	—	1.24	—	18.4	—	770	3.08	3.94	0.0869	0.386	69	57	66
2C x 16	6	0.7	0.3	—	1.6	—	1.4	—	18.8	—	620	1.91	2.44	0.0823	0.383	83	70	83
2C x 25	6	0.9	0.4	4 x 0.8	1.6	1.4	1.4	19.4	21.2	550	730	1.20	1.54	0.09	0.098	114	90	101
2C x 35	6	0.9	0.3	4 x 0.8	1.6	1.4	1.4	20.4	22.2	650	825	0.868	1.11	0.08	0.098	136	103	125
2C x 50	6	1.0	0.3	4 x 0.8	1.6	1.4	1.4	22.7	25.3	800	1050	0.641	0.820	0.078	0.10	161	135	142
2C x 70	12	1.1	0.3	4 x 0.8	1.6	1.56	1.56	25.5	27.1	1000	1250	0.443	0.569	0.077	0.11	197	165	193
2C x 95	15	1.1	0.4	4 x 0.8	2.0	1.56	1.56	28.6	30.8	1250	1750	0.320	0.410	0.076	0.11	235	196	238
2C x 120	15	1.2	0.4	4 x 0.8	2.0	1.56	1.56	30.3	32.7	1450	2000	0.253	0.326	0.072	0.11	264	222	287
2C x 150	15	1.4	0.4	4 x 0.8	2.0	1.72	1.72	33.8	36.2	1750	2450	0.206	0.266	0.072	0.11	295	249	328
2C x 185	30	1.6	0.5	4 x 0.8	2.0	1.72	1.88	37.4	39.8	2100	2750	0.164	0.210	0.072	0.11	330	281	377
2C x 240	30	1.7	0.5	4 x 0.8	2.5	1.88	2.04	40.2	43.8	2550	3300	0.125	0.161	0.072	0.11	385	326	448
2C x 300	30	1.8	0.6	4 x 0.8	2.5	2.04	2.20	43.8	46.7	3050	4250	0.100	0.128	0.070	0.12	431	363	515
2C x 400	53	2.0	0.6	4 x 0.8	2.5	2.36	2.36	50.6	53.3	3800	5150	0.0778	0.100	0.068	0.12	487	412	593

2 CORE, ALUMINIUM CONDUCTOR, XLPE INSULATED, UNARMOURED POWER CABLES

FOR WORKING VOLTAGES UP TO AND INCLUDING 1100 V

No. of Cores & Cross sectional Area	Min No. of wires	Thickness of XLPE Insulation (nom)	Min thickness of PVC Inner Sheath	Min Thickness of PVC Outer sheath	Approx Overall diameter of Cable	Approx weight of cable	Max D.C. Resistance of Conductor at 20°C	Approx A.C. Resistance of Conductor at 90°C	Approx Reactance at 50Hz	Approx Capacitance at 50Hz	Rated Direct in the Ground @ 30°C	CURRENT RATINGS	
												In Single way Ducted Duct @ 30°C	In Air @ 40°C
Sq.mm	Nos	mm	mm	mm	(mm)	Kg/Km	Ohm/Km	Ohm/Km	Ohm/Km	µF/Km	Amps	Amps	Amps
2C x 4	1	0.7	0.3	1.8	13.7	175	7.41	9.48	0.0927	0.465	42	36	38
2C x 4	3	0.7	0.3	1.8	13.8	175	7.41	9.48	0.0927	0.465	42	35	38
2C x 6	1	0.7	0.3	1.8	14.1	200	4.61	5.90	0.0880	0.371	55	46	50
2C x 6	3	0.7	0.3	1.8	14.8	200	4.61	5.90	0.0886	0.397	55	45	50
2C x 10	1	0.7	0.3	1.8	15.8	270	3.08	3.94	0.0837	0.331	69	57	65
2C x 10	7	0.7	0.3	1.8	16.8	250	3.08	3.94	0.0859	0.388	69	57	66
2C x 16	6	0.7	0.3	1.8	16.8	307	1.91	2.44	0.0828	0.391	89	74	84
2C x 25	6	0.9	0.3	1.8	19.2	391	1.20	1.54	0.09	0.098	114	90	106
2C x 35	6	0.9	0.3	2.0	20.2	452	0.868	1.11	0.08	0.098	136	115	133
2C x 50	6	1.0	0.3	2.0	22.3	555	0.641	0.820	0.078	0.10	161	136	153
2C x 70	12	1.1	0.3	2.0	24.8	721	0.443	0.569	0.077	0.11	197	166	196
2C x 95	15	1.1	0.4	2.2	28.1	950	0.320	0.410	0.076	0.11	235	196	241
2C x 120	15	1.2	0.4	2.2	30.8	1150	0.253	0.326	0.075	0.11	264	227	287
2C x 150	15	1.4	0.4	2.3	33.2	1415	0.206	0.264	0.072	0.11	296	254	328
2C x 185	30	1.6	0.5	2.3	36.9	1655	0.164	0.210	0.072	0.11	335	287	379
2C x 240	30	1.7	0.5	2.4	39.8	2135	0.125	0.161	0.072	0.11	392	334	446
2C x 300	30	1.8	0.5	2.5	43.7	2539	0.100	0.128	0.071	0.12	437	386	513
2C x 400	53	2.0	0.6	2.6	51.2	3431	0.0778	0.102	0.071	0.12	487	432	593

STRABAG Infrastructure & Safety Solutions GmbH

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2 CORE, COPPER CONDUCTOR, XLPE INSULATED, ARMOURED POWER CABLES

FOR WORKING VOLTAGES UP TO AND INCLUDING 1100 V

Nominal Cross Sectional Area	Min No of wires	Thickness of XLPE Insulation (nom)	Min thickness of PVC Inner Sheath	Nominal Dimension of Armour		Min Thickness of PVC Outer sheath		Approx Overall diameter of Cable with ± 2 mm tolerance		Approx weight of cable		Max D.C. Resistance of Conductor at 20°C	Approx A.C. Resistance of Conductor at 90°C	Approx Reactance at 50 Hz	Approx Capacitance at 50 Hz	CURRENT RATINGS		
				Strip	Wire	Strip	Wire	Strip	Wire	Strip	Wire					Buried Direct in the Ground @ 30°C	In Single way Buried Duct @ 30°C	In Air @ 40°C
Sq.mm	Nos	mm	mm	mm x mm	mm	mm	mm	mm	mm	Kg/Km	Kg/Km	Ohm/km	Ohm/km	Ohm/km	µF/Km	Amps	Amps	Amps
2C x 4	7	0.7	0.3	—	1.4	—	1.24	—	14.9	—	850	5.61	5.93	0.0927	0.041	51	45	38
2C x 4	7	0.7	0.3	—	1.4	—	1.24	—	15.4	—	850	4.61	5.93	0.0927	0.045	51	45	38
2C x 6	7	0.7	0.3	—	1.4	—	1.24	—	15.9	—	520	3.08	3.96	0.0846	0.071	67	56	47
2C x 6	7	0.7	0.3	—	1.4	—	1.24	—	16.6	—	520	3.08	3.96	0.0846	0.071	67	56	47
2C x 10	7	0.7	0.3	—	1.4	—	1.24	—	16.2	—	675	1.83	2.36	0.0827	0.081	87	71	61
2C x 16	6	0.7	0.3	—	1.6	—	1.4	—	18.8	—	775	1.15	1.47	0.0808	0.085	115	94	100
2C x 25	6	0.9	0.3	4 x 0.8	1.6	1.6	1.6	18.4	21.2	835	1021	0.727	0.933	0.08	0.089	147	122	169
2C x 35	6	0.9	0.3	4 x 0.8	1.6	1.6	1.6	20.4	22.7	1030	1220	0.524	0.671	0.08	0.094	176	146	172
2C x 50	6	1.0	0.3	4 x 0.8	1.6	1.6	1.6	22.7	24.3	1070	1600	0.387	0.495	0.076	0.098	210	170	208
2C x 70	12	1.1	0.3	4 x 0.8	1.6	1.52	1.52	25.5	27.3	1460	2030	0.268	0.343	0.079	0.10	253	211	262
2C x 95	15	1.1	0.4	4 x 0.8	2.0	1.56	1.56	28.4	30.8	2150	2800	0.193	0.248	0.076	0.11	302	252	303
2C x 120	18	1.2	0.4	4 x 0.8	2.0	1.56	1.56	30.3	32.7	2650	3150	0.153	0.198	0.072	0.11	350	284	369
2C x 150	30	1.4	0.4	4 x 0.8	2.0	1.72	1.72	33.8	36.2	3070	4010	0.124	0.159	0.072	0.11	399	307	419
2C x 185	30	1.6	0.5	4 x 0.8	2.0	1.72	1.88	37.1	39.9	4000	4450	0.0991	0.127	0.072	0.11	445	357	482
2C x 240	34	1.7	0.5	4 x 0.8	2.5	1.88	2.04	40.2	43.0	5080	6000	0.0754	0.097	0.070	0.11	491	401	596
2C x 300	34	1.8	0.6	4 x 0.8	2.5	2.04	2.20	45.8	49.5	6020	7450	0.0601	0.077	0.071	0.12	541	451	644
2C x 400	53	2.0	0.6	4 x 0.8	2.5	2.20	2.36	50.0	53.9	6600	9450	0.0470	0.059	0.07	0.12	610	506	736

2 CORE, COPPER CONDUCTOR, XLPE INSULATED, UNARMOURED POWER CABLES

FOR WORKING VOLTAGES UP TO AND INCLUDING 1100 V

Nominal Cross Sectional Area	Min No of wires	Thickness of XLPE Insulation (nom)	Min thickness of PVC Inner Sheath	Nom Thickness of PVC Outer sheath	Approx Overall diameter of Cable with ± 2 mm tolerance	Approx weight of cable	Max D.C. Resistance of Conductor at 20°C	Approx A.C. Resistance of Conductor at 90°C	Approx Reactance at 50 Hz	Approx Capacitance at 50 Hz	CURRENT RATINGS		
											Buried Direct in the Ground @ 30°C	In Single way Buried Duct @ 30°C	In Air @ 40°C
Sq.mm	Nos	mm	mm	mm	mm	Kg/Km	Ohm/km	Ohm/km	Ohm/km	µF/Km	Amps	Amps	Amps
2C x 4	7	0.7	0.3	1.8	13.1	325	4.61	5.93	0.0927	0.045	54	45	44
2C x 4	7	0.7	0.3	1.8	13.8	335	4.61	5.93	0.0927	0.035	54	45	44
2C x 6	7	0.7	0.3	1.8	14.1	375	3.08	3.96	0.0846	0.071	67	56	61
2C x 6	7	0.7	0.3	1.8	14.8	375	3.08	3.96	0.0846	0.071	67	56	61
2C x 10	7	0.7	0.3	1.8	15.8	375	1.83	2.36	0.0827	0.081	88	75	83
2C x 16	6	0.7	0.3	1.8	16.8	425	1.15	1.47	0.0808	0.099	115	96	108
2C x 25	6	0.9	0.3	2.0	19.2	630	0.727	0.93	0.08	0.087	147	122	143
2C x 35	6	0.9	0.3	2.0	20.2	820	0.524	0.67	0.08	0.094	176	146	172
2C x 50	6	1.0	0.3	2.0	22.3	1150	0.387	0.495	0.080	0.098	208	172	208
2C x 70	12	1.1	0.3	2.0	24.8	1500	0.268	0.343	0.077	0.10	253	207	262
2C x 95	15	1.1	0.4	2.2	28.1	2000	0.193	0.247	0.076	0.11	302	250	322
2C x 120	18	1.2	0.4	2.2	30.8	2300	0.153	0.196	0.072	0.11	348	286	369
2C x 150	18	1.4	0.4	2.2	33.2	2920	0.124	0.159	0.072	0.11	399	317	419
2C x 185	30	1.6	0.5	2.4	36.9	3770	0.0991	0.127	0.072	0.11	435	357	482
2C x 240	34	1.7	0.5	2.6	42.0	4830	0.0754	0.097	0.072	0.11	486	409	566
2C x 300	34	1.8	0.6	2.8	45.7	5930	0.0601	0.077	0.071	0.12	541	450	644
2C x 400	53	2.0	0.6	3.0	50.2	7730	0.0470	0.059	0.07	0.12	602	518	736

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3 CORE, ALUMINIUM CONDUCTOR, XLPE INSULATED, ARMOURED POWER CABLES

FOR WORKING VOLTAGES UP TO AND INCLUDING 1100 V

3 CORE, ALUMINIUM CONDUCTOR, XLPE INSULATED, UNARMOURED POWER CABLES

FOR WORKING VOLTAGES UP TO AND INCLUDING 1100 V

3 CORE, COPPER CONDUCTOR, XLPE INSULATED, ARMOURED POWER CABLES

FOR WORKING VOLTAGES UP TO AND INCLUDING 1100 V

No. of Cores & Cross-sectional Area	Min. No. of Wires	Thickness of XLPE Insulation (Nom)	Min. thickness of PVC Inner Sheath	Nominal Dimension of Armour		Min. Thickness of PVC Outer Sheath		Approx. Overall diameter of Cable with ± 2mm tolerance		Approx. weight of cable		Max D.C. Resistance of Conductor at 20°C	Approx A.C. Resistance of Conductor at 90°C	Approx Reactance at 50Hz	Approx Capacitance at 50 Hz	CURRENT RATINGS		
				Strip	Wire	Strip	Wire	Strip	Wire	Strip	Wire					Buried Direct in the Ground 30°C	In Single way Buried Ducts 30°C	In Air 40°C
Sq.mm	Nos.	mm	mm	mm x mm	mm	mm	mm	mm	mm	Kg/Km	Kg/Km	Ohm/Km	Ohm/Km	Ohm/Km	μF/Km	Amps	Amps	Amps
3C×4	1	0.7	0.3	—	1.4	—	1.24	—	10.3	—	330	4.61	5.90	0.1027	0.22	41	36	41
3C×4	7	0.7	0.3	—	1.4	—	1.24	—	10.3	—	335	4.61	5.90	0.1027	0.22	41	35	38
3C×6	1	0.7	0.3	—	1.4	—	1.24	—	11.4	—	425	3.08	3.94	0.0996	0.25	51	43	52
3C×6	7	0.7	0.3	—	1.4	—	1.24	—	11.3	—	425	3.08	3.94	0.0996	0.25	51	47	52
3C×10	7	0.7	0.3	—	1.4	—	1.24	—	11.5	—	466	1.83	2.34	0.0937	0.31	66	62	70
3C×16	6	0.7	0.3	4×0.8	1.4	1.24	1.40	17.6	11.7	625	1033	1.15	1.47	0.0928	0.36	93	79	88
3C×25	6	0.9	0.3	4×0.8	1.6	1.40	1.56	20.1	21.7	1156	1350	0.727	0.930	0.088	0.41	112	102	119
3C×35	6	0.9	0.3	4×0.8	1.6	1.40	1.56	22.2	23.8	1426	1630	0.524	0.671	0.085	0.47	144	124	147
3C×50	6	1.0	0.3	4×0.8	1.6	1.40	1.56	24.6	26.5	1900	2200	0.387	0.495	0.084	0.50	173	144	174
3C×70	12	1.1	0.4	4×0.8	2.0	1.56	1.56	28.8	31.3	2530	3030	0.268	0.343	0.079	0.53	212	177	214
3C×95	15	1.1	0.4	4×0.8	2.0	1.56	1.72	31.1	33.7	3230	3900	0.193	0.247	0.076	0.61	255	212	270
3C×120	18	1.2	0.4	4×0.8	2.0	1.56	1.88	35.7	39.6	4150	4630	0.153	0.196	0.075	0.64	287	240	330
3C×150	18	1.4	0.5	4×0.8	2.0	1.72	1.88	39.2	42.0	4890	5650	0.124	0.159	0.072	0.65	320	269	365
3C×185	30	1.6	0.5	4×0.8	2.5	1.88	2.04	43.3	47.0	6020	7130	0.0991	0.127	0.072	0.66	363	304	420
3C×240	34	1.7	0.6	4×0.8	2.5	2.04	2.20	48.3	53.0	7800	8950	0.0754	0.097	0.070	0.63	419	352	500
3C×300	34	1.8	0.6	4×0.8	2.5	2.20	2.36	51.4	53.2	9280	10750	0.0601	0.077	0.071	0.67	469	395	576
3C×400	53	2.0	0.7	4×0.8	3.15	2.52	2.68	59.4	63.2	10550	14400	0.0470	0.060	0.070	0.69	528	447	662

3 CORE, COPPER CONDUCTOR, XLPE INSULATED, UNARMOURED POWER CABLES

FOR WORKING VOLTAGES UP TO AND INCLUDING 1100 V

No. of Cores & Cross-sectional Area	Min. No. of wires	Thickness of XLPE Insulation (Nom)	Min. thickness of PVC Inner Sheath	Nom. Thickness of PVC Outer sheath	Approx Overall diameter of Cable with ± 2 mm tolerance	Approx weight of cable	Max D.C Resistance of Conductor at 20°C	Approx A.C Resistance of Conductor at 90°C	Approx Reactance at 50 Hz	Approx Capacitance at 50 Hz	CURRENT RATINGS		
											Buried Direct in the Ground 30°C	In Single way Buried Ducts 30°C	In Air @ 40°C
Sq.mm	Nos.	mm	mm	mm	(mm)	Kg/Km	Ohm/Km	Ohm/Km	Ohm/Km	μF/Km	Amps	Amps	Amps
3C×4	1	0.7	0.3	1.8	14.7	275	4.61	5.90	0.1027	0.22	45	38	41
3C×4	7	0.7	0.3	1.8	14.5	285	4.61	5.90	0.1027	0.22	45	38	41
3C×6	1	0.7	0.3	1.8	16.6	330	3.08	3.94	0.0996	0.25	56	49	50
3C×6	7	0.7	0.3	1.8	15.5	350	3.08	3.94	0.0996	0.25	51	47	52
3C×10	7	0.7	0.3	1.8	17.7	475	1.83	2.34	0.0937	0.31	76	67	75
3C×16	6	0.7	0.3	1.8	17.3	650	1.15	1.47	0.0928	0.36	95	79	88
3C×25	6	0.9	0.3	2.0	19.7	985	0.727	0.93	0.088	0.41	123	106	111
3C×35	6	0.9	0.3	2.0	20.8	1200	0.524	0.67	0.085	0.47	144	122	147
3C×50	6	1.0	0.3	2.0	24.2	1600	0.387	0.495	0.082	0.50	173	144	173
3C×70	12	1.1	0.4	2.2	28.0	2200	0.268	0.343	0.079	0.53	212	177	214
3C×95	15	1.1	0.4	2.2	30.8	2900	0.193	0.247	0.079	0.61	255	212	270
3C×120	18	1.2	0.4	2.2	35.4	3400	0.153	0.196	0.075	0.63	287	240	330
3C×150	18	1.4	0.5	2.4	39.8	4500	0.124	0.159	0.072	0.63	321	267	367
3C×185	30	1.6	0.5	2.6	44.7	7300	0.0991	0.127	0.072	0.63	363	305	421
3C×240	34	1.7	0.6	2.8	41.2	7500	0.0754	0.097	0.072	0.66	476	352	501
3C×300	34	1.8	0.6	3.0	53.6	8900	0.0601	0.079	0.071	0.67	469	395	576
3C×400	53	2.0	0.7	3.2	58.2	11600	0.0470	0.060	0.070	0.69	528	447	662

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3.5 CORE, COPPER CONDUCTOR, XLPE INSULATED, ARMOURED POWER CABLES

FOR WORKING VOLTAGES UP TO AND INCLUDING 1100 V

No. of Cores & Cross sectional Area	Min. No. of wires (Main/Neutral)	Thickness of XLPE Insulation Nominal (Main/Neutral)	Min thickness of PVC Inner Sheath	Nominal Dimension of Armour		Min Thickness of PVC Outer sheath		Approx Overall diameter of Cable with ±2 mm tolerance		Approx weight of cable		Max DC Resistance of Conductor at 20°C	Approx AC Resistance of Conductor at 90°C	Approx Reactance at 50Hz	Approx Capacitance at 50Hz	CURRENT RATINGS		
				Strip	Wire	Strip	Wire	Strip	Wire	Strip	Wire					Buried Direct in the Ground @ 20°C	In Single way Buried Duct @ 30°C	In Air @ 40°C
Sq mm	Nos	mm	mm	mm x mm	mm	mm	mm	mm	mm	Kg/km	Kg/km	Ohm/km	Ohm/km	Ohm/km	µF/km	Amps	Amps	Amps
3.5C x 25/16	6/6	0.9/0.7	0.3	4 x 0.8	1.6	1.40	1.40	23.3	22.8	1350	1550	0.727	0.931	0.083	0.41	122	110	119
3.5C x 35/16	6/6	0.9/0.7	0.3	4 x 0.8	1.6	1.40	1.40	23.9	21.5	1620	1810	0.524	0.671	0.078	0.47	146	132	147
3.5C x 50/25	6/6	1.0/0.9	0.3	4 x 0.8	1.6	1.40	1.56	27.1	29.0	2052	2300	0.387	0.494	0.076	0.50	172	160	179
3.5C x 70/35	12/6	1.1/0.9	0.4	4 x 0.8	2.0	1.56	1.56	31.6	34.0	2930	3470	0.268	0.343	0.077	0.53	212	195	225
3.5C x 95/50	15/6	1.1/1.0	0.4	4 x 0.8	2.0	1.56	1.56	35.2	37.6	3808	4250	0.193	0.247	0.076	0.47	256	232	274
3.5C x 120/70	18/12	1.2/1.1	0.4	4 x 0.8	2.0	1.72	1.72	39.8	40.3	4750	5050	0.153	0.196	0.073	0.43	297	266	320
3.5C x 150/70	18/12	1.4/1.1	0.5	4 x 0.8	2.0	1.72	1.88	42.6	45.2	5450	6458	0.124	0.159	0.083	0.43	321	299	365
3.5C x 185/95	30/15	1.6/1.1	0.5	4 x 0.8	2.5	1.88	2.04	46.0	48.7	6975	8209	0.0991	0.130	0.070	0.43	342	334	418
3.5C x 240/120	34/18	1.7/1.2	0.6	4 x 0.8	2.5	2.04	2.20	51.7	55.6	8810	10100	0.0754	0.099	0.072	0.43	418	352	554
3.5C x 300/150	34/18	1.8/1.4	0.6	4 x 0.8	2.5	2.20	2.36	55.6	59.3	10800	12150	0.0601	0.081	0.071	0.49	468	396	536
3.5C x 400/185	53/30	2.0/1.6	0.7	4 x 0.8	3.15	2.52	2.68	64.1	69.2	14050	16450	0.0470	0.065	0.070	0.47	529	447	662

3.5 CORE, COPPER CONDUCTOR, XLPE INSULATED, UNARMOURED POWER CABLES

FOR WORKING VOLTAGES UP TO AND INCLUDING 1100 V

No. of Cores & Cross sectional Area	Min No. of wires (Main/Neutral)	Thickness of XLPE Insulation Nominal (Main/Neutral)	Min thickness of PVC Inner Sheath	Nom Thickness of PVC Outer sheath	Approx Overall diameter of Cable with ±2 mm tolerance	Approx weight of cable	Max DC Resistance of Conductor at 20°C	Approx A.C. Resistance of Conductor at 90°C	Approx Reactance at 50 Hz	Approx Capacitance at 50Hz	CURRENT RATINGS		
											Buried Direct in the Ground @ 20°C	In Single way Buried Duct @ 30°C	In Air @ 40°C
Sq mm	Nos	mm	mm	mm	mm	Kg/km	Ohm/km	Ohm/km	Ohm/km	µF/km	Amps	Amps	Amps
3.5C x 25/16	6/6	0.9/0.7	0.3	2.0	25.8	1250	0.727	0.930	0.083	0.41	122	107	119
3.5C x 35/16	6/6	0.9/0.7	0.3	1.8	23.5	1350	0.524	0.671	0.080	0.47	146	127	149
3.5C x 50/25	6/6	1.0/0.9	0.3	2.0	26.7	1800	0.387	0.495	0.076	0.50	173	144	179
3.5C x 70/35	12/6	1.1/0.9	0.4	2.2	31.2	2550	0.268	0.343	0.077	0.53	212	177	225
3.5C x 95/50	15/6	1.1/1.0	0.4	2.2	34.7	3350	0.193	0.247	0.076	0.47	256	212	276
3.5C x 120/70	18/12	1.2/1.1	0.4	2.2	37.2	4250	0.153	0.196	0.072	0.43	287	242	320
3.5C x 150/70	18/12	1.4/1.1	0.5	2.4	42.2	5150	0.124	0.159	0.070	0.44	321	269	365
3.5C x 185/95	30/15	1.6/1.1	0.5	2.4	45.9	6350	0.0991	0.127	0.072	0.43	362	306	425
3.5C x 240/120	34/18	1.7/1.2	0.6	2.6	51.6	8050	0.0754	0.097	0.072	0.43	418	352	500
3.5C x 300/150	34/18	1.8/1.4	0.6	3.0	55.6	9950	0.0601	0.077	0.071	0.42	469	395	576
3.5C x 400/185	53/30	2.0/1.6	0.7	3.4	64.3	12650	0.0470	0.063	0.070	0.47	529	447	682

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4 CORE, ALUMINIUM CONDUCTOR, XLPE INSULATED, ARMOURED POWER CABLES

FOR WORKING VOLTAGES UP TO AND INCLUDING 1100 V

No. of Cores & Nominal sectional Area	Min No. of wires	Thickness of XLPE Insulation (nom)	Min thickness of PVC Inner Sheath	Nominal Dimension of Armour		Min Thickness of PVC Outer sheath		Approx Overall diameter of Cable with ±2mm tolerance		Approx weight of cable		Max D.C Resistance of Conductor at 20°C	Approx A.C Resistance of Conductor at 90°C	Approx Reactance at 50Hz	Approx Capacitance at 50 Hz	CURRENT RATINGS		
				Strip	Wire	Strip	Wire	Strip	Wire	Strip	Wire					Buried Direct in the Ground @ 30°C	In Single way Ducts Buried @ 30°C	In Air @ 40°C
Sq mm	Nos	mm	mm	mm x mm	mm	mm	mm	mm	mm	(Kg/km)	(Kg/km)	Ohm/km	Ohm/km	Ohm/km	µF/km	Amps	Amps	Amps
4C x 4	7	0.7	0.3	—	1.4	—	1.24	—	17.3	—	530	7.41	1.46	0.0127	0.22	35	39	32
4C x 4	1	0.7	0.3	—	1.4	—	1.24	—	17.7	—	720	4.61	5.90	0.0906	0.25	44	39	42
4C x 6	3	0.7	0.3	—	1.4	—	1.24	—	18.3	—	770	4.61	5.90	0.0906	0.25	44	39	42
4C x 10	1	0.7	0.3	—	1.4	—	1.40	—	20.1	—	775	3.08	3.94	0.0857	0.31	57	48	56
4C x 16	7	0.7	0.3	—	1.4	—	1.40	—	21.6	—	725	3.08	3.94	0.0857	0.31	57	48	56
4C x 16	1	0.7	0.3	4 x 0.8	1.4	1.4	1.40	20.3	22.8	695	875	1.91	2.44	0.0828	0.36	75	61	69
4C x 25	6	0.9	0.3	4 x 0.8	1.4	1.4	1.40	22.3	23.8	805	1050	1.20	1.54	0.081	0.41	95	79	93
4C x 35	6	0.9	0.3	4 x 0.8	1.6	1.4	1.40	24.8	26.8	1000	1300	0.868	1.11	0.080	0.47	114	96	114
4C x 50	6	1.0	0.3	4 x 0.8	1.6	1.56	1.52	27.1	29.2	1300	1550	0.641	0.820	0.079	0.53	136	112	138
4C x 70	12	1.1	0.4	4 x 0.8	2.0	1.56	1.56	31.7	32.5	1650	2030	0.443	0.567	0.077	0.53	166	137	175
4C x 95	15	1.1	0.4	4 x 0.8	2.0	1.56	1.72	35.2	37.8	2020	2450	0.320	0.410	0.076	0.61	199	164	214
4C x 120	15	1.2	0.5	4 x 0.8	2.0	1.72	1.88	35.1	41.8	2470	3010	0.253	0.324	0.075	0.63	225	187	249
4C x 150	15	1.4	0.5	4 x 0.8	2.5	1.88	2.04	42.6	46.3	2980	4000	0.206	0.264	0.075	0.65	249	209	285
4C x 185	30	1.6	0.5	4 x 0.8	2.5	2.04	2.20	47.8	51.7	3650	4450	0.164	0.210	0.072	0.65	283	238	327
4C x 240	30	1.7	0.6	4 x 0.8	2.5	2.20	2.36	53.4	57.1	4700	5800	0.125	0.161	0.072	0.63	327	276	390
4C x 300	30	1.8	0.7	4 x 0.8	3.15	2.36	2.52	57.5	64.7	5500	7000	0.100	0.130	0.071	0.67	369	312	452
4C x 400	53	2.0	0.7	4 x 0.8	3.15	2.68	2.84	67.1	73.1	6800	9100	0.0778	0.102	0.070	0.69	420	356	526

4 CORE, ALUMINIUM CONDUCTOR, XLPE INSULATED, UNARMOURED POWER CABLES

FOR WORKING VOLTAGES UP TO AND INCLUDING 1100 V

No. of Cores & Nominal sectional Area	Min No. of wires	Thickness of XLPE Insulation (nom)	Min thickness of PVC Inner Sheath	Nom. thickness of PVC Outer sheath	Approx Overall diameter of Cable with ±2mm tolerance	Approx weight of cable	Max DC Resistance of Conductor at 20°C	Approx AC Resistance of Conductor at 90°C	Approx Reactance at 50Hz	Approx Capacitance at 50 Hz	CURRENT RATINGS		
											Buried Direct in the Ground @ 30°C	In Single way ducts buried @ 30°C	In Air @ 40°C
Sq mm	Nos	mm	mm	mm	(mm)	Kg/km	Ohm/km	Ohm/km	Ohm/km	µF/km	Amps	Amps	Amps
4C x 4	7	0.7	0.3	1.8	16.7	440	7.41	9.48	0.0927	0.23	35	33	31
4C x 4	2	0.7	0.3	1.8	15.5	405	7.41	9.48	0.0927	0.23	35	33	31
4C x 6	7	0.7	0.3	1.8	15.9	245	4.61	5.90	0.0906	0.25	44	39	42
4C x 6	3	0.7	0.3	1.8	16.7	269	4.61	5.90	0.0906	0.25	44	39	42
4C x 10	7	0.7	0.3	1.8	17.6	295	3.08	3.94	0.0857	0.31	57	48	56
4C x 10	7	0.7	0.3	1.8	19.2	296	3.08	3.94	0.0857	0.31	57	48	56
4C x 16	6	0.7	0.3	1.8	20.4	413	1.91	2.44	0.0828	0.38	75	61	69
4C x 25	6	0.9	0.3	2.0	21.8	630	1.20	1.54	0.0810	0.43	95	79	93
4C x 35	6	0.9	0.3	2.0	26.0	790	0.868	1.11	0.0801	0.47	114	96	114
4C x 50	6	1.0	0.3	2.1	29.2	920	0.641	0.820	0.0788	0.55	136	112	138
4C x 70	12	1.1	0.4	2.2	33.0	1200	0.443	0.567	0.0777	0.53	166	137	175
4C x 95	15	1.1	0.4	2.2	36.3	1610	0.320	0.410	0.076	0.71	199	164	214
4C x 120	15	1.2	0.5	2.4	36.9	2090	0.253	0.324	0.0752	0.63	225	187	249
4C x 150	15	1.4	0.5	2.4	42.6	2501	0.206	0.264	0.075	0.65	248	209	285
4C x 185	30	1.6	0.5	2.6	47.7	3100	0.164	0.211	0.072	0.65	281	238	327
4C x 240	30	1.7	0.6	3.0	52.8	4000	0.125	0.161	0.072	0.63	327	276	390
4C x 300	30	1.8	0.7	3.2	58.6	4800	0.100	0.130	0.071	0.67	367	312	434
4C x 400	53	2.0	0.7	3.4	63.3	6170	0.0778	0.102	0.07	0.67	420	352	520

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4 CORE, COPPER CONDUCTOR, XLPE INSULATED, ARMOURED POWER CABLES

FOR WORKING VOLTAGES UP TO AND INCLUDING 1100 V

No. of Cores & Cross-sectional Area	Min. No. of wires	Thickness of XLPE Insulation (nom)	Min. thickness of PVC inner sheath	Nominal Dimension of Armour		Min. Thickness of PVC Outer sheath		Approx Overall diameter of Cable with ±2 mm tolerance		Approx weight of cable		Max D.C. Resistance of Conductor at 20°C	Approx A.C. Resistance of Conductor at 90°C	Approx Reactance at 50 Hz	Approx Capacitance at 50 Hz	CURRENT RATINGS		
				Strip	Wire	Strip	Wire	Strip	Wire	Strip	Wire					Buried Direct in the Ground at 30°C	In Single way buried Duct at 30°C	In Air at 40°C
Sq.mm	No's	mm	mm	mm x mm	mm	mm	mm	mm	mm	Kg/km	Kg/km	Ohm/km	Ohm/km	Ohm/km	µF/km	Amps	Amps	Amps
4C x 4	7	0.7	0.3	—	1.4	—	1.24	—	15.5	—	800	4.61	5.90	0.0927	0.22	43	39	41
4C x 4	7	0.7	0.3	—	1.4	—	1.24	—	17.3	—	[illegible]	4.61	5.11	0.0927	0.22	45	35	41
4C x 6	7	0.7	0.3	—	1.4	—	1.24	—	17.7	—	760	3.08	3.90	0.0886	0.25	53	47	52
4C x 6	7	0.7	0.3	—	1.4	—	1.24	—	18.5	—	910	3.08	3.94	0.0886	0.40	54	47	52
4C x 10	7	0.7	0.3	—	1.4	—	1.40	—	21.4	—	930	1.83	2.34	0.0857	0.31	74	61	70
4C x 16	6	0.7	0.3	4 x 0.8	1.6	1.40	1.40	20.3	22.0	1020	1050	1.15	1.47	0.0806	0.36	95	79	89
4C x 25	6	0.9	0.3	4 x 0.8	1.6	1.40	1.40	22.2	23.8	1410	1650	0.727	0.930	0.085	0.41	122	102	116
4C x 35	6	0.9	0.3	4 x 0.8	1.6	1.40	1.40	24.4	26.0	1800	2100	0.524	0.671	0.080	0.47	144	123	137
4C x 50	6	1.0	0.3	4 x 0.8	1.6	1.56	1.56	27.9	29.5	2270	2750	0.387	0.495	0.078	0.50	173	146	170
4C x 70	12	1.1	0.4	4 x 0.8	2.0	1.56	1.56	31.1	34.5	3000	3850	0.268	0.343	0.077	0.53	211	179	208
4C x 95	15	1.1	0.4	4 x 0.8	2.0	1.72	1.72	35.2	35.8	4200	4850	0.193	0.247	0.076	0.61	254	212	270
4C x 120	18	1.2	0.5	4 x 0.8	2.0	1.72	1.88	39.1	40.9	5200	6000	0.153	0.196	0.072	0.63	287	240	320
4C x 150	18	1.4	0.5	4 x 0.8	2.5	1.88	2.04	42.4	46.3	6400	7550	0.124	0.159	0.072	0.63	321	269	365
4C x 185	30	1.6	0.6	4 x 0.8	2.5	2.04	2.20	47.8	51.5	7800	9350	0.0991	0.127	0.072	0.63	361	304	420
4C x 240	34	1.7	0.6	4 x 0.8	2.5	2.20	2.36	53.6	57.5	10600	11500	0.0754	0.097	0.072	0.63	416	352	500
4C x 300	34	1.8	0.7	4 x 0.8	3.15	2.36	2.52	59.2	64.5	12200	14500	0.0601	0.077	0.071	0.67	469	396	576
4C x 400	53	1.9	0.7	4 x 0.8	3.15	2.60	2.85	67.4	72.3	14800	19500	0.0470	0.060	0.070	0.67	529	442	692

4 CORE, COPPER CONDUCTOR, XLPE INSULATED, UNARMOURED POWER CABLES

FOR WORKING VOLTAGES UP TO AND INCLUDING 1100 V

No. of Cores & Cross-sectional Area	Min. No. of wires	Thickness of XLPE Insulation (nom)	Min. thickness of PVC Inner Sheath	Nom. Thickness of PVC Outer sheath	Approx Overall diameter of Cable with ±2 mm tolerance	Approx weight of cable	Max D.C. Resistance of Conductor at 20°C	Approx A.C. Resistance of Conductor at 90°C	Approx Reactance at 50 Hz	Approx Capacitance at 50 Hz	CURRENT RATINGS		
											Buried Direct in the Ground at 30°C	In Single way buried Duct at 30°C	In Air at 40°C
Sq.mm	No's	mm	mm	mm	(mm)	Kg/km	Ohm/km	Ohm/km	Ohm/km	µF/km	Amps	Amps	Amps
4C x 4	7	0.7	0.3	1.8	14.8	300	4.61	5.90	0.0927	0.22	45	38	41
4C x 4	7	0.7	0.3	1.8	15.5	340	4.61	5.90	0.0927	0.22	45	38	41
4C x 6	7	0.7	0.3	1.8	16.4	420	3.08	3.95	0.0886	0.25	54	47	52
4C x 6	7	0.7	0.3	1.8	16.7	480	3.08	3.95	0.0866	0.25	56	47	52
4C x 10	7	0.7	0.3	1.8	19.4	575	1.83	2.34	0.0859	0.31	74	62	70
4C x 16	6	0.7	0.3	1.8	21.8	775	1.15	1.47	0.0828	0.36	95	79	89
4C x 25	6	0.9	0.3	2.0	24.6	1150	0.727	0.93	0.080	0.41	122	102	116
4C x 35	6	0.9	0.3	2.0	26.4	1550	0.524	0.67	0.080	0.47	144	123	137
4C x 50	6	1.0	0.4	2.1	29.8	2100	0.387	0.495	0.078	0.50	173	146	170
4C x 70	12	1.1	0.4	2.3	33.0	2950	0.268	0.343	0.077	0.53	212	177	220
4C x 95	15	1.1	0.4	2.5	35.5	3600	0.193	0.247	0.076	0.61	254	213	270
4C x 120	18	1.2	0.5	2.6	39.5	4700	0.153	0.196	0.072	0.63	287	240	312
4C x 150	18	1.4	0.5	2.6	43.0	5900	0.124	0.159	0.072	0.63	321	269	365
4C x 185	30	1.6	0.6	2.8	48.8	8050	0.0991	0.127	0.072	0.63	362	304	422
4C x 240	34	1.7	0.6	3.0	54.6	9300	0.0754	0.097	0.072	0.63	416	352	500
4C x 300	34	1.8	0.7	3.2	61.0	11400	0.0601	0.077	0.071	0.67	469	396	576
4C x 400	53	2.0	0.7	3.6	69.0	15250	0.0470	0.060	0.070	0.67	529	442	692

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PVC INSULATED, ARMOURED CONTROL CABLES AS PER IS: 1554 (P-1)

(FOR WORKING VOLTAGES UP TO AND INCLUDING 1100 V)

No. of Cores & Cross sectional Area	Thickness of PVC Insulation	Min. Thickness of PVC Inner Sheath	Strip Armoured Cable: Nominal size of strip	Strip Armoured Cable: Min. Thickness of PVC Outer sheath	Strip Armoured Cable: Approx. Overall diameter of Cable with ±2 mm tolerance	Strip Armoured Cable: Approx. weight of Cable	Wire Armoured Cable: Nominal diameter of wire	Wire Armoured Cable: Min. Thickness of PVC Outer sheath	Wire Armoured Cable: Approx. Overall diameter of Cable with ±2 mm tolerance	Wire Armoured Cable: Approx. weight of Cable	Standard Delivery Drum Length	Current Rating: Buried Direct in the Ground @ 30°C	Current Rating: In Air/Duct @ 40°C
Sq.mm	mm	mm	mm x mm	mm	mm	Kg/Km	mm	mm	mm	Kg/Km	Meters	Amps	Amps
[illegible]	0.8	0.3	—	—	—	—	1.4	1.24	14.2	375	1000	23	20
[illegible]	0.8	0.3	—	—	—	—	1.4	1.24	14.5	400	1000	21	17
[illegible]	0.8	0.3	—	—	—	—	1.4	1.24	15.4	450	1000	21	17
[illegible]	0.8	0.3	—	—	—	—	1.4	1.24	16.2	500	1000	16	14
[illegible]	0.8	0.3	—	—	—	—	1.4	1.24	17.2	550	1000	15	13
[illegible]	0.8	0.3	—	—	—	—	1.4	1.24	17.2	575	1000	14	12
[illegible]	0.8	0.3	—	—	—	—	1.4	1.4	19.4	750	1000	12	11
[illegible]	0.8	0.3	4 x 0.8	1.24	18.4	475	1.4	1.4	20.4	900	1000	12	10
[illegible]	0.8	0.3	4 x 0.8	1.4	21.2	775	1.4	1.4	22.8	975	1000	11	10
[illegible]	0.8	0.3	4 x 0.8	1.4	22.7	850	1.4	1.4	22.7	1050	1000	11	9
[illegible]	0.8	0.3	4 x 0.8	1.4	23.7	925	1.4	1.4	24.7	1150	1000	10	9
[illegible]	0.8	0.3	4 x 0.8	1.4	24.4	1150	1.6	1.4	26.0	1375	1000	9	8
[illegible]	0.8	0.3	4 x 0.8	1.4	26.9	1200	1.6	1.4	28.5	1450	1000	9	8
[illegible]	0.8	0.3	4 x 0.8	1.4	27.8	1300	1.6	1.4	29.4	1550	1000	9	7
[illegible]	0.8	0.4	4 x 0.8	1.4	29.7	1500	1.6	1.4	31.2	1750	1000	8	7
[illegible]	0.9	0.3	—	—	—	—	1.4	1.24	15.2	425	1000	32	27
[illegible]	0.9	0.3	—	—	—	—	1.4	1.24	15.8	500	1000	27	24
[illegible]	0.9	0.3	—	—	—	—	1.4	1.24	16.8	550	1000	27	24
[illegible]	0.9	0.3	—	—	—	—	1.4	1.24	17.9	625	1000	23	19
[illegible]	0.9	0.3	—	—	—	—	1.4	1.24	19.1	700	1000	21	18
[illegible]	0.9	0.3	—	—	—	—	1.4	1.24	19.1	725	1000	20	17
[illegible]	0.9	0.3	4 x 0.8	1.4	20.2	650	1.6	1.4	21.9	975	1000	18	15
[illegible]	0.9	0.3	4 x 0.8	1.4	23.1	950	1.6	1.4	23.6	1100	1000	17	14
[illegible]	0.9	0.3	4 x 0.8	1.4	25.4	1025	1.6	1.4	25.4	1225	1000	16	13
[illegible]	0.9	0.3	4 x 0.8	1.4	26.8	1100	1.6	1.4	26.8	1425	1000	15	13
[illegible]	0.9	0.3	4 x 0.8	1.4	27.7	1250	1.6	1.4	27.7	1500	1000	14	12
[illegible]	0.9	0.3	4 x 0.8	1.4	31.6	1500	1.6	1.56	32.0	1800	1000	13	11
[illegible]	0.9	0.3	4 x 0.8	1.4	32.2	1625	1.6	1.56	32.6	1950	1000	12	10
[illegible]	0.9	0.3	4 x 0.8	1.56	35.6	1775	1.6	1.56	35.6	2050	1000	12	10
[illegible]	0.9	0.4	4 x 0.8	1.56	36.7	2050	2.0	1.56	36.7	2400	1000	11	9

Construction

1. Solid/Stranded annealed copper conductor & Tinned/Bare
2. General Purpose PVC-A/HR PVC-C Insulation
3. Cores laid up (filled if needed)
4. FR/FRLS/HR/General Purpose PVC ST-1 or 2 inner sheath
5. Armouring round Galvanized steel wires/strips
6. FR/FRLS/HR/General Purpose PVC ST-1 or 2 outer sheath

Max. Conductor D.C. Resistance at 20°C - Conductor Size :

1.5 sq.mm - 12.1 Ohm/Km (bare), 12.2 Ohm/Km (tinned)

2.5 sq.mm - 7.41 Ohm/Km (bare), 7.56 Ohm/Km (tinned)

* Dimensions specified are with stranded conductor

Approx Reactance at 50 Hz

1.5 sq.mm - 0.126 Ohm /Km, 2.5 sq.mm - 0.119 Ohm/Km

Approx Capacitance at 50 Hz

1.5 sq.mm - 0.14 uF/Km, 2.5 sq.mm - 0.15 uF/Km

PVC INSULATED, UNARMOURED CONTROL CABLES AS PER IS: 1554 (P-1)

(FOR WORKING VOLTAGES UP TO AND INCLUDING 1100 V)

No. of Cores & Cross sectional Area	Thickness of PVC Insulation (Nom)	Min. thickness of PVC Inner Sheath	Nom. Thickness of PVC Outer Sheath	Approx Overall diameter of Cable with ±2 mm tolerance	Approx weight of cable	Standard Delivery Drum length	Current Rating: Buried Direct in the Ground @ 30°C	Current Rating: In Air/Duct @ 40°C
Sq.mm	mm	mm	mm	mm	Kg/Km	meters	Amps	Amps
2C x 1.5	0.8	0.3	1.8	12.2	150	1000	23	20
3C x 1.5	0.8	0.3	1.8	12.7	175	1000	21	17
4C x 1.5	0.8	0.3	1.8	13.4	200	1000	21	17
5C x 1.5	0.8	0.3	1.8	14.0	230	1000	16	14
6C x 1.5	0.8	0.3	1.8	15.2	275	1000	15	13
7C x 1.5	0.8	0.3	1.8	15.5	316	1000	14	12
10C x 1.5	0.8	0.3	1.8	17.2	410	1000	12	11
12C x 1.5	0.8	0.3	1.8	17.4	440	1000	12	10
14C x 1.5	0.8	0.3	1.8	20.2	500	1000	11	10
16C x 1.5	0.8	0.3	1.8	21.2	540	1000	11	9
19C x 1.5	0.8	0.3	2.0	22.5	640	1000	10	9
24C x 1.5	0.8	0.3	2.0	25.8	806	1000	9	8
27C x 1.5	0.8	0.3	2.0	26.0	875	1000	9	8
30C x 1.5	0.8	0.3	2.0	27.2	950	1000	8	7
37C x 1.5	0.8	0.3	2.0	29.1	1126	1000	8	7
2C x 2.5	0.9	0.3	1.8	13.4	200	1000	32	27
3C x 2.5	0.9	0.3	1.8	14.0	225	1000	27	24
4C x 2.5	0.9	0.3	1.8	15.8	275	1000	27	24
5C x 2.5	0.9	0.3	1.8	16.1	325	1000	23	19
6C x 2.5	0.9	0.3	1.8	17.2	375	1000	21	18
7C x 2.5	0.9	0.3	1.8	17.3	400	1000	20	17
10C x 2.5	0.9	0.3	1.8	19.2	550	1000	18	15
12C x 2.5	0.9	0.3	2.0	20.4	650	1000	17	14
14C x 2.5	0.9	0.3	2.0	22.2	725	1000	16	13
16C x 2.5	0.9	0.3	2.0	24.2	800	1000	15	13
19C x 2.5	0.9	0.3	2.2	25.3	930	1000	14	12
24C x 2.5	0.9	0.3	2.2	29.4	1125	1000	13	11
27C x 2.5	0.9	0.3	2.4	30.0	1245	1000	13	10
30C x 2.5	0.9	0.3	2.4	31.6	1350	1000	12	10
37C x 2.5	0.9	0.4	2.4	33.7	1600	1000	11	9

Construction

1. Solid/Stranded annealed copper conductor & Tinned/Bare
2. General Purpose PVC-A/HR PVC-C Insulation
3. Cores laid up (filled if needed)
4. FR/FRLS/HR/General Purpose PVC ST-1 or 2 inner sheath
5. FR/FRLS/HR/General Purpose PVC ST-1 or 2outer sheath

Max. Conductor D.C Resistance at 20°C - Conductor Size :

1.5 sq.mm - 12.1 Ohm/Km (bare), 12.2 Ohm/Km (tinned)

2.5 sq.mm - 7.41 Ohm/Km (bare), 7.56 Ohm/Km (tinned)

* Dimensions specified are with stranded conductor.

Approx Reactance at 50 Hz

1.5 sq.mm - 0.126 Ohm/Km, 2.5 sq.mm - 0.119 Ohm/Km

Approx Capacitance at 50 Hz

1.5 sq.mm - 0.14 uF/Km, 2.5 sq.mm - 0.15 uF/Km

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MUMBAI METROPOLITAN REGION DEVELOPMENT AUTHORITY

मुंबई महानगर प्रदेश विकास प्राधिकरण

STRABAG Infrastructure & Safety Solutions GmbH

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XLPE INSULATED, ARMOURED CONTROL CABLES AS PER IS: 7098 (P-1)

FOR WORKING VOLTAGES UP TO AND INCLUDING 1100 V

No. of Cores & Cross-sectional Area	Nom. Thickness of XLPE Insulation	Min. Thickness of PVC Inner Sheath	STRIP ARMOURED CABLE: Nominal size of strip	Min. Thickness of PVC Outer sheath	Approx. Overall diameter of Cable with ±2.0mm tolerance	Approx. weight of Cable	WIRE ARMOURED CABLE: Nominal diameter of wire	Min. Thickness of PVC Outer sheath	Approx. Overall diameter of Cable with ±2.0mm tolerance	Approx. weight of Cable	Standard Delivery Drum Length	Current Rating: Buried Direct in the Ground @30°C	Current Rating: In Air/Duct @40°C
Sq.mm	mm	mm	mm x mm	mm	mm	Kg/km	mm	mm	mm	Kg/km	meters	Amps	Amps
2C x 1.5	0.7	0.3	—	—	—	—	1.4	1.24	13.6	355	1000	30	29
3C x 1.5	0.7	0.3	—	—	—	—	1.4	1.24	14.1	375	1000	25	25
4C x 1.5	0.7	0.3	—	—	—	—	1.4	1.24	14.7	445	1000	25	22
5C x 1.5	0.7	0.3	—	—	—	—	1.4	1.24	15.6	475	1000	24	21
6C x 1.5	0.7	0.3	—	—	—	—	1.4	1.24	16.7	525	1000	22	19
7C x 1.5	0.7	0.3	—	—	—	—	1.4	1.24	16.7	550	1000	21	18
10C x 1.5	0.7	0.3	—	—	—	—	1.4	1.24	18.2	760	1000	18	16
12C x 1.5	0.7	0.3	—	—	—	—	1.4	1.24	19.1	790	1000	17	15
14C x 1.5	0.7	0.3	—	—	—	—	1.4	1.4	21.6	825	1000	16	14
16C x 1.5	0.7	0.3	4 x 0.8	1.4	21.2	750	1.4	1.4	22.6	990	1000	16	14
19C x 1.5	0.7	0.3	4 x 0.8	1.4	22.7	850	1.4	1.4	23.7	1025	1000	15	13
24C x 1.5	0.7	0.3	4 x 0.8	1.4	26.2	1000	1.6	1.4	26.8	1250	1000	13	12
27C x 1.5	0.7	0.3	4 x 0.8	1.4	25.7	1050	1.6	1.4	27.4	1300	1000	13	11
30C x 1.5	0.7	0.3	4 x 0.8	1.4	26.2	1150	1.6	1.4	28.7	1400	1000	12	11
37C x 1.5	0.7	0.3	4 x 0.8	1.4	28.2	1300	1.6	1.4	29.7	1550	1000	11	10
44C x 1.5	0.7	0.3	4 x 0.8	1.4	31.4	1550	1.6	1.56	33.4	1850	1000	11	9
52C x 1.5	0.7	0.3	4 x 0.8	1.56	33.7	1750	1.6	1.56	34.7	2040	1000	10	9
61C x 1.5	0.7	0.4	4 x 0.8	1.56	34.9	1950	2.0	1.56	37.2	2450	1000	9	8
2C x 2.5	0.7	0.3	—	—	—	—	1.4	1.24	14.6	400	1000	39	32
3C x 2.5	0.7	0.3	—	—	—	—	1.4	1.24	15.0	425	1000	34	28
4C x 2.5	0.7	0.3	—	—	—	—	1.4	1.24	15.7	500	1000	34	28
5C x 2.5	0.7	0.3	—	—	—	—	1.4	1.24	16.9	550	1000	31	28
6C x 2.5	0.7	0.3	—	—	—	—	1.4	1.24	17.8	600	1000	29	26
7C x 2.5	0.7	0.3	—	—	—	—	1.4	1.24	17.7	625	1000	27	25
10C x 2.5	0.7	0.3	4 x 0.8	1.40	18.0	725	1.6	1.4	20.5	925	1000	24	21
12C x 2.5	0.7	0.3	4 x 0.8	1.4	19.6	800	1.6	1.4	21.2	1000	1000	22	20
14C x 2.5	0.7	0.3	4 x 0.8	1.4	22.0	875	1.6	1.4	23.6	1050	1000	21	19
16C x 2.5	0.7	0.3	4 x 0.8	1.4	22.1	950	1.6	1.4	24.7	1150	1000	20	18
19C x 2.5	0.7	0.3	4 x 0.8	1.4	24.1	1000	1.6	1.4	26.2	1300	1000	19	17
24C x 2.5	0.7	0.3	4 x 0.8	1.4	27.4	1200	1.6	1.4	29.2	1500	1000	17	16
27C x 2.5	0.7	0.3	4 x 0.8	1.4	28.1	1275	1.6	1.4	29.7	1650	1000	16	15
30C x 2.5	0.7	0.3	4 x 0.8	1.4	29.0	1350	1.6	1.4	30.6	1750	1000	16	14
37C x 2.5	0.7	0.3	4 x 0.8	1.4	31.1	1750	1.6	1.56	33.1	2050	1000	15	13
44C x 2.5	0.7	0.4	4 x 0.8	1.56	35.4	2050	2.0	1.56	37.8	2600	1000	14	12
52C x 2.5	0.7	0.4	4 x 0.8	1.56	36.8	2300	2.0	1.56	39.2	2850	1000	13	12
61C x 2.5	0.7	0.4	4 x 0.8	1.56	38.9	2575	2.0	1.56	41.2	3200	1000	12	11

Construction
1. Solid/Stranded annealed copper conductor & Tinned/Bare 2. Cross Linked Polyethylene (XLPE) Insulation 3. Cores laid up (filled if needed)
4. FR/FRLS/HR PVC Type ST-2 inner sheath outer sheath 5. Armouring round Galvanized steel wires/strips 6. FR/FRLS/HR PVC Type ST-2

Max. Conductor D.C Resistance at 20°C - Conductor Size :
1.5 sq.mm - 12.1 Ohm/Km (bare), 12.2 Ohm/Km (tinned) 2.5 sq.mm - 7.41 Ohm/Km (bare), 7.56 Ohm/Km (tinned) *Dimensions specified are with stranded conductor

Approx Reactance at 50 Hz 1.5 sq.mm - 0.107 Ohm/Km, 2.5 sq.mm - 0.0980 Ohm/Km

Approx Capacitance at 50 Hz 1.5 sq.mm - 0.15 uF/Km, 2.5 sq.mm - 0.18 uF/Km

XLPE INSULATED, UNARMOURED CONTROL CABLES AS PER IS: 7098 (P-1)

FOR WORKING VOLTAGES UP TO AND INCLUDING 1100 V

No. of Cores & Cross-sectional Area	Thickness of XLPE Insulation	Min. thickness of PVC Inner Sheath	Nom. Thickness of PVC Outer Sheath	Approx. Overall diameter of Cable with ±2.0mm tolerance	Approx. weight of cable	Standard Delivery Drum Length	Current Rating: Buried Direct in the Ground @30°C	Current Rating: In Air/Duct @40°C
Sq.mm	mm	mm	mm	mm	Kg/km	meters	Amps	Amps
2C x 1.5	0.7	0.3	1.8	11.0	165	1000	34	29
3C x 1.5	0.7	0.3	1.8	12.3	180	1000	25	22
4C x 1.5	0.7	0.3	1.8	13.1	205	1000	25	22
5C x 1.5	0.7	0.3	1.8	14.0	225	1000	24	21
6C x 1.5	0.7	0.3	1.8	14.7	250	1000	22	19
7C x 1.5	0.7	0.3	1.8	14.9	265	1000	21	18
10C x 1.5	0.7	0.3	1.8	16.0	340	1000	18	16
12C x 1.5	0.7	0.3	1.8	17.1	400	1000	17	15
14C x 1.5	0.7	0.3	1.8	19.2	420	1000	16	14
16C x 1.5	0.7	0.3	1.8	20.2	475	1000	16	14
19C x 1.5	0.7	0.3	1.8	21.1	540	1000	15	13
24C x 1.5	0.7	0.3	2.0	24.4	645	1000	13	12
27C x 1.5	0.7	0.3	2.0	25.1	750	1000	13	11
30C x 1.5	0.7	0.3	2.0	25.9	820	1000	12	11
37C x 1.5	0.7	0.3	2.0	27.7	975	1000	11	10
44C x 1.5	0.7	0.3	2.0	30.8	1100	1000	11	9
52C x 1.5	0.7	0.4	2.0	33.1	1275	1000	10	9
61C x 1.5	0.7	0.4	2.2	34.3	1500	1000	9	8
2C x 2.5	0.7	0.3	1.8	12.6	175	1000	39	32
3C x 2.5	0.7	0.3	1.8	13.2	200	1000	34	28
4C x 2.5	0.7	0.3	1.8	14.1	250	1000	34	28
5C x 2.5	0.7	0.3	1.8	15.1	275	1000	31	28
6C x 2.5	0.7	0.3	1.8	16.1	325	1000	29	26
7C x 2.5	0.7	0.3	1.8	16.1	350	1000	27	25
10C x 2.5	0.7	0.3	1.8	17.8	470	1000	24	21
12C x 2.5	0.7	0.3	1.8	18.6	520	1000	22	20
14C x 2.5	0.7	0.3	1.8	21.8	600	1000	21	19
16C x 2.5	0.7	0.3	2.0	22.5	675	1000	20	18
19C x 2.5	0.7	0.3	2.0	23.5	775	1000	19	17
24C x 2.5	0.7	0.3	2.0	27.3	950	1000	17	16
27C x 2.5	0.7	0.3	2.0	27.5	1025	1000	16	15
30C x 2.5	0.7	0.3	2.0	28.4	1125	1000	16	14
37C x 2.5	0.7	0.3	2.0	30.5	1350	1000	15	13
44C x 2.5	0.7	0.4	2.2	34.8	1600	1000	14	12
52C x 2.5	0.7	0.4	2.2	36.2	1825	1000	13	12
61C x 2.5	0.7	0.4	2.2	38.2	2050	1000	12	11

Construction
1. Solid/Stranded annealed copper conductor & Tinned/Bare 2. Cross Linked Polyethylene (XLPE) Insulation 3. Cores laid up (filled if needed)
4. FR/FRLS/HR PVC Type ST-2 inner sheath 5. FR/FRLS/HR PVC Type ST-2 outer sheath

Max. Conductor D.C Resistance at 20°C - Conductor Size :
1.5 sq.mm - 12.1 Ohm/Km (bare), 12.2 Ohm/Km (tinned) 2.5 sq.mm - 7.41 Ohm/Km (bare), 7.56 Ohm/Km (tinned) *Dimensions specified are with stranded conductor **Approx Reactance at 50 Hz**

1.5 sq.mm - 0.107 Ohm/Km, 2.5 sq.mm - 0.0985 Ohm/Km

Approx Capacitance at 50 Hz
1.5 sq.mm - 0.15 uF/Km, 2.5 sq.mm - 0.18 uF/Km

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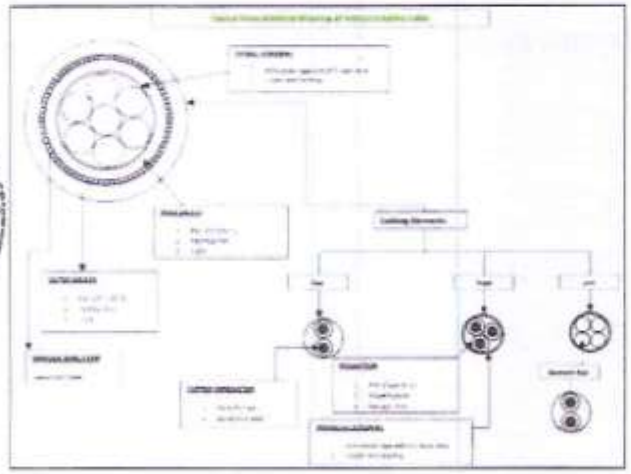
Instrumentation Cables

KEI industries Limited manufactures a wide variety of cables suitable for process instrumentation. In the projects related to power generation & distribution, chemical & fertilizer industries and various other types of engineering industries, the process instrumentation plays a vital role in measurement, supervision and control of the process. Introduction of microprocessor based computerised instrumentation has demanded stringent quality requirements alongwith special electrical parameters for instrumentation cables. Very low level electrical signals pass between measuring and and display units/controllers which are situated far off. These low level signals are prone to external noise pickups and heavy attenuation during transmission.

All this means that the cables to be used for instrumentation should be designed and manufactured very carefully. KEI, with its meticulous efforts in maintaining quality, stringent in process control during manufacture and the knowledge of cable designing, is proud to say that it is capable of supplying instrumentation cables meeting any Indian/ International standard or a specific requirement desired by project authority. The efforts done by KEI are regarded by acceptance of our quality by the country's prime organisations such as NTPC, PDIL, EIL, BHEL, TATA's, IOCL, L&T, ABB, KRUPP Ind, BPCL, HPCL, ESSAR, SIEMENS, Electricity Boards, Reliance, IOTL, Mukand, Honeywell, etc.

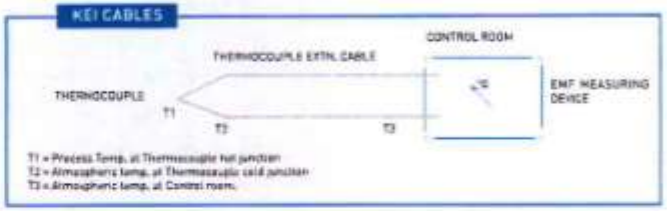
Range of Instrumentation Cables :-

Conductor	:	0.4 mm dia (0.126 sq.mm) to 2.5 sq.mm, or higher sizes of electrolytic copper wire, Tinned/untinned, solid/ stranded copper conductors.
Insulation	:	70° C/85° C. Grade PVC, Polyethylene, Halogen Free FRLS Polymeric Compounds.
Elements	:	Pairs/Triples/Quads, colour coded/number printed ring marked/dual colour extruded.
Shields	:	Aluminimum Polyester tape screen with Copper drain wire or alternately with with Copper wire braiding. Individual element or overall shielding as specified.
Element laying	:	Concentric formation or unit & group formation as per applicable specification.
Armouring	:	Galvanised steel wire/strip amoured.
Sheathing	:	PVC 70° C/90° C grade, PVC FRLS, ZHFR, CSP, PCP, EVA, etc.
Specification	:	BS-5308 (1 & 2), iec-189 (1 & 2), VDE 0815, ENI 0181.00 and customers specifications.



Thermocouple Extension/Compensating Cables

These cables can also be termed as instrumentation cables, since they are used for process temperature measurement. The construction is similar to paired instrumentation cable but the conductor material is different. Thermocouples are used in processes to sense temperature and is connected to the pyrometers for indication and control. The thermocouple and pyrometers are electrically conducted by thermocouple extension/compensating cables. The conductors used for these cables are required to have similar thermo-electric (emf) properties as that of the thermocouple used for sensing the temperature. The cables are manufactured as per IS:8784, ANSI-MC 96. 1, B.S., ENI, DIN and customers specification.



Range of Thermocouple Extension/Compensation cables :-

Extension Cables	Conductor Material	
	Positive	Negative
KX (NiCr/Nial)	Chromel	Alumel
JX (Fe/CuNi)	Iron	Constantan
EX (NiCr/CuNi)	Chromel	Constantan
TX (Cu/CuNi)	Copper	Constantan
Compensating Cables		
KX (A)/VX (NiCr/NiAl)	Copper	Constantan
SX/RX (PtRh-Pt)	Copper	Constantan

COLOUR CODES as per various standard specifications

	STANDARDS REFERRED								
	ANSI MC-96.1 ENI - 163.00			IS : 8784			B. S.		
	+ve	-ve	overall	+ve	-ve	overall	+ve	-ve	overall
EXTENSION CABLES									
KX	Yellow	Red	Yellow	Red	Green	Green	Brown	Blue	Red
JX	White	Red	Black	Red	Blue	Blue	Yellow	Blue	Black
TX	Blue	Red	Blue	Red	Black	Black	White	Blue	Blue
EX	Purple	Red	Purple	Red	Violet	Violet	Brown	Blue	Brown
COMPENSATING CABLES									
KX(A)/VX	—	—	—	Red	Green	Green	White	Blue	Red
SX/RX	Black	Red	Green	Red	White	White	White	Blue	Green

KEI FRLS And Halogen Free Cables

Test	Function	Specification	Typical Values of FRLS Compound	Typical Values of Halogen Free Compound	Typical Values of Ordinary PVC Compound
Oxygen Index	To Determine Percentage of Oxygen Required for Supporting Combustion of Insulating Material at room temprature.	ASTM-D-2863	More than 29	More than 29	22
Temprature Index	To Determine at What Temprature Normal Oxygen Content of 21% in Air will Support Combustion of Insulating Material	ASTM-D-2863 & BICC Handbook Chapter No.6	More than 250 Deg.C	More than 250 Deg.C	150 Deg.C
SMOKE DENSITY RATING	To Determine the visibility (Light Transmission) under Fire of Insulating Material	ASTM-D-2843	More than 40%	More than 80%	10-15%
Acid Gas Generation	To acertian the amount of Hydroclonic Acid Gas Evolved from Insulation of Cable Under Fire.	IEC-754-I	Less than 20%	Less than 0.5%	45-50%

Following additional test is offered on these cables:

1) FLAMMABILITY TEST
   - A) IEEE 383
   - B) IEC 332(PART-I)
   - C) IEC 332 (PART-III)
2) SWEDISH CHIMNEY TEST
   - A) SS 4241475 (F3)

Single Core PVC/ HR PVC / FRLS / ZHFR Insulated Copper Conductor (Unsheathed) House Wires in Voltage Grade upto & including 1100 Volts as per IS 694.

Basic Code	Nominal Cross Section Area of Conductor	Number / Nom. Dia of wires* (Nom.)	Thickness of Insulation (Nom.)	Overall diameter Max.	Current Carrying Capacity in (Amps)				Resistance (Max) at 20°C.
	Sq. Mm	Number / mm	mm	mm	PVC	HR PVC	FRLS	ZHFR	Ohm / Km
KSF - 2420	0.75	24 / 0.20	0.60	2.8	7	8	7	8	26.00
KSF - 1430	1.00	14 / 0.30	0.70	3.2	11	13	11	13	18.10
KSF - 2230	1.50	22 / 0.30	0.70	3.4	13	16	13	16	12.10
KSF - 3630	2.50	36 / 0.30	0.80	4.2	18	20	18	20	7.41
KSF - 5630	4.00	56 / 0.30	0.80	4.8	24	26	24	26	4.95
KSF - 8430	6.00	84 / 0.30	0.80	5.6	31	36	31	36	3.30

Comparitive Properties of House Wires

Feature	Normal PVC Wire	Heat Resistant HR PVC	Fire Retardant FR - PVC	Flame Retardant Low Smoke FRLS	Zero Halogen Low Smoke
Insulation Material	PVC	PVC	Spl. PVC	Spl. PVC	Spl. Polymer
Insulation Property	Normal	Good	Good	Good	Very Good
Temperature Rating	70°C	85°C	70°C	70°C	85°C
Thermal Stability	Normal	Very Good	Good	Good	Very Good
Flame Retardancy	Good	Good	Very Good	Very Good	Excellent
Safety During Burning	Average	Average	Good	Good	Excellent
Requirement of Oxygen to Catch Fire (% in air)	→21	→ 21	→ 30	→ 30	→ 35
Temperature Required to Catch Fire (with 21% oxygen)	Room Temp.	Room Temp.	→ 250°C	→ 250°C.	→ 300°C
Visibility during Cable Burning (%)	←20	← 20	← 35	→ 40	→ 80
Release of Halogen Gas during Burning (% by weight)	←20	← 20	← 20	← 20	ZERO
Abrasion Resistance during Installation	Good	Good	Good	Good	Good

Winding Wires / 3 Core Flat Cables For Submersible Pumps

HR PVC Insulated Winding Wires as per IS:8783 (Part 4/Sec I)

Basic Code	Conductor Diameter (Nom) mm	Thickness of Insulation (Min) mm	Overall Diameter (Approx.) mm	Conductor Resistance at 200°C (Max) Ohms/Km
KWS-0060	0.6	0.25	1.17	62.20
KWS-0070	0.7	0.30	1.37	45.70
KWS-0080	0.8	0.30	1.47	35.00
KWS-0090	0.9	0.30	1.57	27.60
KWS-0100	1.0	0.30	1.67	22.40
KWS-0110	1.1	0.30	1.77	18.50
KWS-0120	1.2	0.30	1.87	15.50
KWS-0130	1.3	0.30	1.97	13.20
KWS-0140	1.4	0.35	2.17	11.40
KWS-0150	1.5	0.35	2.27	9.95
KWS-0160	1.6	0.35	2.37	8.75
KWS-0170	1.7	0.35	2.47	7.75
KWS-0180	1.8	0.35	2.62	6.91
KWS-0190	1.9	0.35	2.72	6.20
KWS-0200	2.0	0.45	3.02	5.60
KWS-0210	2.1	0.45	3.12	5.08
KWS-0220	2.2	0.45	3.22	4.63
KWS-0230	2.3	0.45	3.32	4.23
KWS-0240	2.4	0.50	3.52	3.89
KWS-0250	2.5	0.50	3.62	3.58
KWS-0260	2.6	0.50	3.72	3.31
KWS-0270	2.7	0.50	3.82	3.07
KWS-0280	2.8	0.55	4.02	2.86
KWS-0290	2.9	0.55	4.12	2.66
KWS-0300	3.0	0.55	4.22	2.49

3 Core Flat Cables

Basic Code	Area (Nom.) sq.	Number/ size of Wire	Insulation Thickness (Nom.)	Sheath Thickness (Nom.)	Width 'W' (Approx)	Thickness 'T' (Approx)	Resistance at 20°C (Max.)	Current carrying capacity at 40°C
	mm	No./mm	mm	mm	mm	mm	ohm/Km	Amps
K3FL-2230	1.5	22/0.3	0.6	0.90	11.0	5.0	12.10	14
K3FL-3630	2.5	36/0.3	0.7	1.00	13.0	6.0	7.40	18
K3FL-5630	4.0	56/0.3	0.8	1.00	15.3	6.7	4.95	26
K3FL-8430	6.0	84/0.3	1.0	1.15	18.7	7.9	3.30	31
K3FL-14030	10.0	140/0.3	1.0	1.40	23.7	9.9	1.91	42
K3FL-22630	16.0	226/0.3	1.0	1.40	28.0	11.4	1.21	57
K3FL-35430	25.0	354/0.3	1.2	2.00	35.5	14.7	0.780	72
K3FL-49530	35.0	495/0.3	1.2	2.00	39.5	16.2	0.554	90
K3FL-70330	50.0	703/0.3	1.4	2.20	45.5	18.3	0.386	115
K3FL-36056	70.0	360/0.5	1.4	2.20	51.0	20.0	0.272	143
K3FL-47556	95.0	475/0.5	1.6	2.40	60.0	23.5	0.206	165

Rubber Cables

In keeping with the company's commitment to technological advancement, elastomer materials such as Polychloroprene (PCP), Chloro-Sulphonated Polyethelene (CSP), Nitrile Rubber / PVC blends, Ethylene Propelene Rubber (EPR), Ethylene Vinyle Acetate (EVA) and Silicone have been specially compounded to meet numerous heat oil and fire resisting requirements. In the recent years KEI has also developed special Elastomeric Fire Survival Cables for power, control and instrumentation wiring.

Elastomeric compounds for insulating and sheathing of cables are formulated to meet the requirement of IS 6380, BS 6899, IEC 60502 and other international specification.

GENERAL CONSTRUCTION (Conforming to IS 9968 Part 1 & II)

Conductor	– Annealed tinned Copper wires Solid (Class 1), Stranded (Class 2), flexible (Class 5) complying with the requirement of IS 8130
Seperator Tape	– Suitable material separater tape may be applied over the conductor
Insulation	– General service elastomer compound Type IE1 of IS 6380 Heat Resising elastomer compound Type IE2 of IS 6380 Silicone Rubber Type IE 5 of IS 6380
Core Identification	– Coloured insulation, Nos. PE tape, Coloured proofed tape, Nos. printing
Fillers	– Natural or synthetic fibres or elastomer suitable for the operating temperature and compatible with the insulating material
Sheath	– General service sheath Type SE1/SE2 of IS 6380 Heavy Duty Sheath Type SE3/SE4 of IS 6380

Working Temperature of Commonly used Elastomeric Insulating and Sheathing Materials

Material	Max. Cond. Temp. for continuous opertation °C.	Max. Cond. Temp. for short circuit °C.	Min. Working Temp. °C.
Ethylene Propylene Rubber (EPR)	90	250	-50
Polychloroprene (PCP)	70	200	-40
Chlorosupphonated Polyethylene (CSP)	90	200	-35
Silicone Rubber	150/180	350	55
Chloropropylene Ethylene (CPE)	90	250	-30
Styrene Butadience Rubber	60	200	-55
NBR PVC	90	250	-30

Rubber Cables

Current carrying capacities for Multicore Flexible Trailing cables Armoured / Unarmoured, insulated with EPR for all Voltage Grades

Nominal cross-sectional area of conductor	Max. Resistance at 20°C for tinned flexible conductor(class 5)	Current Rating upto 10 kV E2(EPR)	Current Rating Above 10 kV EPR
mm²	ohms/km	(A)	(A)
2.5	8.21	32	-
4	5.09	43	-
6	3.39	56	-
10	1.95	78	-
16	1.24	104	110
25	0.795	138	146
35	0.595	171	181
50	0.393	213	226
70	0.277	263	279
95	0.21	317	336
120	0.164	370	391
150	0.132	425	450
185	0.108	485	514

Note:

1) This table covers current rating of flexible trailing cable armoured / unarmoured conforming to IS:9968 I & II, IS 14494, VDE 0250 , NCB & other equivalent international specifications for flexible cables.

2) The rating is given above are based on ambient temp.30°C for higher temp. please refer to the following table of correction factors.

Temp. °C	EPR
25	1.05
30	1.00
35	0.93
40	0.86
45	0.80
50	0.72
55	0.63
60	0.54
70	0.31

3) Rating factor for 'MONOSPIRAL' reeling drum winding duty is 0.85 .

4) For reeling-unreeling operation rating factors are as follows :

No. of Times	1	2	3	4
Derating Factors	0.76	0.58	0.47	0.40

*Current rating for higher sizes upon request.

Rubber Cables

Elastomeric Cables Range	Application
Cables up to 11 kV	Machine Trailling, Mining, Power
Flexible Trailing Cables	Reeling unreeling, Trailing, Festooning, Mobile Machines Cranes, Coal Handling and Conveyors
Mining Cables	FT or Pliable Armoured or Landline type as per IS 14494, NCB, SABS specs for UG, Open cast Coal or other mines and mining machines
Thermal Power Plants	For coal handling plants, flexible power and control application
Cables for Steel Plants	Flexible and high temp withstanding cables for furnace, melting shops, material handling
Wind Energy	Flexible cables for power and control for Wind Mill generator connection
Fire Survival Cables	Fire Survival for 3 Hrs or 20 Min
Ship Wiring	As per IEC specs and Naval specs DGS of DEFSTAN, NES
Offshore and Onshore	For platforms and Rig as per IEC, BS and NEK Specs
Shore Supply & Generator Cables	For charging of ship batteries and supply from mobile generators
Motor Coil Leads	Elastomeric and Silicon as per IS, BS, or OEM Specs
High Temp Cables	Silicon insulated, glass fiber braided or unbraided
Pump Cables	For water, submersible and sewerage pumps
Cables for Railway	Coach wiring, Metro railway
Wire	HFFR Low toxic emission under fire
Panel Wiring	For flexible, high power high temp zone, polluted or moist atmospheres
Battery Cables	For High current and long life
Low Temperature installations	Suitable for subzero temp installations and operations
Misc Applications	outdoor high mast lighting site power supply, white goods, oil or chemical resistant
Type	Power and Control cables up to 61 Cores Instrumentation Pairs 30 pairs, triads, quad Wires, flat cables
Voltage Grades	11 kV, 6.6 kV, 3.3 kV, 1.1 kV, 750 V, 250 V, 110 V, 60 V
Conductor Range	0.5 to 630 sq. mm
Polymers Processed Compounds	EPR, EPDM, PCP, CSP, CPE, SILICONE, EVA HALOGEN FREE AND FIRE RESISTANT NONTOXIC COMPOUNDS
Braiding Offered	ATC, GI wire braid, Synthetics or Textile Yarn, Glass Fiber
Armouring	Pliable armour or Steel / Copper Wires / Stainless steel

Conductor Data

Conductor Technical data for Single Core and Multicore cables confirming to IS: 8130 (Stranded-Class-2) Aluminium Conductor or Annealed Copper conductor, compacted circular or shaped

Nominal Size of Conductor	Minimum no. of wires				Max DC Resistance at 20°C		Approx. AC Resistance at 70°C		Approx. AC Resistance at 85°C		Approx. AC Resistance at 90°C	
	Non-compacted		Compacted		Plain Copper	Aluminium	Plain Copper	Aluminium	Plain Copper	Aluminium		
	COPPER	ALUMINIUM	COPPER	ALUMINIUM	PLAIN COPPER	ALUMINIUM	PLAIN COPPER	ALUMINIUM	PLAIN COPPER	ALUMINIUM	PLAIN COPPER	ALUMINIUM
Mm²	No's	No's	No's	Ohm/Km	Ohm/Km	Ohm/Km	Ohm/Km	Ohm/Km	Ohm/Km	Ohm/Km	Ohm/Km	
1.0	7	-	-	-	18.1	-	21.7	-	20.9	-	23.2	-
1.5	7	3	-	-	12.1	18.1	14.5	21.7	15.2	23.8	15.5	23.2
2.5	7	3	-	-	7.41	12.1	8.87	14.5	9.36	15.2	9.50	15.5
4	7	3	-	-	4.61	7.41	5.53	8.89	5.85	9.2	5.92	9.69
6	7	3	-	-	3.08	4.61	3.70	5.53	3.89	5.8	3.94	5.92
10	7	7	6	-	1.83	3.08	2.20	3.70	2.33	3.9	2.35	3.94
16	7	7	6	6	1.15	1.91	1.38	2.29	1.47	2.51	1.49	2.46
25	7	7	6	6	0.727	1.20	0.873	1.44	0.975	1.51	0.997	1.54
35	7	7	6	6	0.524	0.868	0.629	1.04	0.668	1.09	0.677	1.11
50	19	19	6	6	0.387	0.641	0.464	0.769	0.486	0.809	0.495	0.822
70	19	19	12	12	0.268	0.443	0.322	0.532	0.339	0.559	0.343	0.567
95	19	19	15	15	0.193	0.320	0.232	0.384	0.243	0.404	0.247	0.410
120	37	37	18	15	0.153	0.253	0.184	0.304	0.193	0.319	0.196	0.324
150	37	37	18	15	0.124	0.206	0.149	0.249	0.156	0.260	0.159	0.264
185	37	37	30	30	0.0991	0.164	0.119	0.199	0.125	0.207	0.127	0.210
240	61	37	34	30	0.0754	0.125	0.0906	0.153	0.0995	0.160	0.0977	0.161
300	61	61	34	30	0.0601	0.100	0.0723	0.123	0.0786	0.128	0.0779	0.129
400	61	61	53	53	0.0470	0.0778	0.0576	0.0952	0.0619	0.0996	0.0617	0.101
500	61	61	53	53	0.0366	0.0605	0.0464	0.0753	0.0506	0.0788	0.0509	0.0797
630	91	91	53	53	0.0283	0.0469	0.0376	0.0596	0.0406	0.0626	0.0406	0.0640
800	91	91	53	53	0.0221	0.0367	0.0301	0.0484	0.0328	0.0504	0.0328	0.0517
1000	91	91	53	53	0.0176	0.0291	0.0241	0.0405	0.0272	0.0417	0.0273	0.0427
1200	-	-	-	-	0.0151	0.0247	-	-	-	-	0.0239	0.0366
1400	-	-	-	-	0.0129	0.0212	-	-	-	-	0.0211	0.0327
1600	-	-	-	-	0.0113	0.0186	-	-	-	-	0.0194	0.0305

* Shape of Conductor shall be Circular (from 1.0 sq mm upto 10 sq. mm)
* Shape of Conductor shall be Circular/Sector (from 16 sq. mm upto 1000 sq. mm)
* Shape of Conductor may be Circular/Milliken (from 1000 sq. mm and above)

SHORT CIRCUIT CURRENT RATINGS FOR XLPE/PVC CABLES

Short Circuit Rating for 1 second duration for XLPE & PVC Insulated Cables with Copper and Aluminium Conductor (Isc Current in kAmps)

Nominal Size of Conductor	XLPE Insulated (90°C)		PVC-A Insulated (70°C)		PVC-C Insulated (85°C)	
Sq.mm	COPPER	ALUMINIUM	COPPER	ALUMINIUM	COPPER	ALUMINIUM
1.0	0.143	-	0.115	-	0.104	-
1.5	0.215	-	0.173	-	0.156	-
2.5	0.358	-	0.288	-	0.260	-
4	0.572	0.376	0.460	0.304	0.416	0.276
6	0.858	0.564	0.69	0.456	0.624	0.414
10	1.43	0.94	1.15	0.760	1.04	0.690
16	2.29	1.50	1.84	1.22	1.66	1.10
25	3.58	2.35	2.88	1.90	2.60	1.73
35	5.01	3.29	4.03	2.66	3.64	2.42
50	7.15	4.70	5.75	3.80	5.20	3.45
70	10.0	6.58	8.05	5.32	7.28	4.83
95	13.6	8.93	10.9	7.22	9.88	6.56
120	17.2	11.3	13.8	9.12	12.5	8.28
150	21.5	14.1	17.3	11.4	15.6	10.4
185	26.5	17.4	21.3	14.1	19.2	12.8
240	34.3	22.6	27.6	18.2	25.0	16.6
300	42.9	28.2	34.5	22.8	31.2	20.7
400	57.2	37.6	46.0	30.4	41.6	27.6
500	71.5	47.0	57.5	38.0	52.0	34.5
630	90.1	59.2	72.5	47.9	65.5	43.5
800	114.4	75.2	92.0	60.8	83.2	55.2
1000	143.0	94.0	115.0	76.0	104.0	69.0

Rating for any other duration :

1) Max. Initial Conductor Temperature during operation : XLPE 90°C, PVC-A 70°C, PVC-C 85°C

1) Max. Final Conductor Temperature during short circuit : XLPE 250°C, PVC-A 160°C, PVC-C 140°C

Formula relating short Circuit Rating with t second duration

Where, A = Area of cross section
Isc = Short circuit rating for 1 second
t = duration in seconds.
k = a constant depends on Conductor & Insulation material
k = 0.094 for Al conductor & XLPE Insulation
k = 0.143 for Cu conductor & XLPE Insulation
k = 0.076 for Al conductor & PVC-A Insulation
k = 0.115 for Cu conductor & PVC-A Insulation
k = 0.069 for Al conductor & PVC-C Insulation
k = 0.104 for Cu conductor & PVC-C Insulation

Comparative Current Rating of 650/1100 Volts multicore heavy duty PVC Insulated Cable & XLPE Insulated Cables, 3, 3.5 & 4 cores Unarmoured/Armoured PVC Sheathed cables with Aluminium Conductor.

Nominal Size of Conductor	3, 3.5 & 4 Core PVC Insulated & Sheathed cables as per IS: 1554 (P-1)				3, 3.5 & 4 Core XLPE Insulated & Sheathed cables as per IS: 7098 (P-1)		
	In Ground	In Air	Approx Voltage Drop	Approx Voltage Drop	In Ground	In Air	Approx Voltage Drop
Sq.mm	Amps	Amps	V/Amps/Km	V/Amps/Km	Amps	Amps	V/Amps/Km
16	60	51	4.0	4.0	71	70	4.26
25	76	70	2.2	2.3	96	93	2.67
35	92	86	1.8	1.8	114	114	1.96
50	110	105	1.3	1.3	136	138	1.44
70	135	130	0.96	0.94	166	175	1.02
95	165	155	0.68	0.68	197	214	0.75
120	185	180	0.55	0.55	223	249	0.56
150	210	205	0.44	0.44	251	284	0.48
185	235	240	0.37	0.37	282	329	0.40
240	275	280	0.30	0.30	327	392	0.32
300	305	315	0.26	0.25	364	452	0.29
400	335	375	0.22	0.22	409	534	0.27

Comparative Current Rating Of 650/1100 Volts Multicore Heavy Duty PVC Insulated Cable & XLPE Insulated Cables, 3, 3.5 & 4 Cores Unarmoured/Armoured PVC Sheathed Cables with Aluminium Conductor

Nominal Size of cable	3, 3.5 & 4 Core PVC Insulated & Sheathed cables as per IS: 1554 (P-1)			3, 3.5 & 4 Cure XLPE Insulated & Sheathed cables as per IS: 7098 (P-1)		
	In Ground	In Air	Approx Voltage Drop	Inground	In Air	Approx Voltage Drop
sq. mm	Amp	Amp	V/Amps/Km	Amp	Amp	V/Amps/Km
16	60	61	4.0	73	70	4.24
25	76	70	2.5	95	93	2.67
35	92	84	1.8	114	114	1.94
50	110	105	1.3	134	138	1.44
70	135	130	0.94	164	175	1.00
95	165	155	0.68	197	216	0.78
120	185	180	0.55	223	249	0.56
150	210	205	0.44	249	284	0.48
185	235	240	0.37	282	329	0.40
240	275	280	0.30	327	392	0.30
300	305	315	0.26	369	452	0.26
400	335	375	0.22	420	526	0.21

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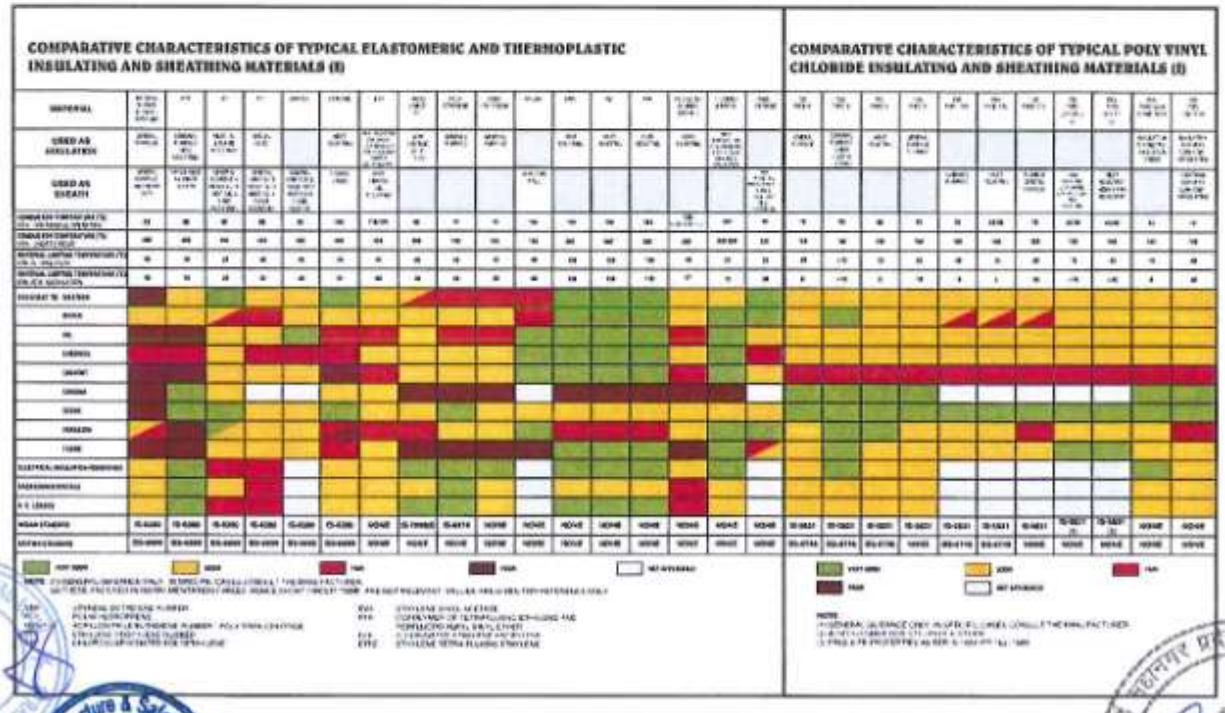
COMPARATIVE CHARACTERISTICS OF TYPICAL ELASTOMERIC AND THERMOPLASTIC INSULATING AND SHEATHING MATERIALS (I)

COMPARATIVE CHARACTERISTICS OF TYPICAL POLY VINYL CHLORIDE INSULATING AND SHEATHING MATERIALS (I)



Handling & Storage

Handling (Unloading at Site)

On receipt of the cable drum, visual inspection of the drum should be made. While unloading the drums from the lorry/trailer, a crane or suitable derrick system with chain pulley arrangement should be used and the drums carefully lifted and deposited on the ground. When lifting the drums with a crane, it is recommended that the lagging should be kept in place to prevent the flanges from crushing on to the cable. If the crane is not availabe, a ramp should be prepared with approximate inclination of 1:3 or 1:4. The cable drum should be rolled over the ramp by means of ropes and winches. Under no circumstances should the drums be dropped on the ground as the shock may cause serious damage to the inner layer of the cables. Cables should not be dragged along the earth surface.

Cable ends should always be sealed by means of suitable end sealing materials to prevent miniaturization of cores and armour Drums should be rolled in the direction of arrows marked on the drums.

Storage

The site chosen for the storage for the cable drums should be dry and covered to prevent exposure to climatic conditions and wear & tear of wooden drum. It should be preferably on a concrete / consolidated surface which will not cause the drum to sink and thus lead to flange and extremely difficult in moving the drums. The drum should be stored in such a manner as to leave sufficient space between them for air circulation. It is desirable for the drums to stand on battens placed directly under flanges. In no case shall the drums be stored flat i.e. with flanges horizontal.

Minimum Permissible Bending Radius

While installing the cables, the following minimum bending radius should be observed in order so that the cables, especially insulation, may not undergo damage. Whenever possible larger bending radius should be used.

VOLTAGE RATING	PVC & XLPE Cables	
kV	Single Core	Multicore
Upto 1.1	15D	15D
Above 1.1 to 11	15D	15D
Above 22 & 33 kV	20D	20D

Where D is outer diameter of cable

Cable Selection Guide

Materials Comparison Chart

KEI offer a wide range of materials for the purpose of insulation and sheathing. KEI is pitting their effort to design the cables by careful balancing the properties of selected materials in combination with a view to meet the specific environmental and installation conditions.

Any material does not possess universal properties which is suitable for all conditions. This will be evident from the comparison chart.

Although this chart does not provide the detailed information of all the materials and combinations of them with every pertinent characteristics, it serves as a guideline of information which a cable specialist requires to ensure most appropriate design to meet specific needs.

Please do consult our experts from the Technical Services Department of KEI Industries Limited, Cable Division.

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U28112DL2012PTC242522 / GSTIN No : 09AAGCR0665K1Z1

An ISO 9001 : 2015 Company

Data Sheet for Hot Dip Galvanized Perforated & Ladder Type Cable Tray

Manufacturer:	M/s RMG STEELS PVT.LTD		
BRAND	RMCON		
Contractor:	M/s EFKON India Pvt. Ltd.		
Project:	Mumbai Trans Harbour Link		
Hot Dip Galvanized Ladder Type Cable Tray	Tray Specification	Raw Material	Hot Rolled As Per IS:1079/10748/2062
		Tray Width	300mm
		Side Channel	75mmx25mmx2.5mm
		Standard Straight Length	2500mm
		Thickness	2.5mm
		Rung Spacing C/C	250mm
		Rung Dimension	30mmx20mmx2.5mm
		Rung Type	Slotted
		Rung Slot Size	10x20mm
		Finish	Hot Dip Galvanized as per IS:2629
		Zinc Coating Thickness	Average 65 Micron as per IS:4759
		Zinc Deposit	Average 460GSM
		Purity of Zinc	99.5% As per IS:209
	Side Coupler Plate	Raw Material	Hot Rolled As Per IS:1079/10748/2062
		Size	65x180x2.5mm (For 75mm Height)
		Thickness	2.5 mm
		Finish	Hot Dip Galvanized as per IS:2629
		Zinc Coating Thickness	Average 65 Micron as per IS:4759
		Zinc Deposit	Average 460GSM
		Purity of Zinc	99.5% As per IS:209
Hot Dip Galvanized Perforated Cable Tray	Tray Specification	Raw Material	Hot Rolled As Per IS:1079/10748/2062
		Tray Width	150,300,600,900mm
		Side Flange	50 mm (For all size)
		Thickness	2.0mm (For all Size)
		Standard Straight Length	2500mm
		Perforation Size	10x20mm
		Finish	Hot Dip Galvanized as per IS:2629
		Zinc Coating Thickness	Average 65 Micron as per IS:4759
		Zinc Deposite	Average 460GSM
		Purity of Zinc	99.5% As per IS:209
	Side Coupler Plate	Raw Material	Hot Rolled As Per IS:1079/10748/2062
		Size	45x180x2.0mm (For 50mm Height)
		Thickness	2.0mm
		Finish	Hot Dip Galvanized as per IS:2629
		Zinc Coating Thickness	Average 65 Micron as per IS:4759
		Zinc Deposite	Average 460GSM
		Purity of Zinc	99.5% As per IS:209
Recommended Standard	IS: 1852	Tolerance	
	IS: 1079/10748/2062	Hot Rolled Carbon Steel and strip (BS:1449)	
	IS: 2629	Recommended practice for Hot Dip Galvanized of Iron & Steel (BS:729)	
	IS: 2633	Method of testing, Uniformity of coating on zinc articles.	
	IS: 6745	Weight of mass of zinc coating	
	Manufacturing Tolerance	Width ± 5mm, Length ± 10 mm, Height ± 3mm, thickness ± 0.2mm	
	IS: 4759	Thickness of Hot Dip Galvanized Zinc Coating (BS:729)	

For RMG Steels Private Limited

Authorized Signatory

QC

MMRDA

RMCON

An ISO 9001 : 2015 Company

RMG Steels Pvt. Ltd.

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Data Sheet for Pre Galvanized Raceway Cable tray

Manufacturer:	M/s RMG STEELS PVT.LTD		
BRAND	RMCON		
Contractor:	M/s EFKON India Pvt. Ltd.		
Project:	Mumbai Trans Harbour Link		
Pre Galvanized Raceway	Raceway Specification	Material	GP Sheet As Per IS:277
		Raceway Width	100,150,200,300mm
		Standard Straight Length	2500mm
		Thickness (Body&cover)	1.6mm (For all Size)
		Raceway Height	40mm (For all Size)
		Finish	Pre Galvanized as per IS:277
		Zinc Coating Thickness	80-120 GSM (Average)
	Side Coupler Plate	Material	GP Sheet As Per IS:277
		Size	35x180mm(For 40mm Height)
		Thickness	1.6mm
		Finish	Pre Galvanized as per IS:277
		Zinc Deposite	80-120 GSM (Average)
Recommended Standard	IS:277	Pre Galvanized Sheet	
	Manufacturing Tolerance as per IS: 1852	Tolerance Width ± 5mm, Length ± 10 mm , Height ± 3mm , thickness ± 0.2mm	
Fabrication Methodology refer as per our QAP.			
Note: Actual manufacturing will be done as per final approved cable tray Data Sheet			

For RMG Steels Private Limited

Authorized Signatory

Technical Proposal

Proposed Construction Schedule

Technical Proposal

Proposed Project Implementation / Construction Plan

STRABAG	Proposed Project Implementation/Construction Plan	एम एम आर डी ए MMRDA

MUMBAI TRANS HARBOUR LINK PROJECT (MTHL)

IFB No.: MMRDA/ENG1/0002561:

Document No.	Document Name	Document Revision
0001	Proposed Project Implementation/Construction Plan	R00

	Prepared By	Checked By	Approved By
Name	Sandeep	Mubashshir	Anuj
Designation	Manager	DGM	GM
Date	29.11.2021	29.11.2021	29.11.2021

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Introduction:

At start of each project a Project Implementation/Construction Plan is an essential tool for a successful execution of the project. It is a guideline that how we will achieve our target and meet the standards which needs to be followed. It provides overall view of the project management system and responsibility of each individual & team. This project Management Plan consists of various activities & its sequential execution. Tentative Project Implementation/Construction Plan activities are described in below sections for this project.

1. PROJECT SCOPE SUMMARY / DELIVERABLES LIST

a. Provides a description of the project and its goals.

b. States all agreed deliverables in the vendor contract, along with the tentative start and completion dates from the first schedule baseline for the project.

2. PROJECT COMMUNICATIONS

a. Identify all Project Points of Contact.

b. Methods of communications, email, phone, face to face, etc.

c. Escalations, and escalation criteria.

d. Format and Frequency of regular team meetings.

e. Format of weekly status reports.

3. SCHEDULE MANAGEMENT

a. Project shall be executed as per Project management guidelines of Initiate, Plan, Execute, Close, Monitor-Control (this contains recurring meetings etc.).

b. All deliverables in contract shall be as per agreed schedule.

d. Milestone (a zero-length task) for each deliverable, and for each sign-off on each deliverable for tracking purposes. Schedule will be in sync with weekly project status reports.

e. Resources shall be assigned for each task for tracking and levelling purposes, and 'duration' for time estimates shall be used.

f. Projects shall be tracked with standard baseline as per the definition of Project Management.

g. The schedule is updated weekly, for issue with the weekly report, but any schedule issues must be reported immediately without waiting until the next report.

h. **Project Key dates:** Project key dates as per the tenders shall be adhered during execution stage

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Appendix-A Contract key dates and Liquidated damage/Penalty

Mile-stone No.	Milestone Requirements	Milestone Completion Date (after the Commencement Date)	Delay Damages (% of the Accepted Contract Amount/Day)
1	Completion of the Works amounting to 15% of the Accepted Contract Amount.	110 days	0.01
2	Completion of the Works amounting to 40% of the Accepted Contract Amount.	220 days	0.03
3	Completion of the Works amounting to 65% of the Accepted Contract Amount.	330 days	0.05
4	Completion of the Works amounting to 90% of the Accepted Contract Amount.	410 days	0.05
5	Final completion and Taking over	Completion period	0.05

4. COST MANAGEMENT:

a. Provides project budget at start of project, identify price for each deliverable.

b. Provides weekly planned/actual/forecast update in weekly report.

5. PROJECT SCOPE MANAGEMENT:

a. Proper change management process shall be followed if a scope change is required.

6. CHANGE MANAGEMENT:

a. If a schedule change is required then the proposed updated schedule must be submitted to **EMPLOYER**.

b. The period of performance of the contract should be written to be 7 weeks longer than the first baseline schedule, so that there is some flexibility in making schedule changes without rescheduling vendor contracts.

c. If a scope change is required that does, or does not, incur a cost to the **EMPLOYER** then the change must be discussed in advance and agreed before submitting a formal change request to **EMPLOYER**.

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7. QUALITY MANAGEMENT

a. Propose deliverable review process for use on this project and include it in the schedule. Iterative review process may be beneficial for some deliverables, if agreed with the **EMPLOYER**.

b. Propose process for agreement of acceptance criteria for each deliverable with **EMPLOYER**, at the start of the project.

8. RISK MANAGEMENT

a. Identification of all risks (scope/schedule/cost/staffing/etc.) at outset of project, together with a mitigation or avoidance strategy for each negative risk.

b. Identification of any possible opportunities ('positive risks') that may exist and how these may be exploited.

c. Continuous monitoring of risks and opportunities during course of project and report status and update of each in the weekly status meeting. Newly arising serious risks must be reported immediately.

9. STAFFING:

a. **EMPLOYER** must approve the staff to be used by the vendor at the start of the project.

b. **EMPLOYER** must be notified well in advance of any proposed vendor staffing changes, and a seamless transition to the new staff member be performed by the client.

c. **EMPLOYER** must approve the new vendor staff prior to them joining the project.

d. Liaison Inspector & Design Engineer shall be based in Mumbai (India) Project Office throughout the Construction Period.

e. Onsite Manpower shall be deployed at Mumbai (India) during the respective activities.

10. PROJECT CLOSING:

a. Assists **EMPLOYER** in finalization of all deliverable sign-offs, final invoice submissions, and any project and contract completion sign-offs.

b. Review and contribute to meet **EMPLOYER's** expectations and recording of lessons learnt for project.

(NOTE: The above-mentioned points are only Outline Project Management Plan and the detailed version will be submitted during Construction/implementation phase.)

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KEY RESPONSIBILITIES:

Details inter-alia indicating names, qualifications, professional experience and corporate affiliation of all proposed key management and engineering personnel and specialists are already submitted in our Technical bid (Please refer respective sections)

PROJECT MANAGER:

- Shall be responsible for the overall control of all deliverables and activities related to scope of the project.
- PM shall ensure that the list of client's provided documents are prepared and updated and distributed to all concerned.
- PM shall inform the client regarding discrepancy in contract documents, if any.
- PM should ensure that folders for incoming and outgoing documents as per standard guidelines are created and archived.
- PM shall ensure consistency in Quality of deliverables. PM should also ensure timely delivery of technical submittals and drawings.
- PM shall attend the Initial Engineering Coordination Meeting.
- PM shall be responsible to co-ordinate with the client for all approvals of the proposed design drawings, calculations etc.
- PM shall review Engineering Queries/Site Queries/information requests raised by CPM/Team Leader/Team Members /site coordinators and shall forward to the client using RFI template.
- After receipt of Input from stakeholders PM will prepare /arrange to prepare project plan and will submit the same to customer as per formats.
- PM shall periodically monitor the progress of the engineering activities through weekly review meeting with his team members.
- PM shall track the project progress using advance software tools.
- PM will ensure that the Hard copy of the comments received from customer is maintained with document controller.
- PM shall ensure that Quality procedures are maintained for drawings submission as detailed in Project Quality assurance plan and shall ensure that corrective action is taken for any non-conformity raised

by QAQC /MEGA as and when required.

- PM shall identify the Training needs of Team Members and Training shall be imparted to team member prior to start up and during execution of the Project
- PM shall communicate with EMPLOYER, architects, professionals, and other stakeholders in the project. PM shall also be SPOC if CPM is unavailable.

DESIGN Engineer

- Overall responsible for design and drawing activities as per specification, making coordination checks and identifying conflicts between the various design disciplines.
- Verifying that shop drawing coordination is satisfactory and in compliance with the specification and regulatory requirements.
- Carry out the required design activities and ensure that subcontractors carry out these activities relevant to the design requirements of the contract.
- Providing all inputs for producing drawings to design engineers/draftsman.
- Coordination with architect and structural engineers and other services while designing.
- Technical compliance checks for all submittal materials and documentation.
- Manage the administration and execution of all office engineering, planning and scheduling necessary to meet the requirements of the construction.
- To ensure timely and appropriate liaison with the Employer and all regulatory agencies and authorities.
- To promote an efficient exchange and distribution of information and documentation.
- Compilation and preparation of all monthly reporting information and documentation. This includes collection of status reports from all the other departments.
- Carry out technical planning and schedule activities for procurement, temporary works, and the execution of the permanent works in accordance with technical specifications and regulations.
- Responsible for the content and development of the Detailed Program of Works.
- Call and conduct job meetings and prepare and distribute meeting minutes.
- Coordinate with the Procurement Specialist and ensuring that the procured material is as per specification and design requirements.

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Resident ENGINEERS:

- Coordinate the day-to-day construction activities of the works, in accordance with the specifications and drawings, in a safe and efficient manner, to achieve the standards of performance and quality of installation stipulated, within the given time frame.
- Coordinate the program of works, shop drawings, temporary facilities, etc. very closely with subcontractors, Civil Department, and any other Interfacing department.
- Implementation and enforcement of the Health & Safety, Security, and Quality Control Programs.
- Ensure work is executed in accordance with the contract specifications, approved drawings, agreed procedures and method statements.
- Carry out technical compliance checks for all submittal drawings, materials, distribution of information and documentation on project works.
- Liaison and cooperate with all regulatory agencies and authorities with the specifications and drawings to achieve the standards of performance and quality of installation.
- Ensure that an overall construction programme is produced, updated, and adhered to and is communicated to respective section of the works as required.
- Preparation, submission and getting approval of submittals for subcontractors, method statements and other related documents.
- Ensuring that safety rules and regulations are communicated to the workforce and are thoroughly enforced.

SUPERVISORS:

- Coordinate the day-to-day construction activities of the works, in accordance with the specifications and drawings, in a safe and efficient manner, to achieve the standards of performance and quality of installation stipulated, within the given time frame.
- Ensuring work is executed in accordance with the contract specifications, approved drawings, agreed procedures and method statements.
- Controlling work force at site.
- Prepare equipment / material procurement schedule.
- General site management.
- Arrangement for the material and necessary manpower well in advance.
- Completing the necessary documentation related to the work under his direct control.

- Ensuring that safety rules and regulations are communicated to the workforce and are thoroughly enforced.

SHE/SAFETY INCHARGE:

- Safety, Welfare, and health of all workers/officers.
- Safety induction of site staff and workers.
- Regular inspection of the plants and tools to ensure that they are as per safety norms.
- Making sure that the safety procedures are fully and strictly implemented as required project safety plan and government laws.
- Inspection of scaffolds to ensure that the erection is correct.
- Inspection of lifting machines, ladders.
- Ensuring that the first aid equipment is available always.
- Coordinate with safety officer of client.
- Reporting to the project manager on the safety aspects.
- Record all accidents at site and implementing actions to prevent such actions in future.
- Prepare safety committee meetings reports.
- Attend safety meeting with client.
- Arranging programs like safety week/safety day etc.
- Motivating the workers to follow safety guidelines.
- Bring potentially dangerous and risky situations to the attention of station manager and resident engineers.

QUALITY ASSURANCE EXPERT:

- Assists in the preparation of the Quality Plan for Project.
- Assists the product managers and related stakeholders in the development of test procedures or whatever is needed to complete the preparation of Quality Control procedures.
- Ensure that the stakeholders' requirements from all products and services are well documented and are conducive to being verified and audited against the final products or services.
- Review and audit the Quality Control procedures on a regular basis to ensure that they will analysis any variance between documented requirements and the final products or services.
- Conduct additional audits or QC reviews by demand of the project manager.

- Document all reviews and audits performed.
- Provide feedback to the project manager on a regular basis or on demand.
- Recommend updates to the Quality Plan periodically to meet standards.
- Keep a noncompliance log and ensure that recorded compliance issues are resolved and corrected

PROCUREMENT EXPERT:

- Interact with suppliers on daily basis to resolve transactional issues and gather critical information invoices, tracking info, tax docs. etc.
- Responsible for appropriate supplier selection/bidding processes for selected purchase requests, and supplier and contract pricing validation for all purchase requests under category management responsibility.
- Responsible for managing projects to improve procurement processes.
- Responsible for supplier communication to resolve transactional issues
- Responsible for resolving invoice price and terms discrepancies to enable order processing.

Liaison Inspector:

- Ensures Liaising responsibilities between stakeholders.
- Responsible for coordination between different departments involved in execution of overall work on site (e.g., Civil, ATMS, TMS, Electrical, Mechanical etc.).
- Acts as contact points for all agency or organizational personnel.
- Keeps lists of the agencies or personnel representing the person, agency, or organization.
- Facilitates meetings and cooperation among people, agencies, and organizations.
- Identifies problems in communications among these groups.
- Collaborates and communicates with necessary constituents and the public.
- conducts post-mortems when an incident is wrapped up.

Link BETWEEN HEAD OFFICE & SITE

The site team in guidance of the Team Leader will be self-independent unit with a decision-making authority for major site activities to cut down extra time consumed in decision making. However, the project activities will also be closely monitored from the Head Office and Regional Office to keep an extra check on project performance as per customer satisfaction. The Team Leader will functionally and administratively report to the Regional Office. There will be a routine [illegible] meeting between the Team Leader and head office wherein

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the project progress and health will be evaluated and scope creep, if any shall be monitored and controlled immediately without impacting the project schedule and budget. All necessary steps for meeting the project schedule, quality and health will be discussed and these will be further reviewed in the subsequent meetings. There will also be site visits by Regional Office for assessing the progress on the project and meeting the project team as well as the client.

Project design, delivery of materials, installation, testing, commissioning, safety, quality, day to day activities at site and invoicing etc. shall be the responsibility of site team. Regional & Head Office responsibility will be to keep a tab on the project progress and financial health.

The Team Leader will have authority to clear most of the orders. However, all major orders shall have a final approval from Regional Office or Head Office.

WORK COMPLETION PROGRAMME MTHL

ID	Task Name
0	Work Completion Schedule
1	Receipt of LOI
2	Receipt of LOI
3	Receipt of Latest Drawings
4	Design & Engineering
5	Civil
6	Submission of Civil Design/Drawings
7	Approval of Civil Design/Drawings
8	MEP
9	Submission of HVAC Design/Drawings
10	Approval of HVAC Design/Drawings
11	Submission of Electrical & ELV Design/Drawings
12	Approval of Electrical & ELV Design/Drawings
13	Submission of Plumbing & Fire Fighting Design/Drawings
14	Approval of Plumbing & Fire Fighting Design/Drawings
15	Toll Management System
16	Submission of Toll management system Design/Drawings
17	Approval of Toll management system Design/Drawings
18	Submission & Approval of Technical submittals
19	CIVIL
20	HVAC
21	& ELV
22	& Fire Fighting
23	ment System
24	SITE MOBILISATION
25	terial to the Site
26	Civil
27	y of Civil Material
28	HVAC
29	VRF ODUs
30	VRF IDUs
31	Air Cooled Precision Air-Conditioner
32	Air Cooled Split Air-Conditioner
33	Refrigerant Piping for VRV system
34	Ventilation Fans
35	Ducting and accessories
36	Electrical & ELV
37	Point Wiring
38	Cable Tray
39	Compact Sub Station
40	Panels & Feeder Pillar
41	UPS System
42	DG Set
43	Lift System
44	Cables

Task | Project Summary | Manual Task | Start-only | Deadline
Split | Inactive Task | Duration-only | Finish-only | Progress
Milestone | Inactive Milestone | Manual Summary Rollup | External Tasks | Manual Progress
Summary | Inactive Summary | Manual Summary | External Milestone

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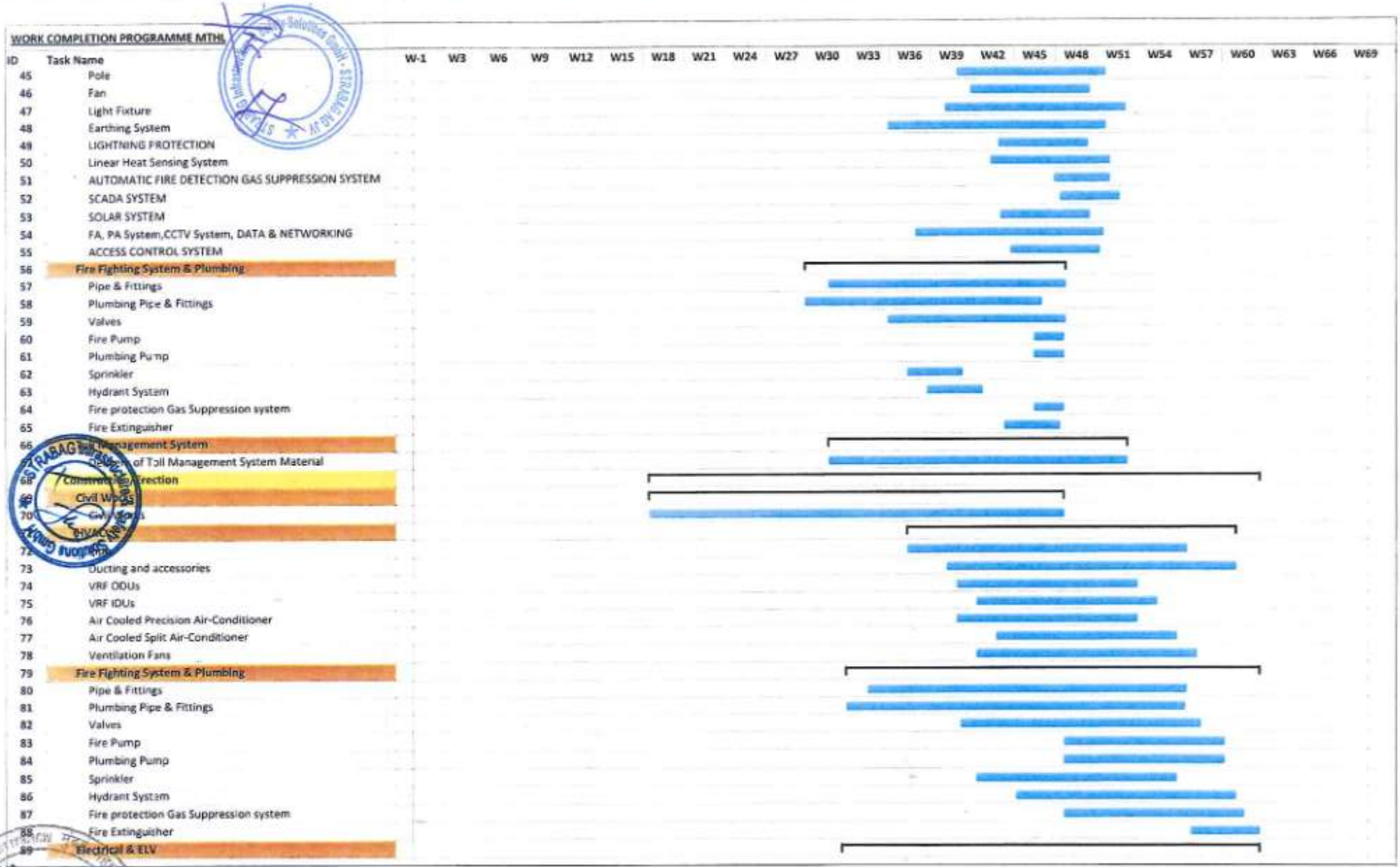
WORK COMPLETION PROGRAMME MTHL

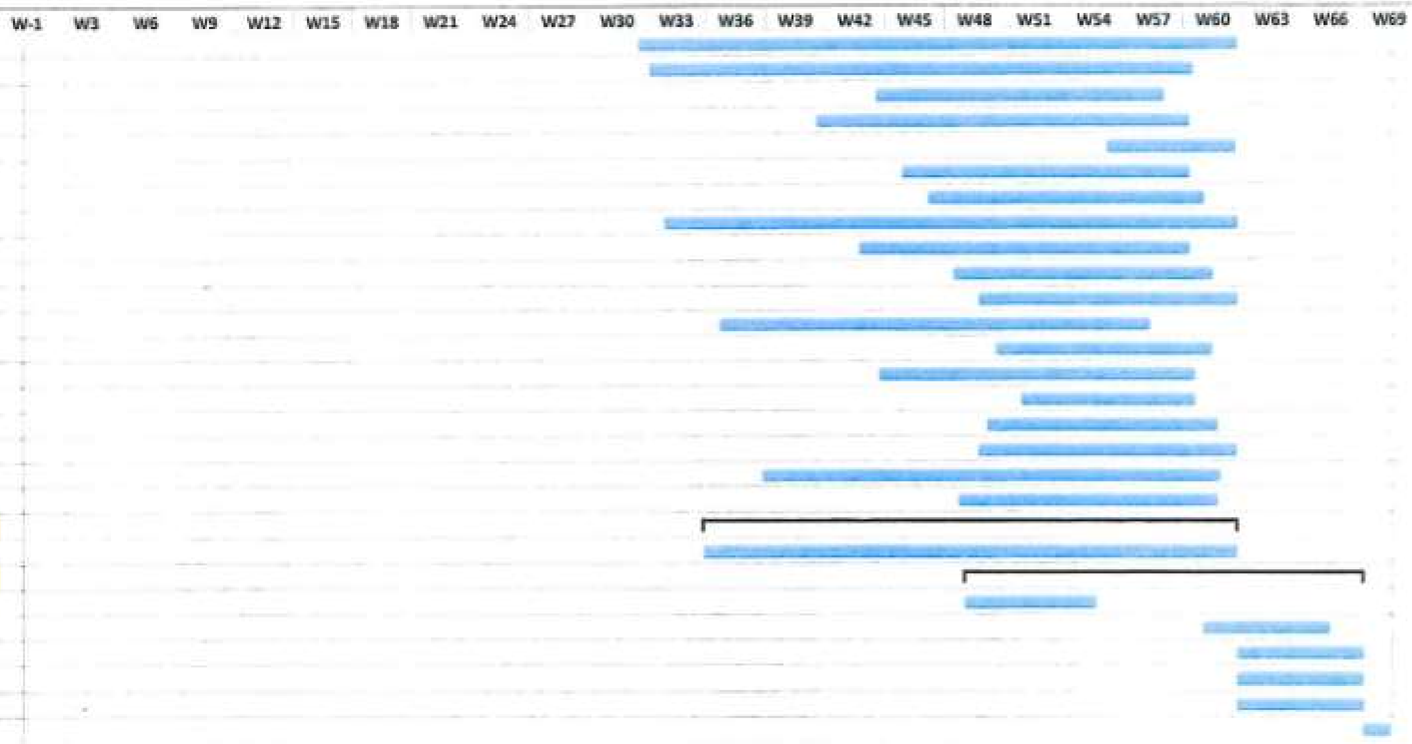
ID	Task Name
45	Pole
46	Fan
47	Light Fixture
48	Earthing System
49	LIGHTNING PROTECTION
50	Linear Heat Sensing System
51	AUTOMATIC FIRE DETECTION GAS SUPPRESSION SYSTEM
52	SCADA SYSTEM
53	SOLAR SYSTEM
54	FA, PA System,CCTV System, DATA & NETWORKING
55	ACCESS CONTROL SYSTEM
56	Fire Fighting System & Plumbing
57	Pipe & Fittings
58	Plumbing Pipe & Fittings
59	Valves
60	Fire Pump
61	Plumbing Pump
62	Sprinkler
63	Hydrant System
64	Fire protection Gas Suppression system
65	Fire Extinguisher
66	Management System
67	of Toll Management System Material
68	Construction/Erection
69	Civil Works
70	Civil Works
71	HVAC
72	
73	Ducting and accessories
74	VRF ODUs
75	VRF IDUs
76	Air Cooled Precision Air-Conditioner
77	Air Cooled Split Air-Conditioner
78	Ventilation Fans
79	Fire Fighting System & Plumbing
80	Pipe & Fittings
81	Plumbing Pipe & Fittings
82	Valves
83	Fire Pump
84	Plumbing Pump
85	Sprinkler
86	Hydrant System
87	Fire protection Gas Suppression system
88	Fire Extinguisher
89	Electrical & ELV



Task | Project Summary | Manual Task | Start-only | Deadline
Split | Inactive Task | Duration-only | Finish-only | Progress
Milestone | Inactive Milestone | Manual Summary Rollup | External Tasks | Manual Progress
Summary | Inactive Summary | Manual Summary | External Milestone

WORK COMPLETION PROGRAMME MTHL

ID	Task Name
90	Point Wiring
91	Cable Tray
92	Compact Sub Station
93	Panels & Feeder Pillar
94	UPS System
95	DG Set
96	Lift System
97	Cables & Termination
98	Pole
99	Fan
100	Light Fixture
101	Earthing System
102	LIGHTNING PROTECTION
103	Linear Heat Sensing System
104	AUTOMATIC FIRE DETECTION GAS SUPPRESSION SYSTEM
105	SCADA SYSTEM
106	SOLAR SYSTEM
107	FA, PA System,CCTV System, DATA & NETWORKING
108	ACCESS CONTROL SYSTEM
109	**Toll Management System**
110	Toll Management System Material
111	**...Testing Commissioning & Handing Over**
11[illegible]	Civil
113	HVAC
114	Electrical & ELV
115	Fire Fighting System & Plumbing
116	Toll Management System Material
117	Handing Over



Task		Project Summary		Manual Task		Start-only	[	Deadline	
Split		Inactive Task		Duration-only		Finish-only	]	Progress	
Milestone	◆	Inactive Milestone		Manual Summary Rollup		External Tasks		Manual Progress	
Summary		Inactive Summary		Manual Summary		External Milestone			

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Technical Proposal

Preliminary Bidding Design

Technical Proposal

Preliminary Bidding Design

Electrical - DBR

DESIGN BASIS REPORT (DBR) – ELECTRICAL SYSTEM

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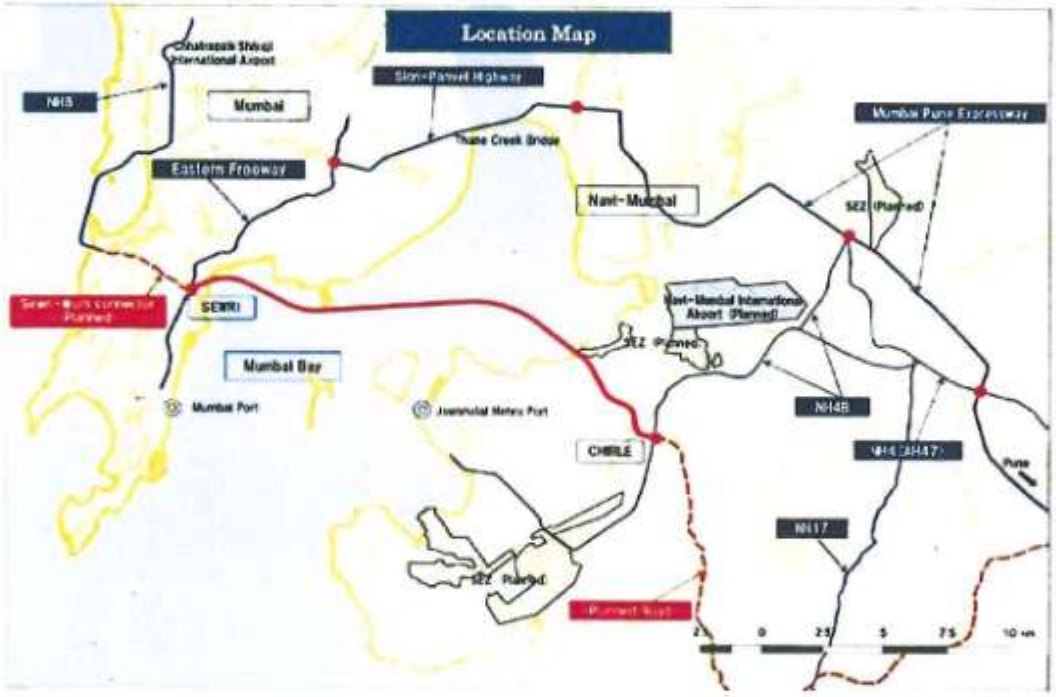
1. DESIGN BASIS FOR ELECTRICAL WORKS FOR BRIDGE

1.1. GENERAL

Outline of Mumbai Trans Harbour Link (MTHL)

Mumbai Trans Harbour Link is a 21.800 km long expressway grade road bridge traversing Mumbai Bay connecting Mumbai with Navi Mumbai. Of the total length, 18.187 km is a bridge above the bay and the rest of the section is mostly viaduct.



Source: The preparatory survey on the project for Construction of Mumbai Trans Harbour Link

There are four interchanges along the road and only Sewri IC is located on Mumbai side, while three ICs will be constructed on Navi Mumbai side.

Construction of the road is divided into three packages as shown below.

Construction Package	Length (km)	Kilo Post	Type	Interchange
1	10.380	SH 10+380	Bridge	Sewri IC
2	7.807	SH 10+380 – SH 18+187	Bridge	Shivaji Nagar IC
3	3.613	SH 18+187 – SH 21+800	Viaduct	SH 54, Chirle IC
Total	21.800			

i) **DESIGN CRITERIA**

For the design of various services, the guide lines, norms and parameters of National Building code, National electrical code and relevant BIS codes, ECBC, Environmental guidelines, CPCB guidelines and relevant local regulations shall be followed.

2. OBJECTIVE

The objective of this design report is to briefly describe the engineering services relevant to external and internal electrical services to achieve energy efficiency, with installations to ensure ease of maintenance and compliance to all statuary regulations. The services systems for the project have been conceptualized based on technical specification and acceptable design standards.

The report is based upon the architectural drawings.

i) **THE ELECTRICAL DESIGN SHALL COVER THE FOLLOWING ASPECTS:**

- Efficient & effective design of the substation.
- Electrical load calculations.
- HT Panel.
- Transformers.
- LT Power distribution.
- Power Backup by Diesel Generating sets.
- Power factor improvement.
- Safety standards for electrical system.
- Internal Lighting scheme.
- External Lighting System.
- Emergency Lighting with Inverter for common areas such as Staircase, Lift Lobbies, office, Circulation area, plant rooms, Lift M/C room, Security room etc.
- UPS for office area computer, server, Fire alarm & PA System, etc
- Earthing system.
- Lightning protection system.
- Renewable energy by solar panels.
- Elevators.
- Voice / data / television networking etc.
- CCTV / Security system.
- Fire Alarm System.
- PA System.

For the design of various services, the guide lines, norms and parameters of National Building code, National electrical code and relevant BIS codes along with the ECBC, Environmental guidelines, CPCB guidelines and relevant local regulations shall be followed.

3. SOURCE OF POWER SUPPLY

The electrical system design shall be based on receipt of bulk connection from Electrical power supply at 11kV from BEST shall be obtained from Sewri - Switching / Receiving Station, the State Electricity Board. The incoming supply voltage shall be as per state electricity regulation based on electrical demand load & availability of HT Line network before building, the contractor shall check and coordinate the entire requirement with department. Since the source is unstable due to frequent brown out / black outs, it is proposed that full DG power backup shall be provided to all the Building. The central UPS power shall be planned to support critical services such as Security systems, Building automation system, Data networks, workstation computers, printers. etc. It is proposed to provide for emergency lighting.

4. ELECTRICAL LOAD ESTIMATE FOR THE PROJECT

The electrical power requirement for the project has been estimated based on as per actual design calculation.

5. ELECTRICAL LOAD SHEET

Sr. No.	Type	Chainage	Location	Total Demand Load
1	500 KVA CSS-01 (SEWARI)	1+615		234
2	250 KVA CSS-02 (NORTH SIDE)	4+625	WEST BOUND	153
3	250 KVA CSS-04 (NORTH SIDE)	7+799	WEST BOUND	149
4	250 KVA CSS-06 (NORTH SIDE)	10+980	WEST BOUND	148
5	250 KVA CSS-08 (NORTH SIDE)	13+910	WEST BOUND	149
6	250 KVA CSS-10 (NORTH SIDE)	16+910	WEST BOUND	149
7	250 KVA CSS-12 (NORTH SIDE)	17+400	WEST BOUND	189
8	630 KVA CSS-14 (ADMIN CENTRE AT SHIVAJINAGAR)	19+550		339
9	250 KVA CSS-16 (NORTH SIDE)		WEST BOUND	179
10	250 KVA CSS-03 (SOUTH SIDE)	1+615	EAST BOUND	143
11	250 KVA CSS-05 (SOUTH SIDE)	4+625	EAST BOUND	149
12	250 KVA CSS-07 (SOUTH SIDE)	7+799	EAST BOUND	148
13	250 KVA CSS-09 (SOUTH SIDE)	10+980	EAST BOUND	149
14	250 KVA CSS-11 (SOUTH SIDE)	13+910	EAST BOUND	149
15	250 KVA CSS-13 (SOUTH SIDE)	16+910	EAST BOUND	159
16	250 KVA CSS-15 (SOUTH SIDE)	19+550	EAST BOUND	219
17	1000 KVA CSS-17 (MAIN ADMIN AND COMMOND CONTROL)	19+550		613

6. BULK POWER SUPPLY

For the above load, we have considered 11kV duel source power connection by the Electrical power supply at 11kV from BEST shall be obtained from Sewri - Switching / Receiving Station at power factor taken by 0.9.

The power shall be made available by State Electricity board and HT Metering Kiosk shall be provided at near the receiving substation the complex.

7. HT PANEL: -

11 kV, HT panel shall be part of compact substation and compact substation shall be installed near the HT Meter for electrical distribution of power.

8. HT CABLE: -

11 KV (E) Grade, 240 sq.mm Al. conductor, XLPE insulated, armoured cables laid in underground / trench at 900 mm, / cable tray shall be used from HT Panel, CSS to CSS and then to 11 / 0.433 KV Compact Substation.

9. 11KV/433V COMPACT SUBSTATION & SCADA SYSTEM : -

As per electrical load calculation, total power requirement is estimated and selection the **Compact type Substation 11 / 0.433 KV** shall be required to cater complete load of campus & Bridge. The specification of distribution transformer shall be as follows:-

- Dry type suitable for outdoor installations
- The 11 KV packaged distribution substation shall be completed with all components and accessories which are necessary or usual for their efficient performance and trouble-free operation under the

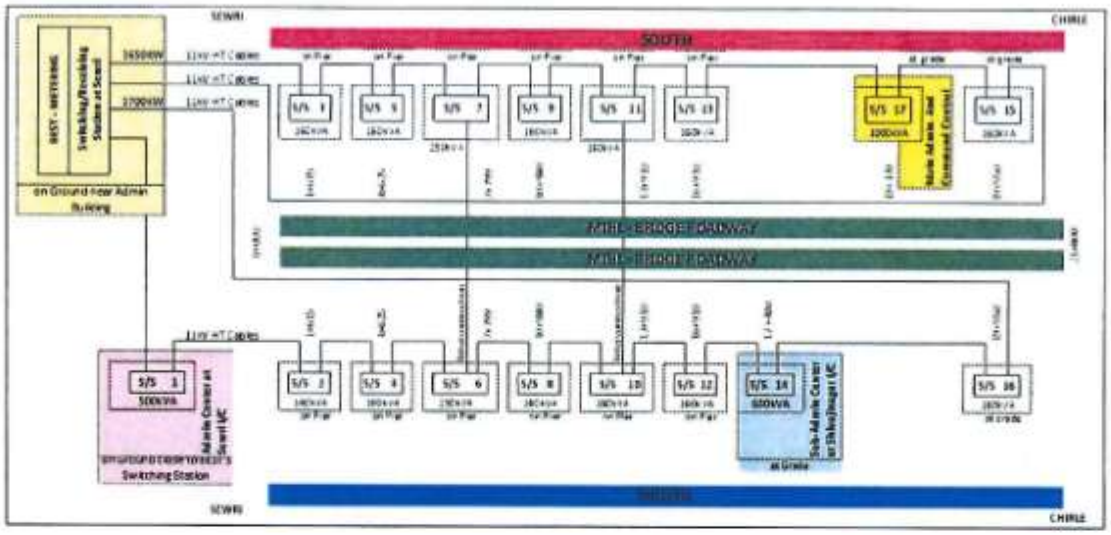
various operating and atmospheric conditions. The handling equipment's required for operation & maintenance shall be in the scope of supply.

- Package Sub-station - 11KV SF6 Insulated Ring Main Unit consisting of
- 11KV protection circuit breaker for transformer protection,
- 11/0.433 kV Dry Type Transformer
- Low Voltage Switchgear Panel including all accessories, fitting & auxiliary equipment
- 415 V, 3 Phase LT power distribution system as per details specified in this specification.
- Copper wound with Delta connection on High Voltage Side and Star at Low Voltage side with neutral terminal brought out for solid earthling.
- Vector group of Dyn-11.
- The earthing of the transformer neutral shall be carried out with copper strip.
- Voltage regulation equipment is being considered by employing off Load Tap Changer arrangement at HV side for each transformer with standard taping for variation +5% to -10% in step of 2.5 percent. (as per IS 1180 (Part-1) : 2014.
- Latest technology which shall have more efficiency with low losses. These losses shall be as per ECBC
- Both HT panel & Transformer shall be located at bridge & Ground Level.
- HV & LT switchgear protection and tripping system shall have 24 volts DC power supply through dedicated sealed maintenance free battery pack with battery charger.

FIG – COMPACT TYPE SUBSTATION (11/0.433 KV)

10. ELECTRICAL RING MAIN DISTRIBUTION FROM BEST, SEWRI

Sketch 0-1 HV Ring Schematic 11 KV Ring Main Network



11. SCADA SYSTEM FOR SUBSTATION EQUIPMENT

The SCADA system is intended for centralized monitoring and control operation of CSS equipment remotely from Sub-station (BEST) as well equally from in Command Center on the workstation and on large screen as require. This shall include automatic acquisition of energy parameters and preparation of customized reports and monitoring / control of the Circuit Breakers / Switches/ Isolator etc. The objective shall be achieved with the help of SCADA software and substation RTUs. Integration of rooftop/over ground solar through net meter,

12. ELECTRICAL DISTRIBUTION SYSTEM COMPONENTS FOR BRIDGE ARE AS LISTED BELOW

Sr. No.	Equipment	Description	Minimum Qtys
1.	HT Metering Kiosk, BEST		As per Design
2.	11kV Switchgear Panels, as per BEST' Specs.	11kV breakers Protection and Metering Panel. SCADA System for control and monitoring of Sewri Switching/Receiving Station.	As per Design
3.	11 KV HT Cables	11kV HT Cables One set each Cable Ring Mains to connect Switch Station Substations and MTHL's Substations (CSS) in Loop in Loop Out manner all along the Bridge and buildings as require as per the drawings. 2 Sets of 11 kV Cable Rings as spare with interconnection as per Drawing.	4 Sets of 11 kV Cable (Loop in Loop Out) to cover complete Bright, Building etc.

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4.	11/0.433 kV Compact Secondary Substations (Type A)	11kV RMU with configuration of 2 No,s of 11kV 630A LBS & 1 No,s of 11kV 630A SF6 Circuit Breaker with all necessary protections. Transformer- 11kV/0.433kV, Dry type Distribution Transformer of 250/500/630/1000 KVA Rating of the Specification in compliance with ECBC for minimum losses. LT Compartment/ External LT Panel – Facilitating further LT Distribution with the ACBs & MCCBs with suitable ratings as per the load's requirements like Street Lighting loads, ITS loads, Space Heating loads and Various Building Services & associated loads in MTHL Project Buildings & Structures, shall be as per Drawing.	17 Locations.
5.	Power Factor Correction Panels	Improvement of power factor to be targeted as 0.95 by using APFC panel with detuned harmonic filters.	17 Nos. as above with each Substations.
6.	Feeder Pillars	LT Sub-Distribution Panels for Various Services & associated loads for the Bridge, Toll plaza etc.	56 Locations. minimum and shall be decided during Design.
7.	LT Cables	LT Cables for Power distribution from LT Panel to various DBs of varying Loads (as per design) as required. The 3 phase 4 wire, 1.1 kV grade XLPE LT Cables between Panel and DBs shall be of aluminum. This shall include termination joints and all accessories in complete.	

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13. STANDBY POWER (DG SETS)

- DG sets for 100% standby power for Sewri Sub Admin building, Shivaji Nagar Admin Building, Gavhan Main Admin Building, Sewari, Best Switching Building & Food Plaza Building have been provided.
- Essential electrical load works out for Sewri Sub admin Building to be **293 KVA** and hence (Refer DG Sizing Calculations) 1 **Nos. 500 KVA** sets, Switching Best Substation Building to be **293 KVA** and hence (Refer DG Sizing Calculations) **1 Nos. 500 KVA** sets, Shivaji Nagar Admin Building to be **424 KVA** and hence (Refer DG Sizing Calculations) 1 **Nos. 630 KVA** sets, Gavan Main Admin Building to be **767 KVA** and hence (Refer DG Sizing Calculations) 1 **Nos. 1010 KVA** sets & Each Food Plaza Building to be **149 KVA** and hence (Refer DG Sizing Calculations) 1 **Nos. 160 KVA** sets .
- Radiator cooled type DG sets shall be provided as the DG sets are proposed to be placed at ground level.
- Each DG Set shall be provided with 990 liters diesel storage day oil tank.
- All D G Sets will be with canopy and CPCB certified for noise and emission
- PLC shall be used for Synchronizing and load management and sequential interlocking of Transformer Incomer, DG incomer and Bus Couplers.
- Stack height for the flue pipe from the DG sets shall be as per CPCB norms. The DG Exhaust gas shall be discharged outdoors by taking the exhaust pipe above the nearest highest Height
- The noise level from DG sets will not exceed 75 dB(A) at 1 m distance, or as per CPCB norms.
- DG Exhaust insulation shall be 75mm thick rock wool of density 96 KG/M3.

FIG - SILENT DG SET

14. LT POWER DISTRIBUTION SYSTEM

All Transformer & DG sets shall be connected to their respective LT isolator panels using Aluminium armoured cable and thereafter, Aluminium armoured cable are used for interconnection between Isolator Panel of Transformer, DG sets and Main LT panel (located at Ground Floor),
All cable shall be taken through ceiling of Girder box over the cable trays.

Further, Main L.T. Panel with AMF, Load Management, and interlocking facility is proposed to installed in L.T. Panel room to control & Distribute the Grid Power. The LV switch boards shall comply with type tested assembly as per latest IEC 61439 – 1&2. All test shall have been carried out as defined in the standard. The panel manufacturer should have ISO 9001/9002 – 2000 certification having adequate manufacturing & testing facilities. All medium voltage switchboards shall be suitable for operation at three phase/three phase 4 wire, 415 volt, 50 Hz, neutral grounded system with a symmetrical short circuit level.
The Switch Boards, shall comply with the latest edition with upto date amendments of relevant Indian Standards and Indian Electricity Rules and Regulations and IEC.
Main switch board and Panel (inclining MLP and Emergency Panels) shall confirm to Form 4B and rest of Panel of Form 3b Type 2 to be used as per IEC.
Switch board shall also pass the internal arc containment test for 50KA for 0.4 sec in accordance with IEC61641 without compromising the IP level as required. Internal arc type test must have been done in various locations in the panel as stated in standard implies as on busbar compartment both vertical and horizontal feeder, functional unit compartment, cable alley compartment etc., to prove the safety requirement.
The type tested design of the switchboard shall be proven design from the main switchgear manufacturer (OEM). Tenderer shall submit type test certificated for totally type tested and verified assemblies.
The panels shall be suitable for 415V, 50Hz, 3 phase 4 wire system having fault level of 50 KA. The main LT panel shall receive incoming connections from the transformer. and DG set. The size of feeders and cable may be so, selected to have economy in overall distribution as well as to have minimum voltage drop in the system.

Further, remaining distribution panel, UPS Panel, Fire, Elevator, Ventilations, WTP, sump pumps etc shall be feed from Main LT Panel through XLPE insulated aluminium cables. The switching of incoming & outgoing circuits up to 800 amps shall be by moulded case circuit breakers (MCCB) and above 800 amps shall be by air circuit breakers (ACB). Aluminium bus bar shall be provided for all power distribution panels and for all motor control centres. Final distribution boards shall incorporate miniature circuit breakers of 10 KA minimum interrupting capacities (MCB) & residual current circuit breaker of 30 mA (RCCB).

Distribution boards shall be located in accessible positions to suit the area of each floor within the building. Sub Distribution Boards (SDB's) shall be located on area basis including metering system. Final Distribution Boards shall be fed from these MDB's & SDB's by means of either PVC insulated aluminium armoured cables or PVC insulated copper wires in appropriately sized MS / PVC conduits. FRLS cables of appropriate size shall be provided for emergency systems like UPS, ventilation fans, fire fighting pumps etc.

15. POWER FACTOR CORRECTION PANEL

Automatic power factor compensating multiple capacitor units shall be provided for maintaining of average power factor between 0.95 to unity to have effective savings in energy cost.

As per the condition of Electricity Board, consumers are advised to improve and maintain the power factor of their installation to minimum 0.9 or above because of various advantages. Improvement in the power factor would affect savings in the energy bill. Also the life of individual apparatus can be increased considerably by high power factor. For the improvement of power factor, suitable size of capacitor panel banks shall be provided. Automatic power factor correction relay of reputed make shall be provided to sense the power factor of the system and switch on the capacitors depending on the system requirements. The power factor shall be maintained around 0.95 to unity through this system. Detuned filters for reducing harmonics shall also be provided to sense the power factor in the system and automatically switch ON/OFF the capacitor units to achieve the preset power factor. MV harmonic filters shall be used with harmonic-filter-duty power capacitors to mitigate harmonics, improve power factor and avoid electrical resonance in MV electrical network.

CAPACITOR BANK

16. ELECTRICAL FEEDER PILLARS LOCATIONS:

List below showing numbers of Feeder Pillars and Substation location / Chainages etc. for Bridges & Toll Plazas are as Listed Below:

Sr, No,	Feeder Pillars		Location / Chainage**	Sr. No	Feeder Pillars		Location / Chainage**
1	FP	1.1	Sewri- near Sewri I/C	29	FP	9.2	11+840 (MP171 South)
2	FP	1.2	Sewri- CSS	30	FP	9.3	≈ 13+038 (MP182 South)
3	FP	1.3	Sewri- near Sewri I/C	31	FP	10.1	≈ 13+910 (MP191 North)
4	FP	1.4	Sewri- near Sewri I/C	32	FP	10.2	14+810 (MP206 North)
5	FP	2.1	≈ 0+715 (MP5 North)	33	FP	10.3	≈ 16+010(MP226 North)
6	FP	2.2	1+615 (MP20 North)	34	FP	11.1	≈ 13+910 (MP191 South)
7	FP	2.3	≈ 2+455 (MP34 North)	35	FP	11.2	14+810 (MP206 South)
8	FP	3.1	≈ 0+715 (MP5 South)	36	FP	11.3	≈ 16+010(MP226 South)
9	FP	3.2	1+615 (MP20 South)	37	FP	12.1	≈ 16+910 (MP240 North)
10	FP	3.3	≈ 2+455 (MP34 South)	38	FP	12.2	17+902 (MP261 North)
11	FP	4.1	≈ 3+715 (MP53 North)	39	FP	13.1	≈ 16+910 (MP240 South)
12	FP	4.2	4+625 (MP69 North)	40	FP	13.2	17+902 (MP261 South)
13	FP	4.3	≈ 5+308 (MP[illegible] South)	[illegible]	FP	14.1	17 +400, I/C (North)
14	FP	5.1	≈ 3+715 (MP[illegible] South)	[illegible]	FP	14.2	17 +400, I/C (North)
15	FP	5.2	4+625 (MP 69 South)	43	FP	14.3	17 +400, I/C (North)

16	FP	5.3	≈ 5+308 (MP75 South)	44	FP	14.4	17 +400, I/C (North)
17	FP	6.1	≈ 6+539(MP89 North)	45	FP	14.5	17 +400, I/C (North)
18	FP	6.2	7+799 (MP110 North)	46	FP	14.6	17 +400, I/C (North)
19	FP	6.3	≈ 8+620 (MP124 North)	47	FP	14.7	17 +400, I/C (North)
20	FP	6.4	≈ 9+600 (MP135 North)	48	FP	15.1	≈ 18+500 (South)
21	FP	7.1	≈ 6+539(MP89 South)	49	FP	15.2	19+550 (South) Gavan S/S
22	FP	7.2	7+799 (MP110 South)	50	FP	15.3	≈20+500(South)
23	FP	7.3	≈ 8+620 (MP124 South)	51	FP	15.4	≈21+500(South)
24	FP	7.4	≈ 9+600 (MP135 South)	52	FP	16.1	≈ 18+500 (North)
25	FP	8.1	≈ 10+980 (MP156 North)	53	FP	16.2	19+550 (North) Gavan S/S
26	FP	8.2	11+840 (MP171 North)	54	FP	16.3	≈20+500(North)
27	FP	8.3	≈ 13+038(MP182 North)	55	FP	16.4	≈21+500(North)
28	FP	9.1	≈ 10+980 (MP156 South)	56	FP	17.1	≈19+370 (South)Chirle I/C

17. UPS POWER SUPPLY

The UPS power shall be planned to support critical services such as Security systems, Building automation system, Data networks, workstation computers, printers etc. It is proposed to provide centralized modular UPS to support critical services. The UPS shall be with IGBT technology, Low harmonic distortion (THD<3%) & High input and output power factor, hence separate filters are not considered. The UPS proposed are modular type, hence N+1 parallel redundancy configuration with a minimum back-up time of 30 min is considered. The UPS and battery back-up for the Project Buildings shall be housed in AC environment for better battery life
Life safety, security and communication systems all along the MTHL roadway including monitoring / Control of equipment of Substation Platform.

Life safety items, Security & Communication systems, IT & ITS Server including Traffic control system for Service Buildings and Control Centre.

The UPS for ITSs Systems, , IT & ITS Server Loads Traffic Management Systems shall be in the UPS Rooms in the respective MTHL Project Buildings.

18. LIGHT & POWER WIRING SYSTEM

The wiring in all the areas of the Building shall be provided with FRLS insulated flexible Copper Wiring in recessed / surface PVC / MS conduits. The wiring installations shall conform to IS-732:1963. The wiring for lights shall be with FRLS insulated flexible Copper Conductor wires of 1.5 sq. mm size and power wiring shall be carried out with 2.5 /4.0 /6.0 sq. mm FRLS flexible Copper Conductor wires. Color Codes shall be maintained for the entire wiring installations, i.e. Red, Yellow and Blue for the phases, Black for the neutral and Green for earth.

All electrical wires shall run through one side of the corridor ceiling and communication / data wiring shall run through other side of the ceiling to keep distance between electrical and low current cables. Minimum distance between LV/LT cables would be kept as per stipulated norms in case electrical & data cables are running parallel to each other.

19. SYSTEM EARTHING

Earthing system shall be designed in accordance with IS: 3043 / BS 7430 for earthing system. Dedicated earthing pits shall be provided for neutral earthing of major substation equipment like Transformer, DG sets. Interconnected Earthing pits shall be provided for body earthing of major substation equipment like HT Panel, Transformers, DG sets, MV panel etc. Distribution earthing shall be carried all along the MV distribution system, and effectively bonding the equipment.

Earthing for light and power points shall be carried out with insulated copper earth wire running throughout the length of the circuit and shall be terminated at equipment, fixtures, etc with effective bonding to main earthing grid.

Sr No.	Earth Pits	Purpose	Requirement	Method
1.	Substation Earthing (Body)	Equipment Body Earthing	At every 3KM Substation platform has piles which are provided with Steel Liners for Bridge.	2Nos. for Body Earthing and earth connection using 1cx 240Sqmm Cu, class-2, HR PVC insulated cable bonded to pile steel liner and welded to liner by using another steel plate in marine area as well on the land portion for approval of CEIG from the Bridge.
2.	Substation Earthing Neutral	Neutral Earthing Transformer /Compact substation	At every 3KM Substation platform has piles which are provided with Steel Liners for Bridge	2Nos. for Transformer Neutral Earthing and earth connection using 1cx 240Sqmm Cu, class-2, HR PVC insulated cable bonded to pile steel liner and welded to liner by using another steel plate in marine area as well on the land portion for approval of CEIG from the Bridge.
3.	Substation Lighting Protection	Lighting Protection	At every 3KM Substation platform has piles which are provided with Steel Liners for Bridge	1 No. Earthing and Earth connection for lightening protection using 1Cx 240Sqmm Cu, class-2, HR PVC insulated cable bonded to pile steel liner and welded to liner by using another steel plate in marine area as well on the land portion of bridge (Superstructure) as require for Substation Earthing.
4.	Equipment Body earthing across the Bridge	Body earthing	At every 150Mtrs for Bridge aligned Equipment like, Poles, structural framework, Metallic framework, Feeder pillars, panels etc.,	1 No. Earth connection for lightening protection using 1Cx 300Sqmm Cu, class-2, HR PVC insulated cable bonded to pile steel liner and welded to liner by using another steel plate in marine area of bridge (Superstructure) as require for Earthing. Measures to avoid close contact with saline water to be ensured and shall be provided with test link at appropriate location for earth resistance testing.

5	Equipotential Earthing & Bonding All along the Road/Bridge	Equipotential Earthing	Continuous GI Earth strip of 32mmx6mm or equivalent conductor section shall be provided on Road Bridge across the entire length ofthe Project.	The Insulated cable shall be connected to this GI Strip which will run across the Bridge Length connecting all the ITS Equipment & Lighting Pole, Metal structure, Cable Trays, Panels etc. for proper body earthing.

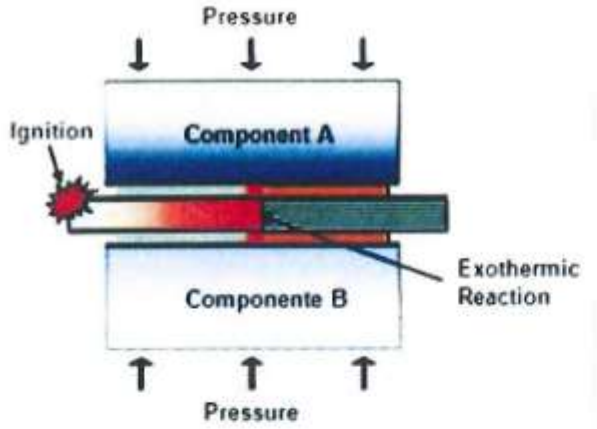
All the Cable Trays shall be provided with suitable size of 2 Nos. G.I. strip in full length. Separate Earthing shall be provided for medical equipment / Computers / UPS Network and entire earthing shall be insulated with PVC sleeve

TYPICAL EARTING CONNECTION

Separate and distinct earth stations with insulated electrode shall be provided for the following:

- HT panel
- LT Panel
- Neutral & Body of transformers
- Neutral & Body of DG Sets
- Neutral & Body of UPS
- Elevator

All earth pits shall be based on chemical earthing to keep resistance for clean earth and for electrical system earth below ***one ohm***. Chemical earthing has been considered, because, it is maintenance free earthing and provides clean earth and low resistivity values. All the earthing stations shall be connected to each other to make a common earthing electrode grid. *It is recommended to use* ***Exothermic welding*** *to enhanced life and strength of the joints in earthing system.*



EXOTHERMIC BONDING

20. RECOMMENDED ILLUMINATION LEVELS IN VARIOUS AREA OF BUILDING & TOLL PLAZA

The general lighting of various spaces shall be planned to provide the following illumination levels:

Area/ Room	Average Lux Level	Area/ Room	Average Lux Level
Toll Booth Cabin	300	HTMS Control Room	300
Toll Collection Bay & Canopy	200	Toll Control Room (Manager + Staff W/S Room)	300
Cash Tunnel	200	HTMS Control Room	300
Toilets	200	VMSS Room	300
Showers	200	Emergency Call Box	300
Stilt Parking/ Covered Parking/ Secured Parking	150	CCTV Room	300
Ticket Cabin	300	HTMS Room	300
Kitchen/ Pantry	300	ATCC Room	300
Cashier	300	Audit Room	300
Staircase/ Corridors/ Lift Lobbies	150	Network Equipment Room	300
OPD Area & First Aid	300	CITY ITS UPS Room	300
Nursing Staff Room	300	Meteorological OBS Room	300
Server Room	300	Stores	200
UPS Room	200	Documents Room	300
Generator Room/Mechanical Room/Electrical Room/ MV Switchgear Room/ Metering Room	200	Staff Workstation Room	300
Staff Rooms/ Offices/ Manager Cabins	300	Rest Room	200
Reception/Pre-Conference	300	Sales Room	300
Conference Rooms	300	Staff Room	300
Control Room	300	Terrace - Open/ Covered	150
ITS Control Room	300	Ramp	150

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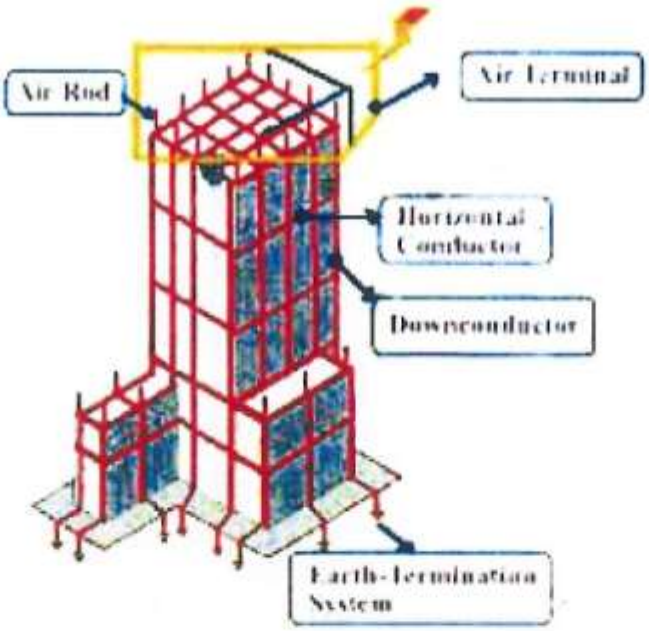
21. EMERGENCY LIGHTING SYSTEM

Emergency lights through centralized Inverter system with 90 minute battery backup (As per NBC) shall be provided for 50% of the Stairways and 10% of circulation space, corridor, lift lobby, indoor car parking, plant room and all the aviation lamps shall be provided. Self illuminated Exit Signs shall be provided on all entry and exit locations. Following are the minimum requirements associated with emergency lighting inverters.
1-BEST Switching Station,
2-Sub-command Center Sewri,
3-Command Centre Shivaji Nagar,
4-Main Command Centre Gavan, and
5-Porta Cabin,
6-Toll Plaza and Tunnel.

22. LIGHTNING PROTECTION SYSTEM

It is proposed to provide conventional lightning protection system as per IS/IEC 62305 to protect the building structure from lightning.

In this system, the building structure shall be protected from damage due lightning strikes by intercepting such strikes and safely passing their extremely high current to ground.



The system includes a networks of horizontal conductor (runs at the surface of terrace), vertical down conductor, air terminals, bonding conductors & earth electrode to provide low impedance path to ground / earth for potential strikes.

Further, levels of protection scheme, size of conductor (GI or Al), number of down conductor, air terminals and earth electrode shall be calculated as per IS / IEC 62305.

Sr No.	Earth Pits	Purpose	Requirement	Method
1	Lightening protectionof ITS Equipment & Metal	Lightening Protection	At every 150Mtrs for Bridge aligned Equipment like, Poles,structural	External Connection (1Cx 300Sqmm Cu, class-2, HR PVC insulated cable to the Steel Liner and welded and
	frameworks of the Bridge		framework, Metallic framework, Feeder pillars, panels etc.,	covered with Steel plate and welded to avoid further contact with saline water at the bonding and shall be provided with test link at appropriate location for earth resistance testing.
2	ITS Equipment, Metal structure, all metallic barriers shall be inter-connected Across the Bridge	Equipotential Bonding for Lightening Protection	Continuous GI Earth strip of 25mmx3mm shall be provided across the entire length of the Project.	The insulated cable shall be connected to this GI Strip which will run across the Bridge Length connecting all the lightening arrestors provided on top of ITS Equipment & Lighting Pole, all view barriers for proper earthing the electric charge.
3	Electrical Equipment Lightening protection	Lightening Protection	At every 3KM Substation which has piles which are decvided with Steel Liner for Bridge.	External Connection separate) by insulated 1Cx240 Sqmm Cu, class-2 ,HR PVC insulated cable to the Steel Liner and welded and covered with Steel plate and welded to avoid further contact

				with saline water at the bonding and shall be provided with test link at appropriate location for earth resistance testing.

23. CABLE SUPPORT SYSTEM

The following shall be used for carrying wires / cables from the electrical distribution boards to loads:

a. PVC conduit wherever the conduit is buried in slab at the time of casting..
b. M.S conduits wherever the conduit runs exposed in ceiling space or chased in wall.
c. GI cable trays and G.I. raceways for carrying multi conductor cables to workstations.

The fire partitions penetrations by raceways / cable trays shall be protected by approved sealing methods, maintaining the same fire resistance rating as the partition.

24. LOW VOLTAGE SYSTEM

A dedicated room and associated riser shaft for ELV Services and IDF shall be used for telephone riser cables, Data cable, Fire Detection & Alarm System, Public Address System and security cabling. The effects of electromagnetic radiation on LV System shall be considered in locating of all LV system and cable. Shielding shall be provided where necessary.

25. PUBLIC ADDRESS SYSTEM

Public address system comprising speakers, amplifier, microphone and control panel shall be provided. The speakers shall be installed in all the common areas. This system is required in order to make emergency announcements in case of fire or any other emergency. The Public Address can also be integrated with Fire Detection system.

26. FIRE DETECTION AND ALARM SYSTEM

The Intelligent addressable networkable Fire Detection and Alarm system is proposed so that in case of fire in any area it can be immediately detected and required measures can be taken to fight it.

In the Basement Services Areas, AHU Room in each floor, Electrical Rooms, combination of Smoke / Heat Detector shall be provided.

On the floors combination of Smoke & Heat detector shall be provided in all the Areas, both above false ceiling & below false ceiling areas.

Control Modules and Monitor module shall be installed for integration with Fire Fighting, Ventilation Fan, Pressurization Fan and AHU's.

Manual Call point & Hooter shall be located on the occupied side of the door to each exit stair and at intermediate locations as required (Maximum distance between pull stations shall not exceed 45 m).

The fire detection and alarm system control panel shall monitor and display the activation of each device in the system, such as heat detector, smoke detector, manual pull unit, sprinkler water flow switch and sprinkler valve tamper switch or any other input device which may be required.

The system shall be of the addressable analog multiplexed type, completely supervised, such that a break in any wire (loop) shall not prevent any device from operating, with multiplexing cabinets installed in appropriate approved locations. The system shall be of the type such that each device connected to the system shall be provided with unique address and separately identified at the Main control panel (MCP).

The material appliances equipments and devices shall be listed by UL 864/FM/EN/54.

Main Fire Alarm Control Panel

The Main control panel shall be located in the at Ground Floor of each building as approved by the Architect. The location should preferably be in an area readily accessible from the outside, for easy access for fire rescue team. The most preferred location in the main entrance lobby. The exact location shall be approved by the appropriate authorities. All Fire alarm panels in turn shall be interconnected.

Repeater Panel

A repeater panel in the form of video display unit (VDU) shall be installed in the operator's room in a location clearly visible to the operators and in an engineering or security area manned 24 hours per day. This remote unit shall repeat all alarm functions displayed at the main control panel. The silencing circuit shall be automatically reset when the fire alarm system is reset. The RCU shall provide a summary indication of any alarm condition on the system. Graphic LED display (GD) for fire shall be installed in the Operator's Room adjacent to the remote repeater panel (RRP) and in an engineering area manned 24 hours per day adjacent to the repeater panel.

Battery Backup

Standby batteries backed up from UPS shall be provided to operate the entire Life Safety System in its normal supervisory mode for a period of 48 hours followed immediately by a minimum of one-half hour in full alarm.

All wire and cable used for the Fire detection & Alarm system shall be approved for use in fire alarm systems for prolonged use during fire conditions. FRLS / Fire survival cable shall be used for fire detection and alarm system.

27. FIBER OPTIC LINEAR HEAT DETECTOR (LHD) & LINEAR HEAT SENSING CABLE (LHSC)

Objectives

The main electrical infrastructures viz. Cable Wires, Feeder Pillar and Lighting / Power Distribution

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system HT & LT etc. shall be planned to install in the Void of Box Girder. Therefore, the Box Girder shall have adequate protection in case of Fire etc. The Linear Heat Detection System shall provide such protection under such exigencies.

Technical Specification

The Linear Heat Detection System shall use Raman based OTDR technology that includes the Optical Fiber LHSC and an LHD Control Unit that houses the electronics.

The optical fiber shall be connected to the Control Unit in a single continuous loop or shall be connected on either end to a single Control Unit to ensure redundancy and full coverage of the protected fire zones even if the cable is broken / cut / damaged at one point. FRNC coated Stainless Steel wire armored fiber optic cable shall be used for coal conveyors and thermoplastic fiber optic sensor shall be used for other applications.

The sensor cables shall be tested and approved for functional integrity for 2 hours at temperatures up to 750 °C according to IEC 60331-25.

The system shall provide continuous heat detection / temperature monitoring over the entire length of 10 km. A cable break or fire / alarm condition shall be indicated / located / identified within 40 seconds and to within 1-6 meter.

The Control Unit shall provide a minimum of 1, 2, 4 (one, two, four) measurement channels. The system shall be fully programmable with respect to zone lengths and alarm thresholds. Alarm set-points may be set to fixed temperature, deviation from average and/or rate-of-rise temperature, which should further be adjustable in terms of fixed temperature, rate of time and number of iterative counts to eliminate false alarms.

The Control Unit shall have a min. 44-volt free non-latching, certified relay outputs. (1 contact is for fault signals and remaining 43 contacts are programmable zonal relay contacts).

The control unit should have 4 opto-decoupled programmable input relays to enable remote alarm to reset and other functions.

The Control Unit shall have the capability to be interfaced via an Ethernet link or USB port for interface to a PC and Modbus over Ethernet (Modbus TCP) for a site control system. The PC shall include programs / licensed software for displaying real time zone temperatures.

A real time temperature trace of the sensor cable shall be displayed on the PC and alarm messages highlighted and acknowledged, including identification of the actual position of a cable break / fire condition.

All accessories such as Control Units, fittings, fastenings, sleeves, straps, staples, clips (mountings), rings, test terminals, junction boxes, etc. which are required for interconnection with the fire annunciation system shall be provided.

The control unit should be able to operate in temperatures between -10 and +60 °C on a continual basis without loss of performance.

The system should not be able to produce a source of ignition under any circumstance (inherently safe operation) and should be internationally approved as such. (ATEX or equivalent.)

The system should be internationally approved for fire detection by UL and FM according to US standards and approved by VdS according to EN 54-22.

Safety function meets the requirement of SIL2

Typical power consumption shall be less than 20 W (room temperature / 25 °C)

Laser Source shall be based on a Laser Diode according Class 1M, as specified by EN60825-1 (2000).

The Laser output power shall be less than 20mW.

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28. EXTERNAL STREET LIGHTING :

General exterior lighting develop design in accordance to IRC using dialux software and meet 40 Lux, overall uniformity 0.4, and transvers uniformity 0.33 illumination on the surface of Road.

The Circular / Conical Smart Poles for Street Lighting Applications Installations. This includes 2x150 W LED Street Lighting fixtures. However, the provisions of mounting structure on crash barrier are being made at every 26 meters interval (indicative) to suit mounting arrangement for Light Pole.

Area and purpose	Lux Level (Minimum)	Overall Uniformity	Transvers Uniformity
Bridge Roadway – 10 m high Pole (above Road level) with 2x150 W LED Lights @26m interval), mounted on crash barrier of roadway, shall be as per design and indicative drawings.	40lux	0.4	0.33
Ramp / Interchange - 25 m high Mast Pole (above Road level) with 10x400 W LED Flood Lights Fittings as per the Lighting Design Calculations as per design and indicative drawings.	40lux	0.4	0.33
Toll Plaza - Roadway Lanes 25m High Masts with 10x400W LED Flood Light Fittings as per the Lighting Design Calculations as per design and indicative drawings.	40lux	0.4	0.33
Girder Box- 44W LED Flood Light Fittings as per the Lighting Design Calculations as per design and indicative drawings.	10lux		
Feeder provide by Aesthetic Light	As per aesthetic report generated by the Package 1,2 & 3 Contractor. Specified in this Employer Requirement.		

29. LUMINAIRE DESCRIPTION

The Luminaires shall work on single phase three wire system (phase, neutral & earth). The luminaire light output (lumen) shall be constant and shall be able to withstand allowable supply source voltage variations within 120-270V AC.

The streetlight luminaire shall be capable of withstanding voltage stress of 440V. The Luminaires shall be suitable for operation within the input supply voltage range specified. The driver of the light should be able to sense and cut-off power to the light in case of phase-to-phase/ 440 V fault. No claim in this regard shall be considered

The Luminaries shall have a sturdy and corrosion resistant high pressure Die cast Aluminium alloy housing with weatherproof gasket for lamp and control gear accessories

The housing shall be top open able powder coated, without any cracks or thorough holes, made in a single piece of die cast LM6 Aluminum alloy. The luminaries shall be totally enclosed, dust tight and waterproof.

The dimensions of luminaries shall be optimum and adequate to permit enough heat dissipation, through the body itself, to prevent abnormal temperature rise inside the lantern and consequential damage to the cover and

gasket materials, LEDs, lenses and electronic drivers. Heat sink must be thermally connected to MCPCB/ LED light source. The optical system shall consist of Poly Carbonate lenses on high power LEDs designed & tested to achieve typical street lighting distribution from the LED Luminaire. These lenses provided for individual LEDs are to be fixed on lens plate to have consistent light distribution from luminaries. Luminaries should conform to the Photometric Distribution / requirements of Cut-Off / Semi Cut – off light distribution.

Suitable number of LED lamps/array shall be used in the luminaries. The wattage of each LED should be greater than 1 watt.

The Luminaries shall be provided with distortion free, clear, high tensile, heat resistant, toughened glass of minimum 0.8mm thickness or UV resistant polycarbonate cover fixed or with Integrated optics with corrosion free/ stainless Steel screws.

30. LUMINAIRE DESCRIPTION

S..No.	Criteria	Specification for Street/ Flood LED Light
1	Luminaire configuration	Side entry type for roads (exceptions being, top for pedestrian crossing luminaire and high mast luminaire
		will have mounting brackets at rear). Shall consist of separate optical and control gear compartment. Both LED & Driver should be easily replaceable in the field condition.
2	Technical requirement	Shall consist of separate optical and control gear compartment. Inclination adjustable at 0 / 5 / 10 / 15 degrees for streetlight luminaire as per design.
3	Housing / Body of fitting Finish	Pressure Die cast housing with powder coated surface. Aesthetically designed housing with Black / Grey / Cream color/ Silver/ Red corrosion resistant polyester powder coating.
4	Cover / glass	All luminaries - Fixture cover - UV stabilized Polycarbonate. Shield in extra-clear (transitivity more than 91%) temperature glass with impact resistance IK08(EN62262). Test certificate for the material of the fixture cover should be submitted to the Employer / Employer's representative for their approval.
5	Product qualities	Energy efficient, high quality consistency, glare control, lumen maintenance. LM 80 report to be submitted to the Employer / Employer's representative for their approval for LEDs to be used in each type of Luminaire.
6	Protection – IP	Minimum IP65 protection. IP 66 is desirable. (as per IS/IEC60529-2001, to be confirmed with test certificate)
7	Impact resistance	Impact resistance should be greater than or equal to IK 08.
8	Total system wattage of Fixture including Driver	Total system power consumption should be within +/- 5% of rated wattage.
9	LED Chip efficacy	Efficacy of bare LED should be greater than 120-132 Luminous/watt.
10	LED Luminaire efficacy	The system lumen output of the Luminaire should be more than [illegible] Lumens/Watt supported with LM79 report at the time of installation. Toll power consumption should be inclusive of driver wattage loss.
		Structured LED array for optimized roadway photometric distribution with photometric lenses designed to optimize

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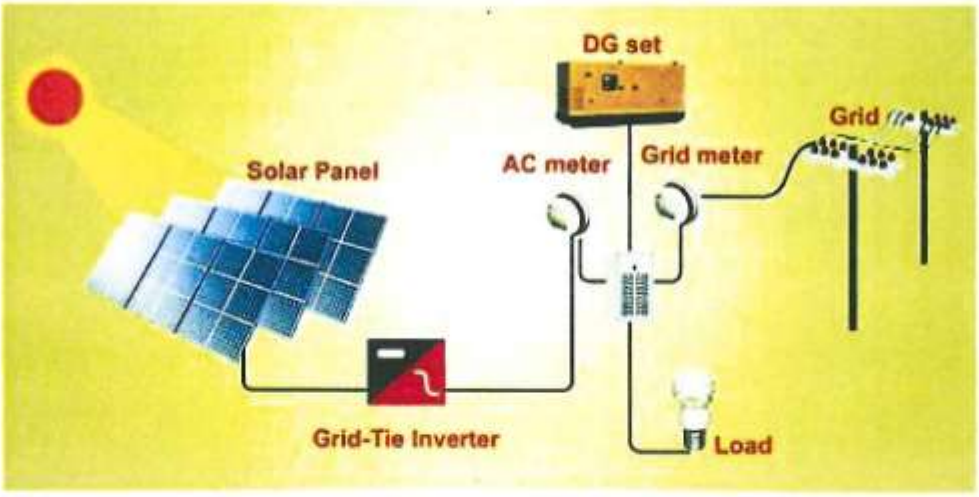
11	Optical assembly	application efficiency and minimize glare also to have optimized independent assembled LED modules for easy replacement at site. Excellent uniformity and glare reduction be ensured. Must have constant luminous flux control for exact and high energy efficient lighting throughout life.
12	Operating voltage	150-277-volt AC electronic driver.
13	Frequency	50 Hz (with 2 % variation on both sides).
14	Power factor	> 0.95.
15	Fixture Ambient Temperature	0°C to + 50°C (Must withstand Sun radiation continuous temperature of 84 degC) (Certification in this respect from an independent lab is needed).
16	Working Humidity	10% to 90% RH.
17	Driver Temperature	ta=65°C; tc=90°C.
18	Storage Temperature	Range -30°C to +80°C
19	Total Current Harmonic Distortion	< 15% (to be confirmed with test certificate)
20	Total system wattage of Fixture including Driver	Rated power consumption should be
21	Total system wattage of Fixture including Driver	For LED Street Lights 150W
		For High Masts - LED Flood Lights - 400W
		Total system power consumption should be within +/- 5% of rated wattage. Total power consumption should be inclusive of driver wattage loss.
22	Power efficiency / LED driver efficiency	The efficiency shall be more than 90 % in all the types of luminaires.
22	Calculated Lifetime	50,000 hr.
24	Correlated Colour temperature	3000K (or as applicable for marine lives)
25	CRI	The value of CRI shall be more than 70.
26	Light distribution	Optimized roadway photometric distribution
27	Make of LED Lamps	Osram /CREE /Philips/ Lumileds / Nichia / Bajaj
28	LED Drive Current	>=700 mA to <=1200 mA. 150-277 Volt AC electronic driver with
29	Driver Specification	150-277 Volt AC electronic driver with Internal surge protection of at least 10kV. Wide range of voltage to withstand the fluctuation.
30	Heat dissipation / heat sink	Heat sink must be of aluminum extrusion with proper Thermal management system.
31	Heat Proof Internal Wiring	Should be able to withstand heat up to 105°C
32	Standard Compliance	CE / BIS Conformity.
38	Driver Standards	IEC 61347-2-13, IEC 61000-3-2, CISPR 15, IEC 61547.

39	Mounting	The LED streetlight fittings should be suitable for fixing to conical /octagonal smart street lighting pole. The LED flood light fittings should be suitable for fixing to brackets on High-Masts.
40	Controlling	LED Driver power source should be controlled by Astrological timer/Photocell/ Toggle Switch located in feeder pillar through the Street/Area Lighting Management System. The luminaires will be controlled by means of CCMS panel and Remote Management, Switching, Streetlights using group control systems to be supplied.
41	Light distribution requirement	As per Deign.

31. RENEWABLE ENERGY SYSTEM

i) SOLAR POWER (RENEWABLE ENERGY)

Solar power system is a renewable energy system, converting the sunlight into electricity by using photovoltaic cells. The light is converted into electricity by the use of photovoltaic effect. The solar power is ideally suited wherever surplus shadow free space and sun light available.



Typical Solar System Schematic (ON GRID)

Considering environment mandatory requirement, generated and fed by solar system.

Hence 245 KW should feed from Solar of all building. Solar panel shall be installed at the roof of building. About 1550 sq. Meter shadow free shall be provided for the installation for the system at roof top The solar cells shall face South direction.

In the event of power failure, option to change over to power supply network shall be built into the electrical design.

ii) SOLAR MODULE

Solar Module shall be made of crystalline silicon cells connected electrically. These shall be placed between layers of protective material. This 'sandwich' shall be heat laminated to a protective glass sheet. An anodized aluminum frame shall surround this glass. Solar modules come in various power rating, which shall be measured in watts. These shall be manufactured to international standards and approved by TUV, in Accordance with IEC 61215 (2nd Edition) and other reputed Agencies / Department.

Typical Solar Module

iii) SOLAR SYSTEM

Solar Plant shall comprise of the following.

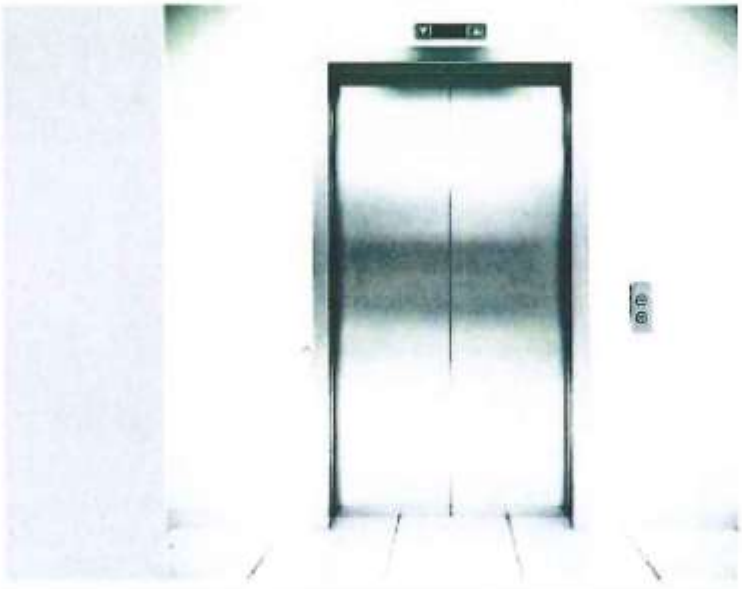
- The solar Module to convert sunlight into DC electricity.
- Using Grid Interactive Inverter (UNIT) it convert DC to AC and directly coupled with Grid Bus in Panel.
- Further, Load shall directly connected to main bus of panel.

32. ELEVATOR

Details of elevators considered for the project are as follows:

Qty.	Capacity	Speed	No. Of Floor	Lift type
5	8 Passenger	1.0 MPS	G + 4 Maximum	Passenger

Interiors of all passenger elevators shall be designed by the interior designers, however, interior of elevators shall be provided with anti-scratch stainless steel and steel chequered plate flooring, unless otherwise specified.



All elevators shall connect to normal and to emergency power supply. One elevator from each bank of elevators in each group shall be key operated to be used as fireman's lift as per NBC. All elevators shall be provided with emergency lights in each cabin supported by local dry cell rechargeable battery. Automatic self-leveling feature shall be provided to bring the elevator car level within + 3 mm of the landing floor regardless of load or direction of travel.

Car and Hoist-way Door Operation: For each elevator door, an electric door operator shall be provided to simultaneously open the car and the hoist-way door when the car is at a landing, and also close both the doors simultaneously before the car leaves landing after a predetermined time interval has lapsed.

Photo Electric Monitor: Photo electric device shall be installed on each elevator. This device will monitor traffic across the threshold of the door and shall initiate door closing two seconds after last beam interruption thus overriding door open delay.

Over Load Features: All elevators shall be provided with the load weighing feature to illuminate "Over Load" fixture and defeat car's operating circuits when car load reaches 110% or more than the rated load.

Car Position Indicator: Alpha numeric/ digital car position indicator shall be provided above each car operating panel.

Hall Buttons: At each terminal landing a single micro movement push button shall be provided, that is on the top most and the lowest floor landings; two micro movement buttons on a single plate shall be provided at each intermediate floor landing. When a hall call is registered by momentary pressure on a landing button, that button will become illuminated and will remain illuminated until the call is answered.

Lighting: Lift car manufacturer shall make all provisions for installation of lighting fixtures specified by the interior designer, including integration of emergency lighting fixture. Necessary wiring shall be included in the car traveling cable for lighting and communication system.

Architraves & Doors: Doors, threshold, door hangers and electro mechanical locks as a system shall be fire rated for not less than 1 hours.

Control: AC variable voltage and variable frequency control system shall be provided for all elevators.

CCTV – All lifts cars shall be under surveillance of CCTV.

ARD – An automatic rescue device (ARD) will drive elevator to the next available floor, open the doors and release the passengers safely in the event of any power failure.

33. SECURITY SYSTEM

Enhanced Security System shall be provided to protect the premises from intrusion and also carry out internal as well external monitoring.

The design basis for the proposed security system is based on the consideration that the area to be protected is large and there are several operational areas, Where there is a requirement to allow restricted movement of people. There are also other critical areas, which require restriction of entry and only operational people shall be granted access.

Keeping in mind the above, following security shall be envisaged.

- CCTV (Closed Circuit Television)

- Boom Barrier at Entry & Exit

34. CCTV & ACCESS CONTROL

i) CLOSED CIRCUIT TV SYSTEM (CCTV)

The requirements of security system vary as per the requirement along with its geographical location. The document gives overview of CCTV services designed for the proposed Complex.
The security system shall be proposed by the security consultant. However, for provision purpose the following is proposed by Electrical Consultant.

ii) SYSTEM OBJECTIVE

- Enable the important areas of the premises to be remotely monitored.
- The enable automatic recording by network video recorder on hard disk and to play back the recorded events on selected monitors & back- ups of the Events on Hard Disk/Pen Drive.

iii) SYSTEM REQUIREMENT

The CCTV System shall be real - time, true IP - based system consisting of Day Night P/T/Z Cameras, indoor varifocal dome cameras, indoor varifocal fixed camera, outdoor varifocal Dome camera, outdoor varifocal fixed camera. It should have real time recording & data fetching feature using suitable capacity network Video recorder (NVR), switches, interfaces and monitors and all equipment necessary for functioning of the system.

Recommended Area Under Surveillance

Following spaces shall be provided with camera:

- Fire command centre & CCTV control room.
- Main security room
- Main lobby & lobby entrance of all area.
- Main building entrance (outdoor type)
- Car park ramp entrance and exit only.
- Campus Main Entry / Exit.
- Guard room.
- Lift lobby & Stair Case lobby of main entrance and on Each Floor.
- Inside all Lifts.
- Campus periphery.
- Any space required by client

All External Area Including Entry & Exit points of the Campus Shall be monitored round the clock.

Each access controlled point shall be monitored with a fixed CCTV cameras integrated with a network digital recorder, so that all access related events or alarms shall have a corresponding digital video clip associated with it. The entire solution needs to be implemented on a dedicated "Security LAN" which shall be created for this purpose.

iv) GENERAL SYSTEM CONSIDERATIONS

The security console shall be located in the security room. Ample space shall be provided to view monitors. A video wall / LED Screen will be used for viewing images & dedicated personnel will be monitoring the same.

Care shall be taken to ensure that the number of display per screen is limited so that "individuals" can be recognized when viewing the display in all areas.

For image recording following procedure shall be adopted:

- CCTV recording method shall be NVR based.
- Utilizing "Watermarking" software to insure integrity of all image recording
- Memory to maintain a record at 20 fps at 1MP resolution for 30 days minimum, unless local laws require a longer storage time.
- Administration functions for user access and system auto recovery as required.
- Real time monitoring of all images as required.
- On screen display function as a standard requirement

v) INTERFACES

Power to cameras & all associated equipment shall be supplied by the emergency generators.

vi) VIEWING METHODOLOGY

Video will be viewed by dedicated LED screen as will be required at detailed engineering stage

35. REFERENCE AND STANDARDS

a) National Building Code

b) National Electrical Code

c) Indian Electricity Rules

d) IS : 3043 : Earthing

e) IS : 732 : Electrical wiring installation

f) IS : 1225 : Installation and Maintenance of power cables up to and including 33 KV Rating

g) IS : 3661 (Part-2) : Current rating for cable

h) IS : 1944 (part 1&2) : Lighting of public thoroughfares

i) IS : 1554 (part 1) : PVC insulated heavy duty electrical cables

j) IS : 7098 (part 1&2) : XLPE insulated PVC sheathed electrical cables

k) IS : 5216 (Part-1) : Recommendations on safety procedures and practices in electrical work.

l) IS : 10028 (Part-1) : Selection, Installation and Maintenance of Transformers

m) IS : 10118 (Part-1) : Selection, Installation and Maintenance of switchgear and control gear

n) Energy Conservation Building Code (ECBC)

004448

Technical Proposal

Preliminary Bidding Design

HVAC - DBR

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DESIGN BASIS REPORT (DBR) – HVAC SYSTEM

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AIR-CONDITIONING & VENTILATION SYSYEM (HAVC SYSTEM)

1.0 INTRODUCTION-

Outline of Mumbai Trans Harbour Link (MTHL)

Mumbai Trans Harbour Link is a 21.800 km long expressway grade road bridge traversing Mumbai Bay connecting Mumbai with Navi Mumbai. Of the total length, 18.187 km is a bridge above the bay and the rest of the section is mostly viaduct.

Source: The preparatory survey on the project for Construction of Mumbai Trans Harbour Link

There are four interchanges along the road and only Sewri IC is located on Mumbai side, while three ICs will be constructed on Navi Mumbai side.

Construction of the road is divided into three packages as shown below.

Construction Package	Length(km)	Kilo Post	Type	Interchange
1	10.380	CH 0+000 – CH 10+380	Bridge	Sewri IC
2	7.807	CH 10+380 – CH 18+187	Bridge	Shivaji Nagar IC
3	3.613	CH 18+187 – CH 21+800	Viaduct	SH 54, Chirle IC
Total	21.800			

The intent of this design basis for HVAC works is to list out the design philosophy considered to provide reliable Cooling comfort to meet the Air Conditioning & ventilation requirement to ensure smooth, hassle free operation of the proposed MTHL Project (Ramps, Bridge on the Sea & Bridge on Land and Building Structures & Toll Plazas).

2.0 DESIGN CRITERIA

2.1 OUTSIDE CONDITION

Based on outdoor design data specified for Mumbai in ISHRAE the outdoor design conditions have been considered as follows:

		Summer	Monsoon
a.	Dry Bulb	97ºF (35.9ºC)	89ºF (31.4ºC)
b.	Wet Bulb	73ºF (22.7ºC)	82ºF (27.7ºC)
c.	Specific Humidity	13.0 g/Kg DA	22.1 g/kg DA

2.2 INSIDE CONDITION

NON-AIR CONDITIONING AREA-

Lift Lobby, common passage, & staircase which is not considered as air-conditioned area.

AIR CONDITIONING AREA-

All Work Stations, UPS Room, Server Room, Electrical Room, Offices, Toll & HTMS control Room, Meeting, Conference, Entrance Lobby, Lift Lobby & Documents Room are considered as air-conditioned area as per Table-1.

VENTILATION AREA-

Toilets, Store, Kitchen, Battery Room, Mechanical Room & Tunnel shall be mechanically ventilated, as per Table-2. Basement Car Parking is Mechanically Ventilated through Axial Flow Fans.

Pressurization of Lift Lobby, Lift Well & Staircase –

All Lift lobby, lift well & Staircase shall be mechanically pressurised through positive pressure 30 pa, 50 pa & 50 Pa respectively.

TABLE-1 (AIR CONDITIONING INSIDE DESIGN CONDITION)

Sr. No.	Description	Dry Bulb Temp	Relative Humidity	Occupancy (Nos/Sft per Person)	Equipment Loa (W/SFT)	Lighting Load (W/SFT)
1	Server Room	22 ± 1ºC	55%	2*	10.0**	1.2**
2	UPS Room	25 ± 1ºC	50%	1*	10.0**	1.2**
3	Offices	24 ± 1ºC	55%	100	1.5**	1.5**
4	Battery Room	25 ± 1ºC	50%	1*	1.0**	2.5**
5	Lift Lobby /Common Area	24 ± 1ºC	55%	200	0.8**	1.0**
6	Control Room	24 ± 1ºC	55%	100	5.0**	1.5 **
7	Citi UPS Room	25 ± 1ºC	50%	2*	7.0**	1.2**
8	Meeting / Conference Room	24 ± 1ºC	55%	25	1.5**	1.2 **
9	Electrical Room	24 ± 1ºC	55%	2*	5.0**	1.2 **

* Data of occupancy considered as per previous experience.

** Data of Equipment load (Heat dissipated by equipment) considered as per previous Residential projects experience.

Outdoor ventilation rate as per ASHRAE 62.1 2016 shall be considered.

TABLE-2 (MECHANICAL VENTILATION)

Space	Exhaust / purge
Toilet	6 – 10 ACPH (asper NBC).
DG Room	Air cooled DG shall have its own ventilation fans
Enclosed CarParks	6 ACPH for normal operation, accelerated to 12ACPH in case of operation.
Battery room	1cfm/sqft for H2 removal 12 ACPH for fire operation
Generator room	For gensets without acoustic enclosure: Max 5 Deg C temperature rise across room or as per OEM manufacturer's recommendation, whichever higher For air cooled gensets provide auxiliary cooling fan

Pantry (Non-cooking kitchen)	12ACPH
Kitchens (fullcooking)	As per catering consultant's directive
Change Rooms / lockers	6ACPH
STP	30ACPH, with openings equal to 50% floor space for natural ventilation
WTP	30ACPH for plantroom area
Other Plantrooms	15ACPH

TABLE-3 (EMERGENCY VENTILATION)

Space	Exhaust / purge
Lift well (for buildings over 15M in height)	50pa w.r.t ambient
Stairwell pressurization	2 Nos x 0.5 sqM openings on opposite or adjacent walls of the mumty for naturally ventilates stairwells 50pa w.r.t ambient for enclosed stairwells
Lift lobby / fire escape corridor	30pa w.r.t ambient
Enclosed Car parks	6ACPH for normal operation Additional 6ACPH for fire operation
Common Area	12 ACPH smoke exhaust for fire operation

3.0 DESIGN PARAMETERS

The design parameters for various rooms are as follows:

Heat gains in various areas attributable to the following sources:

- Solar Load
- Heat transmission through walls
- Lighting Load
- Miscellaneous rooms equipment
- Occupants
- Outside air
- Infiltration

4.0 COOLING LOAD ESTIMATION

The complete room load will be evaluated by the addition of the various load components like fresh air, lighting, equipment, occupancy and solar load. The solar load figures only in the load evaluation for each room and consists of load due to skylight and some heat transmitted from the roof in top floor.

The cooling capacity shall be calculated on the basis of sensible and latent heat SHR will be determined which further determines the ADP of cooling coil based on inside condition to be maintained.

Finally, air quantities required to condition the particular enclosed space shall be calculated on the basis of ASHRAE Standard. The Heat Load estimation shall be as per Annexure-I

Parameters	Values	Remarks
Wall	U = 0.1 Btu / hr ft2 °F (0.56 w/m2 °K)	Final values will be as confirmed by Civil team
Roof Options		
Glass Specifications	Double Glass with following details: a. Glazing U = 0.61 Btu / hr ft2 °F SHGC: 0.5660%WWR	Wall window ratio will be as confirmed by civil team based on energy efficiency targets and daylight analysis

5.0 SYSTEM DESIGN

5.1 Air Conditioning

To achieve above stated inside conditions in the A/C rooms we propose to use VRV/VRF DX system. Detail Design of VRV system of individual rooms shall be as per Annexure-II.

The air conditioning system shall consist of air cooled centralized outdoor unit comprising of multiple scroll compressors for each area. All air-conditioned spaces in the building shall be provided with required capacity indoor unit (type- hi- wall/ducted/cassette). These indoor units shall be connected to outdoor units through copper refrigerant pipe system. Compressor in the outdoor unit shall be connected to a variable frequency drive whereby refrigerant flow through copper pipe shall be varied based on the AC load. The outdoor unit shall have built-in energy efficiency features like capacity control, oil return operation controls, intelligent defrost control and compressor control etc.

General

The equipment for variable refrigerant volume/flow (VRF) system is air-cooled consisting of Outdoor units and multiple Indoor units for cooling the space in summer and monsoon. The system shall consist of suitable Outdoor units, Indoor units as required, interconnecting copper refrigerant piping, control cabling and accessories as required. In this system it is possible to connect multiple Indoor units on a single refrigerant circuit. The Indoor units on any circuit may be of different type and allow individual control.

VRV/VRF means variable refrigerant flow/volume; it is an extension of split system with more control and flexibility. It works on the principle of variable supply of refrigerant for variable load requirement to save electrical energy. In other words, it saves running cost during plant life.

All the units are provided with built-in microprocessor control panel, for automatic operation and capacity control.

The units are provided with Cordless Remote/ Corded Remote and one Centralized Intelligent Touch Remote controller able to control up to 64 Indoor units.

Other advantages of VRV/VRF system is easy to install just like normal split units but the main advantage of VRV/VRF system is that we can have single compounded outdoor unit from which we can attach number of indoor units as per our requirement hence space requirement is comparatively less for outdoor units generally located at terrace/roof.

The branching of refrigerant piping from the main line shall be carried out using either specially designed 'Tee' connectors or 'Y' joints. These joints should ensure that each branch receives the required refrigerant flow.

All pipe sizing shall be based on sizing data of the concerned manufacturer and should ensure adequate oil return back up to the compressor.
Maximum permitted piping length between outdoor and indoor unit is also comparatively more hence we don't need to get more than one location for outdoors as required in case of split systems.

Principles of operation:

Every indoor unit is provided with indoor temperature sensor which controls the electronic expansion valve on the refrigerant line. The quantum of flow of refrigerant through the indoor unit is regulated to meet the set indoor temperature requirement. Because of variation in indoor load, the requirement of refrigerant flow varies. This is achieved by modulating the compressor capacity and thus reduced power consumption at part load. The outdoor unit is equipped with multiple numbers of compressors which increases its redundancy.

Unit size: The units are available in standard modules which can be assembled. All modules have same dimensions. Units can be assembled from 6 HP to 60 HP with 2 HP increments at every higher selection.

Indoor units: There is absolute flexibility in selection of indoor units which is wall mounted, ceiling mounted, duct able units to cover a number of rooms.

Refrigerant: - R-410A/Environment Friendly Refrigerant

Limitation of installation: All manufacturers by and large have following limitations in installations of outdoor and indoor units.

Level difference between outdoor & indoor units limited to	= 50 m
Maximum Actual Piping Length	= 165 m
Total Pipe length	= 1000m

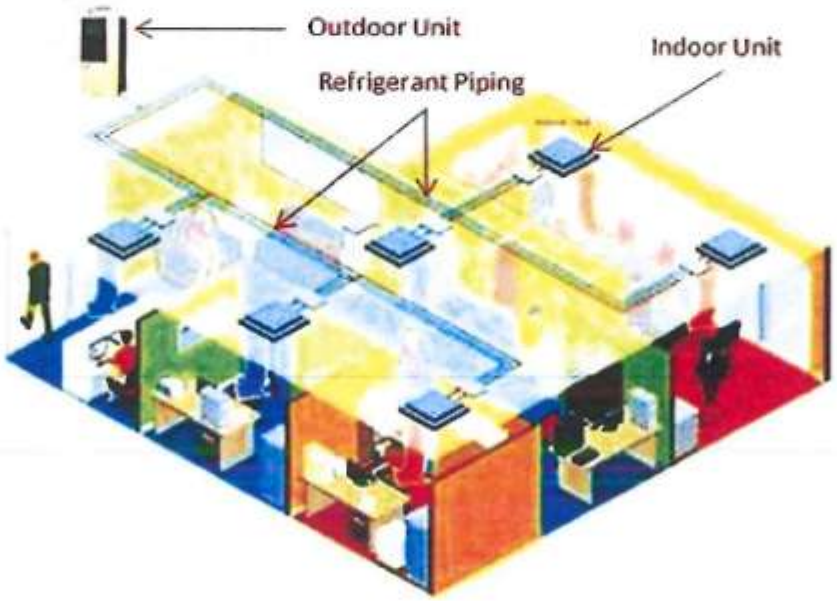
Fresh Air: - The fresh air quantity is consider as per ASHRAE standard 62.1 for the calculation purpose however Indoor units do not have facility of adding fresh air. The fresh air shall come through infiltration & door opening.

Refrigerant Line: - The outdoor and indoor units are connected with copper refrigerant pipe of different diameter for liquid and gas line. All accessories such as branching pipes, headers are supplied along with the units. The refrigerant lines can be laid both from outside or inside the rooms.

Drain pipes: - Every indoor unit is provided with drain pipe which is discharged to nearest drain point by gravity flow.

Control system: - A large number of indoor and outdoor units can be controlled centrally and can also be connected with CRC and schedule timer system. Individual wired remote controls also provided with indoor units.

VRF SYSTEM TYPICAL ARRANGMENT DIAGRAM



VRF system

The indoor units shall be similar in operation and appearance as conventional indoor units of split units and provide independent on-off control, temperature setting etc

4 WAY CASSETTE	Ductable unit	one-way cassette unit
		

The system shall provide considerable energy saving over traditional air-conditioning system (consisting of split units) due to following features: -

Individual accurate temperature control

- Multiple compressors in outdoor unit (8 HP & Above) in conjunction with inverter drive compressor to modulate refrigerant flow based on requirement.
- Minimizing heat transfer losses due to superior refrigerant piping system with ecofriendly refrigerant. Temperature setting of each indoor unit shall be controllable through individual corded micro-processor-based controller.
- The outdoor units will be mounted on Service Slab / space allocated by architect in open space available.
- The indoor and the outdoor units would be interconnected with refrigerant piping and cabling. Piping shall be duly supported with cable trays
- Each indoor unit's hall be provided with a wireless controller (for hi-wall type units) or wired wall mountable controllers for ductable units

- Refrigerant pipes from outdoor unit to wall indoor split units shall generally be routed along the perimeter of walls or beam leading to the DX wall mounted high wall split unit. These pipes shall be enclosed within bulkheads / pelmets / false beams and necessary aesthetic treatment by the Architect is required to blend with the interior if there is no false ceiling

- The Condensate drainpipes will be routed to nearest drain point. Preferably gravity drained condensate drain arrangement shall be prioritized by locating the indoor units close to drain points or by selecting ductable units for large spaces instead of hi-walls or cassette units. If the same is not possible, the indoor unit's hall include a condensate pump for pumping out the condensate

- Scope of supply shall include mounting frames and stands as required for installation

- DX Precision Type Air Conditioning system shall be proposed for critical area such SERVER room

- Systems are designed and selected keeping in mind the limited space availability for accommodating all services equipment and operational flexibility for UPS and SERVER area

- Provision of Space must be considered for the Industrial type Split Units for smaller rooms and DX PACs for larger rooms. This system will provide year-round thermal environmental for proposed area considering all the constraints.

- Indoor units selected would be in accordance to the interior requirement matching to the system performance, to achieve the desired room conditions.

- Units will be selected in 1W+1S configuration. If VRF Outdoors are connected to these units, the two indoor units in each room shall be connected to different outdoor units

- The outdoor units will be mounted on Service Slab / space allocated by architect in open space available.

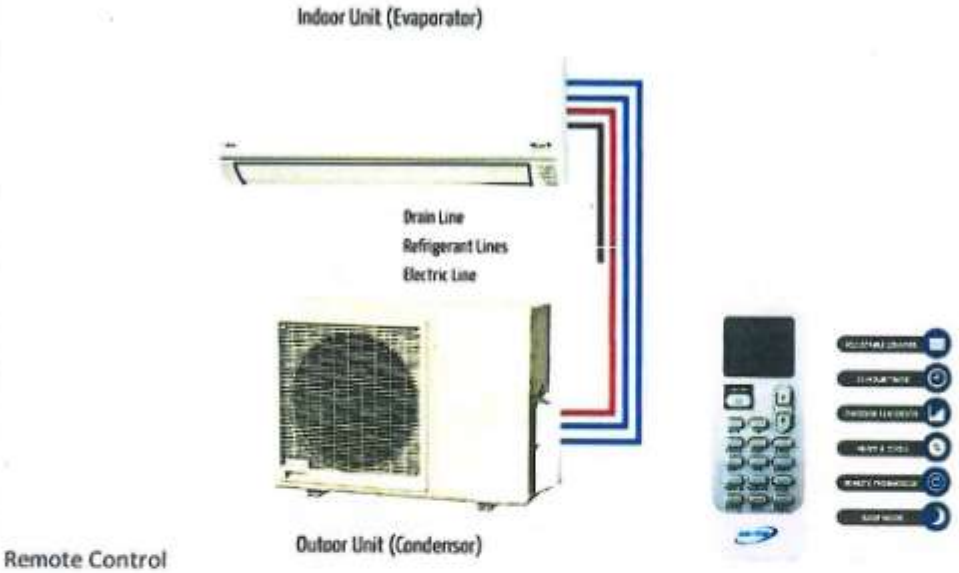
- The indoor and the outdoor units would be interconnected with refrigerant piping and cabling. Piping shall be duly supported with cable trays

- Every specific zone or room would be provided with a self-diagnostic cordless remote controller to have individual system control.

- Refrigerant pipes from outdoor unit to wall indoor split units shall generally be routed along the perimeter of walls or beam leading to the DX wall mounted high wall split unit. These pipes shall be enclosed within bulkheads / pelmets / false beams and necessary aesthetic treatment by the Architect is required to blend with the interior if there is no false ceiling.

- ❖ The Condensate drainpipes will be routed to nearest drain point.
- ❖ Scope of supply shall include mounting frames and stands as required for installation

WALL MOUNTED TYPICAL ARRANGMENT DIAGRAM



Electrical Load

- ❖ The Total Electrical Load of VRV/VRF/Split Unit system shall be as follows as per Annexure-I.

5.2 Ventilation System

Any area requires adequate ventilation arrangement in order to provide breathing to human being as well as enabling equipment's to function normally and optimally.

The purpose of this document is to design ventilation (calculating required CFM of air and exhaust fans requirement) in Car parking, DG Room & Pump Room of Basement and Toilets, store, Kitchen & servant room toilet of Flats as per Table 2 Mechanical Ventilation.

Methodology

Ventilation, Smoke & Pressurization System Descriptions:

Fresh Air for Basement Service Area shall be through Axial Flow Fan connected through Shaft at Ground Level. Exhaust Air shall be pushed through Axial Flow Fan from Shafts up to Ground Level for normal case. The normal supply air & exhaust air shall be ducted.

This System would generally provide a clean and safe pollution free Atmosphere.

There would be Axial Flow Fans of different capacities ranging for emergency Smoke Exhaust operation for all the Basements in area. These Fans would be connected to the fire detection /sprinkler system of the building and would start automatically in case of Fire in any zone.

CO sensors shall be installed to monitor air quality in the Car parking area during operational hours. CO sensors shall be connected with various Fans through in-built PLC controller and Fire alarm Panel/BMS, which synchronies the air flow as per the requirement guided by CO sensors.

To monitor Carbon Monoxide (CO) levels and control ventilation inside the basement area. The basement is divided in various zones and each zone is having various ventilation fans. The numbers of CO sensors depend upon area of zone. In normal CO levels, below the defined threshold, normal Ventilation fans will remain in stop condition. As soon as the CO levels monitored by any of these CO sensors in a zone exceed the defined threshold, PLC will give the Start command to the both normal ventilation fans of that zone. Fan Run status will be monitored by electrical panel output to ensure the correct condition and proper operation of ventilation fans.

2 Hours rating fire damper with fusible link shall be installed at inter-section of fire wall wherever required.

Lift well and Lift Lobby shall be pressurized in case of Fire through Axial Flow Fans placed at various locations shown in the drawings. These fans would be connected to the fire alarm system of the building and would start automatically in case of Fire. Also all staircases are provided with pressure relief dampers which open when pressure exceeds 50 Pa and 30 Pa respectively.

All Internal Staircase shall be mechanically pressurized as per NBC-2016. Staircase above ground shall not be mechanically pressurized which is partially open to atmosphere.

Car Park Ventilation

As defined in the National Building Code of India, car parking areas shall be treated as naturally ventilated if they meet the following criteria

0.4sqM opening per running meter on façade
No part of the parking should be more than 30M from façade
50% of perimeter (length) should be open or 75% of perimeter has 50% openings.
As per architectural design, all car parks meet this norm, hence no car parking ventilation is required

Plant Room Ventilation

Plant rooms shall be provided with mechanical ventilation. The system shall consist of tube axial or propeller fans for supply & exhaust air. Ventilation air quantity shall be considered as per latest NBC

Battery Room Ventilation

Battery rooms shall be ventilated using 2 Nos fans per room

Fan-A	Sized for 1cfm/sqft and scheduled to operate based on H2 sensor located within the room. The motor shall be spark-proof. The panel shall be provided with in-built timer to switch OFF the fan after a preset time (say 300 seconds) once triggered
Fan-B	Sized for 12ACPH as scheduled to operate of signal from fire alarm panel. This fan and motor shall be fire rated to 250 Deg C for 2 hours or as indicated in the specifications

Suitable make up arrangement shall be provided to the battery room for inlet of fresh air when fan operates

Tunnel ventilation

A tunnel is planned from the toll plaza to the main building for ferrying cash manually to the main building. The same shall be ventilated at 12ACPH. Roof extractor type ventilation fans shall be provided for ventilating the tunnel with fresh air intake at one end and exhaust at another end. Both fresh air and exhaust shall be provided with curb walls that prevent water ingress. The fans shall be fire rated as per EN12101 at 250 Deg C for 2.5 hours.

GIRDER BOX ventilation

All electrical cable tray and cable services installed inside the girder box are designed with suitable number of jet fans to ensure proper ventilation and for any heat dissipation as well as provided tenable environment for maintenance personnel inside the girder box during routine maintenance with velocity of 1 m/s inside the girder box.

Staircase / Lift Well Pressurization

All staircases above ground floor adjacent to ambient shall be naturally ventilated. with minimum opening of 0.5 sq.mt. each landing, hence, For stairwells which are enclosed inside the building, pressurization shall be provided to maintain the stairwell at 50pa with respect to ambient

Lift wells shall be provided with pressurization with pressure of 50 Pascal by supplying the air through supply air fans installed on roof top.

Lift lobbies shall be pressurized at 30pa with respect to ambient to prevent ingress of smoke during fire evacuation. Protection through pressurization shall be extended to any egress corridors connecting to the lift lobbies

Axial Fan

Cabinet Type Centrifugal fan

Generator room ventilation

Generator room ventilation shall apply to open DG sets located within building floor print

Generators shall be air-cooled (radiator cooled) type. The radiator fan itself shall provide required air flow through the room. To achieve this, the radiator and fan shall be enclosed in a plenum. When operating, the radiator fan shall draw air from within the generator room and discharge the same outside through the plenu box. The plenum will act as a cowl to prevent any hot air recirculation within the room. The radiator fan shall be designed to maintain a 5 Deg C dT across the DG room and the heat rejection of the alternator, switch gear and engine skin radiation shall be considered for the purpose. Makeup air shall be drawn in through a set of louver located on the alternator side. The room shall be acoustically insulated and both fresh air and exhaust louvers shall be provided with attenuators to reduce sound outsode DG room to 75dBA. After the DG has come off load, the DG will continue to operated at no load for a short period of time to prevent radiator water heat soak. Subsequently, an auxiliary fan shall be operated to remove residual heat inertia from the room and DG shell. The auxiliary fan shall operate till room temperature reached 5 Deg C above ambient or for 30 minutes, whichever earlier

Ventilation cash handling rooms

Due to possibility of pathogens on the surface of currency notes, cash handling rooms shall be air-conditioned separately from the rest of the spaces. Though the refrigerant side can be common, there shall be no return air taken from cash handling rooms. Also, these rooms shall be provided air equal to a dedicated exhaust of 0.5 cfm / sqft. These rooms shall be maintained at a slight negative pressure with respect to ambient

Mechanical Ventilation for Toilets & Kitchen

Wall mounted exhaust fan with back draft damper are proposed for individual toilets on external wall and Ceiling suspended exhaust fan are proposed for toilets not having walls exposed to atmosphere. louvered area at each exhaust air opening is proposed.

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For kitchen exhaust, individual fan is proposed in each kitchen. Fan will be provided with back draft damper to avoid recirculation of air back in the kitchen. louvered area at each exhaust air opening is proposed.

Rewarming pantries will be provided with a simple exhaust system with no pretreatment of exhaust air. Full cooling kitchens shall be provided with electrostatic scrubbers in the exhaust streams to remove the cooking grease from air stream before discharge to ambient

Fan Data:

Maximum fan outlet velocity for fan upto 450 mmdia.	:	9.14 m/sec (1800 fpm)
Maximum fan outlet velocity for fan above 450 mmdia.	:	12 m/sec (2400 fpm)
Maximum fan speed for fans upto 450 mm dia.	:	1440 RPM
Maximum fan speed for fans above 450 mm dia.	:	1000 RPM

5.3 Air Distribution

Air Distribution System:

All ducts shall be factory fabricated from galvanized steel sheets (Class VII) light coating of zinc, nominal 180 gm/sq.m. Surface area and Lock Forming Quality prime material along with mill test certificates, of various thicknesses ranging from 26 gauge to 18 gauge according to duct sizes and in accordance with SMACNA standards. Galvanized steel sheets shall be produced by hot dip process. Grilles/ diffusers shall be powder coated extruded aluminium construction and shall be provided as per the requirement of interior design.

- The Supply/Exhaust air from the fans shall be distributed through G.I ducts, duly insulated with fire retardant material.
- The ducts would be fabricated as per IS/SMANCA/NFPA standards, as applicable.
- The supply and Exhaust air would be distributed through extruded aluminium grilles / diffusers. The supply/Exhaust air outlets would be provided with volume control dampers to adjust the air quantity as per the requirement.
- The face velocity at louver shall be 2.5 m/s and 2 m/s for exhaust and intake respectively.

DUCT DESIGN

Maximum flow velocity in duct for air conditioning	:	9.1 m/sec (1800 fpm).
Maximum flow velocity in duct for ventilation in Plant room, toilet exhaust and kitchen exhaust	:	7.5 to 12.5 m/sec (1500-2500 fpm)
Maximum friction	:	0.65 Pa/m run Inch WG/100ft run)

Insulation:

Insulation: Insulation material for ducts & pipes shall be closed cell electrometric nitrile rubber or cross-linked polyethylene foam. Nitrile rubber pre-moulded pipe sections shall be used for branch pipes of smaller diameter only. Pipes provided with thermal insulation shall be provided with protective coating against mechanical damages. All exposed thermal insulation shall be provided with Aluminum cladding including those inside the plant room.

Sound & Vibration isolator:

Mechanical services shall generally be designed and installed with provisions to contain noise and the transmission of vibration, generated by moving plant and equipment at source to achieve acceptable noise rating for NC levels for occupied spaces. Vibration isolators shall be designed for minimum isolation efficiency of 90%. All items of rotating / reciprocating plant and equipment shall be isolated from the foundation / structure using anti-vibration materials, mountings or spring-loaded supports fixed to either concrete bases, inertia blocks or support steels as indicated.

Sound Attenuators / acoustic lining shall be installed in ducts in accordance with requirements of drawings and shall be as per specifications. Acoustic performance of the attenuators (net insertion loss) shall meet or exceed the specified values

Seismic resistance

Building services and all equipment shall be provided with seismic bracings to withstand earthquake as per seismic zone. Calculations for seismic design shall be included with the detailed submissions.

Electrical Load

- The Total Electrical Load of Ventilation system shall be as follows as per Annexure-II.

6.0 Documentation

Following documents shall be submitted along with Tender.

6.1 Drawings

- Air conditioning layout for Admin Building At Gavhan.
- Air conditioning layout for Sub Admin Building at Sewari

- ❖ Air conditioning layout for Sub Admin Building at Shivaji Nagar Interchange.
- ❖ Air conditioning layout for Porta Cabins.
- ❖ Air conditioning layout for Food Plaza.
- ❖ VRV Schematic Layout for Admin Building at Gavhan.
- ❖ Lift Lobby, Staircase & Lift Well schematic Layout of Admin Building at Gavhan
- ❖ VRV Schematic Layout for Sub- Admin Building at Sewari.
- ❖ VRV Schematic Layout for Sub- Admin Building at Shivaji Nagar Interchange.
- ❖ HVAC layout for AXIAL Flow Fan Hanging Detail.
- ❖ HVAC Duct Support layout.

6.2 Calculations

- ❖ Heat Load calculation For All Building
- ❖ Ventilation Calculation for All Building
- ❖ Pressurisation Calculation for Main Toll Plaza & Command Centre At GAVHAN

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Technical Proposal

Preliminary Bidding Design

PHE & FF -DBR

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DESIGN BASIS REPORT (DBR) – PLUMBING & FIRE FIGHTING

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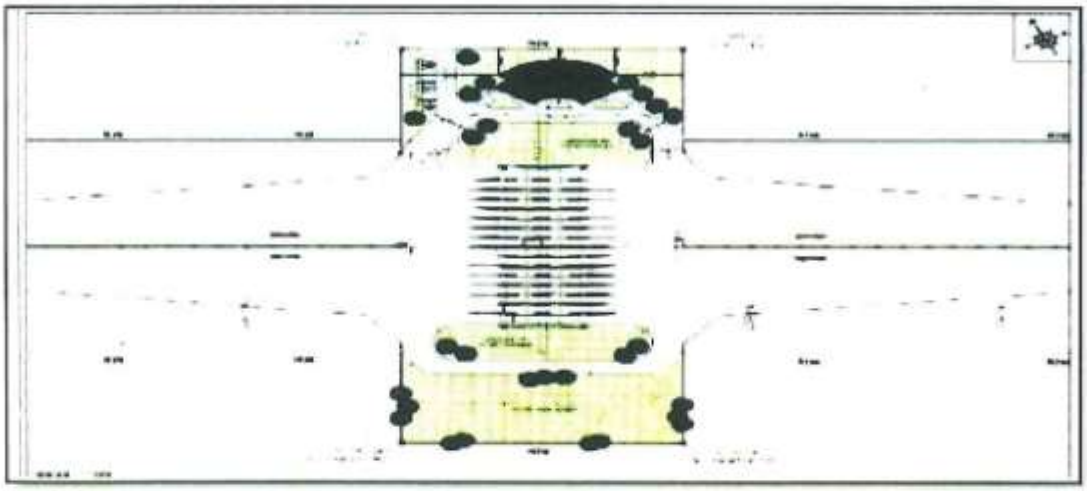
PLUMBING DRAINGE & WATER SUPPLY SERVICES

1 DESIGN AND CONSTRUCTION OF MTHL

The Outline Specifications for the design and construction of the MTHL involved in the Works.



2 INTRODUCTION

Main Building & Toll PlazaCovered in Design Report following as below: -

1. MAIN ADMIN. AND COMMAND CONTROL CENTER AT GAVHAN
2. SUB ADMINISTRATION AND COMMAND CONTROL CENTER AT SEWRI
3. ADMINISTRATION AND COMMAND CONTROL CENTER AT SHIVAJINAGAR
4. ADMINISTRATION BUILDING PORTA CABIN
5. MAIN FOOD PLAZA & HIGHWAY TOILET

Reliable and safe Domestic water supply and distribution along with quick and efficient disposal for crude soil and grey waste are essential in any development.

Report intends to highlight the design planning of the public health engineering services in the proposed development. It will briefly highlight the design parameters and fundamental principles which are proposed for the following public health services; and shall include:

a) Water supply system – Demand, Source, Storage, Treatment and Distribution

b) Sewerage system – Soil, waste and ventilation system - Collection, Conveyance

c) Water Treatment System

d) Drainage system - Collection, Conveyance and Disposal

e) Horticulture / Irrigation system

f) Septic Tank

g) Hot Water Supply

h) Sanitary fixtures and appliances

i) CP fittings and accessories

j) Storm/Rain Water collection

k) Drinking water Provision

l) Tunnel Drainage Collection and Disposal

3 ABBRIVATION

ABBREVIATION	DETAIL DESCRIPTION
NBC	National Building Code of India
SS	Stainless Steel
GI	Galvanised Iron
HDPE	High Density Polyethylene
DWS	Domestic Water Supply
HWS	Hot Water Supply
HWR	Hot Water Return
LPM	Litre Per Minute
STP	Sewage Treatment Plant
WTP	Water Treatment Plant
OHT	Over Head Tank
RO	Reverse Osmosis
MBR	Membrane Bio-Reactor
RWH	Rain Water Harvesting
LPD	Litre Per Day
PH	Potential of Hydrogen
BOD	Biochemical Oxygen Demand
COD	Chemical Oxygen Demand
TSS	Total Suspended Solids

4 CODES AND STANDARDS:

Plumbing/Sanitary systems will be designed and installed in conformance with the following codes and standards:

a) NBC 2016 Part-9: National Building Code - Plumbing Services

b) Manual on water supply and treatments published by Central Public Health and Environment Engineering Organisation under Ministry of Urban Development, Govt. of India.

c) Manual on sewerage and sewage treatment published by Central Public Health and Environment Engineering Organization under Ministry of Urban Development, Govt. of India.

d) Applicable Codes by Bureau of Indian standards

e) Uniform Plumbing Code of India -2008

f) Good Engineering Practice

5 DESIGN PRINCIPLES:

The Plumbing Services for the Administration & Command Control Center Buildings shall be Designed keeping in view the following: -

a) Requirement of Adequate Flow and Pressure of Cold Water and Hot Water (WHEREVER APPLICABLE) in Toilets, Kitchens / Pantries and other Designated Areas.

b) The Water Storage Tank Capacity shall be Adequate to Ensure Availability of Water required for Each Building.

c) Implementation of requirements of MOEF relating to Rain Water Harvesting, Water Conservation, etc.

d) Levels of Roads / Pavements & Other Services in the Area.

e) Drainage & Water Supply provision for Irrigation.

f) Water Conservation using Low Flow Fixtures.

g) Energy Conservation Measures.

6 SYSTEM REQUIREMENTS:

a) The Principal Source of Water will be Municipal / Local Authority Water Supply. However, in case the same is not available in Sufficient / Enough Quantity to fulfil the Project's Requirement, Alternate Source such as Tanker / Bore Well Water needs to be considered. In this event, Tanker / Bore Well Water to be Treated in accordance with Indian Standard for Potable Water Supply (IS: 10500) for use of Domestic & Drinking Purpose only.

b) Overhead Storage Facility for Fire, Domestic and Flushing/Irrigation Water. Sewage & Sullage Collection & Conveyance System based on NBC / Indian Standards Applicable Guidelines wherever required.

c) Storm / Rain Water Drainage from the Top Terraces of the Buildings as well as from the Roof Area of Toll Booths shall be Terminated in / Connected to External Storm Water Network; which shall also catch the Storm Water from Roads & Other Open Areas. The External Storm Water Network Shall Ultimately be Terminated in / Connected to Municipal / Local Authority Storm Drain Network.

d) Sewage Water Drainage from the Buildings shall be Terminated in / Connected to External Sewage Water Network. The External Sewage Water Network Shall Ultimately be Terminated in/ Connected to Municipal / Local Authority Sewage Drain Network/Septic Tank.

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7 WATER CALCULATION

The water requirement as per codes and standards shall be as below:

FOR MAIN ADMINISTRATION & COMMAND CONTROL CENTER BUILDING AT MAIN TOLL PLAZA, CHIRLE, NAVI MUMBAI						
WATER REQUIREMENT CHART						
Sr. No.	**Description**	**No. of Occupants**	**Water consumption per unit (LPCD)**	**Domestic Water Requirement Litres/day**	**Flushing Water Requirement Litres/day**	**Total Water Consumption Litres/day**
A	**Building**					
	Office Staff -Fixed Population	137	45	3425	2740	6165
	General other Supporting Staff(House Keeping + Security+ Maintenance)	14	45	350	280	630
	Visitor Population	14	45	70	140	630
	Total Water requirement			**3845**	**3160**	**7425**
B	Landscape / Irrigation Water Requirement	Lum sum			21000	21000
	Total Fresh Water Required			**3845**	**24160**	**28425**
	Total Fresh Water Proposed (KL)			4	24	28

FOR ADMINISTRATION BUILDING AT INTERCHANGE SHIVAJINAGAR						
WATER REQUIREMENT CHART						
Sr. No.	**Description**	**No. of Occupants**	**Water consumption per unit (LPCD)**	**Domestic Water Requirement Litres/day**	**Flushing Water Requirement Litres/day**	**Total Water Consumption Litres/day**
A	**Building**					
	Office Staff -Fixed Population	21	45	525	420	945
	General other Supporting Staff(House Keeping + Security+ Maintenance)	2	45	50	40	90
	Visitor Population	2	45	10	20	90
	Total Water requirement			**585**	**480**	**1125**
B	Landscape / Irrigation Water Requirement	Lum sum			10500	10500
	Total Fresh Water Required			**585**	**10980**	**11625**
	Total Fresh Water Proposed (KL)			2	12	14

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FOR SUB ADMINISTRATION & COMMAND CONTROL CENTER BUILDING AT SEWRI INTERCHANGE, MUMBAI						
WATER REQUIREMENT CHART						
Sr. No.	**Description**	**No. of Occupants**	**Water consumption per unit (LPCD)**	**Domestic Water Requirement Litres/day**	**Flushing Water Requirement Litres/day**	**Total Water Consumption Litres/day**
A	**Building**					
	Office Staff -Fixed Population	36	45	900	720	1620
	General other Supporting Staff(House Keeping + Security+ Maintenance)	4	45	100	80	180
	Visitor Population	4	45	20	40	180
	Total Water requirement			**1020**	**840**	**1980**
B	Landscape / Irrigation Water Requirement	Lum sum			10500	10500
	Total Fresh Water Required			**1020**	**11340**	**12480**
	Total Fresh Water Proposed (KL)			2	12	14

FOR ADMINISTRATION BUILDING AT SHIVAJINAGAR INTERCHANGE, NEAR / NEXT TO RAMP AC, AM, CA, MA, MJ & JM (APPLICABLE FOR EACH ADMINISTRATION BUILDING)						
WATER REQUIREMENT CHART						
Sr. No.	**Description**	**No. of Occupants**	**Water consumption per unit (LPCD)**	**Domestic Water Requirement Litres/day**	**Flushing Water Requirement Litres/day**	**Total Water Consumption Litres/day**
A	**Building**					
	Office Staff -Fixed Population	6	45	150	120	270
	General other Supporting Staff(House Keeping + Security+ Maintenance)	1	45	25	20	45
	Visitor Population	1	45	5	10	45
	Total Water requirement			**180**	**150**	**360**
B	Landscape / Irrigation Water Requirement	Lum sum			5250	5250
	Total Fresh Water Required			**180**	**5400**	**5610**
	Total Fresh Water Required (KL)			2	6	8

LPD: Litres per Day

LPCD: Litres Per Capita per Day

Reference Considered: -

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*1) **NBC Part-9 Table-1** - 45 litres/day is taken for staff, 20 litres/day would be used in toilet flushing and rest of 25 litres/day would be used for hand wash and drinking purpose.*
*2) **NBC Part-9 Table-1** -15 litres/day is taken for Visitors, out of which 65% i.e. 10 litres/day would be used in toilet flushing and rest of 35% i.e. 5 litres/day would be used for hand wash.*
*3) **NBC Part-9 Clause No. 4.1.5.2** -The water demand for landscaping purposes is generally taken as 6 to 8 litre/m2/day for lawns.*

8 SOURCE OF WATER

The Principal Source of Water will be Municipal / Local Authority Water Supply. However, in case the same is not available in Sufficient / Enough Quantity to fulfil the Project's Requirement, Alternate Source such as Tanker / Bore Well Water needs to be considered. In this event, Tanker / Bore Well Water to be Treated in accordance with Indian Standard for Potable Water Supply (IS: 10500) for use of Domestic & Drinking Purpose only.

9 DESIGN PARAMETERS OF WATER DISTRIBUTION SYSTEM

The design of water distribution lines to the fixtures shall be based on following load factors:

NBC-2016, Part-9, Table-2, Water Supply Fixture Units (WSFU) for Different Fixtures with Minimum Pipe Sizes

Type of Fitting	Fixture Unit Value as load factors (Units)
Water Closet with flush tank (Public)	3
Urinal (Sensor operated)	2
Shower	3
Wash Basin	1.5
Ablution faucet/Bidet	1

10 WATER SUPPLY DISTRIBUTION SYSTEM

a) The water from Municipal line has stored in underground Domestic/Flushing water storage tank.

b) The water from underground Domestic/Flushing water storage tank shall be pumped and taken into the Overhead Domestic/Flushing water tanks of Buildings. (Assuming the Municipal water are of potable quality).

c) Domestic R.O unit shall be provided in common area. Localized R.O. System shall be proposed.

d) Localized Geyser shall be proposed for Hot Water in Kitchen/Pantry Areas.

e) Water from Overhead Tanks shall be distributed to various parts such as Toilet, Kitchen / Pantry and Other Designated Areas in the Each Building by means of Gravity Feed System.

f) Water Supply Piping will be designed as per Hazen-Williams Formula based on the available Gravitational Head. Min. Pressure of 1.5 kgf/cm2 shall be provided at Every Toilet & 2 Kitchen / Pantry Connection / Fixture. Client to confirm the Residual Pressure Requirement.

g) Pressure Zones will be created by using Pressure Reducing Valves to Limit Pressure at Any Floor within 4.2 kgf/cm2 as per NBC 2016. Whenever Pressure Exceeds 4.2 kgf/cm2 and the

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Distribution System may not be able to withstand the same, Pressure Reducing Valves shall be installed for Reduction of Pressure.

11 WATER TREATMENT SYSTEM:

a) Assuming the Municipal water is of potable quality.

b) Water filtration system shall be provided to eliminate suspended matter, algae and other filterable elements that render the water unappealing.

c) For water filtration system dual media filter shall be provided.

12 WATER STORAGE

Considering minimum requirement of storage for one day (excluding for horticulture purpose), the capacity in tanks shall be as follows:

MAIN ADMIN. AND COMMAND CONTROL CENTER AT GAVHAN				
Sr. No.	**Description of Tank**	**Qty.**	**Capacity of Each Tank**	**Remark**
1.	Fire Water Tank	2 Nos.	50 m^3	
2.	Underground Domestic Water Tank	1No.	4 m^3	
3.	Underground Flushing Water Tank	1No.	24 m^3	
4.	Fire Overhead water Storage Tank	1No.	10 m^3	
5.	Domestic Overhead Water Tank	1No.	2 m^3	
6.	Flushing Overhead Water Tank	1No.	12 m^3	

SUB ADMINISTRATION AND COMMAND CONTROL CENTER AT SEWRI				
Sr. No.	**Description of Tank**	**Qty.**	**Capacity of Each Tank**	**Remark**
1.	Fire Water Tank	1No.	50 m^3	
2.	Underground Domestic Water Tank	1No.	2 m^3	
3.	Underground Flushing Water Tank	1No.	12 m^3	
4.	Fire Overhead water Storage Tank	1No.	5 m^3	
5.	Domestic Overhead Water Tank	1No.	2 m^3	
6.	Flushing Overhead Water Tank	1No.	6 m^3	

ADMINISTRATION AND COMMAND CONTROL CENTER AT SHIVAJINAGAR				
Sr. No.	**Description of Tank**	**Qty.**	**Capacity of Each Tank**	**Remark**

ADMINISTRATION AND COMMAND CONTROL CENTER AT SHIVAJINAGAR				
Sr. No.	Description of Tank	Qty.	Capacity of Each Tank	Remark
1.	Underground Domestic Water Tank	1No.	2 m^3	
2.	Underground Flushing Water Tank	1No.	12 m^3	
3.	Fire Overhead water Storage Tank	1No.	10 m^3	
4.	Domestic Overhead Water Tank	1No.	2 m^3	
5.	Flushing Overhead Water Tank	1No.	6 m^3	

MAIN FOOD PLAZA				
Sr. No.	Description of Tank	Qty.	Capacity of Each Tank	Remark
1.	Underground Domestic Water Tank	1No.	2 m^3	
2.	Underground Flushing Water Tank	1No.	12 m^3	
3.	Fire Overhead water Storage Tank	1No.	20 m^3	
4.	Domestic Overhead Water Tank	1No.	2 m^3	
5.	Flushing Overhead Water Tank	1No.	6 m^3	

Notes: -

- There will be Separate Fire Fighting (AS PER REQUIREMENT MENTIONED IN NBC 2016 PART-4), Domestic as well as Flushing / Irrigation UG Tanks for Each Administration & Command Control Center Buildings. The Underground Water Tanks Capacity shall be of 100% of 1 Day's Requirement and 50% of 1 Day's Requirement shall be stored in Overhead Tanks of Individual Buildings.
- Pump Flow Rate shall be decided based on 2 Hours of Water Transfer for Daily Requirement of the Each Building. Based on the same, Pipes will be designed as per Hazen-Williams Formula to limit Friction Loss & Velocity of Flow in Pipes to Acceptable Values.

PLUMBING WATER TANKS SUMMARY					
Sr. No.	Descriptions	Under Ground Water Tank (KL)		Over Head Water Tank (KL)	
		Domestic	Flushing	Domestic	Flushing
1.	FOR MAIN ADMINISTRATION &COMMAND CONTROL CENTER BUILDING AT MAIN TOLL PLAZA, CHIRLE, NAVI MUMBAI	4	24	2	12
2.	FOR ADMINISTRATION BUILDING INTERCHANGE	2	12	2	6
3.	FOR ADMINISTRATION BUILDING AT SHIVAJINAGAR INTERCHANGE NEAR / NEXT TO RAMP AC	2	6	2	3

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PLUMBING WATER TANKS SUMMARY					
Sr. No.	Descriptions	Under Ground Water Tank (KL)		Over Head Water Tank (KL)	
		Domestic	Flushing	Domestic	Flushing
4.	FOR ADMINISTRATION BUILDING AT SHIVAJINAGAR INTERCHANGE, NEAR / NEXT TO RAMP AM	2	6	2	3
5.	FOR ADMINISTRATION BUILDING AT SHIVAJINAGAR INTERCHANGE, NEAR / NEXT TO RAMP CA	2	6	2	3
6.	FOR ADMINISTRATION BUILDING AT SHIVAJINAGAR INTERCHANGE, NEAR / NEXT TO RAMP MA	2	6	2	3
7.	FOR ADMINISTRATION BUILDING AT SHIVAJINAGAR INTERCHANGE, NEAR / NEXT TO RAMP MJ	2	6	2	3
8.	FOR ADMINISTRATION BUILDING AT SHIVAJINAGAR INTERCHANGE, NEAR / NEXT TO RAMP JM	2	6	2	3
9.	FOR SUB ADMINISTRATION &COMMAND CONTROL CENTERBUILDING AT SEWRI INTERCHANGE, MUMBAI	2	12	2	6
10.	MAIN FOOD PLAZA	2	12	2	6
11.	HIGHWAY TOILET BLOCK	2	12	2	6

13 CLEAN WATER SUPPLY SYSTEM/ WASTE WATER RECYCLING

a) In the distribution system, horizontal branch has to be tapped off from the vertical mains at all floor levels with isolation valves for feeding water supply to individual floors and individual areas.

b) Main water supply lines could be Copper pipes and internal distribution pipes could be Copper pipes. The internal water supply lines in the toilets and wet areas can traverse in ceiling to drop down (in chase) to the sanitary fixtures as per requirements.

c) Pressure reducing valves is to be used to regulate the pressure as and where required in the distribution system.

d) Water supply to landscape areas is recommended in the green areas which may be extended to suit the specific requirements by landscape consultants.

e) The networks will be sized for the following maximum velocities:

i. 1.5 m/s in general supply lines

ii. 1.2 m/s in the distribution risers

iii. 1 m/s in branch lines to fittings

14 SOIL, WASTE, VENT & RAIN WATER DISPOSAL PIPE SYSTEM

a) Soil and waste system shall be two pipe systems in which the internal soil & waste pipes shall be separate and distinct. Soil pipes collecting crude sewage shall be connected to the soil stack and all waste appliances generating sullage shall be connected to waste stack. The waste line shall be provided with gully trap before being merged to sewer line at ground level.

b) Minimum diameter of pipes shall be adopted as:

- All main soil pipes -- 100 mm
- All branch soil pipes -- 100 mm
- All main waste pipes -- 100 mm
- All branch waste pipes -- 50 mm
- All main soil and waste pipes stack -- 100 mm OD
- Wash basin/Sink waste connection to floor trap -- 32/40mm OD
- Urinal -- 40 mm OD

c) All soil, waste and vent water pipes running vertically, shall be exposed and approachable, in vertical shafts as per architectural design.

d) Each connection from the fixtures shall be provided with access doors for cleaning (door junctions).

e) Where two or three fixtures are connected to a single horizontal pipe leading to a vertical stack (in toilets), clean-out plugs are provided at starting point. The clean-out plugs shall be flush with the top of floor.

f) All traps shall be with a minimum water seal of 50mm.

15 SANITARY FIXTURES AND FITTINGS

a) All sanitary wares shall be selected by the Architect / Interior Designer/Client.

b) Water closets (European pattern) shall be floor mounted or wall mounted vitreous china, having "S" or "P" trap. All water closets shall have low level consoled cisterns duel type of 3 to 6 litres capacity. However, provision of flush valve shall be made for public area toilets.

c) All wash basins shall be of vitreous china, below-counter oval, with single lever basin fitting coming through the marble counter. Hot water return piping shall be provided to minimize hot water delay time thus benefiting in water & energy conservation. Pop-up waste and waste coupling with CP bottle trap shall be provided to the drain outlet. Inlet water connections shall be made thru CP angle stop cocks below the counter.

d) Showers shall have single lever mixer arrangement to regulate water flow and temperature. The shower arm and rose shall be of the throw-off type and the spray from the rose shall be adjustable by lever.

e) Urinals shall be flat back white vitreous china, with auto-flushing system and CP spreader. Provision of waste coupling with CP bottle trap, connected to deep seal floor trap, shall also be made.

f) Accessories such as toilet paper holder, towel rails, soap dispenser and hand drier shall be provided as identified by the Architect / Interior Designer.

g) Since the project is located at very humid place, hence necessary protection shall be required for safe and long life of the equipment's.

h) All the Plumbing equipment's which shall be installed in open space or remain in contact of outdoor air shall be provided with special anti-corrosion/ epoxy coatings like pure epoxy zinc rich primer or equivalent coatings as recommended by manufacturers.

Appurtenant

Following appurtenant shall be included in the design of water supply system for efficient functioning:

a) **Domestic Air Vents:** Automatic air vent shall be provided on cold and hot water risers to eliminate possibility of air locking and to ensure efficient water flow / pressure availability at the user outlets.

b) **Pressure Reducing Valve:** Pressure reducing valves shall be provided where abnormally high pressures are envisaged.

c) **Vacuum Breaker:** Vacuum breaker shall be provided on fixtures where cross connection to sanitary system could occur.

d) **Backflow Prevention:** Double check valve type back flow prevention valve shall be provided on all connections to non-potable water systems such as pool, irrigation and flushing water supply for ensuring high hygiene standards.

e) **Flow Restrictors:** Appropriate flow restrictors shall be provided for economizing on water consumption. The flow resistors shall be hydraulically sized for following flow / discharge.

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- Wash Basin : 2.0 LPM (Sensor Based)
- Urinal : 1.0 Litre per flush (Sensor Based)
- Shower : 7.9 LPM

f) **Ball Valve:** Full bore gun-metal ball valve shall be provided for isolation of cold and hot water supply for the designated area. Further chrome-plated angle valve shall be provided for cold / hot water isolation to wash basin faucets and for WC cistern & bidet water supply.

g) **Pressure Gauge:** Pressure Gauge shall be provided on Inlet and outlet of the each water supply Pumps for efficient balancing and monitoring of the system.

16 WASTE WATER TREATMENT ARRANGEMENT

a) The Soil & Waste shall be carried down separately in independent Down take Pipes. Two Pipe Drainage Systems shall be adopted as per NBC 2016 Standards. The Sanitary / Soil, Waste & Vent System shall be Water Tight & Gas Tight Designed to prevent escape of Foul Gas & Odour from Various Fixtures.

b) Vent System shall be Designed to facilitate escape of Gases & Odour from all parts of Sanitary / Soil & Waste System to the Atmosphere at a point above the Building & to allow Admittance of Air to All Part of the System, so that Siphon, Aspiration or Back Pressure Conditions do not cause Loss of Seal at Traps & Entry of Foul Gases Inside Habitable Areas.

c) The Toilets & Kitchens / Pantries will have Sunk from 150 mm to 300 mm to Lay Drainage Pipes in Sunken Area with required Slope & the Horizontal Header shall be Subsequently Connected to the Vertical Stack Located Inside the Associated Pipe Shaft which shall be Coordinated carefully with Other Services & in Consultation with Architect / Other Stake Holder. Care shall be taken to Avoid Pipe running thru' / in Electrical Rooms and Other Critical Areas.

d) Soil waste from water closets and urinals etc. will be collected by horizontal and vertical soil pipes and discharged directly to the manholes. Waste water from wash basins, sinks, and from other waste fixtures shall be collected separately by waste pipes and be discharged through gully traps into the manhole of the external sewerage system. The waste water from the kitchens, restaurants etc. will be taken to grease traps before connection to the manholes.

e) The external sewerage system shall be running around the building periphery having manholes in front of each shaft. The main sewer line will carry the whole sewage by gravity up to the Septic Tank.

f) If existing municipal / Local Authority Sewer Water Network is not there, then Project's Sewer Water Network to be Terminated / Connected into Septic Tank.

Design Parameters

The following parameters shall be considered for design of sewerage system:

Flow of sewage	=	(90 % of Total water requirement)
Peak Flow	=	3 x average flow
Min. velocity of flow in pipes flowing half full	=	0.75 m/sec
Max Velocity of flow	=	2.0 m/sec.

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Min. depth for sewers	=	0.6 m
Infiltration Factor	=	Add 8.33% of average discharge
(For surface run off, subsoil water conditions etc.)		

Formula for calculation for design of sewer lines shall be by Manning's formula:

$$V = \frac{1}{n} S^{1/2} R^{2/3}$$

Where,

V = Velocity in m/sec.

R = Hydraulic radius in m

S = Slope or hydraulic gradient in m/m

n = Manning's co-efficient

17 DRAINAGE & RAINWATER HARVESTING SYSTEM

Proposed Storm Water Drainage System

The detailed system shall be designed on studying the site conditions and considering the following factors:

a) The pattern of slopes of terrain of site.

b) The existing conditions of site and surrounding.

c) The final levels and patterns of different type of roads.

d) The need for incorporation of rainwater harvesting within the site area.

e) Final disposal to external drainage system as per site.

Planning of drainage system shall be as follows:

a) The rainwater from the terrace and related clean paved areas shall be collected in the collection chambers and shall be ultimately connected to the main storm-water drainage system.

b) The network of storm water system shall be around the site.

c) Proper "De-silt Chamber" filtration Media and Bye-Pass arrangement shall be provided as per requirement.

d) Similarly the other paved/road/green areas, the run-off shall be diverted separately for disposing into underground through collection wells and trenches. It is proposed to provide pre-treatment i.e. Grease/Oil separator etc. as may be the requirement.

References

a) Manual on "Rain Water Harvesting & Conservation" by Govt. of India, Central Public Works Department (CPWD), New Delhi, June 2002.

b) Guidelines from Central Water Board – Ministry of Water Resources, Govt. of India.

c) A Water Harvesting manual for Urban Areas Case Studies from Delhi by Centre for Science & Environment.

d) Part "A" National Building Code of India" 2016.

Design/Technical Parameters

a) Intensity of Rainfall

An intensity of 110 mm/hr. for terrace area and 55 mm/hr for landscape, green, open and paved area is found to be suitable for rainfall analysis and run-off calculations.

b) Storm Frequency

The selection of frequency of storm for the design of drainage system depends upon the importance of the area. The drainage scheme for the complex will be designed considering once in 2 years return period. **(Ref: CPHEEO Manual, Page no: 41)**

c) Co-efficient of Run-off

The proportion of run-off, which will reach the surface drain, depends upon the characteristics of the surface such as impervious of soil, slope, extent and shape of the area. Rate of run-off is high when contributing area consists of roofs, paved streets and asphalted roads etc., since these surfaces retain very little of rainwater. While, the pervious and dry ground at the beginning of the storm, absorbs more moisture until it becomes saturated. The run-off remains practically constant after saturations. Various coefficients are considered for run-off calculations and run-off coefficients for various types of area are given in the following table:

The design of drains is based on Manning's formula, for flow due to gravity

$$V = \frac{1}{n} R^{2/3} S^{1/2}$$

Where,

V = Velocity in m/sec.

R = Hydraulic mean radius in m

S = Hydraulic gradient in m/meter

n = Manning's co-efficient (0.013)

Requirement of Rainwater Harvesting

Since fresh water is becoming scarce in most regions of the area, and the increasing dependency on groundwater, the groundwater wells/bore-wells are getting deeper and deeper due to increased water consumption. Also due to increase in paved surface areas, the amount of natural percolation of rainfall is likely to reduce in the locality.

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Therefore, it has become very necessary to harvest the rain water as maximum as possible. The drainage system needs to be planned with a view to incorporate rainwater harvesting principles, as detailed in the following sections.

Systems of Rainwater Harvesting

a) Rainwater harvesting is essentially an old technology, which is gaining popularity in a new way.

b) Out of the various techniques adopted in India, and approved of by the Central Ground Water Authority, the following are the three main classes of rainwater harvesting systems:

i. System that collect direct roof runoff for storage and then reusing for various purposes.

ii. Systems that use in-field or adjoining surface catchments to collect run-off and then impounded for irrigation, horticultural, recreational & domestic purposes, after treatment.

iii. Systems that utilize the rainwater run-off from various surfaces including Terrace and Roads and green areas etc. for re-charging of the underground aquifer, through various measures:

- In this system, the catchment from roof/terrace areas is further segregated for direct recharging of aquifer through filter media.
- The catchment from surfaces of road/paved/park/lawns etc. is segregated and then taken to underground, through de-silting chamber/oil and grease separator etc.

iv. As per CGWA guidelines for regions not subject to year-round rainfall, the most preferred system for Rain Water Harvesting to be adopted is through Under Ground Recharging system.

18 IRRIGATION SYSTEM:

Source of Water

a) Fresh /Raw water shall be used for irrigation system.

Distribution System

a) A network of distribution system is to be designed to supply irrigation water at all locations where green patches are to be developed. The irrigation water is to be supplied through pressure lines by pumping.

b) Water requirement for Landscape, Green Area and various plants shall be as per latest Indian standards.

c) Pressure requirement/Residual pressure for Irrigation System shall be as per latest Indian standards.

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19 DRAINAGE SUMP PUMPS DETAIL:

DESIGN BASIS / CALCULATION FOR DRAINAGESUMPS										
Sr. No.	Description	Quantity of pump	Sump Size	Free board (mm)	Volume (M^3)	Volume (Litre)	Sump Discharge within minutes	Flow rate (M^3)	Head (M)	Power (Kw)
1	Main Admin Pump Room Drainage Sump	1 Set (1W+1S)	1.5 m x 1.5 m x1.5 m Deep	300	2.7	2700	10	16.20	10	1.27
2	Sub Admin Pump Room Drainage Sump	1 Set (1W+1S)	1.5 m x 1.5 m x1.5 m Deep	300	2.7	2700	10	16.20	10	1.27
3	Admin Pump Room Drainage Sump	1 Set (1W+1S)	1.5 m x 1.5 m x1.5 m Deep	300	2.7	2700	10	16.20	10	1.27
4	Porta Cabin-1 Pump Room Drainage Sump	1 Set (1W+1S)	1.5 m x 1.5 m x1.5 m Deep	300	2.7	2700	10	16.20	10	1.27
5	Porta Cabin-2 Pump Room Drainage Sump	1 Set (1W+1S)	1.5 m x 1.5 m x1.5 m Deep	300	2.7	2700	10	16.20	10	1.27
6	Porta Cabin-3 Pump Room Drainage Sump	1 Set (1W+1S)	1.5 m x 1.5 m x1.5 m Deep	300	2.7	2700	10	16.20	10	1.27
7	Porta Cabin-4 Pump Room Drainage Sump	1 Set (1W+1S)	1.5 m x 1.5 m x1.5 m Deep	300	2.7	2700	10	16.20	10	1.27
8	Porta Cabin-5 Pump Room Drainage Sump	1 Set (1W+1S)	1.5 m x 1.5 m x1.5 m Deep	300	2.7	2700	10	16.20	10	1.27
9	Porta Cabin-6 Pump Room Drainage Sump	1 Set (1W+1S)	1.5 m x 1.5 m x1.5 m Deep	300	2.7	2700	10	16.20	10	1.27
10	Tunnel Drainage Sump-1	1 Set (1W+1S)	1.5 m x 1.5 m x1.5 m Deep	300	2.7	2700	10	16.20	10	1.27
11	Tunnel	1 Set	1.5 m x	300		2700	10	16.20	10	1.27

DESIGN BASIS / CALCULATION FOR DRAINAGESUMPS										
Sr. No.	Description	Quantity of pump	Sump Size	Free board (mm)	Volume (M^3)	Volume (Litre)	Sump Discharge within minutes	Flow rate (M^3)	Head (M)	Power (Kw)
	Drainage Sump-2	(1W+1S)	1.5 m x1.5 m Deep							
12	Tunnel Drainage Sump-3	1 Set (1W+1S)	1.5 m x 1.5 m x1.5 m Deep	300	2.7	2700	10	16.20	10	1.27
13	Tunnel Drainage Sump-4	1 Set (1W+1S)	1.5 m x 1.5 m x1.5 m Deep	300	2.7	2700	10	16.20	10	1.27
14	Main Food Plaza Pump Room Drainage Sump	1 Set (1W+1S)	1.5 m x 1.5 m x1.5 m Deep	300	2.7	2700	10	16.20	10	1.27

20 WATER SUPPLY OHT FILLING DETAIL:

DESIGN BASIS / CALCULATION FOR OHT FILLING PUMPS DOMESTIC & FLUSHING									
Sr. No.	Description	Quantity of pump	OHT Tank Volume (M3)	Volume	OHT Filling	Pump Flow rate Required	Pump Flow Proposed	Head	Power
			(M3)	(Litre)	(minutes)	(M3/ Hour)	LPM	(M)	(Kw)
1	Main Admin Domestic Pump for OHT Filling	1 Set (1W+1S)	2	2000	30	4	67	35	1.10
2	Main Admin Flushing Pump for OHT Filling	1 Set (1W+1S)	12	12000	30	24	400	35	6.58
3	Sub Admin Building Domestic Pump for OHT Filling	1 Set (1W+1S)	2	2000	30	4	67	25	0.78
4	Sub Admin Building	1 Set	6	6000	30	12	200	25	2.35

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DESIGN BASIS / CALCULATION FOR OHT FILLING PUMPS DOMESTIC & FLUSHING									
Sr. No.	Description	Quantity of pump	OHT Tank Volume (M3)	Volume	OHT Filling	Pump Flow rate Required	Pump Flow Proposed	Head	Power
			(M3)	(Litre)	(minutes)	(M3/ Hour)	LPM	(M)	(Kw)
	Flushing Pump for OHT Filling	(1W+1S)							
5	Admin Building Domestic Pump for OHT Filling	1 Set (1W+1S)	2	2000	30	4	67	15	0.47
6	Admin Building Flushing Pump for OHT Filling	1 Set (1W+1S)	6	6000	30	12	200	15	1.41
7	Porta Cabin-1 Domestic Pump for OHT Filling	1 Set (1W+1S)	2	2000	30	4	67	15	0.47
8	Porta Cabin-1 Flushing Pump for OHT Filling	1 Set (1W+1S)	3	3000	30	6	100	15	0.71
9	Porta Cabin-2 Domestic Pump for OHT Filling	1 Set (1W+1S)	2	2000	30	4	67	15	0.47
10	Porta Cabin-2 Flushing Pump for OHT Filling	1 Set (1W+1S)	3	3000	30	6	100	15	0.71
11	Porta Cabin-3 Domestic Pump for OHT Filling	1 Set (1W+1S)	2	2000	30	4	67	15	0.47
12	Porta Cabin-3 Flushing Pump for OHT Filling	1 Set (1W+1S)	3	3000	30	6	100	15	0.71
13	Porta Cabin-4 Domestic Pump for OHT Filling	1 Set (1W+1S)	2	4000	30	4	67	15	0.47

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DESIGN BASIS / CALCULATION FOR OHT FILLING PUMPS DOMESTIC & FLUSHING									
Sr. No.	Description	Quantity of pump	OHT Tank Volume (M3)	Volume	OHT Filling	Pump Flow rate Required	Pump Flow Proposed	Head	Power
			(M3)	(Litre)	(minutes)	(M3/ Hour)	LPM	(M)	(Kw)
14	Porta Cabin-4 Flushing Pump for OHT Filling	1 Set (1W+1S)	3	3000	30	6	100	15	0.71
15	Porta Cabin-5 Domestic Pump for OHT Filling	1 Set (1W+1S)	2	2000	30	4	67	15	0.47
16	Porta Cabin-5 Flushing Pump for OHT Filling	1 Set (1W+1S)	3	3000	30	6	100	15	0.71
17	Porta Cabin-6 Domestic Pump for OHT Filling	1 Set (1W+1S)	2	2000	30	4	67	15	0.47
18	Porta Cabin-6 Flushing Pump for OHT Filling	1 Set (1W+1S)	3	3000	30	6	100	15	0.71
19	Main Food Plaza Building Domestic Pump for OHT Filling	1 Set (1W+1S)	2	2000	30	4	67	15	0.47
20	Main Food Plaza Building Flushing Pump for OHT Filling	1 Set (1W+1S)	6	6000	30	12	200	15	1.41

21 MATERIAL OF CONSTRUCTION (MOC) FOR PLUMBING & SANITARY WORKS

Sr. No.	Description of Services	Material of Construction (MOC) Proposed
1.	**Internal Piping :Inside Toilet/Kitchen / Pantry**	
a)	Rigid Pipe: From Wash Basin / Sink To Floor Trap	uPVC Socket (4 kg)
b)	Waste Pipe: From Floor Trap to Vertical Waste Water Pipe in Shaft	SWR Ring Fitting (Type-B)
c)	Soil Pipe: From WC to Vertical Soil Water Pipe in Shaft	SWR Ring Fitting (Type-B)
d)	Condensate Pipe: From Indoor Unit (IDU) to Vertical Waste Water Pipe in Shaft	uPVC Socket (4 kg)
e)	Perforated Pipe: In Landscape	uPVC Perforated (6 kg)
2.	**Downtake Piping: Inside Shaft**	
a)	Waste Pipe: From Terrace (1.5 m Above) Level to First Chamber	SWR Ring Fitting (Type-B)
b)	Soil Pipe: From Terrace (1.5 m Above) Level to First Chamber	SWR Ring Fitting (Type-B)
c)	Vent Pipe: From Terrace (1.5 m above) Level to Lowest Floor Connection	SWR Ring Fitting (Type-A)
d)	Rain Water Pipe: From Terrace to First Chamber	SWR Socket (Type-B)
3.	**Diversion Piping: Ceiling Level Diversion at Stilt / Ground Floor**	
a)	Waste Water Pipe	CI Pipe as per IS 3989
b)	Soil Water Pipe	CI Pipe as per IS 3989
c)	Rain Water Pipe	CI Pipe as per IS 3989
4.	**External Pipe: From First Chamber to External Connection**	
a)	Waste Water Pipe	DWC HDPE / uPVC

Sr. No.	Description of Services	Material of Construction (MOC) Proposed
b)	Soil Water pipe	DWC HDPE / uPVC
c)	Storm Water Pipe	RCC NP2 Hume Pipe
5.	Downtake Pipes: From Shaft Valve to Toilet & Kitchen / Pantry Entry as well as Inside Toilet & Kitchen / Pantry	
a)	For Domestic, Flushing Water Supply Pipes	uPVC Sh.40 / CPVC SDR 11
b)	For Hot Water Supply Pipes	CPVC SDR 11
6.	Garden Hydrant System (External)	UPVC Pipe & Fittings
7.	Drainage Sump Pump discharge Pipe & Header	GI Class 'C' Pipe & Fittings
8.	Terrace Looping: From OHT to Shaft Valve	GI Class 'C' Pipe & Fittings
9.	Rising Mains: From UGT to Over Head Tanks (OHT)	GI Class 'C' Pipe & Fittings
10.	Piping within Pump Room / Tanks	GI Class 'C' Pipe & Fittings
11.	Municipal/LocalAuthority Connection: Municipal / Local Authority Line to Under Ground Tanks (UGT)	DI / uPVC

FIRE FIGHTING SERVICES

1 INTRODUCTION

Fire is one of the most serious hazards, threatening life/safety of building occupants as well as causing damages to properties. Sensitive early fire warning system and effective fire suppression system are very important to make sure that fire is detected when it is still in the smouldering stage and to put out or retard the development and spread of fire when it is still in its early stage. On the other hand, the fire detection and alarm system will not generate nuisance false alarms thus causing undue panic.

All the fire alarm and first aid firefighting systems will be automatic and self-monitoring so as to eliminate possible failure due to human errors. Also, fire detection and fighting system will be able to locate immediately and precisely the origin of the fire and allow the building management and security officers to respond immediately to any emergency situation, as well as providing the fire brigade with all necessary means and facilities to fight the fire if the fire cannot be controlled by the firefighting systems.

2 BASES OF CALCULATION

The installations described below must conform to the operative standards and local rules.

Fire protection systems for the proposed facilities are envisaged to be developed in line with the guidelines of IS/NBC standards:

- NBC 2016 Part-4: National Building Code – Fire and Life Safety Services
- NBC 2016 Part-9: National Building Code – Plumbing Services
- IS 2065: Code of Practice for Water Supply Building
- IS 15105: Code of Practice for Design and Installation of Fixed Automatic Sprinkler Fire Extinguishing Systems
- IS 13039: Code of Practice for External Hydrant Systems – Provision and Maintenance
- IS 9668: Code of Practice for Provision and Maintenance of Water Supplies for Fire Fighting
- IS 3844: Code of Practice for installation and maintenance of internal fire hydrants and hose reel on premises
- IS: 2190: Code of Practice for selection, Installation and maintenance of Internal Portable First – Aid Fire Extinguisher
- IS: 884: Specifications for First –Aid Hose reel
- IS: 903: Specifications for Fire Hose delivery coupling, branch pipe, nozzles and nozzles spanner
- IS: 5290: Specifications for Landing Valve

All piping shall be above ground in MS Heavy class construction as per IS 1239 for pipes up to 150mm dia and above 150mm shall be as per IS 3539.

Pipes shall be below ground at road crossings / unavoidable places. Piping material shall be ductile iron as per IS 8329 with cement mortar lining.

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3 ABBREVIATION

ABBREVIATION	DETAIL DESCRIPTION
NBC	National Building Code
IS	Indian Standard
FHC	Fire Hose Cabinet
EFH	External Fire Hydrant
LPM	Litre Per Minute
DIA	Diameter
KW	Kilowatt
M	Meter
ACV	Alarm Control Valve
PG	Pressure Gauge

4 BUILDING CLASSIFICATION AS PER NBC-2016

BUILDINGS	MAIN ADMIN. AND COMMAND CONTROL CENTER AT GAVHAN	SUB ADMINISTRATION AND COMMAND CONTROL CENTER AT SEWRI	ADMINISTRATION AND COMMAND CONTROL CENTER AT SHIVAJINAGAR
Group (as per NBC)	Business Building (E-3) Above 15M & upto 24M in Height	Business Building(E-2)Above10M but not exceeding 15Min Height	Business Building (E-1) Less than 10M Height

4.1 MAIN ADMIN. AND COMMAND CONTROL CENTER AT GAVHAN

Building Total Height 20.95M

Type of Building occupancy :		Business Building (E-3) Above 15M & upto 24M in Height
Sr. No.	Type of Fire Fighting Installation	Provision as per NBC 2016 Part IV Table 7
1.	Fire Extinguisher	Provided
2.	Hose Reel	Provided
3.	Wet Riser	Provided
4.	Down Comer	Not Required
5.	Yard Hydrant (External Fire Hydrant System)	Provided
6.	Automatic Sprinkler System	Provided
7.	Manually Operated Electric Fire Alarm System	Provided

Type of Building occupancy :		Business Building (E-3) Above 15M & upto 24M in Height
Sr. No.	Type of Fire Fighting Installation	Provision as per NBC 2016 Part IV Table 7
8.	Automatic Fire Alarm System	Provided
9.	Underground Static Water Storage Tank	1,00,000 litres capacity
10.	Terrace Tank	10,000 litres capacity
11.	Fire Fighting Pumps	1 Electrical Main Pump of 2280 LPM Capacity,1 Diesel Standby Pump of 2280 LPM Capacity and 1 Electrical Jockey Pump of 180LPM Capacity
12.	Fire Fighting Terrace Pump	Not Required

4.2 SUB ADMINISTRATION AND COMMAND CONTROL CENTER AT SEWRI

Building Total Height 13.35M

Type of Building occupancy :		Business Building (E-2) Above 10M but not exceeding 15M in Height
Sr. No.	Type of Fire Fighting Installation	Provision as per NBC 2016 Part IV Table 7
1.	Fire Extinguisher	Provided
2.	Hose Reel	Provided
3.	Wet Riser	Provided
4.	Down Comer	Not Required
5.	Yard Hydrant (External Fire Hydrant System)	Not Required
6.	Automatic Sprinkler System	Required to be installed in basement, if area of basement exceeds 200 m2.
7.	Manually Operated Electric Fire Alarm System	Provided
8.	Automatic Fire Alarm System	Provided
9.	Underground Static Water Storage Tank	50,000 litres capacity
10.	Terrace Tank	5,000 litres capacity
11.	Fire Fighting Pumps	1 Electrical Main Pump of 1620 LPM Capacity,1 Diesel Standby Pump of 1620 LPM Capacity and 1 Electrical Jockey Pump of 180 LPM Capacity
12.	Fire Fighting Terrace Pump	Electrical Pump of 450 LPM Capacity

4.3 ADMINISTRATION AND COMMAND CONTROL CENTER AT SHIVAJINAGAR

Building Total Height 6.95M

Type of Building occupancy :	Business Building (E-1) Less than 10M Height

Sr. No.	Type of Fire Fighting Installation	Provision as per NBC 2016 Part IV Table 7
1.	Fire Extinguisher	Provided
2.	Hose Reel	Provided
3.	Wet Riser	Not Required
4.	Down Comer	Provided
5.	Yard Hydrant (External Fire Hydrant System)	Not Required
6.	Automatic Sprinkler System	Required to be installed in basement, if area of basement exceeds 200 m2.
7.	Manually Operated Electric Fire Alarm System	Provided
8.	Automatic Fire Alarm System	Not Required
9.	Underground Static Water Storage Tank	Not Required
10.	Terrace Tank	10,000 litres capacity
11.	Fire Fighting Pumps	Not Required
12.	Fire Fighting Terrace Pump	Electrical Pump of 450 LPM Capacity

4.4 ADMINISTRATION BUILDING AT INTERCHANGE

Building Total Height 9.85M

Type of Building occupancy :		Business Building (E-1) Less than 10M Height
Sr. No.	Type of Fire Fighting Installation	Provision as per NBC 2016 Part IV Table 7
1.	Fire Extinguisher	Provided
2.	Hose Reel	Provided
3.	Wet Riser	Not Required
4.	Down Comer	Provided
5.	Yard Hydrant (External Fire Hydrant System)	Not Required
6.	Automatic Sprinkler System	Required to be installed in basement, if area of basement exceeds 200 m2.
7.	Manually Operated Electric Fire Alarm System	Provided
8.	Automatic Fire Alarm System	Not Required
9.	Underground Static Water Storage Tank	Not Required
10.	Terrace Tank	10,000 litres capacity
11.	Fire Fighting Pumps	Not Required
12.	Fire Fighting Terrace Pump	Electrical Pump of 450 LPM Capacity

4.5 MAINFOOD PLAZA BUILDING

Building Total Height 7.3M

Type of Building occupancy :		MERCANTILE BUILDINGS (F) Ground plus one storey and total of all floor area exceeding 500m2
Sr. No.	Type of Fire Fighting Installation	Provision as per NBC 2016 Part IV Table 7
1.	Fire Extinguisher	Provided
2.	Hose Reel	Provided
3.	Wet Riser	Not Required
4.	Down Comer	Provided
5.	Yard Hydrant (External Fire Hydrant System)	Not Required
6.	Automatic Sprinkler System	Required to be installed in basement, if area of basement exceeds 200 m2.
7.	Manually Operated Electric Fire Alarm System	Provided
8.	Automatic Fire Alarm System	Not Required
9.	Underground Static Water Storage Tank	Not Required
10.	Terrace Tank	20,000 litres capacity
11.	Fire Fighting Pumps	Not Required
12.	Fire Fighting Terrace Pump	Electrical Pump of 900 LPM Capacity

5 SCOPE OF WORK

The scope of work includes Design, Engineering, Supply, and Installation, Testing and Commissioning of Fire Protection and Detection systems for the Toll Plaza. The Fire protection system will cover internal as well as external premises of the building.

This report intends to highlight the planning of the active firefighting services to be provided in the proposed development. It will also cover the design parameters, references and fundamental provisions which have been proposed in the proposed system. The firefighting system in proposed developments shall consist the following:

- Fire (static) water storage tank
- Fire Pumps
- Wet Riser system
- External Hydrant system
- Automatic Sprinkler system
- Fire Brigade Inlet and Suction Draw off connections
- Portable Fire Extinguishers
- Fire piping and control valves

- Motor Control Panel and related cables and wiring
- Fire Suppression System

6 PROJECT OBJECTIVES

Admin. and Command Control Center Building will have special needs for fire safety, because of the large numbers of people in a single space and the need to protect the operational function of the airport against disruption.

The objective of this report is to design a Fire Protection System, which shall provide:

- Life safety of occupants - passengers, staff and fire service personnel.
- Property protection - building and contents.
- Protection of the operational function of the building.
- Maintaining easy access to the fire protection devices, in case of emergency.

7 FIRE FIGHTING WATER TANK DETAILS

FIRE FIGHTING WATER TANKS SUMMARY			
Sr. No.	Descriptions	Under Ground Fire Water Tank (KL)	Over Head Fire Water Tank (KL)
12.	FOR MAIN ADMINISTRATION CENTER BUILDING AT MAIN TOLL PLAZA, CHIRLE, NAVI MUMBAI	100	10
13.	FOR ADMINISTRATION INTERCHANGE	Not Applicable	10
14.	FOR ADMINISTRATION BUILDING AT SHIVAJINAGAR INTERCHANGE, NEAR / NEXT TO RAMP AC	Not Applicable	10
15.	FOR ADMINISTRATION BUILDING AT SHIVAJINAGAR INTERCHANGE, NEAR / NEXT TO RAMP AM	Not Applicable	10
16.	FOR ADMINISTRATION BUILDING AT SHIVAJINAGAR INTERCHANGE, NEAR / NEXT TO RAMP CA	Not Applicable	10
17.	FOR ADMINISTRATION BUILDING AT SHIVAJINAGAR INTERCHANGE, NEAR / NEXT TO RAMP MA	Not Applicable	10
18.	FOR ADMINISTRATION BUILDING AT SHIVAJINAGAR INTERCHANGE, NEAR / NEXT TO RAMP MJ	Not Applicable	10
19.	FOR ADMINISTRATION BUILDING AT SHIVAJINAGAR	Not Applicable	10

FIRE FIGHTING WATER TANKS SUMMARY			
Sr. No.	Descriptions	Under Ground Fire Water Tank (KL)	Over Head Fire Water Tank (KL)
	INTERCHANGE, NEAR / NEXT TO RAMP JM		
20.	FOR SUB ADMINISTRATION & COMMAND CONTROL CENTERBUILDING AT SEWRI INTERCHANGE, MUMBAI	50	5
21.	FOR MAIN FOOD PLAZA	Not Applicable	20

8 FRICTION LOSSES CALCULATION (HYDRANT& SPRINKLER SYSTEM)

Friction Pressure losses in pipe & fitting as per Hazen-William formula.

$$P = \frac{6.05 \times 10^5 \times L \times Q^{1.85}}{}$$

Where

P =Loss of pressure per metre Length of pipe (Bar)
Q =Flow rate through the pipe in (LPM)
d =mean bore of pipe (in mm)
C =A constant for the type and condition of pipe
= Considered 120 mm for Mild Steel
L=Equivalent length of Pipe &Fitting in(m) = 1m

9 FIRE FIGHTING PUMPS DETAILS

Sr. No.	Descriptions	Fire Fighting Pumps (LPM)	Pump Head (M)
1.	FOR MAIN ADMINISTRATION & COMMAND CONTROL CENTER BUILDING AT MAIN TOLL PLAZA, CHIRLE, NAVI MUMBAI	• 1 Electrical Main Pump of 2280 LPM • 1 Diesel Standby Pump of 2280 LPM • 1 Electrical Jockey Pump of 180 LPM	50
2.	FOR ADMINISTRATION INTERCHANGE	Electrical Pump of 450 LPM Capacity	35
3.	FOR ADMINISTRATION BUILDING AT SHIVAJINAGAR INTERCHANGE, NEAR / NEXT TO RAMP AC	Electrical Terrace Fire Pump of 450 LPM	35
4.	FOR ADMINISTRATION BUILDING AT SHIVAJINAGAR INTERCHANGE, NEAR / NEXT TO RAMP AM	Electrical Terrace Fire Pump of 450 LPM	35
5.	FOR ADMINISTRATION BUILDING AT SHIVAJINAGAR INTERCHANGE, NEAR / NEXT TO RAMP CA	Electrical Terrace Fire Pump of 450 LPM	35
6.	FOR ADMINISTRATION BUILDING AT SHIVAJINAGAR INTERCHANGE, NEAR / NEXT TO RAMP MA	Electrical Terrace Fire Pump of 450 LPM	35
7.	FOR ADMINISTRATION BUILDING AT SHIVAJINAGAR INTERCHANGE, NEAR / NEXT TO RAMP MJ	Electrical Terrace Fire Pump of 450 LPM	35
8.	FOR ADMINISTRATION BUILDING AT SHIVAJINAGAR INTERCHANGE, NEAR / NEXT TO RAMP JM	Electrical Terrace Fire Pump of 450 LPM	35
9.	FOR MAIN FOOD PLAZA	Electrical Terrace Fire Pump of 900 LPM	35
10.	FOR SUB ADMINISTRATION & COMMAND CONTROL CENTERBUILDING AT SEWRI INTERCHANGE, MUMBAI	• 1 Electrical Main Pump of 1620 LPM • 1 Diesel Standby Pump of 1620 LPM • 1 Electrical Jockey Pump of 180 LPM	50

- Minimum pressure of 3.5 kg/cm² at the farthest point.

- All fire pumps shall be with positive suction arrangements.
- All the fire pumps shall cut-in automatically based on the pressure settings, so as to ensure that the entire fire main line, risers etc. are pressurized on a continuous basis.
- The jockey pump shall automatically cut-out based on the pressure settings. However, the remaining fire pumps shall off only in the manual mode.

10 PRESSURISATION SYSTEM:

The hydrant and Sprinkler system shall be kept pressurised all the times. The jockey pump shall start automatically upon getting impulse from pressure switch of the pressure vessel and the jockey pump shall stop automatically. The jockey pump shall take care of the leakages in the system, pipe lines, valves etc.

MODE OF OPERATION:

a) The pressurization pump (Jockey pump) shall maintain pressure in the system and shall operate only on account of slow pressure loss. In the event of fire, when one or more valves are opened, the water from the jockey pump will compensate water demand. If the water demand is not able to be met by above, the relevant pressure fall in the header shall start the AC Motor driven fire pump through pressure switches, automatically. In case of failure of electricity or failure of pump to start or the pump not meeting the required water demand, the standby diesel pump set shall start automatically. However, shutting down of the pumps shall be manual except for the jockey pump, which shall start & stop automatically through pressure switches.

b) The setting of the pressure switches shall be adjustable so that any desirable sequence of starting may be achieved at site.

c) In addition to auto start arrangements, the main pump shall also have an overriding manual starting facility by push button arrangement in case of an emergency.

Sequencing of fire pumps is attached for further working. At the BMS only the indication of running and Stop (On/Off) status of the fire pump is required.

FOR MAIN ADMINISTRATION &SUB ADMINISTRATION AND COMMAND CONTROL CENTER BUILDINGS

Sr. No.	Fire Pump	Nos.	Pumping head	Cut in Pressure	Cut Out Pressure	Remarks
1	Electric driven Pressurization Pump (Jockey Pump)	One	5 kg/cm²	4 kg/cm²	5 Kg/cm²	To auto start and auto stop on pressure switch on air vessel to stop.
2	Electric Driven Main Fire Hydrant Pump	One	5 kg/cm²	4 Kg/cm²	Push button manual	To auto start on pressure switch on air vessel and manual off.
3	Diesel Engine Pump	One	5 kg/cm²	3 Kg/Cm²	Push button	To auto start on pressure switch

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Sr. No.	Fire Pump	Nos.	Pumping head	Cut in Pressure	Cut Out Pressure	Remarks
					manual	on air vessel and manual off.

(The above ratings will be adjusted finally at the time of commissioning as per site requirement and final setting shall be recorded & kept safe as per the approval of Engineer-in-Charge/ Project Consultant).

BRIEF SYSTEM DESCRIPTION:

The firefighting system shall consist of jockey pumps, electrical driven fire hydrant pump, sprinkler pump and common diesel pumps for automatic sprinkler & fire hydrant system (Internal & External), air vessel, associated instruments, cabling, piping, valves, control panel etc. have been provided as per NBC requirement. Jockey pumps shall maintain pressure in all water lines for hydrant & sprinkler systems for fully automatic operation in case of fire.

Diesel fuel supply tanks shall be located near to Diesel Fire Pump and shall not be buried.

The Electric Motor Driven Pumps (Main Pump & Jockey Pump) shall also be provided with DG Backup supply also.

Non Return valves shall be provided in the delivery side of the pumps to prevent the back flow in to the pumps.

Each pump shall have an electric controller to control the Starting & Stopping of Pumps, both manually & automatically. All controllers shall be interlocked, so as to prevent the simultaneous operation of any 2 or more pumps. The automatic operation of pumps is controlled by the pressure in the system, which is monitored by the pressure switches. These controllers shall be BMS compatible. The pump controller shall have sufficient contacts of Potential free to receive / send signal from/ to other system

11 INTERNAL WET RISER SYSTEM (HYDRANT SYSTEM)

- Pressurized wet riser system is proposed as per NBC-2016. In this system the hydrant network is pressurized with water at a definite pressure and is maintained in readiness for any eventuality. Once the hydrant valve is manually opened during fire, the fall is pressure in the pipe line is sensed by the pressure switches, activating the pumps, thereby ensuring continuous supply of water and pressure at outlets (Hydrant outlets).
- Wet riser system shall be designed and installed as per IS:3844 (Code of practice for Installation and maintenance of internal fire hydrants and hose Reels on premises).
- No corner of the Building is farther than 30 m. from the nearest riser.
- Minimum size of vertical riser is 150 mm dia.
- The horizontal distance between two risers shall not be more than 50 m.
- The internal hydrants shall be strategically located for easy access.

- Minimum pressure for hydraulically most remote landing valve is 3.5 kg/cm².
- Landing Valve shall be unobstructed and shall be located not less than 0.9 m or more than 1.5 m above the floor.
- Wet riser system will comprise landing valves and accessories on each floor. Each hydrant station shall comprise following accessories.

  a) 1 No. single outlet fire hydrant landing valve.
  b) 2 Nos. RRL hoses 63 mm dia. and 15 m long.
  c) 1 No. First aid Dunlop hose reel 20 mm dia. x 30 m long with drum.
  d) 1 No. branch pipe 20 mm dia.
  e) 1 No. fire man axe.

- All above accessories will be placed in a niche of size not less 1200 mm x 750 mm deep and approx. height 2100 mm. Niche will be covered with MS shutters with glass front and shall be sealed at each floor.
- The slab of nitch meant for fire lines shall be casted along with slab of floors. Necessary cut out will be left in nitch to take vertical fire lines. The gap between fire lines and cut outs after laying of fire lines will be sealed with fire sealant of 2 hours fire rating. Sealant will be provided in gaps strictly as per manufacturer recommendations. No gap will be left between fire lines & openings in order to avoid possible spread of fire vertically.
- The Hydrant System will be semi-automatic in action and shall be laid covering the entire area of all floors internally with independent piping system.
- The internal Hydrant System will be kept pressurized at all times. The proposed Jockey Pump shall take care of the leakages in the system, pipe lines and valve glands.
- The pressure in the hydrant pipe work will be kept constant at 7 Kg/cm2. In the event of fire when any of the hydrant valves in the network is opened, the resultant fall in header pressure shall start the AC motor driven fire pump through pressure switches automatically. There shall be one electrical driven pump as standby for both hydrant systems. In case of failure of electricity or failure of Electric Pump to start on demand, the standby electrical pump shall automatically take over.
- The hydrant risers will be terminated with air release valve at the highest points to release the trapped air in the pipe work. At each tapping from the Riser a Orifice Plate shall be located in the lower floors to reduce the pressure.
- One no Four-way fire brigade inlet connection is provided for hydrant system and one no four-way inlet connection is provided for sprinkler system of the complex. These fire brigade inlet connections are provided in main entry of the complex.
- Pipes for Internal wet riser system shall be of Class-C, heavy duty black steel pipes. Pipes upto 150mm dia. shall conform to IS-1239. Pipes with dia 200mm and above (6mm thick) shall confirm to IS-3589. All pipes shall be I.S.I. marked. Fittings for black steel pipes shall be M.S. forged fittings with tapered screwed threads.
- Vertical wet riser pipes shall be laid in workmanship like manner. Pipe of length not more their floor to floor to height of building vertically fire riser shall be installed at a time in order to avoid possible accidents. Vertical fire risers will be installed on galvanized angle iron brackets with approx. 70 mm spacing from wall.

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12 EXTERNAL FIRE YARD HYDRANT SYSTEM

- Single headed yard hydrants are proposed at strategic locations on perimeter of the building for firefighting from outside building.
- External fire hydrant system is proposed all around the building in the form of ring. The external fire hydrants will be provided at a spacing of 45m center to center. The following accessories are proposed near each yard hydrant.

  a) 1 No. single headed hydrant valves.
  b) 2 Nos. RRL hoses of size 63mm dia. x 15m long.
  c) 1 No. branch pipe.

- RRL hose and branch pipe will be accommodated in aMS hose box mounted on brick pedestals.
- External fire hydrant system will be designed and installed as per IS:13039 (External hydrant Systems-Provision and maintenance-code of practice).
- Pipes for external yard hydrant system shall be of Class-C, heavy duty black steel pipes. Pipes up to 150mm dia. shall conform to IS-1239. Pipes with dia. 200mm and above (6mm thick) shall confirm to IS-3589. All pipes shall be I.S.I. marked. Fittings for black steel pipes shall be M.S. forged fittings with tapered screwed threads.

13 AUTOMATIC SPRINKLER SYSTEM

An automatic sprinkler system, for fire protection purpose, is a network of piping to which automatic sprinklers are attached. The system is connected to an automatic water supply. Sprinkler riser supplies water to the sprinkler piping network and connected sprinklers distributing throughout the protected area. The building shall be protected throughout by an approved automatic Sprinkler System, in accordance with IS-15105.

- It is mandatory to provide sprinklers for all areas as per the requirement. The sprinkler system shall therefore be provided for all areas, including basements, floors, Covered Parking, common areas and all other areas.
- The classification of occupancy is Moderate Hazard (As per page 7 IS: 15105 for Airport Terminal Building). – (Annexure attached)
- Sprinklers shall be provided so as to provide an AMAO (allowable maximum area of operation) of 360 m2, and the density of water discharging shall be 5 LPM per m2.
- Pendant sprinklers shall be provided at approximately @12m2 of built up area, with a distance (center-to-center) spacing accordingly.
- Upright sprinklers shall be provided for any false ceiling areas in lobbies/common areas etc. and similar voids which are greater than 800 mm in height, if any.
- The sprinklers shall be automatically activated at 68 Degree C by breaking of the glass bulb in the event of fire.
- The sprinkler line shall be always energized on a 24-hour basis by automatic system consisting of an Electrical sprinkler pump of required capacity. The main hydrant electrical and DG Pumps also shall back up the sprinkler pump. A separate jockey pump has also been provided for the sprinkler system.

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- Pendent Sprinkler shall be provided if Duct width is more than 0.8 meter.
- Necessary accessories such as Alarm Valves, Flow Switches, Inspection Test Assemblies and Annunciation Panel etc. shall be provided as per the detailed requirements.
- Sprinklers shall not be provided in the areas stated under "Exceptions" a defined by the relevant codes.
- Generally, for sprinkler system design, IS 15105 shall be followed (Indian Standard for Design & Installation of Fixed Automatic Sprinkler Fire Extinguishing Systems). Wherever required, latest NFPA codes shall also be referred as a guideline/good practice.
- The minimum size of any sprinkler drop pipe / branch shall be not less than 25 mm diameter. The maximum size of sprinkler header is up to 150 mm dia.
- Minimum Sprinkler Discharge Pressure at any Sprinkler is 0.35 bar.
- Automatic sprinkler system is considered to be the most effective and economical way to apply water from fixed systems. It is designed to act upon a fire at a pre-determined temperature by measure of water spray.
- Sprinkler system will be proposed in the Main Admin Building. Sprinkler system will be designed and installed as per NBC 2016 and Code of practice 15105: 2002.
- Sprinklers will be designed with sprinkler risers, piping network, sprinkler control valves, floor control valves and sprinkler alarm vales.
- The sprinkler system will be fed by independent fire pump, the delivery header of the pumps will be designed in such a way and it is possible to feed water from the hydrant pump to Sprinkler system during emergencies.
- Tapping is taken from the riser to connect all sprinklers at all floor levels. Additional tapping at all floors will also be provided with isolation valves to cater for future tapping for sprinklers above false ceiling incase gap above false ceiling is more than 800mm.

Areas excluded from sprinkler system:

Following areas are excluded from sprinkler system.

a) Toilets
b) DG rooms
c) Electrical HT & LT rooms

Design considerations

As per NBC-2016 Part-4, (Fire and life safety) Para-5.1.3 (G).

The Maximum floor area on any one floor to be protected by sprinklers supplied by any one sprinkler system riser from an installation control valve shall be based on system protection area limitations considering maximum floor area on any one floor to be 4500 m2 for all occupancies except industrial and hazardous occupancies, where authorities shall be consulted for advice based on type and nature or risk.

Sprinkler system will be further sub-divided in zones for each floor connected in flow switches& annunciation plan. Each sub zone of sprinkler will be connected to annunciation

panel placed in control room at ground floor for easy location of emergency floor and effected area on each floor.

Suitable drainage arrangement with bye pass valves will be provided to facilitate maintenance of sprinkler pipe work.

Sprinkler rating

Sprinkler rating will be selected depending upon the temperature of area as per IS:15105. In general, 68^{0}C temperature rating pendent type or upright type sprinkler shall be provided. Concealed sprinkler of 68^{0}C temperature rating shall be provided in lobby or areas where required by interior architects.

System description of sprinkler system

The sprinkler risers will be charged with water to the system design pressure. The operation system will be automatic. When fire starts, its heat causes fusible glass bulb within sprinkler head to burst and thus pressurized water behind the sprinkler head will get sprayed on fire in a hemispherical pattern. Due to this release of pressurized water from the sprinkler head, there is a pressure drop in the sprinkler system. Water for sprinkler system starts flowing through Sprinkler alarm valve and this drop in pressure will be sensed by a pressure switch in pump house which is turn start the fire sprinkler pump to deliver fire water to meet water demand during sprinkler system operation

Pipes for sprinkler system shall be of Class-C, heavy duty black steel pipes. Pipes upto 150mm dia. shall conform to IS-1239. Pipes with dia. 200mm and above (6mm thick) shall confirm to IS-3589. All pipes shall be I.S.I. marked. Fittings for black steel pipes shall be M.S. forged fittings with tapered screwed threads.

14 OVERHEAD TANK & DOWN COMER

For supply of water for the purpose of Fire Fighting shall always be available in the form of Overhead Water tank at roof level with capacity specified for each building with arrangements.

The selection of the Overhead tank capacities as per NBC (National Building Code -2016) Part 4, Table 7- Fire and Life Safety.

The arrangement of Fire Fighting within the building by means of down-comer pipe connected to terrace tank, gate valve and non –return valve with main pipe not less than 100 mm dia. It is also fitted with inlet connections at ground level for charging with water by pumping from fire service appliances and air release valve at top level to release trapped air inside. The down comers are connected to the Hydrant & sprinkler risers.

15 FIRE BRIGADE INLET AND DRAW OUT CONNECTIONS:

a) 4 way 63 mm diameter instantaneous male inlet connection with blank caps (without non return valve) fixed to a 150 mm diameter pipe which is connected to the fire tank for filling from external sources provided at street level as per IS: 3844. (For UG Fire tank Filling)

b) Fire service inlet with Gate/Butterfly valve and non-return valve to charge the Internal & External hydrant system in the event of failure of the static pump directly from the mobile pump of the fire service shall be provided. (Internal Hydrant +External Hydrant System)

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c) Draw out connection shall be provided for Each fire water tank.

16 PRESSURE VESSEL:

To compensate for slight losses of pressure in the system and to provide an air cushion for counteracting pressure surges/water hammer in the pipe work pressure vessel conforming to IS: 3844 shall be furnished in the pump room near fire pump. The pressure vessel shall normally be half full with water and remaining filled with air, which shall be under compression when the system is in normal operation.

17 ORIFICE PLATE:

In case of excessive pressure in Hydrant/ Landing valve outlet at lower levels, orifice plate of suitable design shall be provided in the landing valve, where necessary to limit the operating pressure to 7.0 Kg/cm2.

a) Orifice Plate shall be provided before connection of Hydrant/ Landing valve.

b) To reduce the risk of hose bursting, arrangement should be made so that when the water is shut off at the nozzle, the static pressure in any line of hose connected to a landing valve does not exceed 700 K Pa (7 Kg f/cm2) [IS 3844 Clause No. 7.7].

18 BRIEF SYSTEM DESCRIPTION:

The firefighting system shall consist of jockey pumps, diesel pumps for automatic sprinkler & fire hydrant system (Internal & External), air vessel, associated instruments, cabling, piping, valves, control panel etc. have been provided as per NBC requirement.

Jockey pumps shall maintain pressure in all water lines for hydrant & sprinkler systems with fully automatic operation with auto On & Auto OFF.

19 FIRE EXTINGUISHERS

Fire extinguisher will be proposed within the building as per IS:2190 depending upon the use and utility of that area considering class of fire that may occur in the area.

Broadly following class of fires are considered for selection of extinguisher.

Sl. No.	Class of fire	Material considered	Type of Extinguishers
1.0	Type-A	Fires involving solid combustible materials of organic nature such as wood, paper, rubber, plastics, etc, where the cooling effect of water is essential for extinction of fires	Water, foam, ABC dry power and halocarbons
2.0	Type-B	Fires involving flammable liquids or liquefiable solids or the like where a blanketing effect is essential.	Foam, dry powder, clean agent and carbon dioxide extinguishers.

3.0	Type-C	Fires involving flammable gases under pressure including liquefied gases, where it is necessary to inhibit the burning gas at fast rate with an inert gas, powder or vaporizing liquid for extinguishment.	Dry powder, clean agent and carbon dioxide extinguishers.
4.0	Type-D	Fires involving combustible metals, such as magnesium, aluminum, zinc, sodium, potassium, etc, when the burring metals are reactive to water and water containing agents and in certain cases carbon dioxide, halogenated hydrocarbons and ordinary dry powders. These fires require special media and techniques to extinguish.	Extinguishers with special dry powder for metal fires.

Quantity and capacity of fire extinguisher will again depend upon class of fire that may occur in particular area. Capacity and quantity of fire extinguisher will be proposed as IS:2190. In general, following extinguishers will be proposed.

Sl. No.	Area	Type of extinguishers
1.0	Car parking area	1 No. 9 litre foam extinguisher, mechanical type, and 1 No. 6 kg dry powder extinguisher for every 200m^2 area with minimum of four extinguishers per compartment. Extinguisher should be available within 15 m radius.
2.0	Office area	1 No. CO2 4.5kg capacity for every 100m^2 floor area or minimum of 2 Nos. extinguishers so located as to be available within 10m radius.
3.0	Electrical rooms	CO2 4.5kg capacity as per layout of panel.
4.0	HT/LT panel rooms	Trolley mounted 22.5 CO2 type fire extinguishers and potable extinguishers will be provided depending upon the size of rooms.
5.0	DG room	Trolley mounted 50 litres capacity mechanical foam type fire extinguishers and potable extinguishers will be provided depending upon the size of rooms.

20 SAFETY SIGNAGES

Safety photo luminescent signage will be provided for easy evacuation and identification of location exit routes and also to reach first aid fire-fighting appliances.

Safety signage will be photo luminescent signs which will be provided in the form of texts or graphs of different sizes, as per standard.

In case of emergencies, during fire, when electricity suddenly goes off, photo luminescent safety signs play a vital role for evacuation & reaching fire safety equipment. Fire safety luminescent signs will be provided in following areas.

a) Emergency exit routes
b) Fire hose cabinets
c) Fire extinguishers
d) Sprinkler control valves
e) Main fire alarm panel
f) Identification of floors and landings

21 FIRE SEALANTS

All pipes puncturing the RCC floors & walls etc. will to be sealed with fire sealants approved by fire authorities.

22 GAS TUBE FIRE SUPPRESSION FOR ELECTRICAL PANELS

Automatic gas tube fire suppression system will be proposed for electrical control panel with following accessories/components.

a) Type of gas- Perfluoro Ketone (FK-5-1-2)/ (HFC227ea)
b) DLP assembly with automatic valve.
c) Mounting brackets for tube.
d) Low pressure switch for monitoring system activation.
e) Linear pneumatic heat detector tube.
f) A/V valve.

23 FIRE SUPPRESSION SYSTEM:

Areas such as main IT, UPS, SERVER and Battery rooms do not require sprinklers. Hence, special fire suppression systems shall be provided and shall be designed in accordance with NFPA 13, "Standard for the Installation of Sprinkler System", NFPA 2001 "Standard on Clean Agent Fire Extinguishing System and NFPA 16 "Standard for The Installation of Foam-Water Sprinkler and Foam-Water Spray System". These are listed below:

Sr. No.	Room Description	Building Name	Dimension Details									
			Length in M.	Width in M.	Area in Sq. m	Height in M.			Volume in M^3			
						CV	RV	FV	CV	RV	FV	Total
1	Server Room	Shivaji Nagar	2.8	4.8	13.44	0	3.5	0	0	48	0	48
2	Battery Room		2.1	5	10.5	0	3.5	0	0	37	0	37
3	UPS/ Electrical Room		4	5.77	23.08	0	3.5	0	0	81	0	81
4	UPS Room	Main Building Gavhan	8.6	2.9	24.94	0	3.5	0	0	88	0	88
5	Battery Room		8.7	3.5	30.45	0	3.5	0	0	107	0	107
6	Server Room-2nd Floor		8.7	5.3	46.11	0	3.5	0	0	162	0	162
7	Server Room-3rd Floor		8.7	5.3	46.11	0	3.5	0	0	162	0	162

8	UPS Room-1	Sewri	4.2	3.5	14.7	0	3.5	0	0	52	0	52
9	Battery Room		2.8	3.5	9.80	0	3.5	0	0	35	0	35
10	Server Room		3.5	4	14.00	0	3.5	0	0	49	0	49
11	UPS Room-2		4.2	5	21	0	3.5	0	0	74	0	74
LEGEND : CV: Ceiling Void; RV: Room Void; FV: Floor Void												

NBC-2016 Extracts For Fire Fighting Services

Table 7 — (*Continued*)

Sl No.	Type of Building Occupancy	Type of Installation: Fire Extinguisher	First Aid Hose Reel	Wet Riser	Down Comer	Yard Hydrant	Automatic Sprinkler System	Manually Operated Electronic Fire Alarm System (see Note 1)	Automatic Detection and Alarm System (see Note 2)	Water Supply (litre): Under-ground Static Water Storage Tank Combined Capacity for Wet Riser, Yard Hydrant and Sprinklers per Set of Pumps	Water Supply (litre): Terrace Tank over Respective Tower Terrace	Pump Capacity (litre/min): Pump Near Underground Static Water Storage Tank (Fire Pump) with Minimum Pressure of 3.5 kg/cm² at Remotest Location	Pump Capacity (litre/min): At the Terrace Tank Level with Minimum Pressure of 3.5 kg/cm²
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
BUSINESS BUILDINGS (E)													
1)	Less than 10 m in height	R	R	NR	R	NR	R (see Note 4)	R	NR	NR	10 000 (5 000) (see Note 6)	NR	450 (450) (see Note 6)
2)	Above 10 m but not exceeding 15 m in height	R	R	R	NR	NR	R (see Note 4)	R	R	50 000	5 000 (5 000) (see Note 6)	(see Note 14)	450 (450) (see Note 6)
3)	Above 15 m and up to 24 m in height	R	R	R	NR	R	R	R	R	100 000	10 000	(see Note 10)	NR
4)	Above 24 m and up to 30 m in height	R	R	R	NR	R	R	R	R	150 000	20 000	(see Note 11)	NR
5)	Above 30 m in height	R	R	R	NR	R	R	R	R	200 000	20 000	(see Note 12)	NR
MERCANTILE BUILDINGS (F)													
a)	F-1 and F-2 (see Note 10)												
b)	Less than 15 m in height												
	i) Owned give one storey, with total of all floor area not exceeding 500 m²	R	R	NR	NR	NR	R (see Note 4)	NR	NR	NR	5 000 (5 000) (see Note 6)	NR	450 (450) (see Note 6)

NATIONAL BUILDING CODE OF INDIA 2016

Table 7 — (*Continued*)

Sl No.	Type of Building Occupancy	Type of Installation: Fire Extinguisher	Fire Hose Reel	Wet Riser	Down Comer	Yard Hydrant	Automatic Sprinkler System	Manually Operated Electronic Fire Alarm System (*see* Note 1)	Automatic Detection and Alarm System (*see* Note 2)	Water Supply (Litre): Under-ground Static Water Storage Tank Combined Capacity for Wet Riser, Yard Hydrant and Sprinklers per Set of Pumps	Terrace Tank over Respective Tower/ Terrace	Pump Capacity (litre/min): Pump Near Underground Static Water Storage Tank (Fire Pump) with Minimum Pressure of 3.5 kg/cm² at Remotest Location	At the Terrace Tank Level with Minimum Pressure of 3.5 kg/cm²
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	iii) More than ground plus one floor	R	R	R	NR	R	R	R	R	100 000	10 000	(*see* Note 10)	450
j)	Multi-Level Car Parking (MLCP)	R	R	R	NR	R	R	R	NR	150 000	10 000	(*see* Note 11)	900
HAZARDOUS BUILDINGS (*J*) (*see* Note 20)													
1)	Up to 15 m in height												
	i) Single Storey Building	R	R	R	NR	R	R	R	R	Minimum 240 min firefighting requirements	NR	(*see* Note 21)	NR
	ii) More than one floor building but not exceeding 15 m	R	R	R	R	R	R	R	R	Minimum 240 min firefighting requirements	50 000	(*see* Note 21)	900

R – Required
NR – Not Required

NOTES

1 MOFFA System shall also include talk-back system and public address system for the occupancies given in the table for (d) (1) (iii) under A-5, (a) (1) (iv) and (a) (2) under C-1, and (a) (2) under D-1 to D-5, in all buildings 15 m and above in height, except for A-3 and A-4 occupancies where these shall be provided for buildings of height 24 m and above. These shall also be provided in car parking areas more than 300 m² and in multi-level car parking irrespective of their areas.

2 Automatic detection and alarm system is not required to be provided in car parking area. Such detection system shall however be required in other areas of car parking such as electrical rooms, cabins and other areas.

3 Buildings above 15 m in height are not to be permitted for occupancies A-1 and A-2.

4 Required to be installed in basement, if area of basement exceeds 300 m².

5 Required to be provided if basement area exceeds 200 m².

NATIONAL BUILDING CODE OF INDIA 2016

Table 7 — (*Concluded*)

6 Additional value given in parenthesis shall be added if basement area exceeds 200 m².

7 Required to be provided for buildings with more than two storeys (Ground + One).

8 Required to be provided for buildings with height above 15 m and above.

9 Sprinklers shall be fed water from both underground static water storage tank and terrace tank.

10 Provide required number of sets of pumps each consisting of one electric and one diesel pump (stand by) of capacity 2 280 litre/min and one electric pump of capacity 180 litre/min (*see* Fig. 11) (*see also* notes 22 and 23)

11 Provide required number of sets of pumps each consisting of two electric and one diesel pump (stand by) of capacity 2 280 litre/min and two electric pump of capacity 180 litre/min (*see* Fig. 12) (*see also* Notes 22 and 23).

12 Provide required number of sets of pumps each consisting of two electric and one diesel pump (stand by) of capacity 2 850 litre/min and two electric pump of capacity 180 litre/min (*see* Fig. 12) (*see also* Notes 22 and 23).

13 Lower levels in high rise buildings 60 m or above in height are likely to experience high pressure and therefore, it is recommended to consider multi-stage, multi-outlet pumps (creating pressure zones) or variable frequency drive pumps or any other equivalent arrangement.

14 Provide required number of sets of pumps each consisting of one electric and one diesel pump (stand by) of capacity 1 620 litre/min and one electric pump of capacity 180 litre/min (*see* Fig. 11) (*see also* Notes 22 and 23).

15 Required to be provided for buildings with more than one storey.

16 Buildings above 30 m in height not to be permitted for Group B, Group C, Group D and Group F occupancies.

17 The requirements given in this table for Group G Industrial Buildings are for small scale industry units. For other industries the requirements will have to be worked out on the basis of relevant Indian Standards and also in consultation with the local fire authorities.

18 Buildings above 18 m in height not to be permitted for G-1 and G-2 occupancies.

19 Buildings above 15 m in height not to be permitted for G-3 occupancies.

20 Buildings above 15 m in height not to be permitted for Group H and Group I occupancies. However, buildings above 45 m in height shall not be permitted for multi-level car parking (MLCP) occupancy.

21 Pump capacity shall be based on the covered area of the building.

22 One set of pumps shall be provided for each 100 hydrants or part thereof, with a maximum of two sets. In case of more than one pump set installation, both pump sets shall be interconnected at their delivery headers.

23 Alternative to provisions of additional set of pumps, the objective can be met by providing additional diesel pump of the same capacity and doubling the water tank capacity as required for one set of pumps.

24 As per the requirement of local authority dry riser may be used in hilly areas, industrial areas or as required.

PART 4 FIRE AND LIFE SAFETY

Technical Proposal

Preliminary Bidding Design

Civil Works - DBR

Design Basic Report - Civil Works

DESIGN BASIC FOR MAIN CIVIL WORKS

The following design basis shall be followed in general for designing the building and its supporting structures.

1.0 STRUCTURAL SPECIFICATION

1.1.1 LOADS

The structures shall be designed keeping the following loads as basis.

i) Dead Loads
The dead loads to be considered in design of structures are based on following density of materials as per IS-875(Part-I)-1987

ii) Live Loads
The live loads considered for the design are as per IRC: 875(Part-II)-1987

iii) Wind Loads
Wind load on the structure is IS: 875 (Part-III)

iv) Seismic Loads
Seismic loads to be calculated as per map of India given in IS-1893-2000(Part-I).

1.1.2 COMBINATION OF LOAD CASES

Combinations of the above loads are carried out as IS: 456-2000.

2.0 DESIGN

Design of all Reinforced Concrete members are as per IS: 456-2000 & IS-3370:2009.

3.0 GRADE OF CONCRETE AND REINFORCEMENT

The following grade of concrete and steel shall be used:

a. For all Structures – M30 concrete

b. For all Structures – Fe 500 - HYSD reinforcement

4.0 CLEAR COVER TO REINFORCEMENT

The minimum clear cover to reinforcement shall be as follows:

a. The minimum cover to the main reinforcing bars for different members shall be as follows unless stated otherwise:

i) Slab (Floor, Roof, Canopy and Staircase) 30mm

ii) Beams (Sides, Bottom & Top) 40mm
iii) Columns 50mm

iv) Pedestals (in contact with earth) 50 mm Basement wall, retaining walls

i. Face in contact with earth 40 mm
ii. Interior face 30 mm
iii. Foundations 75 mm

5.0 DESIGN CONDITIONS FOR UNDERGROUND OR PARTLY UNDERGROUND

All underground or partly underground structures shall be designed for the following conditions:

i. Structure empty (i.e., empty of liquid, any material, etc.): full earth pressure and surcharge pressure wherever applicable, to be considered;

ii. Partition wall to be designed as per specifications mentioned in the drawings;

iii. Structures shall be designed for uplift in empty conditions

iv. Walls shall be designed under operating conditions to resist earthquake forces from earth pressure mobilization and dynamic water loads;

v. Underground or partially underground structures shall also be checked against stresses developed due to any combination of full and empty compartments with appropriate ground/uplift pressures from below to base slab. A minimum factor of 1.2 shall be ensured against uplift or floatation.

6.0 SAFE BEARING CAPACITY

The data for safe bearing capacity of the soil shall be obtained from the soil investigation report.

7.0 DESIGN AND DRAWING SOFTWARE

Approval of the engineer shall be taken for the computer software for the design of the MTHL prior to commencement of the design works.

All the drawing for submission to the Engineer shall be prepared using the Autodesk of the version acceptable to the Engineer, unless otherwise permitted in writing by the Engineer.

8.0 REQUIREMENTS FOR CONCRETE SUPERSTRUCTURE, SUBSTRUCTURE AND FOUNDATION

8.1. General Requirements

8.1.1 Substructures and Foundations

The following requirements shall apply to the design and construction of the foundations of Buildings and Toll Plaza:

(i) At the time of bidding, for the purpose of preparing the preliminary/bidding design, we shall set an estimate based on the geological/subsoil investigation report issued by the Employer in the Technical Design stage after award of the Contract,

(ii) We shall determine the final ground levels at the proposed locations of the Toll Plaza and buildings. Based on that if required additional subsoil investigation may be carried out.

(iii) Soil investigations shall be carried our conforming the provisions of IRC for design of the foundations during the Technical Design stage.

(iv) Subsoil investigations shall be carried out which involves boreholes at least at every proposed Structure or abutment location, to assess the nature and characteristic of founding strata to finalize the base design. Additional boreholes shall also be taken, at no additional cost to the Employer, as may be ordered by the Engineer, as needed to confirm the strata as per requirement emerging during the design or Execution of the Works.

(v) In case there is a variation found in the information presented in the subsoil investigation report provided by the Employer and the depth of foundations assumed in the preliminary/bidding design is required be changed due to the difference in sub-soil strata, costs for the difference in the depth of foundation shall be adjusted equitably under GC Clause 13.

(vi) The onus of proving the variation in the information presented by the Employer in the geological/subsoil investigation report shall be on us.

(vii) Necessary measures shall be taken to prevent siltation.

(viii) The concrete piles shall be verified for its integrity by Sonic echo test. Sonic tubes shall be installed in all of piles, and the test shall be carried out randomly according to the Engineer's decision.

(ix) Foundation types shall be designed for all area. Types of foundation can be proposed to the Engineer by the Contractor for his approval.

8.1.2 Concrete Superstructure

The following requirements shall apply to the design and construction of concrete superstructure of Buildings and Toll Plaza:

(i) The minimum span length of the superstructure will be proposed to the Engineer for his approval,

(ii) Superstructure for the concrete Areas can be proposed to the Engineer for his approval.

8.1.3 Durability

Concrete should be durable to provide satisfactory performance in the anticipated exposure conditions during service. The materials and mix proportions specified and used, and the workmanship employed should be such as to maintain its integrity and to protect embedded metal from corrosion.

Total chloride content in concrete, expressed as chloride-ion, shall not exceed the following values by mass of cement used

Type	Amount (percent)
Prestressed concrete	0.10
Reinforced concrete	-
(i) in severe condition of exposure	0.20
(ii) in moderate condition of exposure	0.30

(1) Chloride Migration Coefficient Test

Chloride Migration Coefficient Test shall be tested as per NT Build 492.

For Substructure, Chloride migration coefficient shall be less than 2 x 10-12m2/s. For Superstructure, Chloride migration coefficient shall be 2 to 8 x 10-12m2/s

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8.1.4 Cement

Cement for various structural elements shall be the following types.

a) Pile (Severe Exposure): PSC as per IS 455, PPC as per IS 1489 Part 1 with minimum compressive strength of 53 MPa at 28 days as per IS 14343

b) Pile Cap, Raft Foundation: PSC as per IS 455, PPC as per IS 1489 Part 1 with minimum compressive strength of 53 MPa at 28 days as per IS 14343

c) Superstructure: OPC, PSC as per IS 455, PPC as per IS 1489 Part 1 with minimum compressive strength of 53 MPa at 28 days as per IS 14343

Cement to be used in the works shall be any of the following types with the prior approval of the Engineer:

a) Rapid Hardening Portland Cement, conforming to IS:8041.

b) Ordinary Portland Cement, 43 Grade, conforming to IS:8112.

c) Ordinary Portland Cement, 53 Grade, conforming to IS: 12269.

Cement conforming to IS: 8112 and IS: 12269 may be used provided the minimum cement content mentioned elsewhere from durability considerations is not reduced. From strength considerations, these cements shall be used with a certain caution as high early strengths of cement in the 1 to 28- day range can be achieved by finer grinding and higher constituent ratio of C3S/C2S, where C, S is Tricalcium Silicate and C2S is Dicalcium Silicate. In such cements, the further growth of strength beyond say 4 weeks may be much lower than that traditionally expected. Therefore, further strength tests shall be carried out for 56 and 90 days to fine-tune the mix design from strength considerations.

Cement conforming to IS: 8041 shall be used only for precast concrete products after specific approval of the Engineer.

9 REQUIREMENTS FOR STEEL SUPERSTRUCTURE

9.1. General Requirements

The following requirements shall apply to the design and construction of the Buildings and Toll plaza Structures:

i. Specific Requirements
ii. General

Our responsibilities include, but not be limited to, the following.

We shall provide all materials and equipment required to complete the Works in every respect, whether such materials and equipment are required as part of the permanent structures or temporary for fabrication or erection or maintenance including specifically structural steel plates, shapes, flats, bars, welding rods, rivets, bolts and nuts, paint, welding sets in the shop and at site, all workshop facilities, derricks, cranes, pulley blocks, wire ropes, slings, hemp or manila ropes, winches, small tools and tackles, jacks, erection cleats and temporary braces or supports and all other materials required to deliver the Works complete in every respect.

We shall supply all labour required for fabrication and erection for any cleaning, making good, rectifying, hauling, and painting and for any other ancillary work required to complete fabrication and erection.

We shall observe all safety requirements for erection of structural steelwork as covered in IS: 7205 as a minimum and other relevant Indian / international standard.