tumi E-Bus Mission

ICLEI Local Governments for Sustainability

THE URBAN LAB

Guidebook for

STANDARD OPERATING PROCEDURES FOR ELECTRIC BUS DEPOT OPERATIONS IN INDIA

Prepared under TUMI E-Bus Mission

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Source: downtoearth.org.in

1 Introduction

1.1 Transitioning Towards E-Buses

The transportation sector contributes a significant amount of greenhouse gases to our atmosphere. Hence, countries across the world are now investing in cleaner public transport systems to mitigate the negative impacts of these GHGs on our climate, air quality and the overall quality of life. Buses form an integral part of the public transport sector. As the world grows more sensitive towards climate change, electric buses are set to become one among the forerunners of this transition. If we look across the globe, Chile has 2659 EV buses in operation and Columbia has 1590 operational units (97% of those are BYD: 1547; 93% runs in the capital city Bogota) as of 2024. (Bus, 2024). Shenzhen, China has achieved 100% electrification deploying 16,000 e-buses. In South Asia, India has taken up a significant role in the e-bus sector with 5700 e-buses and aims to deploy 50,000 e-buses by 2030.

India's electric bus story took off in 2021 with support from the national program to aggregate e-bus demand, coupled with subsidies provided under the Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles in India (FAME) scheme. The resultant demand signal and economies of scale helped e-buses achieve price parity with internal combustion engine (ICE) buses at a much earlier stage of development of the e-mobility ecosystem.

The Prime Minister (PM)- e-bus Sewa scheme, a flagship project launched by the Ministry of Housing and Urban Affairs (MoHUA), Government of India in August 2023 will help deploy 10,000 e-buses through a public-private partnership (PPP) model in 169 cities. More than 15,500 e-buses have been tendered out through demand aggregation as of December 2023. India and the United States have also started a "Payment Security Mechanism (PSM)" to help with the deployment of 38,000 e-buses built in India. (Foundation, 2023)

The commercial freight vehicle ecosystem in the country is also incorporating the lessons learned from India's e-bus experience. During the Clean Energy Ministerial (CEM) in July 2023, NITI Aayog and WRI India jointly introduced e-FAST India (Electric Freight Accelerator for Sustainable Transport – India), the nation's first national electric freight platform. Under this platform, leading Indian manufacturing firms and logistics service providers have united to express their demand for 7,750 electric freight vehicles by 2030.

Key barriers to accelerated adoption of e-buses include payment risks for operators/original equipment manufacturers (OEMs) and operational risks for public bus agencies. Cities across the globe have adopted innovative business models to address these issues.

1.2 Elements of E-Bus Depot

An **e -bus depot** can be defined as the premises where e-buses are serviced and parked after the daily operation. (UITP, 2024) It entails several facility areas designed to cover the managerial, maintenance and administrative tasks needed to operate a fleet of e-buses. The main elements of an e-bus depot can be listed as follows:

- Entry and exit
- Parking bays for buses
- Washing and cleaning
- Charging, including energy storage (2nd life of batteries)
- Maintenance workshops, including fire safety systems
- Warehouse & storage
- Administrative & operational facilities
  - Operational control center
  - Facilities for drivers (cloakrooms, personnel rooms, etc.)
- Parking for staff and externals

Based on the elements and tasks performed in an e- bus depot, this document highlights main considerations and provide tips for the different elements and phases of depot planning, deployment and operation for battery electric, fuel cell hydrogen and natural gas buses.

1.3 Standard Operating Procedures (SOP) for E-Bus Depots

Standard operating procedure (SOP) for an e-bus depot works as a guideline that outlines clear, systematic instructions to all the depot staff members to ensure safe and efficient operations for all the activities within the depot, which typically include maintenance, charging operations, parking management of the e-buses, and also waste management, staff coordination, safety protocols for staff and equipment. An SOP not only explains how to perform a task related to any of the depot section, but also details out who is assigned with the responsibilities and establishes clear standard operational procedures. This ensures that all the staff and support personnel follow a unified approach and methodology, promising accountability and promoting coordination for all the tasks within the depot.

With respect to the e-bus depots, where staff members handle high voltage systems and batteries, and also take up environmentally sustainable practices for the same in the depot, a well-structured and consciously crafted standard operating procedure (SOP) is essential to ensure all depot employees, including drivers and maintenance personnel, are safe and healthy. The workplace is professional and cooperative.

The SOP enables the depot to operate safely and sustainably by unifying all activities under a single framework, supporting the resilience and long-term success of electric bus network.

1.4 Sequential Activities of an E-Bus Within an E-Bus Depot

The sequential activities undertaken by an e-bus from the moment it enters the depot until it is dispatched for its next trip are outlined as follows in detail.

1 Bus Enters the Gate

Conductor de-boards (if any)

2 Gatekeeper Checks the Bus

- Data Entry
- Run Kilometers
- Bus Complaints
- Full Body Check (internal & external)

3 Washing

4 Depot Supervisor

Allots a charger

5 Charging

Bus without a chiller system will require maneuvering time

Bus with a chiller system won't require maneuvering time

Driver de-boards

6 Cleaning

Incase of breakdown or any complaint, bus will go to the ramp (workshop) for maintenance

7 Maintenance

Driver boards

8 Parking at the Parking Bay

9 Bus Exits (According to its shift)

1.4.1 Existing Challenges

Improper management of the State of Charge (SOC) during the charging process, leading to battery degradation over time, resulting in reduced range and efficiency.

After about five years, the battery health in our electric buses really starts to drop. I've had buses stop right in the middle of a trip because of it. OEMs should tell us upfront that the battery might not last beyond five years, so we're not caught off guard on the road. (Refer page no. 18 for potential solution)

~ Bus Driver

When some of our team members are absent, there's no backup staff to fill in. That puts extra pressure on those of us who are present, and it ends up delaying both bus operations and maintenance work. (Refer page no. 51 for potential solution)

~ Workshop Staff

The manufacturing company should carry out product inspections every six months. Without these regular checks, the buses start wearing out faster, and that becomes a major challenge for us depot managers to handle. (Refer page no. 40 for potential solution)

~ Depot Manager

Source: istockphoto.com

2 Global Best Practices

2.1 Best Practices Around the World

The study of specific implementations across the globe with respect to E bus depot, explores best practices in depot operations, with a focus on innovative approaches to efficiency, sustainability, and service reliability. Insights from this review will support the development of a Standard Operating Procedure (SOP) for e-bus depot operations, tailored to ensure effective and future-ready management.

Review of best practices in around the world:

City	Key Feature	City Specific Implementation	Outcomes & Benefits
CHARGING OPERATIONS			
Shenzhen, China	**Overnight Smart Charging & Energy Storage**	• Shenzhen uses **smart charging stations** that optimize charging schedules based on grid demand, charging buses during off-peak hours to reduce costs. (Lin, 2019) • Integration of **energy storage systems** (e.g., batteries) to store electricity from the grid during off-peak times and discharge during peak periods. • Charging infrastructure is **cloud-connected**, allowing for real-time monitoring and predictive maintenance.	• 50% energy cost savings due to optimized charging schedules • Enhanced fleet uptime by reducing charging downtime • Reduced load on the electrical grid during peak hours
Hamburg, Germany	**Modular Charging Infrastructure**	• Hamburg designed **modular charging stations** to allow for quick expansion as the fleet grows. (Siemens, 2021) • **Charging units can be added or removed** with ease, making the depot adaptable to future demand. • Infrastructure includes **high-power chargers** that provide faster turnaround times for e-bus charging, reducing downtime.	• 25% faster installation time for new charging stations • Scalability of infrastructure supports future fleet growth • Reduced operational disruption due to flexible infrastructure

City	Key Feature	City Specific Implementation	Outcomes & Benefits
		• The system integrates **data-sharing platforms for real-time tracking** and energy management. (Sustainable Bus, 2021)	
Chile, Santiago	**Modular Charging Infrastructure**	• **Provided smart charging infrastructures** for 1,594 electric buses, • **Use of telematics and vehicle monitoring systems** to track charging status, route performance, and maintenance needs enabled predictive maintenance • Depots are **designed to be modular**—capable of scaling up as more e-buses are added.	• Optimizing energy use and ensuring efficient charging schedules. • Reduced downtime. • Facilitates phased deployment and future expansion without major redesign.
Surat, India	**Solar-Powered Charging Infrastructure**	• **Surat inaugurated India's first solar-powered electric bus depot at the Althan bus depot.** A 100-kW rooftop solar power plant, powers the facility by generating solar energy stored in refurbished second-life batteries.	• Enables e-bus charging even at night.
Rajkot, India	**Robust Charging Infrastructure**	• The depot is equipped with 14 DC fast chargers, each capable of charging an e-bus battery from 20% to 100% in approximately 55 minutes	• Ensures rapid turnaround times for buses.
GENDER INCLUSIVITY			
Stockholm, Sweden (SL)	**Inclusive Depot Design and Recruitment**	• Depots designed with **gender-neutral restrooms**, break rooms, and locker facilities to ensure comfort and equality for all employees. • Gender sensitivity incorporated into	• Increased representation of women in traditionally male-dominated roles (engineering and maintenance) • Higher retention rates among female

City	Key Feature	City Specific Implementation	Outcomes & Benefits
		employee training programs for all levels. • Flexible work hours and career progression opportunities tailored for **women with caregiving responsibilities** (Friman, 2019)	employees due to inclusive work environment • Recognition as a leader in gender inclusivity within transport sector
Berlin, Germany (BVG)	**Gender Equality in Training and Career Development**	• Introduced targeted training programs for women in sustainable technologies, such as e-bus fleet management and energy systems. • Implements mentorship programs pairing female employees with senior leadership. • Gender diversity objectives included in performance reviews for managers. • Offered on-site childcare and flexible scheduling to support work-life balance for female staff (BVG, 2021)	• 30% increase in female applicants for technical roles • More women in leadership roles due to mentorship programs • Improved gender parity in workforce, leading to better team dynamics and innovation
PARKING			
Melbourne, Australia (Ventura Bus Lines)	**Mixed-Use Depot with Shared Parking**	• Implemented **color-coded zoning** to designate spaces for electric-only parking and charging. • Uses **real-time parking occupancy monitoring** to prevent congestion. (Department of Transport and Planning, 2024)	• Smooth coexistence of legacy and electric fleets • Clear demarcation reduced parking errors • Allowed for gradual electrification without major depot redesign.
ENVIRONMENTAL PROTOCOLS			
London, UK (TfL)	**End-of-Life Bus Component Recycling Framework**	• Establishes depot-level **disassembly protocols for decommissioned buses** — segregating	• >85% of decommissioned e-bus components recycled.

City	Key Feature	City Specific Implementation	Outcomes & Benefits
		electronics, metals, and plastics. • **Contracts with certified recyclers** who meet UK Environment Agency standards. • Uses a **green rating system for depots** based on waste recovery efficiency. (Transport for London, 2024)	• Promoted sustainable procurement practices. • Supported national circular economy goals.
Hamburg, Germany	**Water Recycling & Reuse Systems**	• Uses filtration systems and sedimentation tanks to reuse greywater for cleaning.	• Saves up to 80% of water, reduces operating costs, and complies with environmental norms.
Shenzhen, China	**Green Depot Infrastructure with Solar Integration**	• New **e-bus depots feature green roofs, solar panels, and rainwater harvesting systems**. • **Solar energy** supports lighting, admin blocks, and partial charging load (iF Design, 2025) • **Roofs planted with sedum and moss** help reduce urban heat. • Depot design **optimized for natural ventilation and daylight use**.	• Reduced grid dependency and cooling energy demand. • Lowered operational carbon footprint • Helped meet city's green building standards.
ENERGY MANAGEMENT			
Los Angeles, USA (LA Metro)	**Energy Management System (EMS) with Renewable Integration**	• EMS monitors energy usage across chargers, HVAC, and auxiliary systems. • **On-site solar panels** with battery energy storage system (BESS) power ~30% of depot load. • **Buses charged based on route priority** and **battery SoC** to balance grid load.	• Reduced peak energy demand by 40% • Lower carbon footprint through renewables • Increased resilience during grid strain and outages

City	Key Feature	City Specific Implementation	Outcomes & Benefits
		• Active demand response protocol with the utility (LADWP).	
Bogota, Colombia	**Renewable Energy and Energy Efficiency**	• Equipped Bogotá depots with **photovoltaic solar panels** and **LED lighting**,	• Improved energy efficiency and sustainability.
Paris, France (RATP)	**Staggered Fast-Charging & Depot Microgrid Pilot**	• **Operates a mix of fast and slow chargers**, deployed in a rotation to avoid simultaneous peaks. (Sustainable Bus, 2023) • **Depots monitored for energy use per vehicle per shift** to optimize load allocation.	• Reduced total energy cost per km by ~20% • Improved planning for energy infrastructure upgrades • Demonstrated replicability for multi-depot energy planning
Rajkot, India	**Comprehensive Electrification of Fleet**	• Achieved 100% electrification of its Bus Rapid Transit System (BRTS), deploying 352 electric buses across all 13 routes.	• This transition underscores the city's commitment to reducing carbon emissions and promoting sustainable public transportation.
MAINTENANCE			
Amsterdam, Netherlands (GVB)	**Compact Depot Design with Preventive Maintenance Modules**	• With limited space in Amsterdam, GVB created compact service bays equipped with vertical storage, quick-access pits, and stackable charging interfaces. (The Mobility House, 2021) • They adopted a modular preventive maintenance schedule based on mileage and battery cycles, tracked through RFID and onboard systems. • Technicians receive digital alerts and checklists	• **Higher space efficiency** allowed full-service maintenance in small footprints. • Reduced technician error through **digitized, bus-specific instructions**. • Efficient fleet rotation with **minimal parking shuffles**, helping keep depot operations lean and timely.

City	Key Feature	City Specific Implementation	Outcomes & Benefits
		customized for each bus's configuration and use pattern.	
Rajkot, India	**Comprehensive Maintenance Facilities**	• The depot includes specialized bays for the maintenance and servicing of electric buses.	• Facilitates regular upkeep and minimizing downtime
SAFETY			
Shenzhen, China	**Fire Suppression & Thermal Monitoring**	• All e-bus depots are equipped with automatic fire detection and suppression systems specifically designed for high-voltage batteries. • Real-time thermal monitoring sensors detect abnormal heat generation from battery packs. • Emergency shut-off systems allow remote disconnection of charging in case of anomalies.	• Drastic reduction in battery-related fire incidents • Enhanced safety of staff and assets • Minimized downtime due to proactive intervention

Table 1 Best Practices Across the World

Ultimately, adopting global best practices for e-bus depot operations is important in order to ensure safety, efficiency, sustainability, also to ensure fleet reliability long-term. If you do develop a Standard Operating Procedure (SOP) that is effective, then you must integrate all these practices with consideration and consider feasibility with adaptability locally.

Source: sustainable-bus.com

3 Charging Operations

3.1 SOP for Charging Operations

1 PLANNING OF CHARGING INFRASTRUCTURE

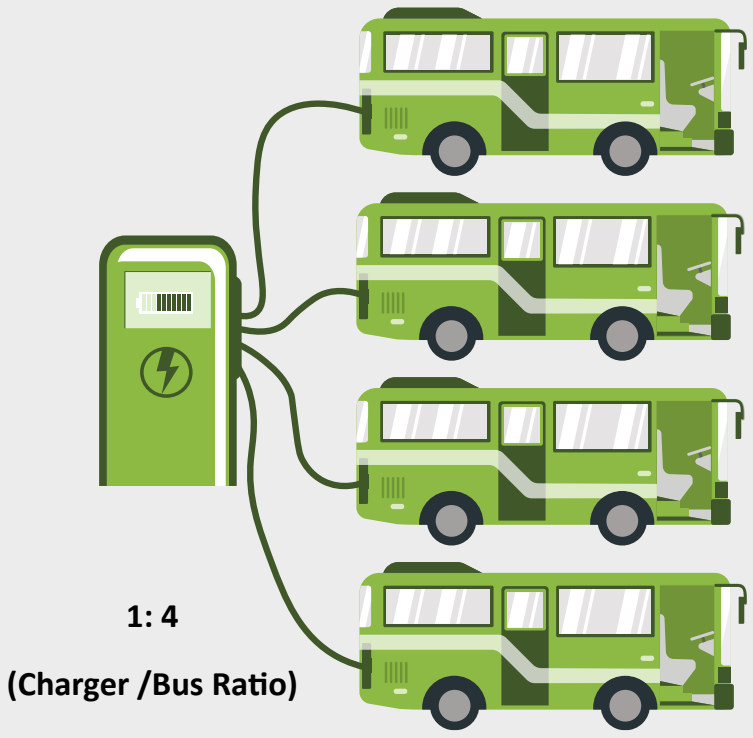
STEP 1: ESTIMATION OF NUMBER OF CHARGERS

The OEMs or the transport authority usually estimates the number of chargers that exist in an e-bus depot if they do consider the fleet size, daily energy needs, charging types and operational hours. Smooth depot operations along with timely charging rely on several factors being included. For these factors are charger capacity, bus-to-charger ratio, and a buffer for delays or future expansion.

STEP 2: DETAILED CHARGING SCHEDULE

Based on the chosen charging strategy (overnight, fast, opportunity charging), the OEMs provide a detailed charging schedule. This scheduling considers factors such as fleet size, operational hours, trip details and capacity of charger. This aids energy efficient power usage, minimize queuing of the buses at the depot and maintain preparedness of the entire bus fleet.

Estimation of Number of Chargers for Depot by State Transport Undertakings



- **Estimation of number of chargers** required to operationalize a bus depot with '**x**' number of e-buses is done **based on factors like Rated Range (Km), On Board Battery Capacity (kWh), Daily Runs (Km), Number of E-buses, Proposed Capacity of Charger (Kw) and Charger/Bus ratio**.
- Assuming that the electric public buses would be subjected to both day and night charging in bus depots, the charger requirement for AC and Non-AC buses of 12m and 9m length has been worked out. (CESL, 2022)
- Estimation of number of chargers is usually provided by STUs or Government.

STEP 1: ARRIVAL AND ENTRY PROTOCOL

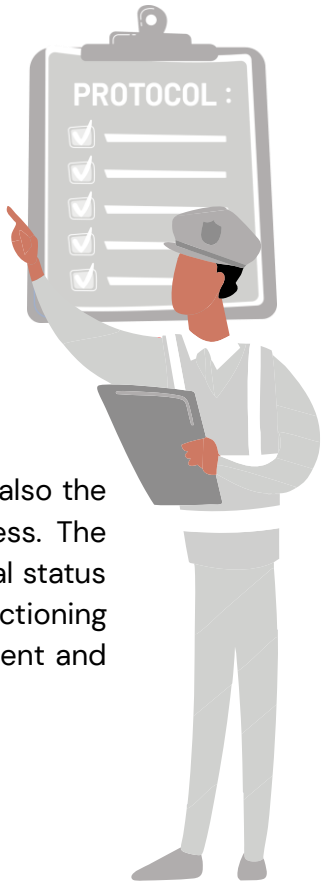
Upon arrival of each bus post trip, should have its entry time logged using RFID, OR code scanning, or a manual log sheet. Based on factors such as the arrival schedule, current battery charge, and next dispatch timing, buses should be directed to charging as instructed in the detailed charging schedule. This ensures organized movement and prioritization within the depot.

STEP 2: CHARGER ALLOTMENT

Charging bays/ Charger should be assigned for we consider operational priority, upcoming dispatch time, also the current battery status of bus. Depot supervisors manage allocation. They act according to their choice. It also can be managed through software for automated charging management as well. Ahead of directing a bus toward the bay, it is important to confirm a charger exists. It's important to check if the charger is open.

STEP 3: CHARGING HOOK UPS

Staff working at charging operations must be at the charger. It is authorized to connect the charger to the bus for personnel who are certified with PPE that is appropriate only. Accurately record charger ID, battery percentage, and start time, as key charging details.



STEP 4: PRE CHARGING CHECKS

Before charging can begin, inspect the charger connectors and also the vehicle's charging ports for wear or for damage and cleanliness. The software interface is there to help in checking on the operational status for the charger. This way verifies that the charger is ready and functioning properly. If required, clean the connector pins to maintain efficient and safe charging.

STEP 5: MONITORING DURING CHARGING

Each bus's charging status has to be continuously monitored by the charging operations staff as well. For the maintenance of battery health, they must make sure that buses are not charged beyond their State of Charge (SOC) limit. The battery system will then function correctly. Supervisors should be notified immediately about any irregularities, faults, or alerts. The system that is affected must be isolated in the event of serious issues that arise, and the maintenance team must be notified without any delay.

STEP 6: POST CHARGING PROCEDURE

Record the end battery percentage, cumulative charging time, and efficiency values in the system. Disconnect the charger safely through appropriate procedures and keep the cable stowed neatly for safety. Update the system status to indicate the bus as "Charged" and transfer it to the assigned dispatch lane or post-charging parking bays for the next utilization.

3 STAFF TRAINING

STEP 1: FRESHER TRAINING

All of the newly appointed charging operations staff members must receive a more thorough training in the electric vehicle (EV) systems. The training must focus upon electric bus fundamentals, battery types, also slow, fast, and opportunity charging methods. To ensure smooth operations and personal safety, people should adhere to proper procedures, identify risks, and stress high-voltage safety to connect and disconnect chargers.

STEP 2: SAFE HANDLING OF EQUIPMENT

For fewer safety risks, workers require training about correct choice, use, and keeping of PPE. In knowing the kind of PPE needed for various functions such as gloves helmets and insulated clothing and that it is properly worn is involved. Instructors have a need to instruct safe storage habits for retaining the PPE's integrity in order to make it ready for use during dangerous operations.

STEP 3: SAFETY PREPAREDNESS

Workers must be required to join an in-depth fire safety and crisis reaction course. This will get them ready. They would handle fire-related incidents effectively. This training must include a comprehension of fire hazards, the proper use of fire extinguishers, as well as evacuation procedures. Trainees should learn also to operate emergency cut-off switches.

STEP 4: REGULAR TRAINING AND DRILLS FOR STAFF

Organise such regular monthly training sessions and safety drills in order that vital knowledge is updated regarding EV charging systems, high-voltage safety, emergency procedures and PPE use. Periodic drills will keep staff well-trained in emergency procedures and fully prepared for both regular operations and emergency response situations.

4 MONITORING AND REPORTING

STEP 1: REGULAR INSPECTION OF INFRASTRUCTURE

Conduct daily inspections of all charging infrastructure ensuring safe equipment and efficient functioning. Charger connections, cables, and also high-voltage components should be checked. Integrity of the overall system also should be checked now. Quickly repair any wear, damage, or failure that seems likely to stop problems and risks.

STEP 2: MAINTENANCE OF SUMMARY LOGS

Detailed summary logs for all charging operations at the e-bus depot should as well be maintained up-to-date. This would include recordings for charger usage, charging times, energy consumption, system faults, and activities that require maintenance. Accurate documentation renders operations transparent also helping to troubleshoot problems. Reporting also gets informed, with performance monitoring supported.

STEP 3: FEEDBACK FROM STAFF

The inputs and feedbacks from the staff could be collected in the form of feedbacks and surveys regarding any sort of operational issues faced during the day. This provides valuable information to understand existing gaps , which when resolved adds to the overall efficiency .

Source: economictimes.indiatimes.com

4 Parking Management

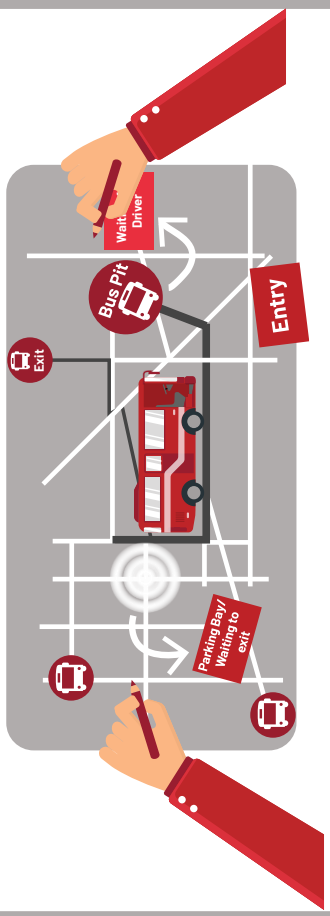
4.1 SOP for E-Bus Depot Parking

1

PLANNING OF DEPOT LAYOUT

STEP 1: LAYOUT PLANNING

The depot layout should be planned in such a way as to ensure that movement of buses is smooth, safe, unobstructed and also confusion-free. They ensure smooth movement because entry and exit points, parking bays, and bus lanes are clearly marked. For easy access, tactically locate charging stations in maintenance zones.



STEP 2: SMART TECHNOLOGY SETUP

For efficient management, CCTV should equip the depot to monitor internal bus movements within the parking area. Real time vehicle tracking systems monitor bus location. They will be able to also help with monitoring operational status. To ease internal flow, parking combines with charging hardware. Charging schedules can also coordinate in a better way because of this integration.

2

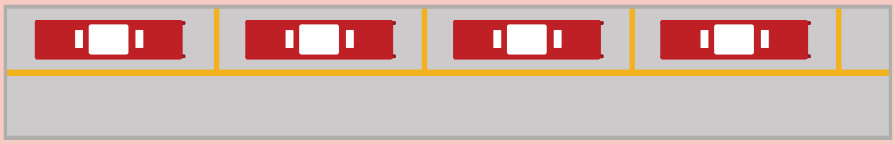
DESIGN ELEMENTS FOR DEPOT

STEP 1: NUMBERING AND SIGNAGE

Each of the parking bays must be clearly marked and numbered to help drivers and staff identify locations quickly. Provide signages that show direction to guide internal movement and cautionary signages (like speed limits and 'no horn' zones) would enhance operational discipline. Signages must be visible and placed at key points to ensure functionality and safety.

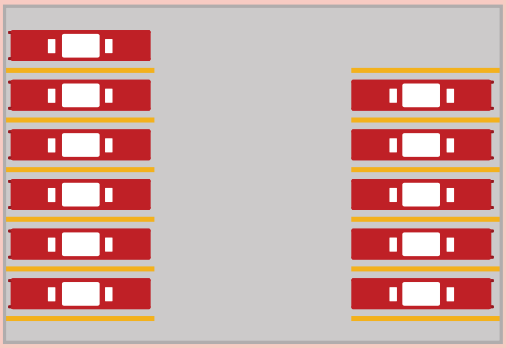
TYPES OF PARKING

1. PARALLEL PARKING



In this layout, buses are parked along the length of the lane, parallel to the direction of movement. It is suitable for narrow spaces and offers better space utilization especially in constrained areas. However, it has lower parking capacity, requires more maneuvering time and is generally slower making it unpreferable for operations like entry and dispatch.

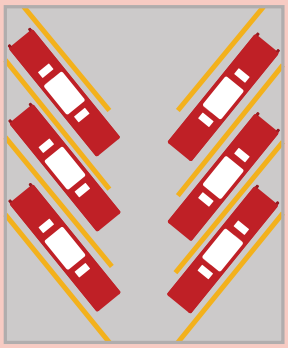
2. PERPENDICULAR PARKING



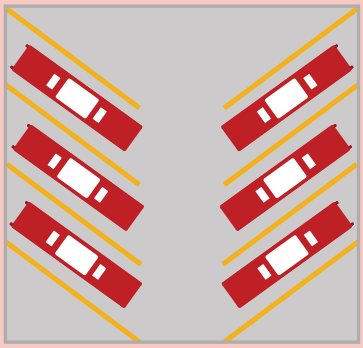
Buses are parked at a right angle to the driving lane. This layout maximizes the number of vehicles that can be accommodated in a given area. It is best suited for depots with ample space where bus movement is slower and more controlled.

3. ANGULAR PARKING

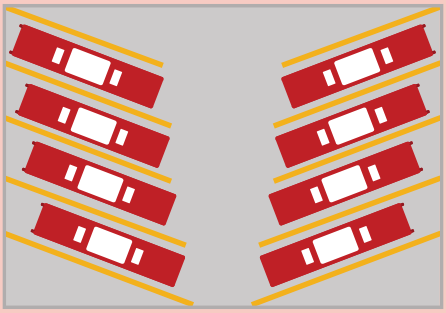
30°



45°



60°



In this layout, buses are parked at an angle (typically 45 or 60 degrees) to the driving lane. It allows easier and quicker entry and exit for drivers compared to 90-degree parking. This setup strikes a good balance between efficient use of space and ease of maneuvering. (Wikipedia, 2025)

STEP 2: ADEQUATE SPACING

Provide sufficient space between charging points and parking bays to ensure safe and easy manoeuvring of buses. Having proper spacings would reduce the risk of avoidable accidents and also allows for the safe handling of charging equipment. Installing safety features such as bollards along the parking bays would protect both the infrastructure and vehicles.

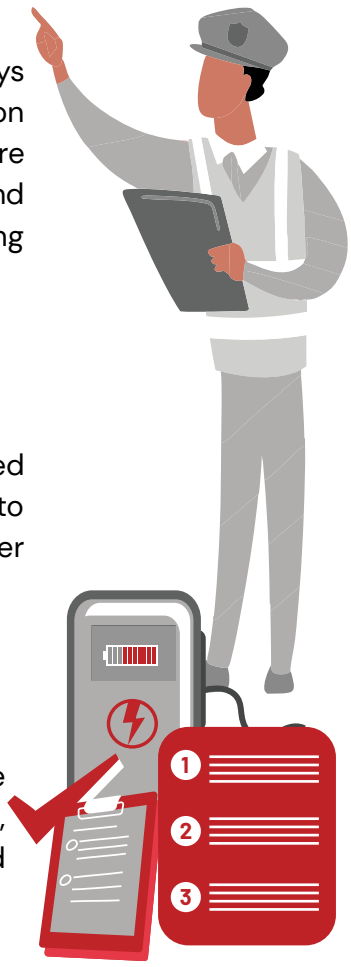
3 DAILY OPERATIONS MANAGEMENT

STEP 1: ARRIVAL AND ENTRY PROTOCOL

Upon arrival, each bus needs a manual log sheet, RFID, OR code scanning for logging its entry time. Appropriate parking bays should have buses directed toward them based on factors such as current battery charge, next dispatch timing, and the arrival schedule. This ensures that movement organizes and depot prioritizes for you.

STEP 2: BAY ASSIGNMENT

Depot supervisors or automated software can assign parking bays based on bus priority levels. The priority level can be based upon the battery levels. Battery buses have greater priority if they are low. It is important for maintaining operations that are smooth and timely within the depot, adhering to the plan for the parking schedule.



STEP 3: PARKING PROCEDURE

Drivers must strictly follow the marked lanes and adhere to speed limits within the depot. Parking attendants should be allotted to guide buses into their designated bays and confirm proper positioning to ensure safety and order.

STEP 4: CHARGING ALLOTMENT

If charging is required, only trained staff should handle the connection of the bus to the charging unit. Charging start time, battery percentage, and estimated time to SOC charge should be accurately logged for operational tracking.

4 SHIFT MANAGEMENT

STEP 1: STAFF ROTATION

Dedicated teams should be assigned for each shift, covering roles such as entry control, bay guidance, and charger operation. A daily briefing and proper handover between shifts are essential to maintain continuity and address any operational concerns.

5 MONITORING AND REPORTING

STEP 1: INSPECTION OF INFRASTRUCTURE

A routine visual inspection should be conducted to check the visibility and condition of demarcated parking bays, as well as the clarity and placement of the signages. Any sort of damages, faded markings, or missing signages (directional or cautionary) should be promptly recorded and reported for maintenance to ensure continued safety and operational efficiency.

STEP 2: MAINTENANCE OF SUMMARY LOGS

Maintain a daily record of all buses that were parked, charged, and dispatched. This log helps in tracking depot activity, managing schedules, and analysing operational performance.

STEP 3: FEEDBACK FROM STAFF

The inputs and feedbacks from the staff could be collected in the form of feedbacks and surveys regarding any sort of operational issues faced during the day. This provides valuable information to understand existing gaps , which when resolved adds to the overall efficiency .

Source: ackodrive.com/

5 Energy Management

5.1 SOP for Energy Management

1 LOAD ESTIMATION AND PLANNING

STEP 1: ASSESS CHARGING DEMAND

Estimate the total energy requirement of the depot by taking into consideration the number of e-buses in the fleet, their specifications (such as AC or Non-AC, 9m or 12m buses), and their average daily operational kilometres. This helps in determining the cumulative energy demand and guides the design of the electrical infrastructure and charger capacity needed for seamless depot operations.

STEP 2: DETERMINE NUMBER OF CHARGERS

Calculate the number of chargers required by applying a standard bus-to-charger ratio, typically 1:4 or 1:5, depending on operational needs. Consider the charging schedule; whether buses are charged during the day, night, or in staggered shifts. This ensures sufficient charging slots without delays. This estimation ensures optimal infrastructure utilization and avoids bottlenecks in fleet readiness.

Estimation Of Power Requirement for Depot (For 9 And 12m E-Buses) By STUs

Sl. No.	Description	9m AC Bus	9m non-AC Bus	12m AC Bus	12m non-AC Bus
1	Rated Range (Km)	180	180	200	200
2	On Board Battery Capacity(kWh)	220	200	350	260
3	Energy Consumed (kWh/Km)	1	0.85	1.3	1.1
4	Daily Run (Km)	200	200	225	225
5	No of e-buses	100	100	100	100
6	Proposed Capacity of Charger (kW)	180	180	240	240
7	Bus/charger ratio	4	4	4	4
8	Estimated no. of Chargers to meet energy demand-Dual Gun	25	25	25	25
9	Total Charger load/ Bus Depot (kVA)	4500	4500	6000	6000
10	Upstream capacity required/ Depot (mVA)	4.5	4.5	6.0	6.0

- An estimate of Power required to operationalize a bus depot with 100 pure e-buses is presented in the table above. Assuming that the electric public buses would be subjected to both day and night charging in STU owned bus depots, the charger requirement for AC and Non-AC buses of 12m and 9m length has been worked out. (CESL, 2022)
- Estimation of Load requirement is ***usually provided by STUs or Government***.

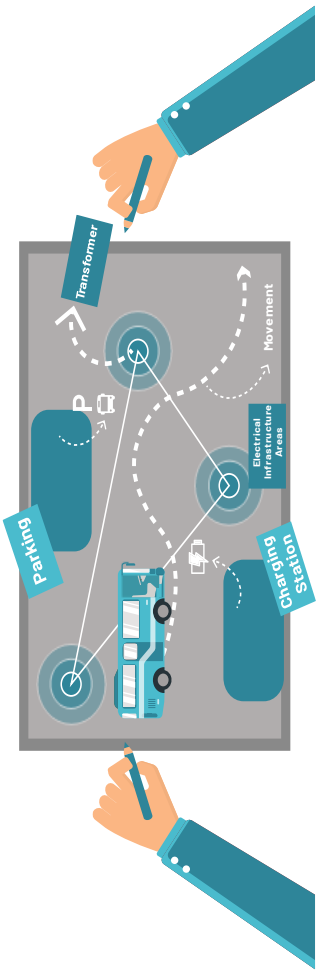
STEP 3: ESTIMATE TOTAL POWER LOAD

Depending upon the size of the fleet and charging infrastructure available, the power load required for the depot can be determined. The typology of the bus, capacity of the charger and simultaneous charging needs have to be also considered. This estimation becomes the basis on which amount of power supply required from **DISCOM** (Distribution Company) and the related electrical infrastructure is determined.

2 COORDINATION WITH DISTRIBUTION COMPANY

STEP 1: PREPARATION OF SITE LAYOUT

Prepare a comprehensive site layout that clearly marks **zones for bus movement and parking**, **charging stations**, and **dedicated areas for electrical infrastructure** such as **Energy Storage Systems (ESS), transformers, and substations**. The layout should also show emergency access and account for future expansion. This plan must be then submitted to the DISCOM as part of the power connection application process.



STEP 2: APPLICATION FOR CONNECTION

For a **High Tension** (HT) or **Extra High Tension** (EHT) electrical connection, submit a formal application to the DISCOM. The application needs to contain the site layout plan, the estimated power load, and all technical supporting documentation, including power system drawings, safety certifications, and charger specifications. This step starts the process of ensuring that the depot has a dependable power source.

Classification of Supply under Regulation 6(1) of Supply Code Regulations (Delhi)

SNo	Classification		System of supply
01	High Tension	Load exceeding 100kW/108kVA and up to 4000kVA	3 phase at 11kV
02	Extra High Tension	Load exceeding 4000kVA	3 phase at 33kV or above

STEP 3: SUBMISSION OF REQUIRED DOCUMENTS

In addition to sending the DISCOM the required paperwork **(technical drawings, site layout plans, safety certifications, and charger test reports from authorized laboratories)**, one must also pay the fees listed. Delays in the approval and electrification processes can be prevented by making sure all documentation is correct and comprehensive.

3 SPACE ALLOCATION & DEMAND ESTIMATE

STEP 1: PREPARATION OF SITE LAYOUT

The aim of preparing a site layout is to allocate space for the Electrical Substation (ESS) for the depot based on the electricity demand, supply and voltage levels. DISCOM will recommend the space required for the ESS after conducting a technical and commercial feasibility survey of the STU's application. The size of the ESS will vary depending upon whether the supply is 11kV, 33kV, or 66kV and must comply with DISCOM's supply code and regulations. The recommended area should be clearly marked in the depot layout and made accessible for DISCOM installation and inspection.

STEP 2: ESTIMATION OF DEMAND

DISCOM then issues a formal demand note which has outlined the estimated cost technical specifications for providing the electrical connection and the estimated cost. It would also include details such as supply voltage, connection point, and applicable charges. This document now acts as an official approval to move forward with the infrastructure planning and execution.

STEP 3: EXECUTION OF INTERNAL POWER INFRASTRUCTURE

Execution of internal power distribution infrastructure can be carried out in two ways,

- The STU may opt for the Deposit Work Scheme, under which the DISCOM executes the internal distribution infrastructure based on the approved plan and the deposit amount paid by the STU.
- Alternatively, the STU can execute the infrastructure independently through its own contractors, while paying supervision charges to DISCOM, which will monitor and approve the work as per technical and safety standards.

4 TIMELINE

- In India, this entire process typically takes **around 3 to 4 months** to complete from planning to agreement.
- Based on the **load demanded by the STU**, if the provision of a new electrical connection requires **augmentation of the existing distribution system, the DISCOM will carry out necessary upgrades**.

In **electrified areas with existing 11kV infrastructure**, power connection is generally completed **within 6 months post-payment**. In areas requiring **grid augmentation (66/33kV)**, the process may take up to **8 months** depending on the complexity of the infrastructure upgrades.

5 BACKUP FACILITIES

STEP 1: SETTING UP RELIABLE BACKUP SYSTEMS

As a backup system, install generators (diesel or gas-powered) to ensure power supply during power outages. These systems provide an emergency power source to maintain essential depot operations like street lighting, HVAC, and administration activities without disruption, particularly during unexpected power failures.

STEP 2: REGULAR TESTING AND MAINTENANCE

Backup generators, battery storage facilities and other emergency power systems must undergo a routine testing and maintenance. They can be subject to monthly or quarterly inspections to ensure that the systems are in operational condition; fuel levels, batteries in good health and the functionality of key components.

STEP 1: FEASIBILITY STUDY

The possibility of incorporating **renewable energy sources** such as solar, wind or geothermal into depot functions should be studied and assessed. Determinants such as **local climate** (sunlight, wind patterns), availability of **space for installations** (e.g., rooftops for solar panels), and the associated **costs** would determine their viability and cost effectiveness.

- ***Photovoltaic (PV) solar panels on rooftops or parking structures can be utilised to generate renewable energy which would reduce the depot's reliance on grid power.***
- ***Small-scale wind turbines or hybrid systems that combine solar and wind energy can be incorporated, if viable to diversify the energy sources.***
- ***The performance of both solar and wind systems should be regularly monitored to ensure that they meet energy needs and adjust operations based on weather conditions and energy output.***

STEP 2: INTEGRATION OF RENEWABLE ENERGY

Renewable energy sources such as solar or wind can be directly connected to the bus charging stations. These can be used as the primary power source wherever feasible or integrated to the regular power supply through an energy management system. Or, consider utilizing renewable energy for other depot activities such as street lighting, HVAC systems, etc, to further reduce reliance on grid power and enhance overall sustainability.

Source: curlytales.com

6 Environmental Protocols

6.1 SOP for Eco-friendly Practices

1 IDENTIFICATION AND CATEGORISATION

STEP 1: IDENTIFICATION OF WASTE & WASTE WATER

Begin by identifying and documenting all types and quantities of waste and wastewater generated within the depot (e-waste, battery waste, packaging materials, used oils, cleaning agents, greywater from cleaning, sewage from staff facilities). Categorize the waste into hazardous, recyclable, biodegradable, and non-biodegradable types to enable appropriate disposal, recycling and management methods. This classification forms the foundation for implementing an effective and sustainable waste management system.

STEP 2: SEGREGATED DISPOSAL

Clearly marked, color-coded bins should be placed all across the depot areas including workshops, charging bays, parking zones, and staff rest areas to promote effective waste segregation. Use durable signages with bilingual labels (local language and English) indicating categories such as hazardous waste, recyclables, biodegradable, and general waste. Greywater, blackwater, oily water, and stormwater should be collected through separate pipelines, with oil-water separators and gratings installed to filter out grease and debris to ensure effective treatment and prevents cross-contamination across the depot's drainage systems. These measures ensure clear identification and encourage responsible disposal practices among staff and visitors.

2 COLLECTION PROTOCOLS

STEP 1: WASTE COLLECTION

Appropriate number of cleaning staff should be trained and designated to collect waste from all segregation bins at least twice daily to maintain cleanliness and prevent overflow. For hazardous and battery-related waste, use sealed and labelled containers to ensure safe handling and temporary storage, minimizing the risk of exposure, leaks, or contamination within the depot premises. For waste water, Effluent Treatment Plants (ETPs) can be put up to treat greywater and oily wastewater through separation, filtration, and chemical or biological processes to reduce pollutants. Sewage Treatment Plants (STPs) to

process blackwater using multi-stage treatment to enable safe reuse or compliant discharge.

STEP 2: SAFE TEMPORARY STORAGE

The waste collected should be stored in clearly designated temporary storage areas located safely away from active operational and high-voltage zones. Toxic materials (used batteries, oils, chemicals) are to be kept in sealed, leak-proof containers with proper hazard labels. Storage practices must comply with applicable environmental safety norms to prevent spills, contamination, or accidental exposure.

3 DISPOSAL PROCEDURE

STEP 1: DISPOSAL OF FAULTY BATTERY

In case of a faulty battery, submerge the faulty or potentially hazardous battery in a container of water for 72 hours, usually distilled water often with a small amount of salt to make it mildly conductive. This method is used as a temporary neutralization or cooling measure before safe disposal.

STEP 2: SAFE STORAGE

Place the defective or degraded batteries in ventilated, dry, and cool storage areas which have appropriate hazard signages to minimize fire and contamination risks. Maintain detailed records including battery serial numbers, dates of removal, and condition status to ensure traceability and compliance with battery waste management regulations.

STEP 3: TIE-UP WITH AUTHORIZED VENDORS

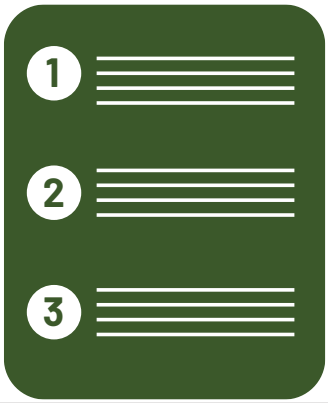
Partnerships with authorized recyclers and hazardous waste management agencies, preferably local would aid disposing off unmanageable wastes such as e-wastes, used oils, battery scrap, other hazardous materials etc. Sending the hazardous waste which are safe to dispose to respective OEMs head office could also be recommended.

STEP 4: DISPOSAL RULES

All end-of-life batteries must be safely handed over to government-approved recyclers in full compliance with the Battery Waste Management Rules, 2022. Each of the disposal transaction must be properly recorded maintained. This ensures regulatory adherence and encourages responsible recycling practices.

STEP 5: PROMOTE RECYCLING AND REUSE

Actively promote recycling paper, plastics, metal scrap and other recyclable materials generated during depot operations. Encourage the reuse of packing materials, containers, and maintenance tools if they are in serviceable condition and safe to use. This practice would help reduce waste generation, conserve our natural resources and a step forward in the overall sustainability efforts within the depot.



4 ECO-FRIENDLY PRACTICES

STEP 1: EFFICIENT WATER USE

Install water saving nozzles and fixtures in cleaning bays, restrooms and maintenance areas to minimize water consumption and to reduce wasteful usage. Wherever feasible, set up water recycling or treatment units to reuse treated water for bus washing and non-potable applications, promoting sustainable water management within the depot.

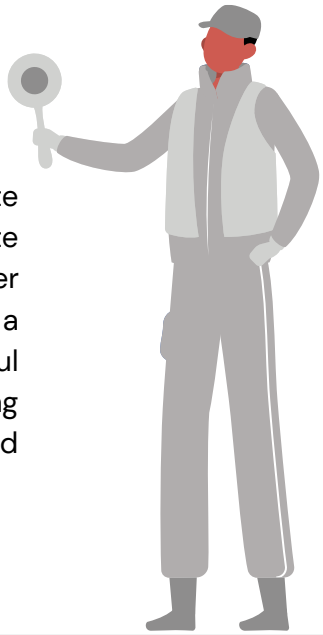
STEP 2: GREEN ENERGY PRACTICES

Installing solar panels on depot rooftops or available open spaces helps harness solar energy which is renewable and reduces the dependency on the grid. Smart meters and automated control systems would help monitor, regulate, and optimize electricity usage across lighting, bus chargers, HVAC systems and fans ensuring energy efficient operations throughout the depot.

5 STAFF TRAINING

STEP 1: TRAINING SESSIONS FOR STAFF

Conduct quarterly training sessions for all depot staff focused on proper waste segregation, safe battery handling, and implementation of eco-friendly practices. Their learnings can be reinforced by displaying visual SOPs, posters, and signage across the depot to promote daily awareness and encourage sustainable behaviour among all employees.



STEP 2: RECOGNITION OF ECO-ACTIONS

Recognize and reward teams or individuals who demonstrate outstanding efforts in promoting sustainability, such as waste reduction, recycling initiatives, or energy-saving practices. Offer certificates, awards, or public acknowledgment to encourage a culture of eco-responsibility. Additionally, document successful strategies and integrate them into the revised SOPs, ensuring that best practices become part of the depot's standard operations.

6 MONITORING AND REPORTING

STEP 1: MAINTENANCE OF WASTE MANAGEMENT LOGS

Systematically track waste generation, disposal dates, vendor details, and battery handover records using depot management software or physical registers. Maintaining accurate and up-to-date logs ensures regulatory compliance, supports internal audits, and helps monitor the effectiveness of the depot's waste management practices over time.

STEP 2: PERIODIC AUDITS AND COMPLIANCE CHECKS

Conduct monthly internal audits to monitor adherence to waste management and eco-friendly practices. Additionally, organize annual third-party environmental audits to independently verify compliance with environmental regulations and SOP standards, ensuring continuous improvement and accountability within depot operations.

Source: moneycontrol.com

7 Maintenance

7.1 SOP for Maintenance

1 DAILY PRE-SERVICE CHECKS

STEP 1: VISUAL INSPECTION

As soon as the bus enters the depot, a quick visual check should be conducted at the entry gate. This includes examining the interior and exterior (specifically the lights, mirrors, tires, windshield, and body) for any damage, wear, or irregularities. Detecting errors early helps prevent safety hazards and reduces potential service disruptions.

STEP 2: LOGGING OF DRIVER'S FEEDBACK

Take note of any complaints or performance-related observations shared by the driver at the end of the shift. These inputs should be promptly logged into the maintenance system to ensure necessary follow-up and timely resolution of issues before sending it for washing.

2 DAILY WASHING AND CLEANING OF BUS

STEP 1: WASHING (EXTERNAL)

External washing should be carried out once the bus completes its shift for the day. This process also becomes a cool-off time especially for buses which are not equipped with an in-built chiller system. After washing, the bus should be directed to the charging bay for the next cycle of operation.

STEP 2: CLEANING (INTERNAL)

Internal cleaning should be carried out after the bus is fully charged and parked at the designated bay. A cleaning team of 1–2 staff members should thoroughly clean the bus interior, including seats, flooring, handrails, mirrors, and windows, ensuring it is ready for the next day's service.

STEP 1: DAILY INSPECTION (FOR EVERY 250 KM)

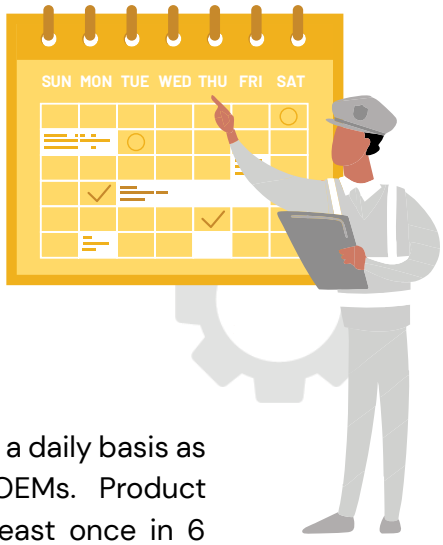
Daily preventive maintenance should be carried out in accordance with OEM-recommended schedules, typically after every 250–300 km of operation (subject to variation by OEM). This includes checks of electrical systems, mechanical components, bus body, and tyres. All maintenance activities must be recorded systematically to ensure timely servicing and effective performance tracking for each bus.

STEP 2: WEEKLY INSPECTION (FOR EVERY 2,000 KM)

Weekly preventive maintenance should be carried out in line with OEM-recommended schedules, typically after every 2000 km of operation (subject to variation by OEM). The process includes detailed checks and functioning of internal and external facilities (driver lamp, fog lamp, brake light, etc), suspension and underbody, high-voltage cables, working conditions of chiller system, and the steering system. It also involves testing the functionality of charging ports, inspecting the HVAC system and air filters, verifying software diagnostics, and cleaning battery compartments. Accurate logging of these activities is essential to monitor vehicle performance and ensure timely maintenance.

STEP 3: MONTLHY INSPECTION (FOR EVERY 10,000 KM)

Monthly preventive maintenance should be carried out in line with OEM-recommended schedules, typically after every 10,000 km of operation (subject to variation by OEM). The process includes detailed checks and functioning of overall components of an e bus. Logging of these status of each component after the check, is essential to monitor vehicle performance and ensure timely maintenance.



Note: Preventive maintenance should be performed on a daily basis as per the recommended schedule by respective OEMs. Product inspections should also be carried out by OEMs atleast once in 6 months.

PREVENTIVE MAINTENANCE CHECKLIST: DAILY IN-SPECTION

Sl. No.	Activity Description
1	Check functioning of Low Air pressure warning device
2	Check all Tell Tales and Gauges in Cluster in Self-Test
3	Check for error Code in Instrument Cluster
4	Check functioning of HV Components: Air Compressor, Steering Motor, DC Convertor, HVAC
5	Check compressor cutoff on gauge @ 8.1 Bar
6	Check Functioning of Driver Compartment Lamp
7	Check Functioning of Driver Fan
8	Check functioning of fog Lamp,
9	Check Functioning of Parking Lamp
10	Check proper working of Isolator switch
11	Check functioning of brake light.
12	Check functioning of tail lamp
13	Check functioning of Night lamp
14	Check functioning of Front and Rear roof marker lamps
15	Check the function of all dashboard switches
16	Check Horn
17	Check functioning of indicators.
18	Check Functioning of Hazard Warning Switch
19	Check head lamp & Beam (Adjust Focus if required)
20	Check Wiper Motor Function Low, High & Reset
21	Check function of NSR switches, light and buzzer
22	Check Function of Step LED Front, Rear & BRTS Doors
23	Check operation of passenger doors-Front, Rear & Reset
24	Check operation of BRTS doors & Reset Function
25	Check operation of Swap door and Reset Function
26	Check Functioning of Side Repeater Lamps
27	Check gear shifter function
28	Check reverse light & beeper.
29	Check proper working of LED Destination boards / GPS symbol G in DCU).
30	Working condition of Chiller pump & Chiller compressor
31	Check for active error codes with Scan Tool - Read, Troubleshoot, rectify and Erase thro' Diagnostics Tester] (Ignition ON/ Engine Starting / Vehicle run)

Sl. No.	Activity Description
32	Check Inverter Mobile charger function
33	Check locking / opening of driver door / strap condition
34	Check pneumatic hand brake for proper functioning.
35	Check for air leaks in the brake system and rectify
36	Check coolant level and top up if required (Give qty topped in remarks). Check for leakage in case its low
37	Check Steering oil level and top up if required (Give qty topped in remarks). Check for leakage in case its low
38	Check all Fire extinguisher availability & Disposal Lock and Pressure. Indicator to be on Green Band. (Co-driver side, rear, middle & HV Battery)
39	Check Windshield Washer water level. Top-up if required.
40	Check for Front hub grease melting / overheating signs. Tighten Hub Dust cover if any leakage noticed
41	Ensure all Service Cutout Bolts are in place & tightened properly
42	Working condition of Coolant pump & if any leak in the pump
43	Check Chiller coolant level & check for any leak or kink near HV Battery & Chiller pump 1 & 2
44	Check roof hatch functioning & Locking mechanism
45	Stanchion Pipes/Handrails should be clean. No Grease / Oil Black Marks should be visible.
46	Pax Seat Should not be Torn or loose.
47	Flooring: All Hatches to be properly Fixed with fasteners. No Protrution.
48	Pax Compartment Sticker should not be in Torn or loose Condition.
49	Check AL Logo & Lettering on Ft & Rear.
50	Inspect condition of front and rear bumper. Tighten mountings if required.
51	Check Both Rear View Mirror & Round Bumper Mirror for Mounting tightness, crack/Loose.
52	Reflective Tape Red (Rear Body), Yellow (Both Sides of Bus) & White (Front Bumper) should not be Torn.
53	Check Both Rear View Mirror & Round Bumper Mirror for crack/Loose.
54	Check cleanliness of interior and exterior of the coach.
55	Driver seat belts fully extended position
56	Check tyre pressure. Should be 125 psi (in fast). Swap front 90 psi & Rear 110 psi 1/3rd of the fleet / day
57	Check tyres for any uneven wear & inspect the tyre for any damages
58	Check visually, tightness of the wheel bolt

NOTE: This checklist is provided by the OEMs (ASHOK LEYLAND) and may vary depending on the specific requirements and standards of each OEM.

PREVENTIVE MAINTENANCE CHECKLIST:

EV WEEKLY INSPECTION (Every 2,000 km)

SNo	Activity description
1	Check functioning of Low Air pressure warning device
2	Do Self-Test for all Tell Tales and Gauges in Instrument Cluster
3	Check for error Code in Instrument Cluster using Menu Control unit
4	Check all tell tales & cluster gauges for proper functioning.
5	Check functioning of HV Components: Air Compressor, Steering Motor, DC Convertor, HVAC
6	Check compressed air buildup on gauge (8.25 kg/cm^2).
7	Check Functioning of Driver Compartment Lamp
8	Check Functioning of Driver Fan
9	Check functioning of fog Lamp,
10	Check Functioning of Parking Lamp
11	Check proper working of Isolator switch
12	Check functioning of brake light
13	Check functioning of tail lamp
14	Check functioning of Night lamp
15	Check functioning of Front and Rear roof marker lamps
16	check the availability of FDSS Disposal Plastic Lock
17	Check the function of all dashboard switches
18	Check Horn
19	Check functioning of indicators
20	Check Functioning of Hazard Warning Switch
21	Check functioning of head lamp & Adjust Focus if required
22	Check Functioning of Wiper Motor Low, High & Reset Function
23	Check function of NSR switches, light and buzzer
24	Check Functioning of Passenger Door Step LED Fr, Rr & BRTS
25	Check locking / opening of driver door / strap condition
26	Check operation of passenger doors - Front & Rear & Reset Function
27	Check operation of BRTS doors & Reset Function
28	Check operation of Swap door and Reset Function
29	Check Functioning of Side Repeater Lamps
30	Check gear shifter function a) Driver
31	Check reverse light & beeper.
32	Check pneumatic hand brake for proper functioning.
33	Check service brake for proper functioning & for air leakage and rectify if any.

SNo	Activity description
34	Check coolant level and top up if required (Give qty topped in remarks). Check for leakage in case its low
35	Check Steering oil level and top up if required (Give qty topped in remarks). Check for leakage in case its low
36	Check proper working of LED Destination boards / GPS symbol G in DCU).
37	Check all Fire extinguisher availability and pressure. Indicator to be on Green Band. (Co-driver side, rear, middle & HV Battery)
38	Stanchion Pipes/Handrails should be clean. No Grease / Oil Black Marks should be visible.
39	Pax Seat Should not be Torn or loose.
40	Flooring: All Hatches to be properly Fixed with fasteners. No Protrution.
41	Pax Compartment Sticker should not be in Torn or loose Condition.
42	Check Windshield Washer water level. Top-up if required.
43	Check AL Logo & Lettering on Ft & Rear.
44	Inspect condition of front and rear bumper. Tighten mountings if required.
45	Check Both Rear View Mirror & Round Bumper Mirror for Mounting tightness, crack /Loose.
46	Reflective Tape Red (Rear Body), Yellow (Both Sides of Bus) & White (Front Bumper) should not be Torn.
47	Check Both Rear View Mirror & Round Bumper Mirror for crack /Loose.
48	Check cleanliness of interior and exterior of the coach. (1/3rd of buses to be washed; remaining buses wiping of body & glass cleaning)
49	Check tyre pressure. Should be 125 psi (in fast). Swap front 90 psi & Rear 110 psi 1/3rd of the fleet / day
50	Check tyres for any uneven wear & inspect the tyre for any damages
51	Check and tighten wheel mounting nuts for specified torque values 644-712Nm
52	Check for Front hub grease melting / overheating signs. Tighten Hub Dust cover if any leakage noticed
53	Driver seat belts fully extended position
54	Ensure all Service Cutout Bolts are in place & tightened properly
55	Working condition of Coolant pump & if any leak in the pump
56	Check Chiller coolant level & check for any leak or kink near HV Battery & Chiller pump 1 & 2
57	Working condition of Chiller pump & Chiller compressor
58	Check roof hatch functioning & Locking mechanism
59	Check for active error codes with Scan Tool - Read, Troubleshoot, rectify and Erase thro' Diagnostics Tester (Ignition ON/ Engine Starting / Vehicle run)
60	Check Inverter Mobile charger function
61	Ensure Brake pedal Sensor and Accelerator Pedal Sensor Connector and Lock in Place
62	Check for windscreen glass and other glass frames for proper seating
63	Check Voltage & electrolyte level, top up distilled water for batteries if required. Check specific gravity of battery electrolyte, and apply petroleum jelly in terminals
64	Lubricate drag link ends

SNo	Activity description
65	Check Front brake actuator, slack adjuster & S-cam operation visually by applying brakes
66	Lubricate propeller shaft UJ cross
67	Lubricate propeller shaft splines
68	Check for air leaks in the brake system and rectify
69	Drain water from air tank
70	Check for free exhaust of relay valve on brake pedal application
71	Lubricate the Rear S cam shaft (schedule)
72	Check Rear brake actuator, slack adjuster & S-cam operation visually by applying brakes
73	Clean underbody thoroughly, remove mud & Dirt accumulated (using compressed air)
74	Ensure all fuse box covers are closed & bolted properly
75	Check air pipe for kink, bend
76	Check Steering column adjusting function Forward & Backward)
77	Check driver seat reclining system, front and back movement
78	Air Compressor: Oil quantity to be checked and filled in sump and dipstick
79	Air compressor: Clean the Air filter
80	Coolant Pump: Make sure the weep hole ports are not clogged with debris.
81	Coolant Pump: Ensure mounting connections are tightened to proper torque rating. Inspect support structure for any damage or loose hardware.
82	Radiator fan: Inspect radiator fans for dust or clogging if necessary clean
83	EHVT Components: Check the rubber bush & boot condition (Wear, Cuts, Deformation)
84	EHVT Components: Check the HV cable crush shield for any cracks, scratches, corrosion or cable damage with body / Chassis
85	EHVT Components: Check for any physical damage on component
86	EHVT Components: Ensure the connectivity of positive cable, negative cable and battery terminals are connected
87	EHVT Components: Check for any loose connection between HV & LV connectors
88	EHVT Components: Check for any cooling tubes / pipes are kinked in or in leaking condition
89	Check stone guard for damage
90	HVAC: Clean the inlet suction filter
91	Clean all LV & HV connectors locks to avoid dust accumulation

NOTE: This checklist is provided by the OEMs (ASHOK LEYLAND) and may vary depending on the specific requirements and standards of each OEM.

PREVENTIVE MAINTENANCE CHECKLIST:

EV MONTHLY INSPECTION (Every 10,000 km)

SNo	ELECTRICALS	SNo	CLUSTER & SWITCHES
1	Head Lamp Low	1	All Teltales
2	Head Lamp High	2	Park brake teltale
3	Head Lamp Passover	3	Seat belt telltale
4	Side Indicator	4	Dashboard Switches
5	Parking Lamp Front	5	Combi Switch
6	Parking Lamp Rear	6	Vehicle speed guage
7	Reverse Lamp	7	SOC Guage
8	Brake Lamp	8	SOC Bar
9	Side Marker Lamp Front	9	Air pressure gauge 1
10	Side Marker	10	Air pressure gauge 2
11	Roof Marker Lamp Front	11	LV Battery Voltage
12	Roof Marker Lamp Rear	12	Low Air Pressure telltale
13	NSR switches	13	Steering
14	NSR Warning buzzer	14	Coolant Level
15	NSR Warning lamp	15	AC Controller and Knob
16	Passenger Door Lamp	16	Parking Brake pull & release
17	Interior Roof Lamp		
18	Destination board	SNo	TYRE
19	Destination board	1	Tyre Condition
20	Compartment lamp	2	Wheel Nut tightness
21	Wiper	3	Tyre Pressure
22	Night lamp	4	Brake Linner
23	Reverse beeper		
24	Hazard Lamps	SNo	AIR PIPE
25	Driver fan	1	Kink
26	Swap Door System Functionality	2	Leak
27	Emergency Declaration	3	Drain water From Air tank
28	Step Lamp		
29	ITMS Supply		
30	Ensure Roof Hatch Fixed properly		

SNo	OTHER
1	Seat Belt
2	Passenger Door
3	BRTS Door
4	Driver Door Open and close
5	Driver Seat
6	Steering
7	Fuse box Cover
8	Wiper Blade
9	Combination Switch
10	Service Cutout Open & Close
11	Service Cutout are Closed

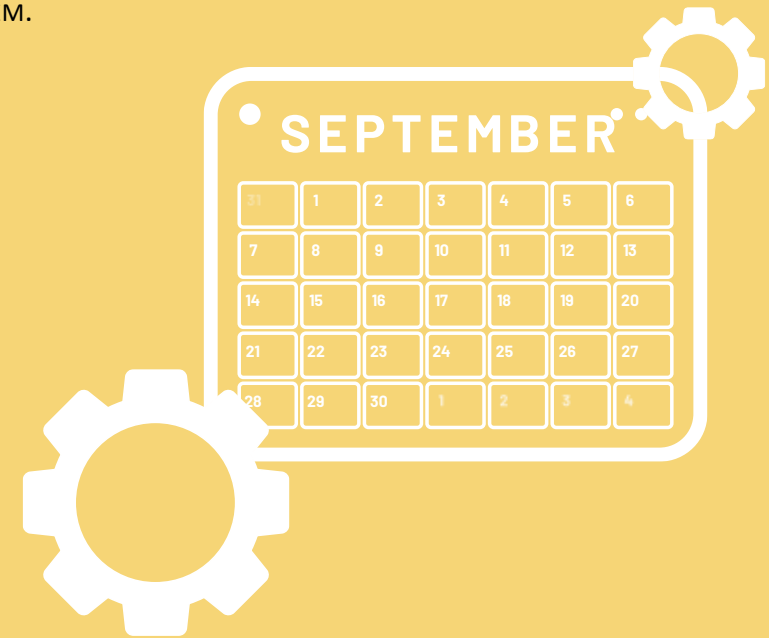
NOTE: This checklist is provided by the OEMs (ASHOK LEYLAND) and may vary depending on the specific requirements and standards of each OEM.

SNo	AGGREGATE	
1	Propeller Shaft	Lubricate propeller shaft UJ cross and splines
		Check and tighten propeller shaft flange bolts
2	Rear Axle	Check UJ cross/spline for wear and replace if found worn out
		Check oil level and top up/Drain differential oil when hot and replace it
		Ensure hub end play and pole wheel to ABS sensor gap as per specification.
		Check condition of wheel end bearings and replace if required
3	Steering	Check Oil level and top up/Drain if required
		Check tightness of steering box mounting fasteners
		Check UJ fastener tightness
		Check steering wheel free play and adjust, if necessary, ensure zero free play.
4	Suspension	Check and tighten shock absorber, rubber pads, mounting bracket bolts and nuts
		Check air bellow height variation on Rear - RHS & LHS
5	Vehicle Electrical Equipment	Check the battery electrolyte level. Top up, if necessary, with distilled water only
		Check battery terminals. Apply petroleum jelly if required
		Check battery cells - voltage and specific gravity, rectify if necessary
		Paint removal over the body ground area need to be ensured.
		Proper mounting of fuse and relay box to be ensured.
6	Brake	Brake liner clearance (Front & Rear) Check the Brake system air leakage and Check the Physical Isolation in PDB Box
7	Isolation Check	Traction motor on bracket M10 X 1.5 - 70 Nm
8	Transmission Mounting Bolt	Traction motor on bracket M12 X 1.5 - 120 Nm
9	Traction Mounting Bolt	Clean the suction, Condenser & expansion valve filter
10	HVAC Filter Clean	Clean the Air compressor AIR filter
11	AIR compressor Filter	Nipple Greasing in UJ propeller shaft, Kingpin (up & down), s cam track rod & drag link ball joint Steering column (below floor)
12	Nipple Greasing	joint Steering column (below floor)
13	Bus Body	Passenger Seat Should not be Torn or loose.
		Check Windshield Washer water level. Top-up if required.
		Inspect condition of front and rear bumper. Tighten mountings if required.
		Relective Tape & Decal should not be Torn.
		Check Both Rear View Mirror & Round Bumper Mirror for crack /Loose.
		Check Both Fire extinguisher availability and Pressure. (to be on Green Band)

NOTE: This checklist is provided by the OEMs (ASHOK LEYLAND) and may vary depending on the specific requirements and standards of each OEM.

Sl. No	HV Aggregates	Sl. No	Other Items and to be checked
1	DC-DC Converter	1	Isolation Check
2	Aux Inverter	2	Common
3	Traction Motor Controller	3	Common
4	On Board Charger	4	Dashboard
5	Power Distribution Box	5	BCU
6	Junction Box Charger	6	Cluster
7	Traction Motor + Transmission	7	Transducer
8	Energy storage system	8	Fuse Holder
9	Battery Chiller	9	HV Battery
10	E-Air Compressor	10	Main Fuse
11	E-Steering	11	VCCU & EVCU
12	Isolation & Bounding Check	12	Aux Inverter
		13	Tyre Rotation

NOTE: This checklist is provided by the OEMs (ASHOK LEYLAND) and may vary depending on the specific requirements and standards of each OEM.



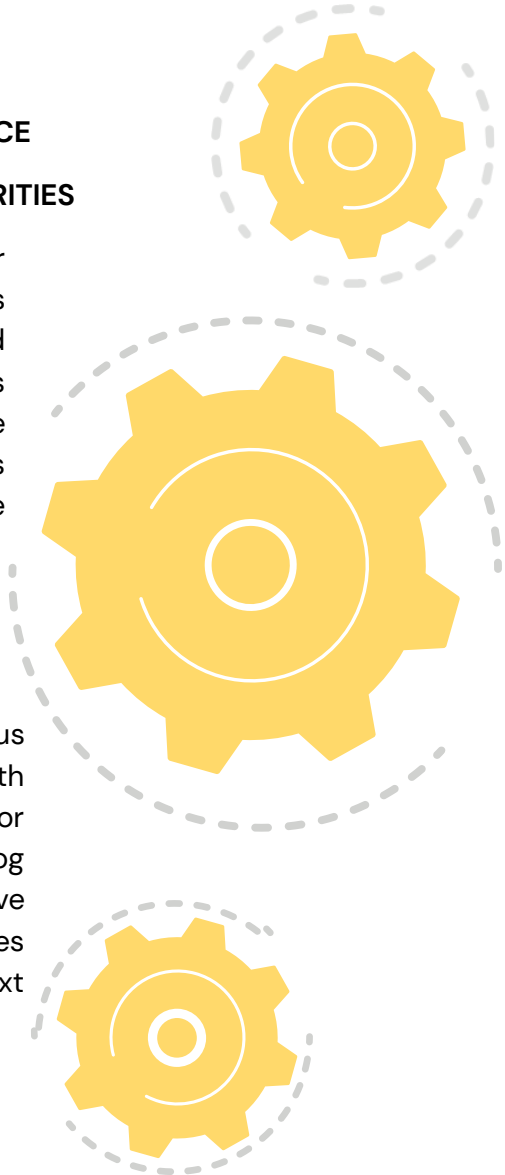
4 CORRECTIVE MAINTENANCE

Corrective maintenance is undertaken in two key scenarios; first, when a driver reports faults or irregularities after completing a trip in the depot and second, when a vehicle breaks down on-site during operation. In both instances, prompt diagnosis and necessary repairs are carried out to restore the bus to working condition and minimize any disruption to service schedules.

SCENARIO 1: IN-DEPOT CORRECTIVE MAINTENANCE

STEP 1: IDENTIFICATION OF FAULTS OR IRREGULARITIES

As soon as the bus enters the depot, the driver should report any identified faults or irregularities observed during the trip. These should be recorded at the entry point along with key operational details such as bus entry time, kilometres covered in the trip and battery level. Timely logging of this information supports effective maintenance planning and ensures quick resolution of issues.



STEP 2: COMPONENT SPECIFIC MAINTENANCE

Upon receiving complaints from the driver, the e-bus is directed to the maintenance workshop along with the logged details of the reported faults or irregularities. The maintenance team reviews the log and carries out component-specific corrective maintenance to resolve the identified issues efficiently and ensure the vehicle is ready for its next deployment.

STEP 3: UPDATING MAINTENANCE RECORDS

After the corrective maintenance is completed, the maintenance log should be updated with detailed information on the work carried out. This would also include the issues reported, actions taken to address them and details of any components replaced or repaired. Accurate documentation ensures traceability, supports future diagnostics, and helps maintain the service history of the bus.

SCENARIO 2: BREAKDOWN MANAGEMENT

STEP 1: IMMEDIATE ISOLATION

If a vehicle breaks down on-site, immediately isolate the faulty e-bus from the operational fleet to ensure safety. The control room should be informed promptly for further action and for the dispatch of maintenance personnel.

STEP 2: ON-SITE MAINTENANCE RESPONSE

In case of a vehicle breakdown or issue reported during operation, maintenance staff should be promptly dispatched to the site for inspection. They will assess the situation and attempt on-the-spot resolution to minimize downtime. If on-site repair is not feasible, arrangements should be made for towing the bus back to the depot for further maintenance.

STEP 3: IDENTIFICATION OF FAULTS OR IRREGULARITIES

As soon as the bus enters the depot, the driver should report any identified faults or irregularities observed during the trip. These should be recorded at the entry point along with key operational details such as bus entry time, kilometres covered in the trip and battery level. Timely logging of this information supports effective maintenance planning and ensures quick resolution of issues.

STEP 4: COMPONENT SPECIFIC MAINTENANCE

Upon receiving complaints from the driver, the e-bus is directed to the maintenance workshop along with the logged details of the reported faults or irregularities. The maintenance team reviews the log and carries out component-specific corrective maintenance to resolve the identified issues efficiently and ensure the vehicle is ready for its next deployment.

STEP 5: UPDATING MAINTENANCE RECORDS

After the corrective maintenance is completed, the maintenance log should be updated with detailed information on the work carried out. This includes the issues reported, the actions taken to address them, and details of any components replaced or repaired. Accurate documentation ensures traceability, supports future diagnostics, and helps maintain the service history of the bus.

Note: After the corrective maintenance, vehicle should be taken for trail run either in the depot or outside (as per convenience) by the driver, to ensure irregularities are addressed.

5 POST MAINTENANCE TEST

STEP 1: MAINTENANCE VALIDATION

Once repairs are completed, functional testing of the affected systems must be conducted, followed by a diagnostic scan to confirm that no error codes remain. A short test run within the depot should be carried out to ensure the issue has been fully resolved. Upon successful verification, the technician signs off on the repair, and the supervisor authorizes the bus to return to active service.

STEP 2: FEEDBACK - POST MAINTENANCE

Following the post-maintenance test run, the driver should provide feedback on the performance of the bus, specifically relating to the repaired components or systems. This feedback must be documented as part of the maintenance record to confirm repair effectiveness and ensure the vehicle is fully ready for service.

6 SHIFT MANAGEMENT

STEP 1: STAFF ROTATION

Dedicated teams should be assigned for each shift, covering roles that is appropriate for the scheduled maintenance for e-buses. A daily briefing and proper handover between shifts are essential to maintain continuity and need to address any operational concerns.

7 REPORTING AND RECORDKEEPING

STEP 1: MAINTENANCE OF RECORDS

Once repairs are completed, functional testing of the affected systems must be conducted, followed by a diagnostic scan to confirm that no error codes remain. A short

test run within the depot should be carried out to ensure the issue has been fully resolved. Upon successful verification, the technician signs off on the repair, and the supervisor authorizes the bus to return to active service.

8 STAFF TRAINING

STEP 1: FRESHER TRAINING

All fresher maintenance staff must undergo comprehensive training in electric vehicle (EV) systems, with particular focus on high-voltage safety and fire response procedures before the start of their duty. To ensure continued safety and operational efficiency.

STEP 2: SAFETY PREPAREDNESS

Maintenance staff should be regularly briefed on the proper use of Personal Protective Equipment (PPE), including insulated gloves, tools, and the placement of safety signs. Emphasizing the correct handling of equipment and adherence to safety protocols is essential when working with high-voltage EV systems to prevent injuries and ensure a safe work environment.

STEP 3: REGULAR TRAINING AND DRILLS FOR STAFF

Conduct monthly refresher training sessions and safety drills to reinforce essential knowledge of EV systems, high-voltage safety, emergency protocols, and proper use of PPE. These regular exercises ensure that maintenance staff stay updated, vigilant, and fully prepared to manage daily operations as well as emergency situations safely and effectively.

Source: indianexpress.com

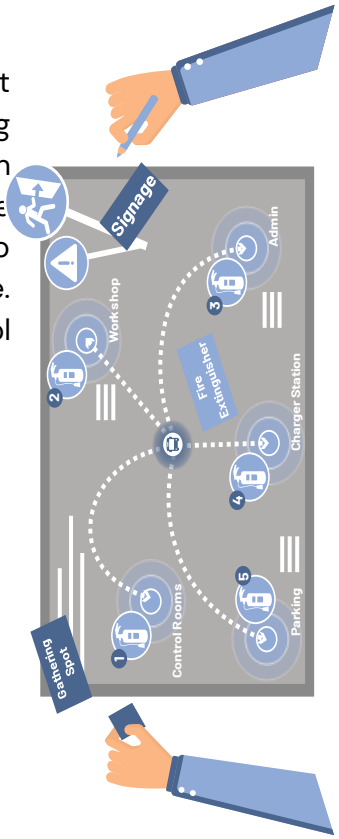
8 Safety

8.1 SOP for Emergency and Safety

1 SAFETY EQUIPMENT PLANNING

STEP 1: STRATEGIC PLACEMENT OF SAFETY EQUIPMENT

Safety in an e-bus depot involves strategic positioning of correct and sufficient EV-compatible fire extinguishers close to charging points, parking spaces, and workshops. Automatic fire detection and suppression systems must be fitted in high-risk areas. Smoke detector installation, gas leak detectors, thermal cameras close to battery zones, and electrical system fault detection software. Ensure that all alerts are integrated in the depot's central control system and emergency dashboards for instant response.



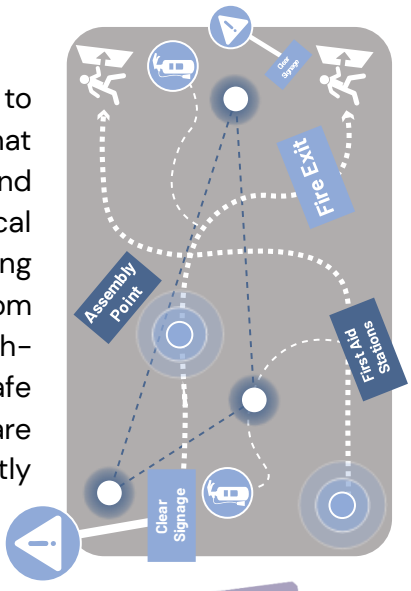
STEP 2: ACCESS CONTROL AND SURVEILLANCE

Ensure sure that restricted areas are clearly marked, and incorporate ID and biometric checks into access control systems. Areas such as storage, vehicle inspection zones and critical equipment with CCTV cameras that include night vision for round-the-clock surveillance, in addition to entry/exit points must be covered. For added security, use biometrics in addition to ID cards. To provide various staff members access to particular zones according to their jobs, implement role-based access.

2 INCIDENT AWARENESS AND PREPAREDNESS

STEP 1: PREPAREDNESS MEASURES

A site-specific Emergency Response Plan (ERP) specific to depot operations should be created. Post floor maps that indicate fire exits, assembly points, firefighting appliances, and first aid facilities. Position chargers and other electrical appliances at least 3 feet above the floor or higher, considering the precipitation levels of the area, to protect them from possible flooding. Easily visible and clear signage for high-voltage regions, fire alarms, and exit routes is vital for safe working. Also ensure that emergency contact numbers are prominently displayed at strategic locations and frequently updated throughout the premises.

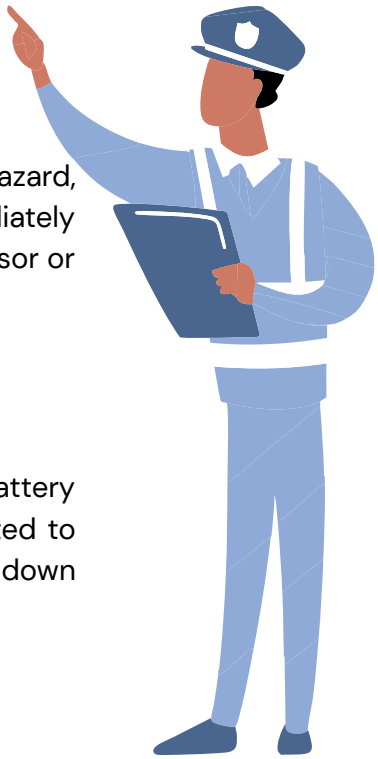


STEP 2: BRIEFING ON INCIDENT DETECTION

Staff should be trained to respond to medical emergencies (shocks, burns, cardiac arrests) by organising first aid classes. They should also be alert enough to respond to incidents such as electrical faults (due to overheating, short-circuits), fire or smoke in buses or charging areas, hazardous leaks from batteries or chemicals or structural failures like canopy collapse etc.

3 EMERGENCY ACTION PROCEDURE

The Emergency Action Procedure outlines the steps to be taken in the event of incidents such as fire accidents, flooding, or other natural disasters.



STEP 1: IMMEDIATE RESPONSE

In case of an emergency such as fire, smoke or an electrical hazard, the individual who spots the situation first must immediately activate the emergency alarm and inform the nearest supervisor or safety officer without delay.

STEP 2: POWER CUT-OFF

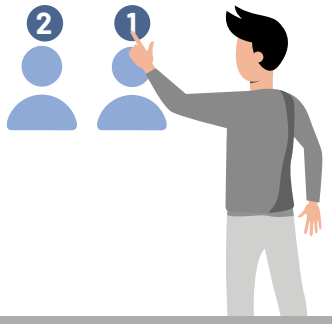
The emergency shut-off switches for charging systems, battery equipment or workshop tools should be immediately activated to minimise hazards and prevent escalation of the incident. Shut down high-voltage equipment remotely if it is safe to do so.

STEP 3: EVACUATE PERSONNEL

All personnels present at the emergency site should be evacuated through the nearest emergency exit following clearly marked escape routes. Zone Marshals would be responsible for thoroughly checking their assigned areas to ensure that no one is left behind. Special attention to be given to enclosed or high-risk zones.

4 ASSEMBLY AREA PROCEDURE

STEP 1: ASSEMBLY AREA RESPONSIBILITIES



As soon as the evacuated reach the designated assembly area, team supervisors must conduct a headcount to account for all personnels. The affected zone should be isolated and its periphery secured to prevent re-entry.

5 POST EVACUATION PROCEDURE

STEP 1: EXTERNAL SUPPORT AND SAFETY CLEARANCE

In case of serious incidents, immediately contact the local fire safety department and if needed, consult OEM (Original Equipment Manufacturer) technical support. These external agencies will conduct a thorough inspection of the affected areas and certify it's safety. Depot operations should only resume after formal clearance is obtained to ensure that there are no hidden or lingering risks.

STEP 2: FIRST AID SUPPORT

First aid should be provided to anyone injured or showing signs of distress. Trained staff should administer basic care using the depot's first aid kits until professional medical assistance arrives. Ensure that emergency medical services are contacted as soon as possible and that the injured are kept stable and comfortable.

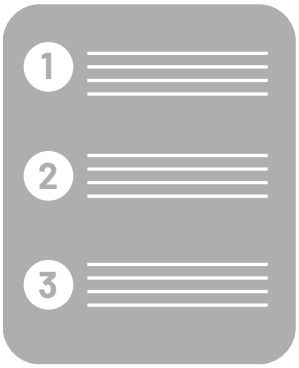
6 TRAINING AND REPORTING

STEP 1: TRAINING FOR EMERGENCY RESPONSE

All of the depot staff should undergo monthly emergency response training which would include fire extinguisher usage, handling electrical fires, conducting evacuation drills, and providing basic first-aid. Quarterly simulation drills should also be conducted to cover multiple scenarios such as fire outbreaks, electrical hazards, and medical emergencies ensuring that the staffs are well-prepared to respond quickly and safely under pressure.

STEP 2: INCIDENT REPORTING

All safety risk incidents (fires, electrical faults, injuries, evacuations) must be reported immediately to the depot safety officer or supervisor. A detailed incident report should be logged in the depot's safety management system capturing the date, time, location, nature of the incident, personnels involved, response actions taken and outcomes. Regular review of incident logs helps in identifying any patterns or trends and updating SOPs accordingly.



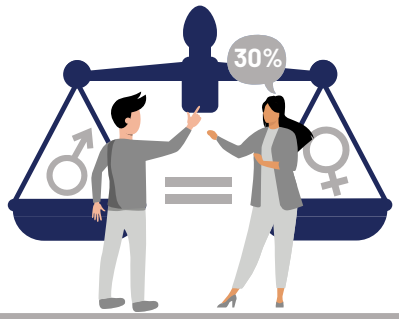
STEP 3: LEARNING FROM PAST INCIDENTS

Recorded incidents should be systematically reviewed and analysed to identify root causes and gaps in existing procedures. These real-life cases can then be incorporated into future training sessions to enhance practical understanding and preparedness. By designing safety drills and instructional content around past incidents, depot staff can build stronger awareness, improve response times, and reduce the likelihood of repeated occurrences.

Source: ahmedabadmirror.com

9 Gender Inclusivity

9.1 SOP for Gender Inclusivity



1 GENDER INCLUSIVE PRACTICES

STEP 1: BIAS-FREE RECRUITMENT

All recruitment practices should employ nondiscriminatory and inclusive language in recruitment materials and job announcements. To promote diversity among employees, actively solicit women and other minorities to apply for positions. To model other gender-diverse transportation centers' best practices, for all functional categories such as operations, maintenance, administration, and supervisory functions, aim to achieve at least **30% female participation.**

STEP 2: EQUAL PAY AND ROLE ALLOCATION

Ensure all employees, both male and female, get **equal remuneration** for doing equal work in all functions at the e-bus depot. Do away with gender stereotyping by allocating technical, operating, and leadership **duties on the basis of competence and qualification**, not gender. This promotes an equitable, inclusive, and performance-based work culture.

STEP 3: ANTI-HARASSMENT FRAMEWORK

Organize an **Internal Complaints Committee (ICC)** according to the **POSH Act** to handle workplace harassment. Provide **anonymity and confidentiality in reporting** avenues, and post anti-harassment policies openly around the depot to promote a respectful and safe work culture.

2 INCLUSIVE INFRASTRUCTURE SETUP

STEP 1: SAFE AND ACCESSIBLE FACILITIES

Design depots to include **separate or gender-inclusive restrooms** and changing rooms to accommodate all employees respectfully. Ensure all areas—**parking bays, entry/exit points, and workstations—are well-lit and equipped with safety features** like CCTV, emergency alarms, and security personnel to foster a safe and welcoming environment for everyone.

STEP 2: BASIC AMENITIES

Provide safe and comfortable rest areas for all staff, along with accessible menstrual hygiene products and first-aid kits. Where applicable, establish nursing rooms to support working mothers, ensuring that all employees' basic health and comfort needs are met equitably.

3 STAFF TRAINING AND WORKSHOPS

STEP 1: SENSITIZATION WORKSHOPS

Organize compulsory **quarterly gender-sensitization and anti-harassment workshops** for all depot personnel. During these sessions, emphasis needs to be given to fostering respectful workplace behaviour, countering stereotypes, learning about gender equity, and strengthening the guidelines of the POSH Act to foster an inclusive and empathetic atmosphere.

STEP 2: TECHNICAL TRAINING

Activate **special skill-development schemes** for women and other minorities to enhance their representation in technical and operating positions, e.g., providing access to Type C driving permits for women to drive e-buses. Also, encourage **mentorship programs** that assist and nurture them in becoming better professionals, moving to supervisory and management ranks in the depot.

STEP 3: REGULAR SURVEYS AND FEEDBACK

Hold **bi-annual anonymous surveys** to measure workplace climate and openness. Apply the lessons learned to guide **policy revision** and tackle new issues. Create **physical and virtual suggestion forums** to promote constant employee input, building a more responsive and open workplace.

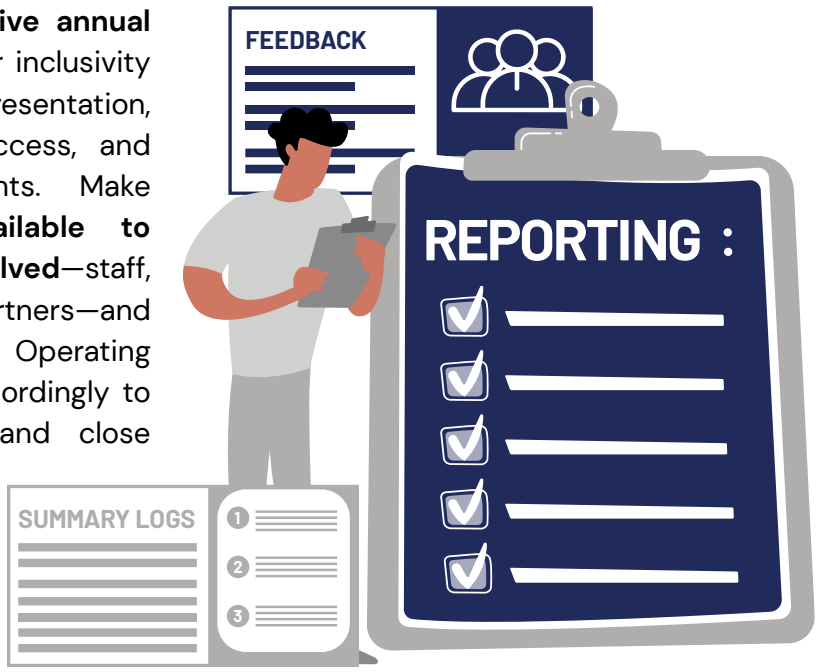
4 MONITORING AND REPORTING

STEP 1: MONTHLY MONITORING REPORTS

Develop and review monthly reports **monitoring gender composition in all departments**, **incidents of violence against women and other minorities, and attendance in training programs**. The reports assist in assessing progress, gaps, and informing on-going improvement in fostering gender inclusivity in the depot operations.

STEP 2: ANNUAL GENDER AUDIT

Perform a **comprehensive annual audit** to assess gender inclusivity measures, such as representation, pay equity, facility access, and response to incidents. Make **findings openly available to everyone involved**—staff, management, and partners—and amend Standard Operating Procedures (SOPs) accordingly to build on inclusivity and close identified gaps.



10 Conclusion

The Standard Operating Procedure (SOP) for e-bus depot operations provides a holistic framework for the efficient, safe and inclusive management of e-bus services in India. It covers important aspects such as depot maintenance, vehicle charging, safety protocols, fleet management and the relevant environmental considerations derived out from the best global practices and regulations of the country.

The SOP emphasises certain key points which include:

- Adopting systematic operational methods is essential for keeping the electric bus fleet reliable and extending its lifespan, which in turn helps make public transport on the overall, more efficient.
- This guide is an important resource for maintaining consistency, safety and high standards in depot operations. These factors play a direct role in ensuring that passengers are satisfied and services remain dependable.
- By providing detailed procedures for every aspect of depot management, the SOP makes integration of electric buses into public transit systems easier while supporting the broader push for greener, more sustainable urban mobility.

This report acts as a pivotal resource for supporting the successful operation of clean and efficient e-bus depots which in turn contributes to the larger goal of promoting sustainable public transportation in our country.

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