

10 PROJECT FACILITIES/ROAD SIDE FEATURES/ROAD SAFETY

10.1 Project Facilities

The Project Facilities proposed on the expressway shall include:

- (a) i. Toll plazas
- ii. Ramp plazas;
- (b) Roadside furniture;
- (c) Lighting / illumination;
- (d) Pedestrian facilities;
- (e) Landscaping & tree plantation;
- (f) Traffic and medical aid posts;
- (g) Telecom System
- (h) Intelligent Traffic Management System (ATMS/ ITMS);
- (i) Wayside Amenities
- (j) Toilet Block

Further details are given in the following sections:

10.2 Toll Plaza

Toll Plaza as per Section-12 of IRC:SP:99-2013, complete in all respect including service area, Toll Plaza complex, room of sufficient size for ATMS control center, Traffic Aid Post and medical aid post, shall be provided. Toll plazas are provided at start and end section, and at all double trumpet interchange location as follows:

Sl. No.	Chainage (Km)	Location	Remarks
1	4+360	Main carriageway	-
2	55+879	Lalganj-Fatehpur-Banda Road (NH 335)	Double Trumpet Interchange
3	86+103	Kanpur -Sagar Road (NH 34)	Double Trumpet Interchange
4	174+646	Lucknow-Kanpur-Jhansi-Shivpuri Road (NH 27)	Double Trumpet Interchange
5	243+335	Delhi-Kolkata Road, NH 18 (AH 1)	Double Trumpet Interchange
6	287+000	Main carriageway	-

Layout of Toll Plazas shall be designed for 10 normal lanes, 2 nos. Extra-wide lanes. All lanes shall be enabled for combination of cash, and complete integrated ETC system (Local ETC tag as well as Fastag ready) suitable for closed tolling system expandable to 14 lanes for ETC system. Equipment for toll plaza shall be as per Section-12 of the Manual.

Toll Plaza Complex/Building as per Section 12 of the Manual along with Control Centre for ATMS shall be provided for Toll Plaza. A power sub-station including generator of sufficient capacity shall be installed to meet out all power requirement of the toll plaza complex; booths and external lighting. The size of the office complex shall be with adequate provision for future expansion taking into consideration various requirements.

Prevention of Overloading: Medium Speed Weigh in Motion Systems (MSWIM) to prevent overloading: Toll plaza/ toll booth location shall also be provided with system for checking and preventing overloading of vehicles at toll plaza/booth. For this purpose; medium speed weigh in motion systems at approaches to each toll lane are to be installed. Separate space along with static weigh bridge shall be provided and area to hold off-loaded goods from overloaded vehicles shall also be provided after the toll barriers for each entry direction of travel.

Vehicle Rescue Posts/Cranes: The EPC Contractor shall provide cranes of capacity as prescribed in Clause 14.4 of Contract Agreement at suitable location with all necessary equipment so that it can reach the site of the incident within 30 minutes of call and clear the disabled/accident met vehicles. It shall also be fitted with GPS based Vehicle Tracking System to monitor its movement on 24 hours x 7 days of a week basis.

Ambulance: The EPC contractor shall also provide an GPS fitted Advance life saving (ALS) ambulance with all life saving equipment, trained staff and first aid items including the supply of consumable items which will be replenished as and when required during DLP period of 5 years.

Interchange/Ramp Plaza

There have to be 2 Toll Booths with 2 Nos. of toll lanes (one for normal sited vehicle and one for over dimensioned vehicle) at exit of all interchanges. The locations are as follows:

Sl. No.	Chainage (Km)	Location	Interchange	No. of Toll Booth
1	0+000	Jhansi- Mirzapur Road (NH 35)	Trumpet	0
2	24+411	Fatehpur-Kartal Road (SH 71)	Diamond	4
3	43+267	Banda –Baberu-Rajapur Road (SH 92)	Semi Clover Leaf	6
4	50+681	Bahraich-Fatehpur-Banda Road (SH 13)	Diamond	4
5	125+250	Hamirpur- Rath- Jhansi Road (SH 42)	Diamond	4
6	164+330	Lakhimpur-Sitapur-Panwari Road (SH 21)	Diamond	4
7	201+925	Jalaun-Bhind Road (SH 70)	Diamond	4
8	280+085	Etawah-Bela Road (NH 234)	Semi Clover Leaf	6
9	294+131	Agra-Lucknow Express	Trumpet	0

All toll booths shall be equipped with complete integrated ETC system (Local ETC tag as well as Fastag ready) suitable for closed tolling system and shall have toll/fee collection system (TMS) for cash collection as a back-up. At Interchange / Slip Road locations all necessary building construction, provisions, equipment, as per Section -12 of the Manual, the state of the art facilities etc. shall be provided for smooth toll collection, safety to commuters and facilities for commuters, toll collection and O & M staff. Along with MSWIM in all entry lanes, separate space for static weigh bridge, supply and installation of static weigh bridge, ETC reader and SWB booth TMS system and area to hold off-loaded goods from overloaded vehicles shall be provided after the toll barriers for each entry direction of travel. All required furniture for toll booths, ramp plaza complex, Lane canopy camera in all lanes, PTZ camera for lane and plaza monitoring, cash room

camera, Cash Vault camera, Fog Light, Speed Breaker to slow down vehicles, PA System and ID scanner camera, booth camera with mic in all booths shall also be provided.

Interchange / Slip Road locations shall be provided with Sub-Complex and Sub-Centre including medical aid post as per requirement and to provide user services like sale of Passes/ Smart Cards/ OBUs; public interaction counter; public parking space; etc. Sufficient number of culverts shall be provided on each ramp/slip road of the interchange.

Vehicle Rescue Posts/Cranes: The EPC Contractor shall provide cranes of capacity as prescribed in Contract Agreement at suitable location and at each interchange with all necessary equipment so that it can reach the site of the incident within 30 minutes of call and clear the disabled/accident met vehicles. It shall also be fitted with GPS based Vehicle Tracking System to monitor its movement on 24 hours x 7 days of a week basis.

Ambulance: The EPC contractor shall provide a GPS fitted Advance life saving (ALS) ambulance at suitable location at each interchange with all lifesaving equipment, trained staff and first aid items including the supply of consumable items, which will be replenished as and when required during DLP period of 5 years.

10.3 Traffic Control Devices, Road Safety Devices and Roadside Furniture

Traffic Control Devices, Road Safety Devices and roadside furniture shall be provided as per Section – 10 and 12 of IRC:SP:99-2013. The details are as follows:

10.4 Road Signs

Road Signs include roadside signs; chevron signs; overhead signs and kerb mounted signs along the entire Project Expressway and service road.

All road signs shall be of Prismatic Grade Sheeting corresponding to Class 'C' Sheeting described in IRC: 67-2012 and any of the types VIII; IX or XI as per ASTM D-4956-09. The road signs and overhead signs erected on the Project Expressway and service road with regard to requirement of number of signs, type and size of sign, size of letter, color of sign, layout of sign; etc. including signs installations shall conform to Section-10 and Section-12 of "Manual" and IRC: 67-2012. Code of Practice for Road Signs and where the said codes are silent, other codes in the same order of preference shall be used. Chevron signs shall be installed on curves and interchange loops/ramps. In addition to signs prescribed in "Manual" other signs such as signs showing safety slogans, toll free numbers, nearby hospital and police station facilities, lane discipline signs on gantry etc. will also be provided as directed by Authority's Engineer.

The overhead signs shall be placed on a structurally sound gantry or cantilever structure made of tubular structure or steel structure. The final locations shall be finalized in consultation with the Authority's Engineer. The height, lateral clearance and installation of the sign structures shall be as per the MoRT&H/IRC guidelines.

Overhead Signs: Cantilever Type shall be provided at Interchanges as advance direction and exit signs on all arms of interchange.

Additionally, Overhead Gantry Type (4-lane width) are also proposed on each side of main carriageway.

Design and location of route marker signs for Project Expressway shall be as per the IRC: 67-2012.

On cross roads where interchange/slip roads has been provided, necessary information signboards on cross roads on both sides shall also be fixed suitable for the category of cross road

10.5 Pavement Markings

Pavement markings shall cover the entire Project Expressway and service roads (on 7.0m wide portions) and shall be as per Section-10 of the "Expressway Manual" and IRC: 35-2015. These markings shall be applied to road carriageway lane; edge lines; continuity line; stop lines; give-way lines; diagonal/chevron markings; zebra crossing and at parking areas, toll booths etc. by means of an approved self-propelled machine which has a satisfactory cut-off valve capable of applying broken lines automatically.

Road markings other than on main carriageway edges (both shoulder and median side) shall be of hot applied thermoplastic materials with glass reflectorizing beads as per relevant sub clauses of MoRT&H specifications;

Raised profile edge lines as per Clause 7.7 of IRC 35 shall be provided on main carriageway edges (both shoulder and median side right lane).

Acrylic water based road marking paint shall be used for kerb, concrete barrier painting, and to display details of structure number; span arrangement etc. on all culverts and bridges with required description as per MoRT&H guidelines.

10.6 Boundary (ROW) Stones

These shall be provided for the entire Project Expressway at an interval of 100m c/c as per clause 10.8 of the "Expressway Manual".

10.7 Hectometer & Kilometer Distance Marker

Type design of Kilometer (Km) and Hectometer (100m) marker shall be provided as per Annex- II to Schedule 'C'. These shall be provided for the entire Project Expressway. The arrangement for fixing and placement on expressway for kilometer distance marker shall be as per IRC:67-2012 and for 100m marker as per "Guidelines for Expressways".

10.8 Crash Barrier

This shall be provided as per clause 10.7 of section-10 of IRC:SP:99-2013. Thrie-Beam crash barrier shall be installed all along the Project Expressway on earthen shoulders on either side and w – beam) crash barrier on median in two rows. In total four rows of (2 rows of Thrie beam and 2 rows of W-beam) crash barrier shall be provided on main carriageway. New Jersey type Crash Barrier shall be provided at all interchanges including ramps / loops, major / minor bridges, underpasses, viaducts, culverts on service road and ROBs etc. New Jersey crash barriers are proposed on slip roads, ramps and loops of all interchanges.

Retro-reflective (same material as of road signs and Fluorescent yellow / white colour) Stickers (150mm width) shall be provided on alternative vertical posts of W beam barrier throughout.

10.9 Fencing

As the Expressway is completely access-controlled facility; fencing is its integral part to help enforcement of the acquired access rights. Access control extends to the limits of the legal access control on the ramps i.e.; along the ramps to the beginning of the taper on the local road. Barbed wire conforming to IS:278 -1978 shall be fixed on RCC (M25) posts of minimum size 110 x 110mm. RCC posts shall be embedded in M15 grade concrete to a depth of 700mm below ground having size of 500x500mm. The height of fencing shall be 2.5m above ground. All exposed surfaces shall be painted with synthetic enamel paint over cement primer. Chain line fencing of 1.5m height is provided across the road from fencing to embankment at all the VUP/PUP locations so that no cattle can go towards expressway.

On the side where service road is being provided, fence will be placed in between expressway and service road. On the side where service road is not being provided the fence will be placed at ROW edge.

10.10 Reflective Pavement Markers, Solar Studs and Delineators

Raised pavement markers shall be provided as per Clause 7 of IRC 35 2015 on both should edges and median sides. Relaxation pavement markers and solar studs shall be as per Clause 10.5 and Table 10.4 of manual.

Delineators shall be provided as per clause 10.4 of "Manual". At merging/diverging areas; service areas; ramps of interchanges; bridges and their approaches; the spacing shall be reduced to 30m. The design; location and materials to be used for road delineators shall be as per IRC: 79-1981.

10.11 Blinker Lights

Yellow flashing lights using solar power with full alternative power back-up shall be provided to alert the drivers about oncoming interchange; major bridge, and toll plazas.

10.12 Glare Reduction

The devices shall be provided as per clause 10.11 of the "Expressway Manual".

10.13 Lighting/Illumination

External and Internal Lighting will be as per Section-15 of the "Expressway Manual" shall be provided. Street Lighting shall be provided at the locations of toll / ramp plaza, interchanges/slip roads and lighting on structures such as major bridges, ROB's, Flyovers, Minor Bridges and Underpasses including high mast at toll plaza, interchange/slip roads. A power connection of appropriate load shall be taken from state electricity department at above locations including all expenses. The use of solar power is optional in lieu of a regular power connection for isolated locations such as Bridges, ROBs, underpasses and flyovers. Provision of adequate capacity Diesel Generator sets as standby arrangement shall be made at Toll / Ramp Plaza, Interchange and Slip road.

Arrangement of lighting installations shall be staggered except on curves.

10.14 Pedestrian Facilities

There is no separate pedestrian facility like FOB etc. PUP has been provided for pedestrian to cross expressway.

10.15 Landscaping & Tree Plantation

Landscaping of road shall be as per IRC SP-21. Four rows of tree on the side where service road is not provided and 2 row of tree on the side of service road shall be provided. Compensatory afforestation shall be undertaken within ROW as prescribed in environment and forest clearances. Landscape treatment shall be provided in the entire open areas near major bridges, at interchanges, toll / ramp plaza, and O & M areas.

Planting along the Project Expressway shall follow a variety of schemes depending upon location requirement as per the IRC: SP: 21-2009. The choice of trees to be planted shall also be made as per IRC:SP:21-2009; "Manual of Landscaping". Local, indigenous species that grow in that area shall be preferred.

On medians and island: planting of dust and gaseous substance-absorbing shrubs shall be provided.

The treatment of the highway embankment slopes shall be as per the recommendations of IRC: 56; depending upon the soil type involved and the provisions mentioned elsewhere in this document.

Visibility of any signs; signals or any other devices erected for traffic control, traffic guidance and/or information shall not be obstructed by plantation.

The central island of trumpet and loop area of interchanges has space for attractive landscaping which provide scope for both soft and hard landscape. Special attention will be given that each interchange has a distinct and unique landscape based on some theme. The theme and design of landscaping of each interchange will blend with the local surroundings. Careful selection of plant species will be done in order to match the climatic conditions to merge with the surrounding area. Rainwater/ ground water recharging system should also be integrated with landscaping in order to provide proper drainage to avoid ponding of water. The plantation will be inter-mixed with evergreen species and seasonal flowers. Plantation of flowering species will be done in such a way that each area has different colour pattern. The outer margins of the central islands in the loops of interchange must have low ground covers to avoid any vision obstruction of the drivers to ensure visibility. The central portions of these islands will be provided with objects of any art; creation of pleasing/ attractive land pattern including plantation of trees keeping the aspect of vision in view. Designer lights along the periphery of the islands and central lighting in the form of high masts will be suitably provided for ensuring proper illumination of the area. Different types of water fountains may also be erected at the interchanges. No private advertisements; commercial information; hoardings etc. shall be permitted inside the interchange area. The scheme of landscape for each interchange has to be approved by the Authority's Engineer and the Authority.

10.16 Traffic and Medical Aid Posts

These are proposed at Interchange Sub Complex / Sub Center locations.

10.17 Telecom system

All necessary hardware, equipment, software, optical fibre cable etc. required for Communication System to interconnect Toll Plaza and Ramp Plaza /Toll Booths etc. are proposed and to be provided by the Contractor.

10.18 Wayside Amenities

Wayside amenities are proposed at 50 km interval except first and last section. These will have connectivity through grade-separated structure from both sides. The proposed locations are as follows:

Table 10.1: Wayside Amenities

Sl. No.	Chainage (km)	Location (Left or Right)	Remarks
1	70+500	RHS	Access from both carriageways through grade-separated structure
2	128+500	LHS	Access from both carriageways through grade-separated structure
3	179+050	RHS	Access from both carriageways through grade-separated structure
4	224+325	LHS	Access from both carriageways through grade-separated structure

10.19 Toilet Block

Separate Toilet Blocks with full facilities for public use shall be provided within the toll plaza for public access. The provisions listed below are

- a) 4 Nos. urinals (Ladies) along with wash basin
- b) 4 Nos. urinals (Gents) along with wash basin
- c) 2 Nos WC in each washroom
- d) Drinking Water facilities shall also be provided.
- e) Water Supply/Electrical fixtures shall also be provided.
- f) Landscaping along with parking space shall also be provided.

10.20 Intelligent Traffic Management System

Implementation of latest Advanced/Intelligent Traffic Management System (ITMS), Highway Incident Control System, Facility Management System (FMS) for the 294 kms long Bundelkhand Expressway Project has been proposed.

By adopting the ITMS, Authority shall be able to enhance, the efficiency of Enforcement Management, Incident Management, Monitoring & Maintenance Control, Smoothing of Road Traffic Movement, Efficient Information sharing, processing and dissemination with the stakeholders.

Advanced/Intelligent Traffic Management System (ITMS) shall be implemented separately and shall not be in the scope of EPC Contractor.

10.20.1 Brief particulars of ITMS Project

Name of the Project	Indicative ITMS System Capital Cost (In INR Cr.)	Indicative Operation and Maintenance Expenses (5 Years) (In INR Cr.)
Intelligent Traffic Management System (ITMS)	53.71	12.88

10.20.2 Time Schedule Proposed for the Implementation

- a) System Design : 3 months from the date of signing of the Contract
- b) Procurement : 2 months from the date of approval of the System Design
- c) Installation : 6 months from the completion of delivery of material at site and site readiness
- d) Testing & Commissioning: 1 month from the date of Installation of complete system
- e) Trial run : 1 month from the date of commissioning
- f) O&M period : 60 months from the date of issue of Commissioning Certificate

10.20.3 Key ITMS Components

Following Key ITMS Components are proposed:

ITMS Component		Unit	Qty.
ITMS Component			
A	Traffic Management Command Centre with Central Processing System	Nos.	1
A.1	Traffic Management Sub-Centres	Nos.	2
B	ITMS Software	Set	1
C	Traffic Monitoring Camera System Equipment (TMCS)	Nos.	150
D	Video Incident Detection System Equipment (VIDS)	Nos.	60
E	Automatic Traffic Counters-cum-classifier System Equipment (ATCC)	Nos.	48
F	Travel Time Measurement System Equipment (TTMS)	Nos.	42
G	Variable Message Sign Equipment (VMS)	Nos.	54
H	UPS and Power system	Nos.	12
I	Weighting Monitoring System (WMS)	Nos.	12
J	Vehicle Speed Detection System Equipment (VSIDS)	Nos.	24
K	Meteorological Observation System (MOS)	Nos.	3
L	Digital Transmission System	Kms	300
OPERATIONS & MAINTENANCE (5 Years)			
DLP Support of 2 years and Annual Maintenance Charges for 3 years			
Control Room Operations Staff (5 Years)			

10.20.4 Brief Description of the Key Components

The brief description of each key component of ITMS proposed for the project is as given below.

10.20.4.1 Traffic Management Command Centre with Central Processing System

The ATMS for the Project is composed of many components systems. These systems are expected to perform their functions to achieve overall objective for the efficient, safe and smooth traffic on the Expressway.

The Contractor shall provide and construct a central server system that manages various systems comprising the expressway-traffic surveillance and control system in an efficient manner, provides

Operations and Maintenance

Apart from installation of ITMS system, the scope of Contractor shall also include Operation and Maintenance of ITMS for a period of 5 years from the date of Completion of ITMS system. It shall be the Contractor's responsibility to provide sufficient manpower to implement flawless execution of ITMS in operation in the manner originally intended, that is to collect road, traffic and weather condition data, process and analyse the data into useful information, disseminate the information to road users and undertake the Services that are not specifically mentioned in these requirements but essential for the safe and efficient traffic operation on the Project.

The Contractor shall maintain qualified staff at the Traffic Management Centre (TMC), Sub Centre and other places wherever required necessary, tools, shop facilities, equipment, consumables, transportation and materials and perform all works necessary to maintain in good working manner all Intelligent traffic management system and associated equipment.

Traffic Monitor Camera System (TMCS)

TMCS camera shall be installed such that the monitoring of the entire route is ensured (the number of cameras shall be sufficient to monitor the key location, accident prone areas, junctions, major median openings, major structures, urban areas, major villages junctions etc. through entire journey of every vehicle on the road).

The actual locations shall be finalised during the site survey to satisfy the above requirement. The exact location will be determined based on the alignment, geometry, viewing area (also based on site visit) Indicative equipment location has been proposed based on the plan and profile.

The TMCS camera shall be supplied power from the solar panel attached to Camera Pole. The UPS and battery bank shall be able to provide the power backup for minimum of 72 hours.

Camera shall be for industrial use, capable of continuous operation under harsh environment on the highway. Camera shall of PTZ type with full HD colour and 1/3" image sensor (CMOS) or better. It shall have frame rate of up to 60 frames.

The following control functions shall be provided to the system to cover wider area and longer distance:

- 1) Pan (right – left)
- 2) Tilt (up – down)
- 3) Zoom (wide – telescope)
- 4) Focus (near – far)
- 5) Wiper (on – off)

TMCS camera shall be mounted on a tilt pole installed beside the expressway on the shoulder as specified. Height of camera shall be 12 meters. Pole shall be rigid enough so as not to vibrate under strong wind and passage of heavy vehicle. Optical fibre cable and power cable shall be extended from the nearest hand-hole at the shoulder where branch connection of cable is possible. The TMCS camera shall be connected to the nearest Wireless Access-point through repeater / access point / transceiver appropriately.

Video Incident Detection System (VIDS)

Video Incident Detection System (VIDS) will be installed at the accident-prone and other essential areas identified by the enforcement agency and other vulnerable locations. The images taken by VIDS camera shall be transmitted to the Traffic Management Centre (TMC) through Optic Fibre cable or wireless transmission system in real time. In the TMC, images are selectively shown on the monitor display of VIDS workstation and VIDS monitor screen. If an incident occurs within the coverage area of camera, operator shall be able to control VIDS camera remotely and check the status visually. At the same time, images from all cameras shall be recorded on the storage device in specified period.

The VIDS system shall consist of the following components:

- 1) VIDS image sensor and VIDS Controller at roadside;
- 2) VIDS server at Traffic Management Centre and,
- 3) Network equipment.

VIDS shall be installed at the location to identified by during the site survey. The VIDS shall be installed approximately 200m upstream of the off-ramp nose of every interchange or connecting / merging road to monitor the sectional traffic volume on the main carriageway.

The road and traffic condition images taken by VIDS cameras on the project shall be transmitted as video signal to the VIDS Server at the Traffic Management Centre through the communication network. The VIDS Server shall be capable of selecting video signal from any VIDS camera to be displayed on the display monitor of the Server and on video wall.

Sequential display function shall be provided to the VIDS Server. The sequential display function shall allow the video image from the multiple cameras to be sequentially displayed at a pre-set interval. It shall be possible to select the cameras for sequential display and to set the display time of the image from each camera.

The VIDS display monitor on the console and video wall shall have multiple screen capability and shall display either one image or four images at a time. The image on the video wall shall be controlled by the VIDS Server.

The VIDS system shall have a remote control function of pan, tilt and zoom of the camera selected. Each camera shall have a normal position of pre-set pan and tilt angles and a pre-set focal length to return and stay when the manual control of PTZ is released.

Incident detection

The VIDS system shall have an incident detection function and automatically detect incident occurred within its viewing area when the camera is set at home position. Incident refers to those occurrences of slow-moving vehicle, stopped vehicle, and vehicle running in opposite direction.

If an incident is detected, VIDS Server shall issue an alarm and incident image shall be automatically displayed on the VIDS operator console monitor display and video wall.

All images shall be automatically recorded in the storage device of the VIDS server with camera ID and time stamp. Frame rate of the video signal can be reduced to one frame per second to

reduce the requirements for the storage capacity required. Images shall be stored for minimum thirty (30) days.

Local warning flashing lights and Alarm

The local VIDS controller shall be enabled to provide appropriate local warnings (in the interest of road safety) to vehicles on the main carriageway on detection of incidents like reverse traffic (along with warning to the Traffic Management Control Centre).

Gantry/Pole mounted flashing lights of minimum 300mm diameter with a visibility of at least 500m shall be used for local warning.

There shall be at least five such warning lights each mounted typically at a distance of 100 meters and 200 meters before the incidence monitoring point when seen from the direction of travel. The above distances shall be suitably optimized during detailed engineering. Two warning lights shall be installed in the median and three on the shoulder side.

Automatic Traffic Counter and Classifier (ATCC)

The Automatic Traffic Counter and Classifier (ATCC) will be introduced in the Project to measure and analyse the traffic flow on the Project, without any manual operation (e.g. monitoring, counting, detecting).

ATCC shall detect, count and classify vehicles within its sensing area set on the main carriageway. The traffic image captured by ATCC camera is transmitted to the ATCC Server in the Traffic Management Centre (TMC), and those images are post-processed by image processor installed in ATCC Server, to count the traffic volume per vehicle type (e.g. Van, Truck, two-wheeled vehicle, etc.).

The ATCC system shall consist of the following components:

- 1) ATCC image sensor and image processing unit at roadside;
- 2) ATCC server at Traffic Control Centre; and,
- 3) Network equipment.

Integrated type automatic traffic counter cum classifier that accommodates both image sensor and processing unit in a cabinet shall be provided.

ATCC shall be installed at suitable location before / after the toll plazas of the project.

Image taking

The ATCC shall continuously take the image of the coverage area set on the main carriageway or ramp. It shall be possible to adjust the angle and coverage area of the image sensor by software or parameter to maximize the detection accuracy.

Image processing

Image taken by the camera shall be processed to obtain traffic flow parameters. The processing unit shall be capable of:

Location

Location indicates the relationship between the VMS location and the event location. They can be expressed as section (between Interchange A to Interchange B), distance (ahead, xx km ahead), or specific location (near Interchange A).

Event

Event is a thing that has happened or taken place. It includes traffic conditions (accident, congestion, car on fire), traffic regulation (lane closure, road maintenance work), road condition (wet road surface, fallen object, damaged pavement), and weather condition (fog, rain, strong wind).

Instruction / Regulation

The instruction is the action to be taken by the project users such as "slow down", "cautious", "exit here", "exit at next interchange", and "use right/left lane". The regulation is the traffic regulation being enforced like "lane closure" or "Highway closed".

The three components are not necessarily required all the time. Messages consisting of one or two components described above or simple message will also be displayed.

The VMS centre controller will be capable of showing the following screens.

Item	Contents
Route map	<ul style="list-style-type: none">• Schematic road map of project and access road• Detailed VMS location map• Name and station number of interchanges and toll barrier
Equipment location and status	<ul style="list-style-type: none">• Location of VMS and their condition (message / no message and normal / error)
Message	<ul style="list-style-type: none">• Message being displayed at selected VMS with starting time and scheduled end time• Pre-defined words and phrases• Pre-defined messages• Graphic symbol marks
Operation	<ul style="list-style-type: none">• List of VMS currently not in operation• Operation log and error record
Date and Time	<ul style="list-style-type: none">• Current date and time

The VMS centre controller will produce the reports listed below. The reports will be output according to the schedule or upon the system operator's request. It will be possible to output the report as a file in portable document file format.

Item	Contents
VMS operation	<ul style="list-style-type: none">• Daily report summarizing VMS location, message displayed, start time, end time
Error log	<ul style="list-style-type: none">• List of VMS currently not in operation• Error record

10.20.4.4 Weight Monitoring System (WMS)

Passing heavy vehicles causes damage to the structure and pavement. Weight Monitoring System (WMS) shall be introduced in the Project to measure the axle load of vehicle intending to enter the highway in order to control the vehicles and protect the expressway.

The weight overload monitoring roadside equipment shall detect, make alert, record plate number and take photo of overloaded vehicles. All of data measured and captured by the roadside equipment shall be transmitted to the overload monitoring data server in the TMC. The system shall operate on a 24-hour a day 7-day a week basis.

The WMS will consist of:

- 1) Weight sensors, inductive loops, CCTV cameras, still camera (ANPR), WMS cabinet which are installed at main carriageway (Sensors and associated equipment/devices will be installed at all lanes, while WMS Controller will be used to control all the terminal equipment in one direction.),
- 2) WMS Server to be installed at the Traffic Management Centre gathered at each weight station will be sent to this WMS server for monitoring and recording.

10.20.4.5 Vehicle Speed Detection System (VSDS)

Radar sensor-based speed detection system with integrated ANPR shall be introduced on the Project. The Radar system should be able to correctly link the Number plate with concerned vehicle speed.

The sensor shall be mounted permanently to monitor a single lane of a highway as part of a complete monitoring system. Multiple sensors placed on an overhead structure such as a signpost or overpass can be used to give a complete picture of traffic flow by lane in a given location.

In addition to the radar and ANPR based VSDS, Vehicle Actuated Speed Display (VASD) shall be installed in each lane. The purpose of the VASD is to display the speed of the vehicle to the driver and alert about his speed and prevent him/her from over-speeding.

VSDS and VASD shall be installed at suitable locations as identified during the site survey. The VSDS and VASD shall be installed in the section where the over speeding chances are higher. Both the system shall be installed in both the directions (LHS &RHS) of the road at each location.

At some locations only VASD shall be installed, the selection of location shall be such that the standalone VASD and both VSDS & VASD are installed alternately. This will help in saving the cost of Radar based VSDS at half of the location, while the commuters won't be able to know / identify that only the speed display is installed at few locations.

10.20.4.6 Meteorological Observation System (MOS)

Meteorological Observation System (MOS) will be introduced in the Project to recognize weather conditions on the expressway at two (2) location and take appropriate countermeasures in bad weather conditions.

MOS shall collect weather condition data at the meteorological observation stations continuously. The data collected shall be transmitted to MOS data processor at the Traffic Management Centre (TMC) for data processing and logging. In case of adverse weather, the system shall automatically issue an alarm to the system operator.

The MOS system shall consist of the following components:

- 1) MOS Observation Station
 - i. Rainfall detector

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- ii. Rain gauge
 - iii. Thermometer
 - iv. Vane anemometer
 - v. Visibility meter
 - vi. Ambient air temperature sensor
 - vii. Road-surface temperature sensor
 - viii. Humidity sensor
- 2) Data logger at MOS observation station
 - 3) MOS data processor in the TMC
 - 4) Network equipment
 - 5) Power supply equipment and peripheral

10.20.4.7 Digital Transmission System

The Optical Fibre Cable (OFC) shall be laid across the Expressway by the contractor. 48 Core Armoured OFC with all accessories shall be provided along the entire stretch. The OFC shall be laid in the 40 mm PLB HDPE duct as per latest TSEC specifications. The duct shall be laid either in the median or in the shoulder along with all accessories and 1m x 1m x 1.2m (depth) chambers (with concrete cover) with proper reinforcement and minimum M25 grade shall be provided at every 500m. Any additional chamber of suitable dimension, if any required at the equipment location shall be provided separately in addition to these chambers. The other network components have also been considered under each key component, as applicable. The 40mm PLB HDPE duct shall be lay in a trench of 0.8 meter to 1.2 meters depth (above the GSB layer, as applicable) with proper backfilling with sand and soft soil free from debris, stones, etc. as per the TSEC specifications.

10.21 Hybrid ETC based Toll Management System (TMS)

Implementation of latest Hybrid ETC based Toll Management System (TMS), integrated with the NHAI's Fastag program has been proposed for this access-controlled Expressway project.

By adopting the Fastag integrated Hybrid ETC based TMS, the Authority shall be able to enhance the efficiency of toll plazas. The valid Fastag vehicles will be able to pass through the toll plazas seamlessly, without any need to wait in the queue. This will not only reduce the waiting time, but all reduce the cash collection at the plazas, hence substantially reduce the possibility of pilferage.

10.21.1 Scope of System Integrator

1. The scope of System Integrator shall be Design, Supply, Installation, Testing, Commissioning, Configuration, System Integration, and Maintenance of Hybrid ETC based Toll Management System (TMS) in all lanes, Plaza Management System (PMS) at the control room of the concerned Plaza. The scope shall also include the provision of skilled resources at Plaza location for system maintenance.
2. Sending the transaction data and corresponding images/ video clips from the Plaza on real-time basis through dedicated leased line to the Audit and Monitoring System (AMS) at Command & Management Centre of the Authority.
3. Integration with ALEP and other UPEIDA's Expressway TMS System
4. Integration with the Fastag ETC System of NHAI

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5. The scope of work shall also include any upgradation of key equipment, servers, workstations, network devices, application, software, third-party software/tools, etc. within the contract value, required at any stage of the contract period, due to technological advancement or end of life of any the equipment / software / application etc. in order to continue to meet the required service levels, at no extra cost to the Authority.

10.21.2 System Description

The TMS System proposed shall have high reliability, accuracy and security in design. Stoppage of the total system shall not be allowed under any circumstances. Redundant hardware configuration shall be adopted for key components to ensure continuous toll collection operation. Data backup mechanism shall be used to prevent data loss. Operation log shall be kept allowing tracing of operation in case of any dubious transaction. Mechanism shall be incorporated in the system design to prevent illegal or fraudulent activities by Toll Collector or road user.

The Toll Collection and Management System to be implemented on the Plazas shall be a Fastag based ETC system. Toll shall be collected from all motorized vehicles using the Expressway at the Plazas with the exception of Government vehicles, emergency services, and military convoys and other exemptions as per the Authority guidelines

Minimum five types of user fee collection method/ Mode of Payment (MOP) shall be adopted; Fastag Electronic Toll Collection (ETC), Vault payment, NFC/ EMV based Credit/debit card, SMS based cashless payment and Cash. New MOPs may be introduced by the Authority from time-to-time to make user fee collection system more transparent, cashless and user friendly. All lanes shall be Fastag ETC lanes also equipped with manual (cash) system. The ETC system shall be as per the IHMCL's Fastag requirement and guidelines.

Fastag ETC system shall also comply with the relevant NPCI standards (guidelines) adopted by NHAI/IHMCL.

Postpaid payment system may be introduced in future to the User Fee collection and management system, if the Authority/ MoRTH/ RBI guidelines are rolled out for postpaid payment of Toll fees.

A set of equipment shall be installed in the booth, on the island, lane, tunnel, canopy, Plaza building, Web based application for Monitoring at Authority's Head Office Toll Collection, Operation and Management. The operation of all lane equipment shall be monitored continuously by a Plaza Management System (PMS) that shall also compile, audit and prepare the statistical data for print out, for display in the Plaza building control room and onward transmission to respective Command Centre of the Authority.

The Plaza Management System (PMS) shall also provide management facilities such as attendance recording, reconciliation between declared and expected fee collection, float money management, coin management and control of cash transferred from the plaza to the bank.

Each Plaza shall operate as an autonomous system with no data communication between Plazas and between Plaza and CCC being necessary. A data communication network shall be via leased line or fiber optical cable (OFC), as applicable.

The Sensor-hardware shall be capable to pass the quality test from any third-party lab test. System Integrator shall ensure the sensor quality before installation. The primary goal of the specification is to ensure the following objectives are achieved in the systems provided,

- Data Integrity
- Data Redundancy
- Transaction Auditability (Every Transaction and incident related to the transaction can be followed step by step, the transaction number must be linked to the incident)
- 100% Accuracy in Vehicle Detection
- Traffic and Revenue Integrity
- Ease of Use for Operators
- Hassle Free Frequent User Processing
- Hassle Free User Processing

An Accurate, Robust and Flexible Reporting System to be able to ensure all transactions, Incidents, Traffic and Revenue can be easily obtained from the system. The Reports shall be all hard coded and provided in the menu system of the MIS system.

10.21.3 Lane Equipment

The lane equipment shall be understood to be the equipment installed in the lanes at the Plazas.

Lanes shall consist of the following:

A) The indoor lane equipment shall comprise of the following:

- (1) Toll Lane Controller
- (2) Toll Collector terminal (TCT) (TFT, Industrial keyboard, Cash drawer, Thermal receipt printer, Barcode reader, Biometric finger print reader)
- (3) Emergency footswitch
- (4) Intercom slave communication unit
- (5) Booth Camera with voice recording
- (6) Manual Booth Controller

B) The outdoor lane equipment comprises of the following:

- (1) Manual lane Entry barrier
- (2) Canopy Lane Status Display
- (3) User Information Display
- (4) Automatic lane Exit barrier
- (5) Amber Siren Beacon
- (6) Incident Capture Camera
- (7) License Plate Image Capture Camera
- (8) Automatic vehicle classifier system
- (9) ETC Transceiver

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- (10) Load Gauge Detector
 - (11) Flashing Light at the bull nose
 - (12) Medium Speed Weigh-in-motion (entry lanes only)

Lane equipment inside the booth shall process transaction based on the Toll Collector inputs relating to the classification of vehicles.

Vehicles with valid Fastag (ETC RFID passive tag) entering the lanes shall be processed seamlessly. The ETC Transceiver (RFID integrated reader), installed in canopy or lane at the pay-axis shall automatically read the Fastag and lane shall be able to process it as ETC vehicle after verifying the validity of Fastag in the respective blacklist/ whitelist files store in the lane controller.

The blacklist file shall be updated periodically as per the CCH/IHMCL/NPCI guidelines. In case the Lane is offline or not received the updated CCH blacklist/whitelist file since last two pre-defined time cycles, the UID shall display the message to that Fastag system of the lane is offline, kindly pay user fee in cash (or any other alternate mode of payment as available at that Plaza).

In case the ETC reader is unable to read and verify the Fastag, the system shall provide option to TC to select the MOP to process the vehicle in cash or any other applicable MOP category as per the user preference.

Toll Lane Controller shall control all equipment in the lane, analyse inputs from vehicle, AVC equipment in conjunction with TC inputs made via keyboard in the TCT and other automatic and semi-automatic inputs provided by the equipment itself.

The TLC shall store and, under normal operating conditions, transmit to the Plaza Management System (PMS) in real-time, data confirming all events, individual transactions and alarms. If there is no communication between TLC and PMS server, the TLC shall store all data relating to a minimum of thirty (30) days operation under normal operating conditions and throughput, for later transmission to ensure that no loss of audit or statistical data occurs. Facilities such as USB port shall be provided to allow stored data to be extracted from the lane equipment and subsequently transferred to the PMS to protect against long term failures of this item.

The TLC shall have Fastag only or cashless only mode in addition to the mixed payment method mode. Under Fastag only mode, the lane will be dedicated to Fastag vehicles only. No Fee Collector's input of vehicle class is required to initiate the transaction and the ETC reader shall be set in polled operation mode to detect the arrival of Fastag vehicle. Changeover of the operation mode shall be made by a parameter setting and no loading of software shall be required.

Fastag ETC lanes will be Stop & Go lane without ejection mechanism. The default position of Automatic lane exit barrier will be closed. The Fastag vehicle will stop at the entry point, the barrier will open upon successful authorization of the Fastag by the ETC reader. The transaction processing will be same as explained above.

10.21.4 Plaza Management System (PMS)

The Plaza Management System (PMS) shall be understood to be the computer system installed at each Plaza building and shall consist of the following:

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- (1) PMS Server
 - (2) Plaza Video Server
 - (3) Control Room Console with video wall
 - (4) LSDU workstation
 - (5) Audit workstation
 - (6) Snapshot image workstation
 - (7) CCTV monitoring workstation
 - (8) Cash up workstation
 - (9) Supervisor workstation
 - (10) Networking system components
 - (11) Printers
 - (12) Master communication unit
 - (13) Static Weigh Bridges (only at the entry side of the plazas)

A Plaza Management System (PMS) shall be provided in each Plaza building control room. The PMS shall have two main functions:

- (1) Data acquisition from lane equipment and provision of real-time monitoring facilities via visual display unit in the control room of the plaza building.
- (2) Data processing and plaza management via visual display units, printer terminals and data transfer facilities.

The PMS shall comprise various inter-linked software modules, some of which shall carry out real time functions, such as data communication with lane equipment and provision of detailed monitoring facilities.

Each PMS shall be interfaced, via leased line or optical fibre cable network to the Command and Control Centre (CCC) system of the Authority. The PMS shall make available data files relating to plaza operations for transfer to the CCC system and shall receive data files such as operating parameters from CCC system.

Visual display units and printer terminals shall be provided for control, selection and data input and output. Back-up facilities shall be provided through use of appropriate external storage devices to ensure that no long-term loss of data or restrictions on operation occurs as a result of failure of either the PMS or of the data transmission link with the CCC system.

10.22 Audit and Monitoring System (AMS) at the Command and Control Centre (CCC)

The Audit and Monitoring System (AMS) shall be understood to be the computer system installed at the Command and Control Centre (CCC) at the Head Office of the Authority.

AMS shall consist of minimum following components and sub-systems:

- (1) AMS Primary Server
- (2) AMS Secondary Server
- (3) AMS Video Server
- (4) Backup Server / D2D Backup Server & Storage (SAN)
- (5) AMS administration workstation

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- (6) AMS LSDU workstation
 - (7) AMS reporting workstation
 - (8) Financial management workstation
 - (9) Snapshot image workstation
 - (10) CCTV monitoring workstation
 - (11) CCC Video wall
 - (12) Networking system components
 - (13) Printers

CCC primary and secondary server shall exchange the real-time replication backup data to manage the Fail-out. The CCC system shall have the following main functions:

- (1) Data acquisition from PMS
- (2) Data processing and validation via visual display units, printer terminals, portable memory modules and data/parameter transfer facilities
- (3) Downloading of operational parameters from AMS to PMS
- (4) Interfacing with PMS system, CCC system for backup, DR and standby operations.

The CCC system shall be interfaced, via leased line or optical fibre cable network to the PMS. The CCC system shall make available operating parameters relating to plaza operations for transfer to the PMS and shall receive data files from the PMS.

The provision of CCC system at the Head office of the Authority is not part of the scope of this project, only integration with the CCC as per the procedure mentioned above shall be covered under the scope of the TMS proposed for this project.