SCHEDULE – D

(See Clause 2.1)

SPECIFICATIONS AND STANDARDS

1. Construction

The Contractor shall comply with the Specifications and Standards set forth in Annex-I of this Schedule-D for construction of the Project Highway:

2. Design Standards

The Expressway including Project Facilities shall conform to design requirements set out in the following documents:

'Manual on Specifications and Standards for Expressways' published as IRC: SP: 99-2013 with all amendments and additions till date.

Annex - I

(Schedule-D)

SPECIFICATIONS AND STANDARDS FOR EXPRESSWAYS

1 Manual of Specifications and Standards to apply

All Materials, works and construction operations shall conform to the the 'Manual on Specifications and Standards for Expressways' published as IRC: SP: 99-2013 with all amendments and additions till date. (An authenticated copy of the Manual has been provided to the Concessionaire as part of the bid documents. (Referred to as "Manuals" in this Schedule) and MORTH Specifications for Road and Bridge Works (5^{th} revision). Where the specification for a work is not given, Good Industry Practice shall be adopted to the satisfaction of the Authority's Engineer.

2 Deviations from the Manual

2.1 The term "concessionaire", "Independent Engineer" and "Concession Agreement" used in the manual shall be deemed to be substituted by the term "Contractor", "Authority's Engineer" and Agreement" respectively.

2.2 Notwithstanding anything to the contrary contained in the Paragraph 1 above, the following Specifications and Standards shall apply to the Project Highway, and for purposes of this Agreement, aforesaid Specifications and Standards shall be deemed to be amended to the extent set forth below:

Sl. No.	Clause No.	Details of Item	Description of Deviation
1	2.5.1	Median	The median shall be as given in Schedule B (TCS) 6.0 m wide median shall include 0.75m wide edge strip on each side, which shall have same pavement configuration of Main Carriageway as per Clause no. 2.5.3 of Manual 12 m/19.5m wide median shall include 0.75m wide edge strip on each side, which shall have same pavement configuration of Main Carriageway as per Clause no. 2.5.3 of Manual.
2	2.10.2 (iii)	Vertical clearance at PUP/CUP	3.5 m vertical clearance shall be provided at all PUP/CUP Underpasses.
3	2.12.3	Width of Connecting Roads	The location & width of the connecting roads shall be as specified in Schedule B
4	2.16	Typical Cross Section	The typical cross section shall be as given in Schedule B.
5		Addition of New Clause to section 6 Structures in Marine /Aggressive Environment	Additional protection measures shall be taken as per IRC: SP: 80 with all amendments for structures in Marine/Aggressive Environment.

Sl. No.	Clause No.	Details of Item	Description of Deviation
6		Addition of new clause to section 6 (Design of Structures) River training and protection works	River training and protective works shall be provided in accordance with IRC:89 with all amendments and additions till date.
7	5.2	Type of Pavement	The type of pavement shall as specified in Schedule B.
8	6.3	Overall width of structure for Road Over Bridges (ROB)	The Overall Deck Configuration of Road Over Bridges shall be as per the GAD approved by Railways Authority.
9	9.2	Side Drains	Lined Side Drains shall be provided throughout the Project
10	9.4	Drainage where Embankment Height is more than 6 meres	Adequate Continuous Surface RCC drain (Except Structures having approach slabs) shall be provided by the side of both side Earthen Shoulder including RCC Chutes at designed intervals with energy dissipation basin irrespective of any Height of Embankment.
11	10.7.2 (b)	Median Barriers	An additional length of 25m Thrie beam metal crash barrier shall be provided on right side of entry approach for all open median structures shall be constructed.
12	10.7.2 (a)	Median Barriers	Thrie beam median barrier shall be provided for both side of the carriageway (both side of the median.)
13	15.2 (i)	Specifications of Lighting-Table 15.1 Minimum Level of Illumination.	The average level of Illumination shall be 40 Lux.
14	2.11.2	Vertical Clearance at VOP	6.0m Vertical Clearance shall be provided at all VOP locations.
15	4.2.2	Embankment Fill Side Slope	In fill section the embankment side slope shall be minimum 2(H):I(V). The embankment height >6m shall be designed in accordance with IRC:75.
16	Section 11	Traffic Management System	Additional specification for Traffic Management System shall be as given in Annex II of Schedule D.

Annex - II

(Schedule-D)

ADVANCED TRAFFIC MANAGEMENT SYSTEMS (ATMS)

The following Specifications and Standards shall be applied in addition to 'Manual on Specifications and Standards for Expressways' published as IRC: SP: 99-2013 with all amendments and additions till date.

1. ADVANCED TRAFFIC MANAGEMENT SYSTEMS (ATMS)

1.1 General

The work would cover design, supply, installation, commissioning and/or operation and maintenance of Advance Traffic Management Systems (which is one of the components of Intelligent Transport Systems - ITS). The system would include out-door equipment including emergency call boxes, variable message sign systems, meteorological data system, close circuit TV camera (CCTV) system, traffic counting and classification system and transmission system. The indoor equipment would comprise a large display board, central computer (with Network Management System - NMS), CCTV monitor system, call centre system or management of emergency call boxes housed in a control centre with uninterrupted power supply. Any new technology, meeting the requirements specified in these specifications should not be excluded. The systems shall meet following objectives:

- Smooth and uninterrupted traffic flow
- Enhance road safety
- Real time information and guidance to users
- Emergency assistance round the clock
- Alerts for abnormal road and weather conditions
- Reduced journey time and inconvenience

1.2 System Requirement

ATMS shall provide the following facilities to Expressway users:

- make emergency calls to Control Centre in case of accidents, breakdown, fire and ambulance.
- pre-warn the Expressway users about unusual condition on the road.

ATMS shall provide the following information/data to traffic managers for efficient and effective handling of traffic.

- information regarding location of any incident, incoming calls, help required and messages to be passed to third parties.
- Information regarding traffic congestion, speed and weather conditions.

ATMS shall provide the following controls to traffic managers:

- change the variable message signs from the Control Centre.
- mobilize the movement of ambulances, cranes & patrolling vehicles.

ATMS shall provide online recording and reviewing of the voice & visual information for record and analysis.

Value Added Systems in information dissemination to users of the Project, may be taken up in future. These shall include the following:

(i) Value Added Systems in the form of real time information on traffic conditions, unusual events, congestion levels, weather conditions etc.; to facilitate project users as also the operator.

(ii) Through relevant websites including that for the Project SPV/Concessionaire

(iii) Subscription based alert systems

(iv) Dedicated TV channels pertaining to traffic movement

(v) Tie ups with FM radio channels or creation of dedicated AM radio channel

(vi) Dedicated Toll Free Telephone Systems

Note: Local language is emphasized in above systems.

The ATMS shall among many things comprise following sub-systems:

i. Communication backbone

ii. Emergency Communication System

iii. Mobile Communication System

iv. Variable Message Sign System

v. Meteorological Data System

vi. Automatic traffic counter-cum-classifier system

vii. Video Surveillance System

viii. Video Incident Detection System (VIDS)

ix. Central Control Room (CCR)

x. Weigh in motion for axle load measurement

xi. Power Supply System

These systems shall have outdoor equipment consisting of ECBs, VMS panels, weather sensors, traffic sensors, video camera etc. The outdoor equipment shall be connected to the control centre through transmission system preferably comprising optical fibre cable, copper cable and interface equipment. There shall be one control centre per package and shall be located at any one of the toll plazas or administrative building and shall have monitoring equipment, on line information acquisition equipment, processing equipment etc. It shall also have graphic display board showing the highway and the locations of equipment and of incidents.

1.3 Emergency Call System

Purpose and General Information

This is a communication medium to be installed on the Expressway and to be used by the road users to make alarm call to the CCR in case of accidents & other problems on the expressway.

Location

ECB shall be installed every 2km on either side of the road with one unit directly across the road from the other i.e. two call boxes every 2km. It shall be placed along the left side of the carriage-way for each direction of travel on the verge adjacent to the hard shoulders. At each location one ECB shall be master and the other slave. The master ECB shall be equipped with fibre optic interface, solar panel, battery back-up and voice communication mechanism and shall also comply with all the

requirements specified in this section for ECBS. The slave ECB shall be equipped at least with – activation button, vandal sensing mechanism, call progress indication LED, microphone, speakers – in a weather proof housing. To discourage motorists who break down near the start or finish of the expressway from leaving it to obtain assistance, no telephones should be provided within the first and the last 300meters.

To achieve maximum visibility, care should be taken to avoid siting telephones near structures (e.g. bridge piers), particularly where these are close to the hard shoulder on left hand bends.

Based on the above policy and the site condition, the location of the ECBs can be adjusted within 10% variation, however, only with the consent of the NHAI.

The optical fiber and splicing boxes shall be placed in the central median.

Major Components

Main components of the Emergency Call subsystem are:

1. Field components:
    a. Emergency Call Box – Master and Slave units
    b. (Solar) power supply
    c. Guard rail for protection
2. CCR components
    a. ECB server
    b. Headphone, speaker and microphone (Answering Unit)
    c. Voice recorder/logger
    d. Application software
    e. Database software

Functional Specifications

1. The system shall be connected to the CCR over the OFC backbone.
2. ECB shall have loud speaker, microphone, solar panel, and battery and activation button with LED indicating conversation. It shall be housed in vandal proof casing and operate in expressway noise levels with built in diagnostic features.
3. The road user just needs to press the push button on the ECB and shall be connected to the CCR. In case the CCR operator is busy, the user shall hear a recorded message and shall hold till he/she is connected. The Master unit shall be connected to the CCR over the communication backbone. The Slave unit shall be connected to the CCR through the Master unit.
4. The CCR can also call any specific ECB for testing/calling in which case the ECB shall ring. The ring shall go off when someone presses the push button and connects to the CCR.
5. The ECB shall have the following features :
    a. Vandal proof casing with tamper detection switch
    b. Push button
    c. Activation LED
    d. Loud speaker

e. Microphone

f. Two way communication between ECB and CCR

g. Solar panel with batteries

6. ECB shall have hands free operation.

7. Each ECB shall have usage instructions in Hindi, English, Marathi and Guajarati pasted or printed on it along with graphical instructions.

8. Reflective stickers facing the motorist shall be pasted on the ECB indicating that it is a phone.

9. The CCR software shall manage the calls to and from the ECB.

10. The ECB shall have Ringing Tone to indicate progress of call when button is pressed; Confidence Tone to indicate call is still connected when on hold and recorded message if line is busy.

11. There shall be up to four programmable auto dial numbers associated with the push button. The ECB shall automatically dial subsequent numbers if the first number is busy or unavailable.

12. The ECB shall automatically end call when CCR telephone is disconnected.

13. All calls shall be recorded in the CCR voice logger/recorder along with date/time stamp. The voice recorder shall check for following minimum fault conditions :

- Failure of recording electronics
- Failure of storage media used for recording
- Excessive recoverable errors on the storage medium
- Lack of activity on a channel
- Constant activity on a channel
- Constant ringing on channel (answered calls)

14. ECBs shall be programmable from the CCR and from the field by laptop.

15. The system shall have in-built diagnostics and shall be able to detect activation of tamper switch, mic/loudspeaker faulty, line faulty, low DC voltage on line, cross talk and short circuit. Any diagnosed problem shall trigger an audio video alarm in the ECB server at CCR.

16. The diagnosed problems shall be stored in the system as events in the CCR. It should be possible to draw and print report of all such events on time and event category basis. ECB software at CCR shall allow recording and storing of maintenance and corrective action of each event when it is resolved.

17. ECB shall be powered by DC batteries which in turn shall be charged by solar panel. The battery shall support 7 days of operation (under normal circumstances) with minimum talk time of 90 minutes over 3 days in succession in case there is no sunlight for this period.

18. The ECB shall have tamper resistant screw bits on the outside and shall be security locked. It shall not be possible to open the ECB with normal tools or keys.

19. ECB foundation shall be concrete. Cables (communication/power) shall enter from the base of the ECB foundation.

20. Each ECB pillar shall be numbered.

21. The ECB mic/speaker shall be located 1-1.5m above ground.
22. The system shall not permit cancellation of any call before answering.
23. CCR Equipment
    a. The CCR equipment shall consist of an ECB server with large TFT display screen and voice logger for recording of all calls. It shall be possible to play back any call by time specified. Playback should not interfere with record function. The screen shall show the map of the expressway with all Emergency telephones marked in accordance with their actual locations.
    b. The GUI shall be user friendly. ECBs shall be displayed in grey colour icons on the screen. When a call is initiated, the icon shall turn green and blink. When the call is in progress, the icon shall be green and stationary. On-hold calls shall be displayed in orange blinking. Faulty ECBs shall be displayed in red, without blink.
    c. The software shall have the following features:
        i. password protected & accessible only with relevant passwords
        ii. data logging with the currently logged user/ operator details
        iii. different levels of authorization for logging into the system
        iv. automatic Call location identification
        v. call disconnection by operator only
        vi. operator call back facility
        vii. automatic testing facility running in the background at operator selectable intervals
        viii. operator initiated ECB test facility
        ix. facility for holding at least 10 calls from ECB's
        x. Low battery and tamper alerts.
    d. The following shall be recorded by the system software:
        i. Time of incoming call
        ii. Time of call answering
        iii. Time of call termination
        iv. Time of fault occurrence
        v. Time of happening of events
    e. It shall be possible to :
        i. connect to any of the Calls on Hold
        ii. hang up the call
        iii. put on Hold the currently connected call
        iv. call back any of the ECB
        v. monitor faults and events
        vi. send e-mail to defined personnel intimating them about emergency
    f. It shall be possible to draw the following minimum reports for each ECB as well as all/selected ECBs :

i. Call count based on time period selection
ii. Average call duration
iii. Average waiting period for on-hold calls
iv. Unanswered calls (count)
v. Fault and diagnostics report
vi. Incident category-wise report
vii. The reports shall be tabular as well as graphical.

24. The following technical specifications are advised for ECBs. However the system integrator/operator can choose any other technology as long as other requirements are met.

a)	Working	:	work on VoIP
b)	Communication	:	Ethernet type over optic fiber
c)	Power	:	12/24V DC, solar powered max 10W
d)	Audio output	:	>95dB
e)	Microphone	:	unidirectional, noise cancellation type
f)	Wind speed resistance	:	180kmph
g)	Mean Opinion Score	:	Min 4.0

25. ECB shall connect to the Outdoor Technical Cabinet Switch on optic fiber port/copper port (Ethernet may also be used, wherever feasible).
26. The ECB shall be vandal resistant in construction. It shall be made of stainless steel/ Aluminum alloy/ FRP.
27. ECB components shall be corrosion resistant; PCBs shall be coated to prevent water, moisture and fungus.
28. Each ECB shall be protected against external EMI, lighting and static by adequate shielding and earthing. The enclosure shall be provided with a grounding lug for connection to ground wire.
29. ECB enclosure shall be IP65 rated and shall be vermin and rodent proof. Doors shall be with labyrinthine seal, butyl-rubber gaskets, security locks, and metal hinges in conformity with UNE20324 standard.
30. The ECB shall operate in full duplex mode and use signaling which is inaudible to the user.
31. It shall be possible to adjust the acoustic properties.

1.4 Variable Message Signs (VMS)

Purpose and General Information

Variable Massage Signs (VMSs) are to be installed for conveying the traffic conditions ahead to the drivers on real time basis as well as to display messages to support national road safety campaigns. It may also include the variable traffic speed limit depending upon the requirements.

Variable message signs (VMSs) shall provide traveler information for warning, regulating, routing, and managing the traffic in order to improve the overall traffic flow. The philosophy is to inform the driver of impending conditions with up-to-date information. The overall goal of VMS application is to provide permanently located signs that can be programmed remotely to communicate with the drivers the

necessary information such that the driver can choose or be directed to the most appropriate route. The VMSs shall be controlled from the main CCR. Based on requirement, the VMS may be fixed or portable in nature.

VMSs shall be used during the following conditions:

- Recurring Conditions

Mainly peak-period traffic congestion where demand exceeds capacity for relatively short periods of time.

- Non-recurring Conditions

Caused by random or unpredictable incidents. An "incident" is defined as any non-recurring event that causes a reduction of roadway capacity or an abnormal increase in demand. Such events include traffic crashes, disabled vehicles, spilled cargo, expressway maintenance and construction projects and adverse weather conditions.

VMS Usage Priorities

VMS should be used whenever pertinent messages will assist motorists to make helpful decisions. If, however, a situation arises, which requires the usage of a specific VMS for more than one ongoing condition, the following priority criteria should be used for displaying messages, in the order listed.

- Safety

Any VMS message that is necessary to provide safety to the motoring public has the highest priority. Examples include failure of an expressway bridge, roadway or any major incident. In general, safety messages should be kept current and relate to a specific safety campaign. The period of time that a specific message is displayed for a safety campaign should be limited to a few weeks. Motorists tend to ignore messages that are displayed for long periods of time.

- Roadway Closure

The VMS message shall include motorists regarding the roadway (particular carriageway, lanes of the expressway or cross road) closure is important because such a closure directly affects the route a driver would take.

- Minor Traffic Impact

A pre-warning message shall generally be used for planned full closures of carriageway of particular part of the expressway. The message shall be displayed no more than four days prior to the closure, and shall be immediately replaced with an appropriate message when the closure commences.

- Pre-Warning

This category includes construction lane closures, blocking-incidents, and delay information.

- Test

Test messages may be used to sign operation for testing the operating system and prior to placing a VMS into service.

- Public Service Information

Public service information messages do not require the drivers to make any unexpected maneuvers with regards to upcoming traffic conditions. Some examples include "Buckle Up," "Speed Kills," and "Don't Drink and Drive."

Various situations where VMS would be appropriate are as below:

- Incident signs as accidents, traffic diversions, incident management, monitor road work (men at work) adverse weather and road conditions and operation with lane control signals;
- Traveler information such as display of road construction activity in near future, messages for testing of the system and special events that effect the traffic flow;
- Public service announcements like messages relating to driver safety campaign.

Location

VMS shall be provided as per locations determined later. A general policy adopted for locating VMSs is to provide VMS at an average interval of 10km in each direction (not necessarily on the same gantry) to guide and forewarn the users about the traffic and weather conditions on the Expressway.

The most critical locations for installing permanent VMSs are in advance of interchanges or expressways where drivers can have the opportunity to take some action in response to messages displayed on VMSs. A VMS should not compete with existing roadway signs.

Drivers generally do not anticipate using a different route until they see and read a VMS message. Drivers who are traveling in the inside lanes need ample time to read the message and change lanes to exit.

In general, a VMS should be permanently installed at the following locations:

- Upstream from major decision points (e.g., exit ramps, freeway-to-freeway interchanges, or intersection of major routes that will allow drivers to take an alternate route).
- Upstream of bottlenecks, if any
- Where regional information concerning weather conditions such as fog, wind, or dust is essential.

The portable VMS can be mounted at the back of the truck or similar vehicle. The VMS sign mounted on truck could be powered by solar energy or battery.

The exact location shall be adjusted for the maximum utility to the users based on the site conditions, however, only with the consent of the NHAI.

Major Components

The design of the system will be modular except for the housing.

Main components of the VMS subsystem shall be:

- Field components – consists of the sign module having:
  a) VMS case
  b) VMS sign (display modules)
  c) Power supply
  d) Dimmer control (ambient light photo sensor system)
  e) Microcontroller
- CCR components
  a) VMS server
  b) VMS Application software
  c) VMS Database software

Specifications

1) VMS shall be able to display all colours.
2) The VMS shall be able to display the following:
   - English text
   - Hindi text
   - Gujarati text
   - Marathi text
   - Numeric
   - Punctuation marks
   - Graphics
   - Preset messages – at least 10 preset messages shall be displayed and shall be able to change automatically and sequentially in programmable intervals of 1-10 minutes
3) The mounting structure to be provided for the VMS units shall be sturdy, aesthetically designed and capable of bearing wind loads at least up to 200 kmph. The lowest hung part of the display board shall have vertical clearance of at least 5.5 m from the road level. It shall be provided with a walkway to allow at least 2 persons to carry out maintenance of the VMS without obstructing the carriageway. Safety barriers shall be provided at gantry support column (s) for their protection and for safety of road users. The concrete pedestal for support column should be flushed with ground but in no case should protrude for more than 15 cm.
4) The minimum distance of VMS on an expressway should be 1.5 km. prior to decision point. The signs should be visible from a distance of 300m.
5) There should be clear distance between existing road sign and VMS. The minimum distance between road signs and VMS should be at least 250m.
6) The average driver of motorized vehicle at high rate of speed can comprehend two message panels. Each panel should be complete phrase and each phrase should be independent of the other. The messages should consist of:

A problem statement	Road work/accident ahead
An effect statement	Delay/congestion
An attention statement for certain group	Motorist
An action statement	Take the next carriageway

7) Software – The VMS application software shall be installed in the CCR and shall have the following features:
   - GUI display
   - Login/password protected access
   - Database for storing messages and history
   - Reports for – preconfigured messages, login time and user, date/time of display, fault history.
8) Maintenance walkway shall be provided on the gantry at the rear of the sign-case. All component parts shall be easily and readily accessible by a single person for inspection and maintenance. There shall be room for a technician to work. The VMS should have in-built lighting to assist maintenance work during night.

9) Standards

VMS shall be designed to comply to with the following protocols:

- EN 12966 parts 1,2 and 3

10) VMS shall be full matrix, true colour. It shall be made of modules and shall have equally spaced LEDs.

11) Text display - VMS shall be compliant to EN 12966. This includes the following for LED panel:

- Beam : B3
- Colour : C1
- Luminance : L3
- Temperature : T3
- Resistance to pollution : D3
- For wind pressure on enclosure refer EN 12899

12) Display specifications

Sign dimensions	:	Length 8000mm, height 2500mm
Pixel colour	:	True colour (36bit), text displayed in Amber colour
Pixel size	:	25mm
Pixel pitch	:	25mm
LED life	:	> 100,000 hours
Operating Voltage	:	AC 220V, 50Hz
Language	:	Hindi, English, Gujarati, Marathi
Character height	:	upto 450mm
Horizontal viewing angle	:	$>80^0$
Viewing distance	:	15-300m
Ingress protection	:	IP65 for front (LED face); IP55 for rear
Communication	:	Serial, Ethernet, OFC

13) The LED Cluster shall consist of individual LED's encapsulated in a resonated plastic housing proving protection to the elements under worst climatic conditions.

14) The modules shall be individually addressable and field replaceable.

15) Failure of one LED module should not affect the output of any other.

16) The system design shall be such so as the display is legible from a distance of between 15m to 300 m in all weather and lighting conditions.

17) Elaborate Fault diagnostics shall be provided as per EN12966 or other equivalent international standards. Each pixel shall be monitored and feedback shall be provided for the healthy status. Minimum of following shall be provided :

- Power Failure at VMS
- Processor PCB Failure
- LED Cluster Failure

- Loss of incoming message / data not properly received.
- Temperature monitoring

18) The VMS shall withstand shock and vibration existing on the expressway.

19) Controller functionalities

- The controller unit shall provide brightness control facility. The intensity of the VMS shall have at least six levels and it shall select the correct level automatically depending on ambient light conditions. For this, the VMS shall have photo sensor and dimmer control.
- The controller unit shall provide the monitoring of ambient temperature of the housing.
- The controller shall be provided with a test port for local diagnostics via laptop.

20) The VMS software should permit the following :

- Broadcast messages
- Specific address messages

21) It shall be possible to perform fault diagnostics from the central control room via the software.

22) Maintenance panels shall be provided on the rear of the housing

23) Maintenance walkway shall be provided on the gantry at the rear of the sign-case. All component parts shall be easily and readily accessible by a single person for inspection and maintenance. There shall be room for a technician to work. Access shall be made by entering the side of the housing. The housing shall be weather tight, and compliant to the NEMA 3R Standard. The bottom panel of the housing shall have a minimum of four drain holes, with snap-in, drain filter plug inserts.

24) Ventilation - The ventilation system shall be forced air. The system shall be designed to adequately cool the pixels from all sides along with the front and rear of the display module and all other internal components. The ventilation system shall have the following properties:

- Positive pressure (exhaust fans are not acceptable).
- The fans shall have ball or roller bearings, shall be permanently lubricated and shall require no periodic maintenance. The fans are to be positioned in such a manner so as to provide a balanced air flow to the ventilation system in the event of failure of any fan.

a) Sign-case

- All parts shall be made of corrosion resistant materials, such as plastic, stainless steel or aluminum. Painted steel is not acceptable. No self-tapping screws shall be used. The finish shall be matte black. The main body of the sign housing shall be constructed of aluminum with a natural mill finish. All exterior seams shall be continuously welded by an inert gas process, except for the coated fascia material. The sign-case shall be constructed of non-ferrous material to avoid rusting. The VMS sign-case shall have CFL lighting for maintenance during low light conditions.

- The performance of the sign, including the visibility and legibility of the display, shall not be impaired due to continuous vibration caused by wind, traffic or other factors.
- The angular alignment of the sign housing shall be adjustable in the vertical direction from (0 to 10 degrees) down in one-degree increments to optimize the viewing angle.
- The housing shall be capable to withstand the following conditions for Vibration Test

1.	Frequency range	:	10- 50Hz
2.	Vibration amplitude	:	0.35mm
3.	Duration of endurance	:	20 sweeps cycle
4.	Duration at resonant frequency	:	30 min+ 1 min

The Gantries for the VMS shall be designed and the design shall be got approved from the NHAI. It includes all civil works like foundations etc., and shall be done as per relevant standards.

1.5 Automatic Traffic Counter-cum-Classifier (ATCC)

Purpose and General Information

- This system shall be used for identifying and recording all types of vehicles on the Expressway for effective monitoring and data collection at Control Centre. The system shall be capable of detecting and recording all types of vehicles plying on the Expressway.
- Besides the above vehicle classes, the system shall be capable of classifying any other vehicle category as per need. Vehicle classification should be user selectable based on vehicle parameters.
- The system shall have interface with the ATMS software for central monitoring.

Location

- ATCC is proposed to be installed at at suitable location. The final location may be adjusted as per the site condition, only with the consent of the NHAI/Traffic and Transportation expert.
- The ATCC cabinet shall be installed in median or on the side of the expressway at a distance of 2 to 3 meters from the soft shoulder.

Major Components

Main components are:

a) Field components – consists of :
   a. ATCC roadside cabinet / electronics/data logger
   b. In-road/non-intrusive sensors and cables
   c. Field computer/laptop
   d. Power supply
   e. Lightning protection and earthing

b) CCR components
   a. ATCC server
   b. Application software

c. Database software

d. Report printer

Specifications

- The ATCC should be designed for 8 lanes of traffic i.e. one cabinet/data logging unit should be able to record data for at least 8 lanes (4 in each direction)
- System shall use a combination of loop and piezo sensors or any other sensor mechanism (intrusive or non-intrusive) for correctly counting and classifying vehicles.
- Piezo sensor installation shall be in concrete. ASTM 1318-02 recommends a concrete pavement of 90m (60m before sensor and 30m after) to ensure good accuracy.
- The ATCC shall detect all classes of vehicles as per toll classification scheme.
- One or more of the following information shall be generated by the ATCC for each lane to correctly count and classify the vehicle:
  a. Vehicle length
  b. Vehicle speed
  c. Number of axles
  d. Axle spacing
  e. Axle load (WIM) and GVW
  f. Vehicle profile
  g. Vehicle image
  h. Any other proven technology with the consent of the Engineer and NHAI

2. The ATCC shall provide the following additional information:
   a. Occupancy
   b. Headway
   c. Gap
   d. Average Speed
   e. Flow rate

c) Data logger (roadside electronics): The requisite number of entry and exit ports to communication system shall be provided. The logic unit shall be micro-processor based. The system shall be able to count and classify vehicle in each lane. There shall be an indication to display vehicle detection.

d) Data logger shall have a Tamper Detection Alarm facility. Any effort to tamper with the data logger shall trigger an audio and visual alarm in the CCR.

e) Data collection: The system shall be capable of sending data to the ATMS Software which shall enable the Software to count and classify the vehicles, and provide other required information Data collection shall be by RS232, RS422 or RS485 interface or IP connection.

f) Data Storage: The system should be able to upload data to the system as it occurs. The unit shall store data of at least two weeks in event of communication failure.

g) System Accuracy (@95% confidence), whichever is applicable

a.	Vehicle length(m)	:	± 5%
b.	Vehicle speed (kmph)	:	± 1.5%
c.	Vehicle count(nos.)	:	± 1%,
d.	Number of axles (nos.)	:	± 2%
e.	Axle spacing (m)	:	± 2%,
f.	Vehicle class (of detected vehicles)	:	± 3% for Class Car/Jeep/Van
		:	± 5% for Class LCV
		:	± 3% for Class Truck/Bus (Two Axles)
		:	± 2% for higher classes
g.	Headway (m sec)	:	± 7%
h.	Gap (cm)	:	± 8%
i.	WIM accuracy	:	± 15% on axle; ± 10% on GVW
j.	Vehicle speed	:	10-195 kmph

h) Coincidence detection (lane straddling): The ATCC shall be capable of determining and recording vehicles that straddle adjacent lanes. This reduces double counting of vehicles on sites where lane discipline is a problem.

i) Weather: The ATCC shall be capable of working with above mentioned accuracies, 24x7, in all weather conditions including heavy rain, dense fog and specified temperature range.

j) Reverse detection: The ATCC shall be capable of detecting and recording any vehicles traveling in reverse direction.

k) Data retrieval: The system shall be capable of data retrieval, direct data transfer through the Fiber Optic Network or locally through laptop.

l) Recording capability: The system shall have capability of recording vehicle counting and classification, speed, headway at set interval of 1-10 minutes.

m) Compatibility: The system shall have compatibility to transmit data over Optical Fiber Cable.

n) Fault monitoring : The system shall be capable of detecting and reporting the following fault events:

- Mains power failure
- Battery low voltage
- Modem communication error
- Laptop communication error
- CPU reset
- CPU failure
- Sensor fault (for each sensor)
- Door tamper

Software

The Application Software shall have the following features:

- It shall be GUI based
- The Opening Screen shall have password authentication
- Communications Parameters setting
- Configuration Parameters setting
- Raw and Binned data Retrieval
- Vehicle by vehicle Real Time Traffic Display
- Diagnostic Functions – Sensor Test
- Vehicle Classification Configuration & Weight Limits

Specifications for CCR equipment

- Server – The server supplied shall be the latest available in the market at the time of supply. However, the minimum specifications are given in subsection on “Servers” under section “Miscellaneous Equipment”.
- Application Software
  a. Shall be a single software for all data loggers in each package
  b. Shall be Windows based
  c. Shall have unlimited period use license for each package
  d. All upgrades shall be free of cost.
  e. Shall communicate to each data loggers in the field and
  f. Shall be GUI based
  g. Password protected
- Database Software
  a. Shall be password protected
  b. records shall not be editable
  c. Shall not be notepad, MS Word, Excel
- Reports – system shall be able to generate reports. All reports can be time-wise, lane-wise, location-wise or total summary reports for all data loggers. The reports shall be in tabular and graphic form. All reports shall be in metric units and dd/mm/yy time format. The following are the minimum reports :
  a. Average Speed per Vehicle Category per Lane per Day
  b. Traffic Volume per Vehicle Category per Lane per Day
  c. Traffic Volume per Hour per Lane per Day
  d. Axle Volume per Weight Band per Lane per Day
  e. Volume (count) per Class per Lane
  f. Average Speed per Class per Lane
  g. Volume per Lane per Time Band
  h. Volume per Speed Band per Lane
  i. Overloaded Vehicles per Class per Lane
  j. Average Speed per Category

k. Malfunction Management Report (fault report)

l. Traffic Volume by Category by Lane (binned data)

m. The reports shall be transferrable to MS Excel and Acrobat pdf format.

n. Multiyear calendar adjusted for leap years

1.6 Video Surveillance System

Purpose and General Information

The purpose of the Video surveillance system is to monitor specific areas of the expressway remotely from the CCR by use of cameras installed at such critical junctions. This shall help in managing incidents.

The system shall also record and store video for analysis and future reference.

Major Components

Major components are:

- Field components :
  a) CCTV camera with housing
  b) CCTV pole
  c) Video transmission unit (encoder)
  d) PTZ control
  e) Power supply – solar panel
  f) Lightning protection and earthing
- CCR components
  a) Server with OS
  b) CCTV decoder/ switcher unit
  c) PTZ control/joystick
  d) Video Wall
  e) DVR
  f) Application software
  g) Database software

Functional Specifications

- Camera
  a. The CCTV shall be PTZ type video camera.
  b. The Video Camera shall be of dome type to avoid pilferage, be resistant to vandalism and weather-proof. The dome shall be of smoked glass so that it shall not be possible to see the camera (inside the dome) from roadside.
  c. PTZ Cameras shall have 6 or more pre-defined positions.
  d. The camera viewing distance of at least 1km in each direction. The horizontal rotation shall be 360^0 continuous pan and vertical tilt shall be 90^0 down to 0^0 horizontal.
  e. The video camera shall transmit a clear video even in low light and night conditions.

f. The camera and associated units shall be dust-proof and protected against water ingress.

g. The CCTV video camera roadside cabinet shall house the power supply system and video encoding and transmission equipment.

h. CCTV video camera shall preferably run on solar power.

i. There must be a single encoder for each camera.

- Camera mounting

a. The camera shall be mounted on a properly designed pole of at least 10m height. The Video Camera mounting shall have easy accessibility for maintenance purposes while being protected from unauthorized access.

b. The mounting and equipment housing shall be able to withstand adverse weather conditions.

c. The camera mount should be of the same make as that of camera and suitable for the model number offered as specified by the manufacturer and should be an integrated unit.

d. Should support the weight of camera and accessories in a wind speed of 180kmph (min).

- Camera control & display

a. The camera images from all cameras shall be transmitted to the CCR for monitoring and storage.

b. All CCTV cameras shall be controlled by the CCR operator. Each camera shall be individually selectable and also the Pan , Tilt and Zoom functions for each camera.

c. The CCR shall have the facility to decode the video, record the video, display live and recorded video on a large video display and have PTZ controls.

d. The video from CCTV video cameras shall be viewed in the CCR on a video wall. The video wall shall be formed of expandable modules. The system shall allow CCR operator to blow individual images to fit the entire screen or any other size.

e. The CCTV video shall be recorded in the CCR in a DVR or computer.

f. Privacy Zone Masking: the camera software shall blocks scenes/areas that should not be displayed.

g. The CCR shall be designed in a way to ergonomically seat the CCR operators. There shall be one operator for every 6 video images.

h. System to have facility of additional camera installation beyond the originally planned capacity.

- CCTV software and recording

a. The CCR shall have a server with latest specifications for image processing, control and display.

b. System shall be triplex i.e. it should provide facility of Viewing, Recording & Replay simultaneously.

c. CCR shall have facility to record all videos from all simultaneously and store at least 30 days of video. This may be done by a separate DVR or recording on the hard disk of the server. System shall have provision to automatically over-write the new information after the period of 30/31 days (First In First Out).

d. The old recording shall be overwritten by new recording after 30 days

e. The CCR Server shall have application software to control PTZ functions, select individual camera, playback video. It shall have access control (through password/login) so that no unauthorized person may view /edit any videos.

f. The software should be able to control all cameras i.e. PTZ control, Iris control, auto /manual focus, and color balance of camera, Selection of presets, Video tour selection etc.

g. The System should ensure that once recorded, the video cannot be altered, ensuring the audit trail is intact for evidential purposes.

h. System must provide built-in facility of watermarking or Digital certificate to ensure tamperproof recording so that these can be used as evidence at a later date, if so desired. The recording shall support audit trail feature.

i. The OS shall be off-the-shelf, preferably Windows.

j. The offered system shall have facility to export the desired portion of clipping (from a desired date/time to another desired date/time) on CD or DVD. Viewing of this recording shall be possible on standard PC using standard software like windows media player etc.

k. The software is required to generate reports of stored device configuration.

l. The system shall provide User activity log (audit trail) with user id, time stamp, and action performed, etc.

m. The administrator should be able to add, edit & delete users with rights. It shall be possible to view ability / rights of each user or the cameras which can be viewed & controlled as per the permission assigned by the administrator.

n. The software for Employers should also be working on a browser based system for remote users. This will allow any authorized user to view the video of any desired camera on his monitor.

o. Retrieval: The CCTV application should allow retrieval of data instantaneously or any date / time interval chosen through search functionality of the application software. In case data is older than 30 days and available, the retrieval should be possible. The system should also allow for backup of specific data on any drives like CD/DVD/Blu ray Recorders or any other device in a format which can be replayed through a standard PC based software. Log of any such activity should be maintained by the system which can be audited at a later date.

p. Backup: Online backup should be maintained to protect against storage failure.

- Power

a. Surveillance CCTV System shall operate on 230 V, 50 Hz single -phase power supply.

b. Power for all the equipment will be conditioned using on-line UPS with minimum 30minutes back up.

c. If any equipment operates on any voltage other than the supply voltage and supply frequency, necessary conversion/correction device for supply shall be supplied along with the equipment.

1.7 Mobile Radio Communication System

Purpose and General information

This Specification lays down the General, Functional and Technical requirements of Mobile Radio Communication System (MRCS) to be used as a sub-system of the Advanced Traffic Management System. All communication shall be to and from the CCR. The frequency band of operation is envisaged to be in the VHF band.

Mobile sets shall be installed in patrol vehicles, cranes and ambulances and shall communicate with CCR and also among themselves. The system shall use a pair of frequencies to be allotted to the concessionaire with the approval of relevant government bodies.

Major Components

The MRCS shall comprise of:

- Base Station Unit
- Repeater Unit
- Mobile Radio Unit
- Control Centre Equipment
- Rack

a) Base Station Unit:

- Transmitter
- Receiver
- Antenna with tower/mast
- Switch
- Radio Engineering terminal
- Radio Operator terminal
- Power Supply

b) Repeater Unit:

- Transmitter
- Receiver
- Antenna with tower/mast
- Repeater
- Power Supply

c) Mobile Radio Unit:

- Transmitter
- Receiver
- Antenna with tower/mast
- Control Unit
- Power Supply

d) Control Centre Equipment:

- Network Management System
- Headphone and microphone
- Voice recorder (optional)

Specifications

1) The system shall establish voice communication on radio between the Control Centre and the emergency mobile vehicles such as ambulances, cranes & patrolling vehicles.
2) The system shall cover the entire route.
3) The topology of the communication system shall cell centric (Repeater System).
4) All the Repeaters and Control Station shall be connected via Optical Fiber Cable (OFC) backbone on Ethernet port
5) There shall be minimum distortion in overlap areas of two towers.
6) All communication shall be half duplex
7) The system shall use one pair of VFH frequency allocated by WPC. In case two pairs are allocated, they may be reused in alternate sections.
8) The network shall be laid such that all the field mobiles are approachable to at least one Repeater.
9) The system design shall be modular in nature and easily configurable through on site programming.
10) The system shall have voice logger at the CCR to record all calls.
11) The system shall have Operator PC and microphone & speaker for the CCR operator.
12) The system design shall be modular in concept.
13) The radio base/repeater units shall be connected over OFC.
14) The system shall have the following features:
    - Operate in half or full duplex mode
    - Operate in VHF preferably using one pair of frequency (i.e. two frequencies- one RX and one TX). If only one frequency is available, half duplex mode is acceptable.
    - Programmable VOX operation.
    - CCIR / DTMF tones for Mobile to Repeater Communications.
    - Mobile/handheld to mobile/handheld communication.
    - Mobile/handheld to CCR communication
    - CCR to Mobile/handheld communication.
    - Group call communication.
    - Broad Cast Communication
    - Call Limit Timer.

- Digital display on mobile units
- OFC connectivity. The mobile radio shall be integrated with the Fibre Optic Communication system.
- PTT (Push To Talk)

15) The system shall work satisfactorily under adverse conditions like storm, rain, and vandalism resistant. The system shall be compact & rugged in design having ease of maintenance.

16) The system shall neither affect functioning of other telecom equipment installed adjacent or along it, nor get affected by the presence of other equipment / systems.

17) The Mobile Radio shall have provision for mounting the mobile set on ambulances, cranes and patrolling vehicles.

18) The walkie-talkies shall work on re-chargeable batteries with 24 hrs. back-up. Mobile sets shall derive power from battery of the vehicle in which installed.

19) The equipment shall have facility to configure the network for individual, sub-group or broadcast mode of operation for both selective calling and group calling operation.

20) The system shall have the facility to terminate the mobile to mobile connection under the following conditions:

- One of the two parties hangs up
- One of the two parties receives a call from the Control Centre
- The duration of the conversation exceeds 5-minute limit

1.8 Meteorological Data System

Purpose and General Information

Purpose

The Meteorological Data System shall be capable of providing data regarding weather including Air Pollution parameters, atmospheric temperature, humidity, visibility, wind speed & direction. The information based on these data shall be made available to the road users through VMS so that they are forewarned of the weather conditions on the expressway.

Air Quality Index (AQI):

An Air Quality Index (AQI) has been developed by Central Pollution Control Board based on the dose-response relationship of various pollutants. This is called Indian AQI or IND-AQI (for India).

A minimum number of three pollutant parameters (Suspended Particulate Matter (SPM), Sulphur Dioxide (SO2) and Nitrogen Dioxide (NO2) are essential to calculate the AQI. Any additional information on other pollutants such as Respirable Particulate Matter (RSPM or PM 10), Carbon Monoxide (CO) and Ozone (O3) are included to calculate conclusive and complete value of AQI.

The developed index is classified in five categories: Good (0-100), Moderate (101-200), Poor (201-300), Very poor (301-400) and severe (401-500).

The SPM, SO2 and NO2 shall be used and IND-AQI calculated.

Location

The Meteorological Data System shall be located at an interval of average 100km.

However, required adjustment in the locations can be made only with the consent of the NHAI.

Major Components

The Meteorological Data System shall have following components:

a) Sensor for atmospheric temperature

b) Sensor for road surface temperature

c) Sensor for humidity

d) Sensor for visibility

e) Sensor for wind speed & direction

f) Sensor for air pollution parameters like SPM, NO_2 and SO_2.

g) Data Acquisition Unit / Logger

h) Control room computer

i) Software – application, OS, database

Specifications

1) The Meteorological Data System shall provide data regarding
   - atmospheric temperature
   - humidity
   - visibility,
   - wind speed & direction
   - air pollution parameters - SPM , NO_2 and SO_2.
2) The data from all sensors shall be fed into the data logger.
3) This information shall be made available to the users through the variable message signs as per requirement.
4) The Meteorological Data System shall have the facility to communicate through PIJF/Optical fibre cable.
5) The Meteorological Data System shall be compact, rugged in design and have ease of maintenance.
6) The software in the CCR shall be capable of processing sensor data, store and retrieve it and draw reports.
7) The software shall also calculate AQI and generate reports.
8) All reports shall be tabular as well as graphical.
9) The weather data shall automatically be fed to the VMS subsystem. The VMS may also be then capable of display these data at fixed time intervals.
10) Specification of Application Software (in the CCR)
    - The application software for continuous air monitoring shall be Windows based.
    - Provision of Calibration windows for analyzer calibration from computer.
    - Main windows for real time display of all major parameters with status of all analyzers and sensors.

- Control Panel window for control of each analyzer.
- Alarm window for alarms of all analyzers and sensors
- Real time and multi curves / graphs for all parameters.
- Historic multi curves/ graphs over user selectable time period.
- Real time status & diagnostics for maintenance people.
- Programmable down loading of data from Analyser
- Report generation over user selectable time period.

1.9 Video Incident Detection System (VIDS)

Purpose and General Information

The purpose of the VIDS is to sense, detect and record the incident. The system shall be an intelligent image detection using camera. The VIDS shall have inbuilt intelligence to ascertain when the image has meaningfully deviated from the standard image originally recorded. A pilot run for VIDS is suggested before implementation.

Location

VIDS is established at strategic locations.

Major Components

The major components are

- Field components :

b) VID camera with housing

a) pole

b) Data transmission unit (encoder)

c) Power supply – solar panel

d) Lightning protection and earthing

- CCR components

a) Server with OS

b) Data analyzer

c) DVR

d) Application software

e) Database software

Functional Specifications

The system shall capable to

- Measure traffic flow speed between 0 and design speed for up to 6 lanes
- Detect vehicles diving in wrong direction
- Detect stopped vehicles within 10 secs and for up to 16 detection zones
- Detect deceleration
- Detect fog/smoke
- Detect automatically types of traffic flow: normal, dense, delayed, congested and stop and go

- Monitor zone occupancy of the detection area
- Generate alarms for events: queue, stop, Inverse direction, speed drop, no video signal, fog/smoke and error,

1.10 OFC Backbone

Purpose and General Information

The purpose of the OFC backbone is to transport voice, data, LAN and video services between the field equipment and CCR.

As the transmission system would be used as a backbone network, the system shall have following characteristics:

a) High Availability

b) High Reliability

c) Dual ring configuration

d) Easy to install and operate

e) Scalability

f) High degree of flexibility with respect to the types of interfaces

Location

OFC shall be laid all through the expressway. It may be laid on RHS or LHS of the main carriageway or in the median. Lateral elements shall be connected on OFC or copper.

Major Components

The major components are

- Optic fibers
- Ducts
- Manholes/pulling chambers

Specifications

1) Number of cores shall be sufficient to carry all data with 100% spare data carrying capacity.

2) Topology

Each backbone shall consist of access nodes (see section on OTC) interconnected by a dual physical fiber optic ring for redundancy.

The standby ring shall take over automatically with minimum delay whenever a problem occurs on the active ring. If a complete cable break occurs, which means that both the active and standby rings are interrupted, the system shall automatically perform a loop-back operation, isolating the fault, and maintaining communications of all user equipment connected to the network.

After a power failure, a ring reconfiguration or when a new node is added to the ring, the complete network shall start up automatically.

1) The backbone OFC shall connect to field switches (in outdoor cabinets) which are further connected to field devices (cameras etc.). The ECBs may directly be connected with each other i.e. without external field switches.

2) The backbone OFC shall be single mode fiber.

3) Duct –HDPE ducts shall be used to carry OFC along the expressway. In areas where ducting is not possible, trenchless laying shall be done. Road crossovers shall be done using HDD.

4) All fiber optic cable runs installed shall be either main backbone cable or lateral cables. The main backbone cable shall be terminated in the Communications Node. The lateral fiber cables shall be terminated with a fan-out kit at the termination block in the field equipment cabinet.

5) Main backbone and lateral cables shall be suitable for conduit installation. Lateral cables that connect the main backbone cable to the equipment controller cabinets shall be completed with continuous runs of cable. All lateral cable shall include a maximum of three locations of appropriate strain relief within the field equipment cabinets.

6) All optical cables shall comply with International Telecommunications Union (ITU-T).

7) All optical cables shall be new, unused and of current design and manufacture.

1.11 Outdoor Technical Cabinet (OTC)

Purpose and General Information

There shall be data concentrators or integrator switches (also called “field switch” or simply “switch”) installed along the expressway which shall connect the field equipment to the OFC backbone. The purpose of the Outdoor Technical Cabinet (OTC) is to house these field integrator switches or data concentrators along with other necessary equipment and accessories.

The other purpose is to provide a secure and environment controlled surroundings to the equipment housed in it.

Location

The OTCs shall be located along the expressway on the central median.

Major Components

The OTC unit shall consist of:

a) Cabinet

b) Data Concentrator or integrator Switches

c) Power supply and UPS

d) Termination panels

e) Environmental controls

Specifications

The functional specifications are as follows:

1) Cabinet & environmental controls

- The cabinet shall be mounted on concrete pads.
- It shall be lockable and shall have tamper proof lables affixed on it providing details of serial number, date of manufacture etc.
- It shall be weatherproof and shall not allow ingress of water and smoke. It shall maintain an internal temperature within the ambient range of all equipment housed in it. For this it shall have fans and heaters as necessary.

- It shall have a maintenance lamp which shall switch on automatically whenever the door is opened. The lamp shall be easily replaceable and shall be powered by the OTC's power supply.
- It shall be designed in such a manner that all the equipment mounted inside it are easily accessible. For this, it may have doors at the rear.
- It shall have two lifting eyes for lifting during installation.
- It shall have tamper switch and temperature sensors which give an alarm to the CCR if any tampering is being done or if the temperature goes out of the design limit. The sensors shall be connected to the CCR through the switch over NMS.
- The wires and connectors shall be neatly tied and harnessed through channels.
- It shall be properly earthed and have adequate protection from lightning.

2) Power Supply

- The power supply shall be suitable for all the equipment housed in the cabinet. It may be DC or AC or a combination of both.
- The power supply / UPS shall have adequate protection from noise, surge and lighting. For this it may have fuse, MOV and circuit breaker.
- It shall be online type with automatic voltage regulation.
- It shall include sealed maintenance free batteries with backup time of at least 30minutes.
- It shall have overvoltage and over current shutdown.
- The power supply shall have a port which shall connect to the Data Concentrator switch. The data from this port shall notify the CCR of the health of the power supply through NMS.
- It shall have LEDs/display/audio alarm or other indicators on its cabinet which shall indicate health and fault conditions including input voltage, overload, battery charging etc.

3) Termination panels

- The termination panels shall be housed inside the cabinet.
- The communication cables from field equipment shall terminate in this panel.
- Patch-chords shall be used to connect this panel to the Data Concentrator.

4) Data Concentrator or Integrator switches

- The switches shall connect to all field equipment and also to the OFC backbone.
- ECBs and other ATMS equipment shall not be connected on the same switch.
- The switches shall adequate number of ports to connect all field equipment. It shall also have 10% spare ports.
- The switch shall ports cable of handling all output types generated by the field equipment which may include analogue and digital - audio, video and data.

1.12 Power Management System

Functional specifications

1) Solar power shall be preferred over State Electricity Board (mains) and DG power.
2) Mains power shall be preferred over DG.
3) Wherever DG is used, it shall be used to power as many equipment as possible.
4) UPS with minimum 60 min backup shall be used wherever DG power is used. The DG shall be rated to at least twice the UPS rating.
5) The preferred power distribution is as follows :
   - ECB – solar power
   - CCTV/VIDS – solar
   - VMS – DG
   - ATCC – solar
   - Mobile radio - DG
   - Meteorological Data System – DG
   - Outdoor cabinet – solar / DG
   - CCR – mains / DG

1.13 Communication System

Purpose and General information

The purpose of the Communication System is to act as an interface between the field equipment and the CCR devices like displays and monitoring & control devices.

The communication system shall be “transparent” between field equipment and CCR i.e. it shall appear to the CCR device as if the remote field device is connected directly to it. The communication system shall be fast, reliable, support required data rates and have some built in redundancy.

Location

The communication system is located along the expressway and the CCR.

Major components

The communication system shall consist of:

- OFC (including termination panels, manholes, splicing, cables and connectors)
- OTC
- NMS
- Data concentrator at the CCR

Functional specifications

As defined in sections covering OFC, OTC and NMS

Technical specifications

As defined in sections covering OFC, OTC and NMS

1.14 Network Management System (NMS)

Purpose and General Information

The Fibre Optic Transmission System shall be equipped with a user friendly, Microsoft® Windows®-based Network Management System (NMS). The NMS shall allow the operator to manage and monitor multiple sub-networks in an efficient way.

The NMS shall have the following functionality: network configuration, configuration of services, monitoring, diagnostics, activation-deactivation of interface modules, bandwidth allocation, alarms and event logging and graphical network representation.

The network management hardware shall consist of a Personal Computer, which at the time of installation is the current industry standard. The NMS architecture shall be based on Employer-server technology. It shall be possible to connect multiple active Employers to the NMS server allowing network management from multiple and/or remote locations or by multiple users

Location

Software at CCR

Major Components

1) Personal computer
2) NMS software

Functional Specifications

1) It shall be possible to connect the NMS system to the network at any node via Ethernet.
2) Using the NMS, it shall be possible to configure the hardware modules that make up the network: nodes, network cards, interface cards and optical transceivers.
3) The Network Management System shall allow the user to activate or deactivate an interface module.
4) It shall be possible to create various services over the network.
5) The NMS shall allocate the transmission channels to virtual point-to-point or multi-point services in order to achieve an optimal bandwidth allocation. It shall be possible to configure the network and the services without being connected to the network, either via the Graphical User Interface (GUI) or via scripting.
6) NMS shall display a simple map of the network in form of a tree.
7) NMS shall provide Real Time Management Information Bases (MIBs).
8) Automatic reconfiguration

   The management platform shall not be critical in the reconfiguration sequence of the system. It will only report the event in detail to the network operator.

   Relevant configuration details shall be stored in the Random Access Memory (RAM) module of each node. After configuration, the network shall continue to work autonomously and shall reconfigure in error situations. It is therefore necessary that the reconfiguration algorithm resides in the nodes themselves.

9) NMS database

   The NMS shall contain the network database containing all kinds of information: sub-network names, node names, and node configurations including installed network and interface cards. It shall be possible to make the following on-line

changes: activation or deactivation of interface cards, addition or removal of interface cards, and addition, changing or removal of services. Each change shall automatically update the database on the hard disk of the network management PC and the RAM memory of the relevant node(s). It shall be possible to use the database to restore the network configuration in case settings in one or more nodes are lost due to a hardware defect.

10) Fault and Alarm Management

It shall be possible to easily monitor the operation of the different sub-networks that make up the network. During normal operation, the NMS shall continuously poll all the network nodes. It shall compare the status of the network with the information resident in its network database. If a fault or change occurs, the GUI screen on the NMS PC will display an alarm message indicating the nature and location of possible errors or changes. The alarm messages shall include at least the date, time, node, interface slot and/or interface port, alarm severity and description. Via the GUI, it shall be possible to register following events: loss of synchronization, network reconfiguration, node failure, interface card errors and external alarms. It shall be possible to store the events in the NMS database.

Errors and unexpected conditions shall be reported by the network management system in another color than the one used upon correct operation.

11) Internal alarm forwarding

The NMS shall be capable, via an alarm relay card, of forwarding the status of internal alarms to other devices such as beepers or lamps. It shall be possible to use this alarm relay card to convey network alarms to a third party umbrella alarm management system. An SNMP agent on the management system shall offer basic alarm forwarding and retrieval to an SNMP-based umbrella management system. It shall be possible to forward internal alarms to third party equipment via CORBA (Common Object Request Broker Architecture).

12) External event Management

It shall be possible to display the status of external events on the NMS system. It shall also be possible to forward this alarm information to an alarm relay card connected to the NMS PC.

1.15 Central Control Room (CCR)

Purpose and General Information

The purpose of the CCR is to monitor the expressway and to provide information to the road user. The CCR also houses the central servers and data processing equipment.

The CCR shall provide the real-time information and assistance to the Expressway users, collect data for the use of expressway authorities and to monitor and control the Traffic on the expressway as per the requirements.

The CCR shall be designed for round the clock operations of monitoring, on-line information acquisition and processing the same for decision making. The CCR shall be the repository of all the data acquired from the field and their processing, storing, and archiving. All the information for real time monitoring oh expressway shall be generated at the CCR and the relevant information shall be disseminated to the users through VMS, and to O&M teams through mobile radio.

Location

There shall be one CCR located in any toll plaza.

Major Components

- Emergency Call Operator Station (Emergency calls from ECB's)
- Mobile Call Operator Station (Mobile radio calls)
- Integrated Expressway Management / Traffic Manager station (Operating Variable Message Signs, Traffic Counting & Classifying System, Meteorological Data System, CCTV & Video Incident Detection)
- Video Wall
- Servers
- Switches
- Administration Computer and Network Printer
- Computer for NMS for fiber Optic Communication system.
- CCTV console equipment
- VIDS control equipment
- Computers for VMS, AVCC, Met, Traffic Control
- A network printer
- An office computer (administration terminal)
- A power supply and backup system

Functional Specification

The CCR shall have the following functions and capabilities:

1) Real time images of the expressway locations (from camera locations) to the control centre.
2) Emergency communication system for communication from the predefined ECB locations to the control centre.
3) Real time information to the users from control centre (about the route conditions, traffic situation, etc.) using variable message signs installed on gantries.
4) Real time monitoring of the traffic situation and collection of traffic data using traffic counting and classifying system
5) Monitoring of the weather conditions
6) Dedicated Mobile Radio system for communication between the control centre, ambulances, patrol vehicles, etc.
7) Traffic Control System at the interchanges
8) Monitoring and control of the expressway traffic from the main control centre using integrated expressway system
9) Compilation, recording, analysis, processing, storage of traffic information and data
10) Monitoring and control of the various sub-systems and devices installed on the expressway
11) The following shall be the servers at CCR:
    - Server for Emergency Call System
    - Server for Video Surveillance system, VIDS system

- Common server for VMS, ATCC, Meteorological Data System
- Server for Mobile Radio Communication System

1.16 Miscellaneous Equipment

Server

Servers shall be located in the CCR and run application software. The server supplied shall be of the latest configuration at the time of installation. However the minimum specifications are as follows:

1. OS	:	Windows Server (Enterprise) preloaded
2. Processor	:	Quad Core, 3 GHz, 2x4MB shared cache, 1333MHz FSB
3. Memory	:	8GB DDR2 , 800MHz
4. Drive controllers	:	Integrated serial ATA controller with RAID0,1,5 and 10, removable boot drive option.
5. Hard drive	:	minimum 5 SATA drives of 500GB each with RAID5
6. Network adapter	:	Dual embedded gigabit Ethernet NIC & PCI NIC
7. Optical drives	:	DVD/CD RW combo
8. Database	:	Oracle, MySQL or equivalent shall be included
9. Monitor	:	19 inch TFT included
10. Keyboard and mouse	:	included
11. Mounting	:	19” rack mountable

Printer

There shall be one network printer in the CCR for reports. The printer supplied shall be of the latest configuration at the time of installation. However the minimum specifications are as follows:

1) Print speed	:	upto 52ppm letter; upto 50ppm A4
2) Speed	:	first page out < 9sec
3) Resolution	:	min 1200x1200 dpi

UPS

UPS shall be installed wherever necessary, for backup of all electronic equipment so that overall service levels and requirements mentioned in this document are met.

UPS of adequate backup time shall be installed at least for

a) All CCR equipment’s

b) Outdoor Technical Cabinets

c) All other equipment wherever power backup is required

Specifications

The UPS shall have the following specification:

1) Minimum backup time for UPS backed up by other power supply/DG shall be minimum 10 minutes. It shall be ensured by the vendor that power supply (combination of UPS, Solar, Generator , mains or any other supply) is provided in such a manner that all equipment is powered at all times, round the clock.

2) Input

Nominal Input Voltage	:	220 V AC
Input Voltage Range	:	140 V – 300 V AC on Full Load
Nominal Input Frequency	:	50 Hz
Input Frequency Range	:	45 – 55 Hz
Input Power factor	:	>0.97 at 220 V AC for full resistive

Modes of Operation

The UPS shall be designed to operate continuously at rated capacity as an on-line, automatic system in the following modes:

1) Normal - The inverter continuously supplies AC power to the critical load. The converter converts commercial AC power to regulated DC power which then serve as the inverter input and, simultaneously, as a float charge input to the storage battery.
2) Emergency - In the event of a commercial AC power failure, the inverter shall derive its input from the system battery, thus providing uninterrupted power to the critical load. This transition shall be accomplished without any switching or coupling, and with no interruption of power to the critical load from either a failure or restoration of the commercial AC power.
3) Recharge - Subsequent to restoration of commercial AC power, the converter shall automatically reactivate and provide DC power to the inverter, simultaneously recharging the system battery. This occurs automatically and without interruption to the critical load.
4) Bypass - In the event that the UPS must be taken off line due to an overload condition or UPS failure, the critical load shall be transferred to the bypass source via the static switch without interruption of power to the critical load. The static switch shall only be utilized for automatic emergency transfers. A re-transfer from bypass to inverter shall be performed automatically in overload conditions. A re-transfer shall be inhibited if satisfactory synchronization of the inverter and bypass is not accomplished.

Diesel Generator

The contractor shall provide diesel generators wherever required (primarily for VMS and CCR). The rating of the DG set shall depend on the connected load, however DG of 10kVA single phase for VMS and 175kVA 3phase for CCR is suggested. The DG arrangement shall have the following requirements:

1) DGs shall be provided in pairs i.e. two DGs per site with each running continuously for maximum 6 hours.
2) It shall be self-start with 12V DC starter motor.
3) Battery charging Alternator.
4) It shall be silent type.
5) Conform to BS 5514 / ISO 3046
6) Output per phase 220V $\pm$1%, 50Hz
7) Instrument panel with starting switch & key, indication for battery voltage, water temperature, lube oil pressure, engine speed, engine hour counter, battery voltmeter, output voltage and frequency.

Solar Panel

The vendor shall provide Solar Panels of adequate capacity wherever required. The following are the minimum specifications.

1) Photo Voltaic (PV) cells shall be made of crystalline silicon
2) Cell encapsulation: ethylene vinyl acetate (EVA)
3) Mounting: pole mounted
4) Frame structure: Aluminum
5) Front side : Glass with thickness of min 3mm
6) Operating temp range ; -40 to +90 0C
7) Storage temp range ; -40 to +90 0C
8) Wind resistance: 60m/s

Rack

Equipment supplied at the CCR shall be rack mountable wherever possible. This includes servers, controllers, UPS, fiber patch panel etc.

CCR Software

The requirements of individual ATMS subsystems have been defined in relevant sections. The following are the integration requirements of application softwares of the ATMS subsystems:

Sl.	Subsystem	Requirements
1	ECB	• Separate Server with application software, OS and database
2	Video Surveillance System, VIDS	• Separate Server with application software, OS and database • Video may be recorded in Server or DVR
3	VMS, ATCC, Meteorological Data System, Mobile radio	• Common server and database for all these applications. • The relevant weather and ATCC data shall automatically be fed to VMS.
4	NMS	• Can be run on any server

Features

The following features are required from the ATMS software

1) The following shall be provided as option –
   - Although separate servers have been specified for separate applications, it shall also be possible to run any application from any server and all applications from one server in which case there shall be one common database.
   - One additional server to function as database server.
2) Alarm conditions of each subsystem shall triggered in respective application software.
3) The software shall have facility to send e-mail to pre-configured e-mails as per the following :

- Breakdown events – to maintenance team
- Emergency events – to concerned relevant external authorities like police and to designated internal staff. Emergency events shall be triggered by the personnel manning the ECB, CCTV and Radio stations.

  The "e-mail send" process shall be configurable to "manual" and "automatic"

4) The configuration as shown in the table above is suggestive. However, as all computers / servers are on the network, it shall be possible to run any application on any computer.
5) The system software shall run on industry standard server platform.
6) The integrated ATMS software shall monitor and record online all data from all sub-systems of ATMS

1.17 Data Base Management

The database used by the ATMS software shall be an industry standard database like ORACLE, SQL, dbase etc. The system shall have facility to perform certain selected database operations only by authorized users.

1.18 Storage

The system shall store at least 12 months of data. Older data may be archived. However, the system shall provide tools for the retrieval, manipulation and presentation of data. Data store shall be clearly marked with an indicator to show day or period type e.g. normal, holiday, weekly off; by reference to the system calendar. It shall be possible to export data to an external system for further analysis. Transfer shall be available in .xls , csv or any standard formats.

1.19 Archive and Restore

This facility shall allow the archiving of the database to a tape/External HD/DVD . The data archived shall then be deleted from the database. Data may only be archived when it is more than two years old. Only one archive request may be outstanding at a time. Once archived, part or all of the data may be restored by copying from the tape back onto the system, where it remains for 30 days. Only one restore request may be outstanding at a time.

It shall be possible to define a series of notification levels which will raise an alarm when the disk space reaches a specified limit. This is used to alert an operator to the need to archive data.

1.20 Database Back-Up

The system management procedures for producing daily and weekly back-ups shall not need any operator intervention.

1.21 Timetable and Calendar

The system shall have a time table facility. The timetable shall allow commands by day of the week, time of day, day type. The system calendar shall allow days to be marked as normal, holiday, weekly off, etc.

1.22 System Log

The system shall retain a log of all events, alarms, timetable actions, and operator actions(together with operator username). In addition to system generated events the operators shall have facilities to enter events or incidents into the log. It shall be possible to search the log by time/date, event type, operator user name, strategy, location.

The log facility shall provide the means to:

a) Record all important events that occur in the operation of the integrated Expressway management system, both manual and automatic View and manage the status of alarm events,

b) Collect and collate incident information from both manual and automatic sources,

c) Allow the user to record routine operational messages,

d) View all changes and actions taken on the ATMS,

e) Record and view useful contact names and other details.

1.23 Asset Management

a) The system shall incorporate a facility to store records of assets for ATMS.

b) The asset register shall store data relating to location, type, and number of equipment as well as electricity ratings.

1.24 User Management

This facility shall provide the means to make user access to ATMS secure. Only the system administrator(s) shall have access to this facility and will set up details for other users. Each user shall have a username that needs to be configured so that it matches a PC log-in. Hence logging on to the PC will automatically mean that access to ATMS is available for the chosen users. Each user can also be configured to have access to none, some or all of the ATMS facilities.

1.25 Availability Requirements

The inability to perform any required function, the occurrence of unexpected action or degradation of performance below the specifications shall be considered as a failure. The Mean-time-between-failure (MTBF) shall be the average operating time accumulated by the total population of identical items between failures. The system supplier/contractor shall submit MTBF and MTTR figures. The ATMS shall have an overall system availability of better than 99 percent. The ATMS shall be considered unavailable if any of its function cannot be properly executed and when any of the following conditions persist for more than 8 hours on the entire stretch.

i) Variable Message System Failure**:** No display/Improper Display of VMS or failure of their related transmission/control system which would render the VMS inoperative

ii) Emergency Call System Failure: Failure of any three consecutive Call boxes or failure of their related transmission system which would render the call boxes inoperative.

iii) ATCC Failure: Failure of more than one ATCC or failure of their related transmission system which would render the ATCC inoperative.

iv) Met Failure: Failure of more than one Met or failure of their related transmission system which would render the Met inoperative.

v) Video Surveillance System Failure: Failure of more than two Video Cameras or failure of their related transmission/control system which would render the cameras inoperative.

vi) Video Incident Detection System Failure: Failure of more than one Video Cameras or failure of their related transmission/control system which would render the cameras inoperative.

vii) Display at Control Centre: Whenever Control Centre is unable to get display of messages initiated by the Control Centre in-charge.

In addition to the above the system shall be considered unavailable when failure of the integrated ATMS Software or its hardware persists for more than 8 hours.

1.26 Maintainability Requirements

The Mean-Time-to-Repair (MTTR) of the ATMS to full normal operation following a failure shall be less than 8 hours all inclusive.

1.27 System Safety Requirements

All metal enclosures shall be provided with an earthing terminal and earthing of all equipment shall be carried out in accordance with overall earthing policy.

1.28 Environmental/Climatic Requirements

Indoor Equipment:

Temperature (Operating)	:	$0^{o}C$ to + $50^{o}C$
Relative Humidity	:	up to 95% (non-condensing)

Outdoor Equipment

Temperature (Operating)	:	$5^{o}C$ to + $60^{o}C$
Relative Humidity	:	up to 95% (non-condensing)

The system and the equipment used as a minimum shall meet the following climatic and environmental requirements as specified in IS:9000:

Tests	**Severities**
Change of Temperature	(i) Low Temp 0°C + 3°C
(Temp cycling) as per	(ii) High Temp 60°C + 2°C
IS:9000 (part xiv/sec1)	
Rate of cooling and heating 1°C/m	(iii) Duration for each cycle 3 hours
	(iv) No of Cycles 3

1.29 Warranty: The contractor/supplier of the advanced traffic management systems (ATMS) shall furnish the warranty/guarantee for successful commissioning and operation of ATMS for a minimum period of 5 years. The contractor/supplier shall also furnish the certificate that there is no proprietary item and that the systems shall be interoperable. All components and equipment shall be tested for commissioning. The documents with regard to design, technical details, installation details, testing and commissioning, details of fault diagnostics, operation and maintenance manuals and reports shall be submitted to the NHAI by the contractor/supplier.

These guidelines include hardware and software functionalities. Alternately, some guidelines are available in “Specifications for Road and Bridge Works (Fifth Revision) published by IRC” – also called Orange Book, Section 816.