सत्यमेव जयते

भारतीय राष्ट्रीय राजमार्ग प्राधिकरण
(सड़क परिवहन और राजमार्ग मंत्रालय, भारत सरकार)
National Highways Authority of India
(Ministry of Road Transport and Highways, Government of India)
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NHAI/Policy Guidelines/ Standard Documents/2023
Policy Circular No.11.53/ 2023 dated 10th October, 2023
{Decision taken on E-Office File No. IHMCL/2023-24/ATMS (Comp. No. 224126)}

Sub: Implementation of Advance Traffic Management System (ATMS) on National Highways and Expressways - Standard ATMS provisions- reg.

The ATMS Standards and Specifications were issued vide NHAI Policy Circular Technical (214/2016) dated 15.09.2016. The relevance and adequacy of the said Standards and Specifications were examined vis-a-vis latest technology such as AI, leading to a renewed focus on digital enforcement of traffic rules and comprehensive approach road-safety and incident response. The updated Standard ATMS Document has been approved by EC in its 582nd Meeting dated 06.10.2023 for implementation on the National Highways and Expressways with NHAI.

2. The Standard ATMS Document gives the functional and technical specifications of the Advance Traffic Management System (ATMS) solution and its sub-systems:

(i) Video Surveillance System / Traffic Monitoring Camera System (TMCS)
(ii) Video Incident Detection and Enforcement System (VIDES)
(iii) Vehicle Actuated Speed Display System (VASD)
(iv) Fixed and Portable Variable Message Sign (VMS) System
(v) Communication Network with OFC Backbone
(vi) Emergency Call Box*
(vii) Mobile Radio Communication System*
(viii) ATMS Command & Control Center with ATMS Software
(ix) Power Supply for Field Equipment as well as for ATMS Command & Control Center

** The requirement may be assessed by RO/PD as per site conditions and scope may be included/deleted*

3. Apart from the above, there are other provisions like enabling API based e-challan by Enforcement Agencies through VIDES, integration with Rajmarg Yatra, NHAI One, providing live camera feeds to NHAI Offices and Enforcement Agencies etc.

Contd...2/-

4. The Standard ATMS Document also includes the following Appendices which are required to be followed while implementing the ATMS:

(i) Appendix-A : The Guidelines for locations of ATMS field equipment, systems and sub-systems. The exact location of sub-components like VIDES/VASD/VMS etc should be decided after detailed investigation on the Highway stretch based on the broad guidelines given in Appendix-A.
(ii) Appendix-B : Service Level Agreements and Penalties during O&M Period
(iii) Appendix-C : ATMS Command and Control Center Organization and Staffing
(iv) Appendix-D : Reporting and Integration with Datalake

5. This Circular supersedes the Policy Circular Technical (214/2016) dated 15.09.2016.

6. This issues with the approval of Competent Authority.

10/10/23

Encl: Standard ATMS Document

(Sanjay Kumar Patel)
General Manager (Coord.)

To:

All Officers of NHAI HQ/ ROs/ PIUs/ CMUs/ Site Offices

Copy to:

1. Hindi Division for translation in Hindi.
2. Library for hosting the circular on library site.
3. Web Admin for circulation.

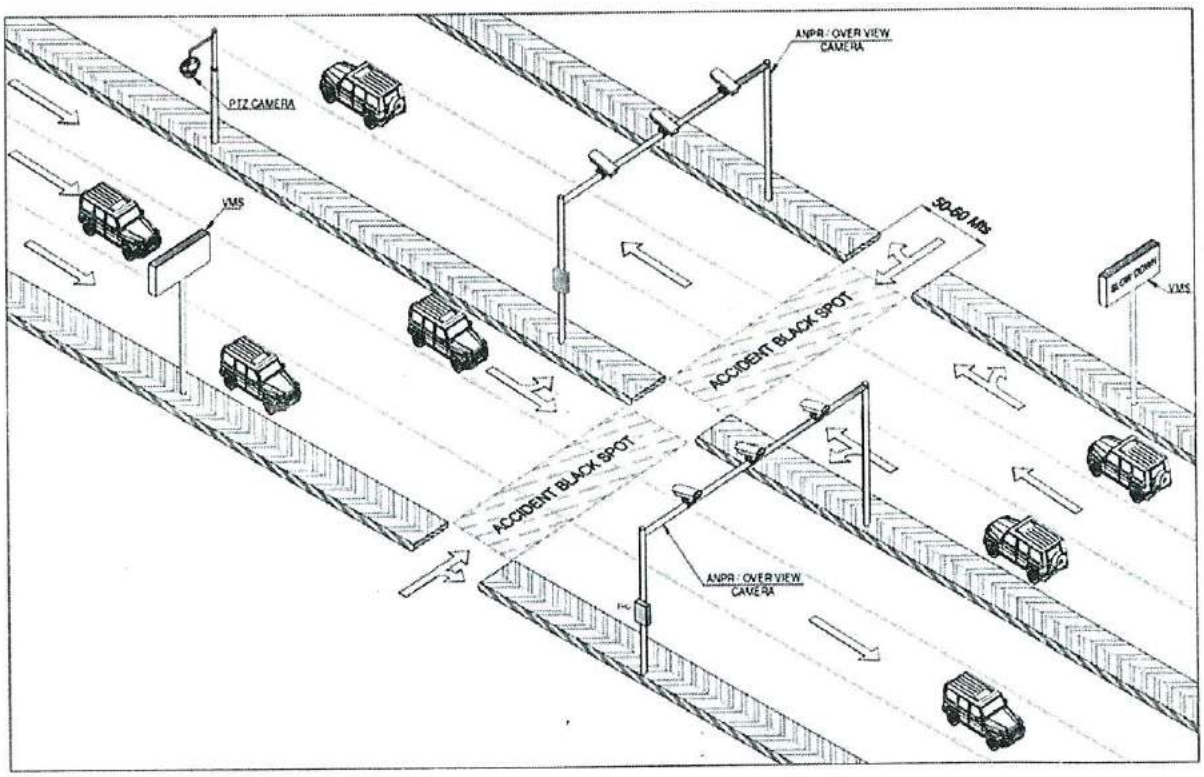
Annexure-

National Highways Authority of India

G-5&6, Sector-10, Dwarka, New Delhi - 110075

Advanced Traffic Management System (ATMS) on NHs

Functional & Technical Specifications of ATMS Components / Sub-Components



October 2023

Document Control Status

Document Amendment Record			
Version	**Date**	**Prepared By**	**Brief Record of Change**
June 2016	05-05-2016	M/s CDM Smith INC. (Formerly Wilbur Smith Associates) having its registered office at No.8, Second Floor, 80 Feet Road, RT Nagar, Bangalore – 560032, Karnataka, India	Part of a set of documents prepared under consultancy project on Road Safety Zone (RSZ) Concept on East-West Corridor NH-25 (27) under Road Safety Component of ADB Loan 2029-IND.
August 2016	02-08.2016	NHAI	Addition of: (i) Travel time estimate system (ii) Disaster Management framework (iii) Addition of requirement on external connectivity. Improvements in Technical Requirements of CCTV, Mobile Radio Communication System..
October 2023	06-08-2023	NHAI	Addition of: a. Basic incident management in Video Surveillance System b. The existing VIDS (Video Incident Detection System) has been upgraded to VIDES (Video Incident Detection and Enforcement System) c. VIDES includes additional incidents, functionalities and capturing photo evidence for eChallan d. Merging of ATCC and VSDS with VIDES e. Improvements in technical requirements of CCTV, PTZ, VMS and Control Center Hardware f. Need based inclusion of Emergency Call Box and Mobile Radio Communication System g. Expansion of objective Service Level Requirements. Deletion of: a. MET b. Portable WIM c. Travel Time Estimation System

ACRONYMS and ABBREVIATIONS

APTS:	Automatic Power Transfer Switch
AI/ML	Artificial Intelligence/Machine Learning
ATMS	Advanced Traffic Management System
BIS	Bureau of Indian Standards
BS	British Standard
CIF	Common Interface Format
CCTV	Closed Circuit Television
DLP	Defects Liability Period
DM	Disaster Management
DDMA	District Disaster Management Authority
ECB	Emergency Call Box
ERT	Emergency Road side Telephone
EN	European Standard
FAT	Factory Acceptance Tests
FPS	Frames Per Second
GUI	Graphical User Interface
HDPE	High-density polyethylene
HVAC	Heating Ventilation and Air conditioning
IRC	Indian Roads Congress
ITM	Integrated Traffic Management
ITS	Intelligent Transport Systems
ITU-T	Telecommunication Standardization Sector of the International Telecommunication Union
JPEG	Joint Photographic Experts Group
LAN	Local Area Network
MET	Meteorological Data Systems
MoRTH	Ministry of Road Transport and Highways
MTBF	Mean Time between Failures
MTTR	Mean Time to Repair
NAS	Network-Attached Storage
NDMA	National Disaster Management Authority
NDRF	National Disaster Response Force
NHAI	National Highways Authority of India
NMS	Network Management System
NVR	Network Video Recorder
OF	Optic Fibre
OFC	Optic Fibre Cable
O&M	Operation and Maintenance
PIJF	Polythene Insulated Jelly-filled
PTZ	Pan, Tilt, Zoom
SAT	Site Acceptance Tests
SDMA	State Disaster Management Authority
SIT	System Integration Test
Solar PV	Solar Photo voltaic
SWB	Static Weighbridge
TEC	Telecommunication Engineering centre of the Government of India
UPS	Uninterruptible Power Supply
VMS	Variable Message Signs
WAN	Wide Area Network
WIM	Weigh-in-motion
WPC	Wireless Planning Council

Note: The document uses "ATMS Contractor", "Service Provider" and "Service Integrator" interchangeably. They refer to the Agency engaged by NHAI for execution of ATMS works.

Table of Contents

Contents

Chapter 1 INTRODUCTION

This document is a part of a set of documents to facilitate NHAI for implementation of the Advanced Traffic Management System on National Highways. Government of India, Ministryof Road Transport and particularly, NHAI have taken the initiative to provide guidelines for ATMS implementation in the past and the references can be found in **IRC:SP:87** (Manual of Specification and Standards for Six-laning of Highways through PPP), **IRC:SP:84** (Manual of Specification and Standards for Four-laning of Highways through PPP), **IRC:SP:99** (Manual of Specification & Standards for Expressway) and MoRTH manual prescribing Specification forRoad and Bridge Works (5th Revision) etc. As these references focused broadly on road infrastructure development, this document is focused mainly on implementation of comprehensive and integrated Advanced Traffic Management System (ATMS) on National Highways.

1.1 Purpose of this Document

This Document is the revisit of NHAI Policy Circular No Technical 214/2016 dated 15.09.2016 for Implementation of Advance Traffic management System (ATMS) on developed Sections of National Highways with NHAI. The adequacy and relevance of the provisions of the Circular dated 15.09.2016 was examined and it was observed that while majority of the provisions under the Circular are still relevant, some provisions required improvements as per latest technology., the Purpose of this document is to identify the essential components / sub-components that should necessarily be included in such a projectand provide detailed functional requirements and standards to be adhered to by such components / sub-components to ensure achievement of desired safety, reliability, availability and environmental requirements.

The Functional and Technical specifications prescribed in this document are the minimum/benchmark requirements individually and collectively to be fulfilled by various ATMS equipment and systems. However, to encourage adoption of best practices with upcoming improved technologies in the field of Intelligent Transport System (ITS) with the passage of time, the implementing agency shall ensure to offer latest and most relevant technical solutions.

1.2 Scope of Document

Broadly, the ATMS implementation shall cover design, supply, installation, commissioning and operation and maintenance of Advanced Traffic Management Systems (which is one of the components of Intelligent Transport System – ITS). The system would include out-door equipment including emergency call boxes, variable message sign systems, vehicle actuated speed system, , Traffic monitoring close circuit TV camera (CCTV) system, traffic counting and classification system, mobile radio communication system and transmission system. Theindoor 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
- Enforcement through eChallans

Keeping in view the above objective, ATMS shall inter-alia provide the following facilities to various stake holders.

Highway Users	➢ Make emergency calls to Control Centre in case of accidents, breakdown, fire and ambulance. ➢ Receive alerts / alarms messages about unusual condition on the road.
Traffic Managers	➢ Data / information for efficient and effective handling of traffic ➢ Control systems to configure / change variable message sign from control centre ➢ Information regarding location of any accident, incoming calls, help required and messages to be passed to third parties (other stake holders) ➢ Mobilize, monitor and guide the movement of ambulances, cranes and patrolling vehicles with Information regarding traffic congestion, speed and weather conditions.
Regional Level Control Centre and Master Control Centre for NHAI, HQ	➢ Provision of reviewing live feed and / or recorded archives of CCTV video footage as well as voice messages ➢ Live audio Patch-up with the highway stretch manager and / or ambulance facility and Trauma Care Centre ➢ Help assessment of traffic position at specific location on NHs for authority to take adequate action thereupon. ➢ Live feed of the GIS map-based monitoring facility of the entire highway stretch including all details related to incident management. ➢ Active monitoring of performance (by sampling) of ATMS System Service Provider ➢ Comparison of similar data between two or more selected ATMS enabled stretches and Video conferencing with one or more ATMS control centres. ➢ Continuous learning to improve process, suitability of technology, optimal choice of devices / equipment for continuous enhancement of NHAI's road safety mission.
Local Traffic Police and Enforcement Agency	➢ Provision of reviewing live feed and / or recorded archives of CCTV video footage as well as voice messages ➢ Help assessment of traffic position at specific location on NHs for authority to take adequate action thereupon. ➢ Provision of dedicated work station in ATMS for Traffic Police Representative to sit and improve coordination and surveillance vis-à-vis traffic police operations. ➢ Integration with Vahaan and data sharing for eChallan generation.

A typical ATMS implementation shall comprise of at least the systems / sub-systems depicted in the table below and meet the applicable latest versions of the international/national standards, included therein:

S. No.	Subsystem	Items	Designed to conform	Certified to Standard
1	Video Surveillance System (CCTV)	CCTV Fixed Camera	PAL, BS EN 62676-1-2, ONVIF specifications profile S & profile G, BS EN 62676-2-2, BS EN 62676-2-3	EN 61000, IEC 60068-2-27, EN 60529(IP66)
		CCTV PTZ Camera		
		Video Encoder	H.264 (IEC 14496-10), EN 62676-1-2, BS EN 62676-2-2, BS EN 62676-2-3	

S. No.	Subsystem	Items	Designed to conform	Certified to Standard
		Road-side Housing and Support Structure	BS EN 12767	EN 60529 (IP56)
2	Video Incident Detection and Enforcement System (VIDES)	Video Camera	PAL, BS EN 62676-1-2, BS EN 62676-2-2, BS EN 62676-2-3	EN 61000, Relevant BIS certification EN 60529 (IP66) Local State Speed Calibration etc.
		Road-side Housing & Support Structure	BS EN 12767	EN 60529 (IP56)
3	Vehicle Actuated Speed Display	Display	EN 12966	EN 60529(IP 56)
		Support Structure	BS EN 12767	
4	Emergency Road Side Telephone System	Phone System		
		Road side Housing and Support Structure	EN 60529 (IP65), BS EN 12767	
5	Variable Message Signs (VMS) [Fixed and Portable]	Display	IRC 67, IRC SP85	EN 12966 EN 60529 (IP56)
		Road side Housing and Support Structure	BS EN 12767	EN 60529 (IP56)
6	Automatic Traffic Counter cum Classifier (ATCC)		MoRTH – Specifications for Road & Bridge works : 5th Revision	
7	Network / Communication Infrastructure	Cable		TEC Approved
		Protocol	IEEE 802.x, RS 485, RS 422	
8	Mobile Radio Communication System		ETSI DMR tier 3 / ETSI DPMR Mode 3/ NXDN Trunking	
9	ATMS Control Centre		EN 50132-7, Relevant NTCIP standards, IEC 12207	

NOTE: Other relevant standards and codes required to be adhered to by the service provider are listed in Chapter 16 of this document. Guideline for placement of various ITS devices and subsystems is detailed in Appendix – A of this document.

1.3 Documents Layout and Contents

This document details the technical specifications for the design, supply, installation, commissioning and maintenance requirements for a comprehensive and integrated Advanced Traffic Management System (ATMS) for National Highways in India. This document describes each type of ATMS equipment under the following headings:

1. Scope
2. Equipment Function
3. Functional Requirements
4. Technical Requirements
5. Environmental Requirements
6. Testing
7. Installation Requirements
8. Maintenance Requirements
9. Operational Requirements

The first section of the document details the general provisions for ATMS equipment, withthe following sections providing details for each type of equipment listed in section 1.3. Where details specified within the specific equipment sections overlap with those of the General Provision for ATMS, the specific equipment section shall take precedence.

1.4 Scope of Work

Briefly, the ATMS components to be deployed shall inter alia include:

(a) Video Surveillance System/Traffic Monitoring Control System
(b) Video Incident Detection and Enforcement System (VIDES)
(c) Vehicle Actuated Radar Speed Displays
(d) Emergency Roadside Telephones
(e) Fixed / Portable Variable Message Sign
(f) Automatic Traffic Counter cum Classifier (as part of VIDES)
(g) The ATMS Control Centre including the equipment (hardware, software, and local networking)
(h) Communications System utilizing Optic fiber, point-to-point wireless links, GSM/GPRS and Wi-Fi Communications linked to ATMS Control Centre.
(i) Power supplies for field equipment: working on Mains power supported with back-up (largely on renewable energy) to facilitate 24 X 7 operation and for the ATMS Control Centre working on Mains power supported by UPS and Diesel generator set of adequate capacities, to facilitate 24 x 7 operation.
(j) Disaster Management Support System.

1.4.1 The essential feature of the proposed ATMS is the presence of an integrated Traffic Management and Rescue Console. The Traffic management and rescue console, under the leadership of the ATMS Control Centre, is intended to introduce an automated check-list based approach to ensure an integrated and efficient service delivery to the various stakeholders to prevent accidents and in case the accident does happen, then timely coordinated action in rescuing accident victims and early restoration of traffic.

1.4.2 Services shall be governed through Service Level Requirements (SLR) mentioned in Appendix-B to this document. Service Level Requirements basically prescribe identified key performance standards and minimum benchmark to be achieved by the Service Provider in service delivery.

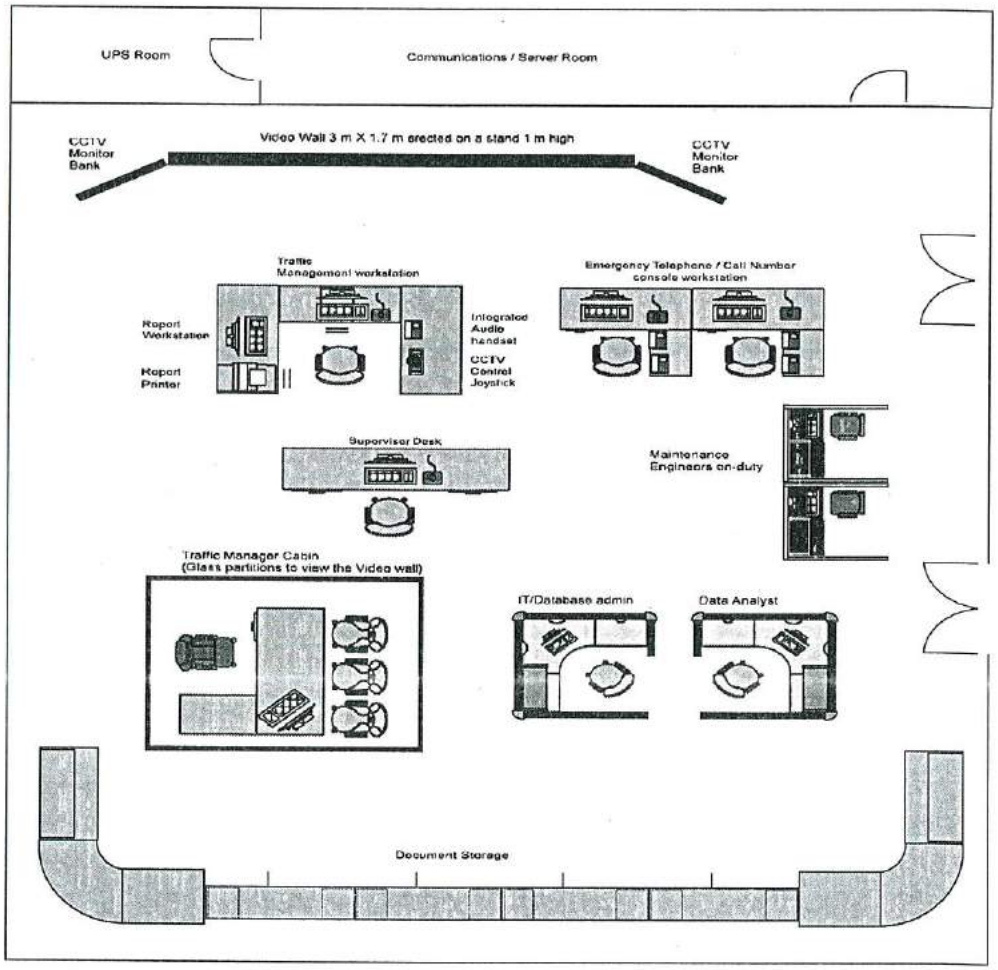
1.4.3 Service Provider shall be responsible to deliver complete turnkey solution of ATMS and entire responsibility for system design, testing, civil and electrical works including cabling / conduit, electrical power requirement including provision of uninterrupted power supply (UPS) of adequate capacity shall vest with the service provider

1.4.4 **ATMS Control Centre**: The most crucial and important part off the projectshall be establishing the ATMS Control Centre that will accommodate and operate the entire ITS systems. The Figure shown below provides an indicative layout of the ATMS Control Centre facility that will accommodateand operate the ATMS systems to facilitate operations such as:

(a) Emergency Response System: call logging (Emergency wayside phones) and incident management on the Integrated, visual console and audio communication station;
(b) Data analysis and reporting systems;
(c) Traffic Management system logging vehicle speed & flow data;
(d) Operational procedures;
(e) Emergency events and incident reporting database.

1.4.5 It is proposed that the ATMS Control Centre facility be established in a building on the highway approximately midway of the corridor within the ROW where feasible. Rescue & Patrol vehicles shall be located at more thanone strategic location along the highway to ensure an adequately rapid

response during rescue and traffic management. A possible choice could be to situate it with the Traffic Aid Post and Medical Aid Post that the Concessionaire is required to provide within Article 17 & 18 of the Concession Agreement. Where as in case of public funded projects the Service Provider shall prepare at least three alternative proposals of ATMS Control Centre and submit to NHAI for approval. Priority be given to choose a location which is within RoW and is in close vicinity to infrastructure (BTS/Exchange) of any telecom service provider so that network connectivity from ATMS Control Centre may easily be ensured.



Concept Layout of ATMS Control

1.4.6 Service Providers Responsibility/Obligations

The Service Provider agrees and undertakes to fulfil the minimum service requirements/ obligations prescribed under Appendix B to this document. Broadly, these shall *inter-alia* include

1.4.6.1 Setting up of an integrated ATMS solution including ATMS Control Centre as per requirements including all related civil and mechanical works on the highway.

1.4.6.2 Coordinate with respective agencies for obtaining the necessary approvals before commencing works. System installation shall be done with minimal disruption to on-going operations.

1.4.6.3 Strictly comply with the prescribed timelines and technical specifications.

1.4.6.4 Operating the ATMS to meet the Service Level Requirements (SLR) prescribed.

1.4.6.5 Performing system maintenance to ensure adhering to the

requirements for system maintenance.

1.4.6.6 Ensure ATMS architecture is capable of remote monitoring. NHAI would monitor the service performed and / or status of traffic /highway administration including handling of incidence by highway patrol through real time access of ATMS Control Centre of the Service Provider through NHAI's Regional Control Centre and / or Master Control Centre in New Delhi / NCR. Service Provider shall provide on- line access to the control centre for NHAI and/or NHAI's representative meeting the prescribed provisions. NHAI may prescribe Electronic Data Interchange (EDI) Protocol for real time access to ATMS data and Service Provider will be bound to follow such EDI protocol.

1.4.6.7 The service provider shall be responsible to comply with all statutory requirements concerning the subject matter viz. compliance to Labour Laws, Tax(es), employee insurance etc. and indemnify NHAI and its employees or representative against any such claims.

1.4.6.8 The service provider shall be responsible for arrangement and provision of all sources of electrical power and communication for setting up the ATMS and providing the required services in complianceof SLR.

1.4.6.9 The Service Provider shall suitably interface their ATMS system with the 24X7 National Highways Helpline (1033) to meet the service level requirements.

1.4.6.10 Reporting Requirements: Providing monthly performance reports related to operations and maintenance of the project. Report formats will be developed in consultation with NHAI and shall include all parameters considered under SLR.

1.4.7 Technical Resources / Personnel

1.4.7.1 The service provider shall form a multi-disciplinary team for undertaking this assignment. The agency shall be fully responsible to deploy its resources / personnel whose qualifications and experience fully commensurate with the task/responsibilities assigned and to achieve the objectives under the. The Personnel deployed should be experienced enough and should have proficiency in the requisite techniques / skills so as to provide practical, realistic and actionable service. Indicative minimum staffing and qualifications requirements for ATMS Control Centre and the process flow is attached to this document (Appendix C).

1.4.7.2 **Removal and/or Replacement of Personnel**

If NHAI (i) finds that any of the Personnel has committed serious misconduct or has been charged with having committed a criminal action, or (ii) has reasonable cause to be dissatisfied with the performance of any of the Personnel, then the service provider shall, at the NHAI's written request, forthwith provide as a replacement a person with qualifications and experience acceptable to NHAI.

1.4.7.3 **Performance standards:**

The service provider shall undertake to perform the services with the highest standards of professional and ethical competence and integrity. Keeping in view the sensitivity involved, the personnel deployed should maintain confidentiality / integrity at all times and work in a professional manner to protect the interest of NHAI. The

firm shall promptly replace any personnel assigned under this contract that NHAIconsiders unsatisfactory.

Chapter 2

GENERAL PROVISIONS FOR ATMS EQUIPMENTS

2.1 Overview

2.1.1 Purpose

This section describes the general requirements for the design, supply, installation, commissioning and maintenance of ATMS systems.

2.2 Non-Functional Requirements

2.2.1 Performance

1. Each equipment specification contained in this document details the specific performance requirements pertaining to that specification.
2. All ATMS equipment shall work 24 hours a day on all days of the year.

2.2.2 Reliability

1. Each type of ATMS equipment shall be designed to operate continuously for a period of time as specified in the relevant section of this document, when usedin the ATMS project environment
2. Generally, each item of ATMS equipment shall have a Mean-Time-to-Repair (MTTR) (time to full normal operation following a failure) specified under required service levels in the associated Service Level Agreement contract. Equipment failure and MTTR metrics will be monitored and recorded throughan exclusive, computerized ATMS Asset Management system to be set up by the service provider that shall be continuously maintained for audit by NHAI or its authorized representative.

2.2.3 Maintenance

Routine and preventative maintenance procedures shall be provided for all ATMS equipment to ensure that the equipment continues to work within the prescribed service levels.

2.2.4 Environmental

1. All ATMS equipment must maintain full functionality and continue to operate within the limits of this specification when subjected to the working environment of the project.
2. All equipment shall function and perform as per the specification, or better, in ambient temperatures ranging from -10°C to 55°C and in 95% relative humidity non-condensing.

2.2.5 Documentation

The ATMS Service Provider shall be adequately prepared with necessary documentation for effective operations and maintenance. Towards this, all ATMS Equipment shall be supplied and used with technical documentation

comprising such manuals and handbooks accompanied by maps, plans, drawings, diagrams, specifications, computer programs, flow diagrams, coding lists, library programs, and all such information as may be necessary for the Service Provider to effectively operate and maintain the system.

1. The documentation shall be provided under the following general headings and indicative contents (which are not necessarily exhaustive) as may be appropriate to the equipment being supplied;

a) GIS Based Design Plan of ATMS

i) The Service Provider will submit a GIS based file with the proposed placement of all key hardware such as all different types of cameras, VMS, VSDS, VIDES, ECB location of command center and any other installations. The KMZ or QGIS project file has to be submitted for approvalto NHAI or representative nominated by NHAI before the finalization of the locations of key hardware.

ii) An indicative Strip Chart as shown in Appendix-E should also be submitted for ready reference.

b) Hardware details:

i) Basic technical data, type nos., ratings, product codes, etc.
ii) Details of energy usage at defined load calculation
iii) Technical description
iv) Warnings and restrictions
v) Drawing lists, parts lists
vi) Module identification codes
vii) Mass and overall size of each type-numbered item
viii) Packaging material details.

c) software manuals:

i) Data, descriptions and details.

d) Drawings - mechanical and structural:

i) General arrangements
ii) Principal detail drawings.

e) Drawings - electrical and electronic:

i) System schematics, circuit and wiring diagrams.

f) Installation instructions:

i) Comprehensive instructions (including drawings for site assembly) for correct installation and connection of all parts of the Equipment, to be retained for reference purposes

ii) Instructions relating to each item of equipment likely to be installed separately.

g) Commissioning instructions:

i) Set-up details of addresses, operating parameters, control ranges and limits,etc.
ii) Commissioning procedures and System Integration tests.

h) Operating instructions:

i) Procedures for normal operation.

j) Maintenance instructions:

i) Details of routine maintenance
ii) Cleaning instructions
iii) Trouble-shooting and fault-finding charts.
iv) Maintenance information cards or booklets.

k) Product 'End of Life' Plan:

i) Instructions for dismantling the equipment without causing damage
ii) Details of re-usable/recyclable components and materials and the coding system used to identify them,
iii) Details of any precious metals
iv) Details of any hazardous substances, heavy metals or other pollutants withinstructions on their safe handling and disposal.

3. Documentation shall be produced in accordance with the standard as requiredby the NHAI or NHAI's representative and shall be approved by the NHAI or NHAI's representative before the system is accepted.
4. Documentation shall use SI units in accordance with ISO 80000-1.
5. Detailed design drawings and structural calculations for each type of pole, gantry or structure (including foundations) used to mount ATMS equipment shall be submitted to the NHAI and/or the NHAI's nominated representative for approval after due certification by a Licensed Structural Engineer using state of the art softwares. The design calculations shall be carried out in accordance with relevant MoRTH/IRC standards where applicable.
6. The drawings shall show materials specification and finishes for each item of equipment proposed for use. All weld types and sizes shall be identified on the design and construction drawings.
7. Power schematic diagrams for all ATMS installations shall be submitted to the NHAI and/or the NHAI's nominated representative for approval.
8. Telecommunications schematic diagram shall be submitted to the NHAI and/or the NHAI's nominated representative for approval. The telecommunications diagram shall include all systems, subsystems and components, including connections to modems, devices and the telecommunications access and backbone network.
9. As-built record drawings shall include longitude and latitude data accurate to within two (2) metres for each of the ATMS equipment and infrastructure installed.
10. Documentation should be organized so that unnecessary repetition is avoided. Topics likely to be frequently referenced by the service provider (e.g. operating and maintenance instructions) should be given prominence. As it is recognized that the volume of the documentation and drawings to be provided will vary considerably with the complexity of the equipment being supplied (ranging from one ring binder to several volumes), the NHAI or NHAI's representative should be consulted for its agreement on the presentation and layout of the documents to be provided.
11. Documents and drawings should be maintained at site as well as provided to NHAI on CD-ROM in Adobe Acrobat (.pdf) file text recognition format (i.e. converted to pdf from the source program rather than scanned) using the version current at the time of supply. A minimum of two sets shall be provided. The disks shall be virus checked and fully marked up / labelled prior to dispatch

to the NHAI.

12. The NHAI or NHAI's representative may additionally require two sets of final documents and drawings in full size paper form for record purposes, which shall be provided on a due confirmation from the NHAI or NHAI's representative.
13. When paper copies of text documentation are to be maintained at site and / or provided to NHAI, they shall be in A4 format bound into durable binders. The manner in which drawings in paper form are bound may vary with their size and should be agreed with the NHAI or NHAI's representative prior to delivery.
14. Installation instructions to be included in the package of any item of equipment likely to be installed separately or in conjunction with the ATMS equipment, shall be in the form of a leaflet or similar. It shall have sufficient information(with diagrams) for the item concerned to be correctly installed in position and connected, and describe any necessary set-up procedure.
15. Maintenance information cards or booklets, one set of which is to be secured within each equipment enclosure or cabinet shall be encapsulated in a durable weatherproof format. They shall show the general layout of equipment and component modules and references in schematic form, and set-up addresses for on-site replacement of component modules.
16. The format and extent of electronic media and/or hardcopy presentation of technical shall be agreed with NHAI / NHAI's representative before finalversions are produced.

2.2.6 Submittals

1. All ATMS equipment shall, as a minimum, meet all the requirements listed in these specifications. Future technological advances may allow for ATMS equipment to be provided that exceed the minimum requirements in these Specifications.
2. Systems and subsystems that minimize the possibility that failure of any single component or module will cause total system failure shall be provided. Failureof one component or module shall not cause the failure of any other component or module.
3. Product data, design and construction drawings for all of the components shall be submitted to the NHAI and/or the NHAI's nominated representative for approval.
4. Heat-load calculation sheets, accompanied by related manufacturer's data sheets to support justification of proposed cooling systems shall be submitted to the NHAI and/or the NHAI's nominated representative for approval. Power consumption calculations to support proposed power distribution type and size shall also be submitted.

2.2.7 Quality Assurance

1. The ATMS equipment provider shall have in place a quality system documentation complying with ISO 9001, for the activities of design, development and production of the ATMS equipment to be supplied unless otherwise agreed by the NHAI or NHAI's nominated representative. The quality system shall cover each and every location where such activities are undertaken.

2. The NHAI or NHAI's nominated representative may audit the potential supplier's quality system and test facilities before approving use of the proposed supplier who shall essentially have an inhouse facility to integrate all major field equipment's and demonstrate to the NHAI NHAI reserves the right for the same.
3. The following requirements must also be considered:
   a) The design and installation of Electrical Installations shall comply with the requirements of the Bureau of Indian Standards.
   b) The service provider shall be required to provide, at their own expense, samples of the proposed equipment and all associated approvals, test reports and schedules to verify that the equipment meets all of the NHAI's requirements.

2.2.8 Field-Access & On-line remote Access during the Contract period

1. Field-Access: All the equipment of the ATMS system shall provide access for data extraction and control (where applicable) in a secure manner from a local laptop computer. The access shall be either in the form of a wired connection via a standard interface like TCP/IP (in the form of an Ethernet connection), RS 232, RS 485 or Wireless Lan. It shall be further possible in a secure manner to view and transfer such accessed data on to the appropriate ATMS server database to 'make-good' any data loss that may have occurred during normal operations. Such an operation of data extraction and transfer to the ATMS server database shall be automatically detected and logged into the system asan event for causing a system alert and appropriately included in the event report.
2. The service provider shall use an appropriate GUI supported software (s) for the performing the above data access, control and transfer to the ATMS database.
3. The systems commissioned by the Service Provider shall provide, during the entire period of the Contract, adequate remote on-line access (via-internet)having a dedicated IP for the NHAI and / or NHAI's representative/Local Traffic Agency for on-line evaluation of the functioning of each equipment / sub-system, including all field equipment. The Service Provider shall also provide the NHAI a suitable Modular software for the same. In the case of PTZ CCTV Cameras, this tool shall also support the facility of observing real-time images from each camera by remote operation of the Pan-Tilt-Zoom facility. NHAI reserves the right to include the results of any such examination by NHAI and / or its representative in the achieved service levels for the period under evaluation.
4. For the purpose of enabling the above on-line access facility, each of the equipment / sub-systems shall be Internet Protocol (IP) based supporting the Simple Network Management Protocol (SNMP), TCP/IP, RTSP or suitable method.
5. The Service Provider will be required to configure direct online access of video streams for each camera through either RTSP, Port Forwarding, HTTP, WebRTC, Cloud NVR or any protocol supported by NHAI ATMS Cloud at HQ and Local Traffice Agency Command Control Centre.
6. Each camera (VIDES , CCTV or one placed in Command Centre) shall be registered on NHAI ATMS Module at HQ. This registration will include but not

limited to lat-long, public IP, RTSP url, authentication details if any and web-link to access the stream of individual cameras respectively.

7. The above tool shall also include a feature by which the NHAI and / or NHAI's representative can generate detailed performance, operation and maintenance reports without the need for any support / intervention from the Service provider's personnel.
8. Where applicable, the ATMS shall be integrated with the Local Traffic Police's Command and Control Centre. This shall include sharing of live feeds of all TMCS and VIDES cameras for viewing and/or controls and any additional modular software that allows for the same. If view-only access can be provided through login into ATMS software such that above requirements are met, that may also be considered.

2.3 Functional Requirements

2.3.1 Power Supply

1. The field equipment shall have the locally available mains power supply (from the electricity utility through Regulated source) as the primary source and supported with a relevant Renewable energy - based power supply for back up and / or generator back up to ensure 24 x7 operation.
2. The ATMS Control Centre shall have the locally available mains power supply (from the electricity utility) as the primary source and supported with a UPS and generator back up to ensure 24 x 7 operation.
3. Except where detailed in specific sections below, all ATMS equipment shall be powered from either
   a) A single phase 230Vac 50Hz supply.
   b) A three phase 440Vac 50Hz supply.
4. ATMS enclosures shall include a power distribution subsystem for supplying power supply to each component within the enclosure and related / inter-connected ATMS equipment. The circuit breakers shall be properly sized according to the expected loads of the ATMS equipment and to meet relevant electrical code requirements.
5. All electrical equipment and cabling shall be provided in accordance with relevant BIS standards. In case there no relevant BIS standard exists the BS 7671 standard shall be applicable.
6. The power distribution panel shall be directly fed by the main circuit breaker at the electrical point of service. The power distribution assembly shall include an interface and connection to the UPS (where provided). The power assembly shall be connected to the earthing system.
7. The enclosure shall be earthed in accordance with the relevant BIS regulations.
8. The enclosure shall include a 230Vac 15 Amps 3-pin dual socket power outletconforming to BIS standard.
9. The power sockets shall be installed in accordance with relevant BIS standard.
10. A Multi-stage Transient Voltage Surge Suppressor (TVSS) shall be provided for each external cable (related to power supply, signal, data or any other), connection which is terminated at any item of exposed external equipment, or routed through an outdoor area. The TVSS shall be rated in accordance with BIS requirements.

11. The TVSS shall be capable of handling minimum 30KA fault current. Provision shall be made for protection of earthing and the shield/armour of coaxial cables and TVSS for each signal conductor
12. The TVSS shall not only clamp the voltage, it shall also divert the fault currentsto ground. If a TVSS is destructively tripped, there shall be a clear visual indication that the ATMS equipment is no longer protected and the TVSS needs a reset or replacement.
13. ATMS equipment shall automatically regain full operational functionality when related electrical power supply is restored, without the need for manual intervention.

2.3.2 Uninterruptible Power Supply (UPS) Subsystems

1. The worst-case power-load data shall be used to design the electrical conductor sizes. These shall be submitted to the NHAI and/or the NHAI's representative for approval.
2. A UPS shall be provided wherever required. The UPS shall meet the requirements of relevant standards of BIS.
3. Unless otherwise stated in the design drawings and/or specifications, UPS with a minimum of Six (6) hour backup shall be provided for all ATMS field equipment and telecommunications device locations. The Batteries of UPS system should be regularly replaced so as to ensure the specified back-up.
4. An Automatic Power Transfer Switch (APTS) shall be provided inside the ATMS ground mounted enclosure which transfers power from one of the external sources to the electrical distribution system. The APTS shall monitor the status of the primary power source and transfer the power connection to the secondary power source when primary power source fails or suffers degradation. The APTS shall be provided with means to operate in manual mode.
5. The APTS must be able to transfer the connection with the internal power system, from the primary power source, to the secondary power source, within 1 mains power cycle (less than 20ms).
6. Additional equipment necessary to eliminate the delay in the transfer of power sources which may cause the ATMS equipment to reboot shall be provided.
7. Each external power supply line shall be terminated at the APTS.

2.3.3 Earthing

All earthing of ATMS equipment shall comply with BIS regulations.

2.3.4 Telecommunications

The field equipment shall be connected to the ATMS Control Centre via an optic fibre network using suitable interfaces. Refer to section 12 within this documentfor details of telecommunications and networks.

2.4 Hardware Design Requirements

2.4.1 Mechanical and Housing RequirementsNon-Ground Mounted Equipment

1. ATMS equipment not contained in a ground mounted equipment enclosure will have specific housing requirements depending on location, weather

conditions and vibration from road vehicles.

2. The housing shall be structurally rigid. Mounting accessories such as nuts, bolts, studs, locks, washers etc. shall be of corrosion resistant stainless /mildsteel. IP 65 or better . The whole assembly shall withstand vehicular fumes without degradation for its entire service life.
3. Housing design shall be conducive to easy maintenance.
4. Housing shall secure the housed equipment, from tampering and theft. Means shall be provided to raise an alarm in the control room in case of tampering.
5. Cable entries to connect the signal, power and control wires to the encased equipment shall be provided and the housing shall meet IP65 to the minimum (unless otherwise specified for a particular ATMS equipment under the relevant section of this document).
6. Housing shall have adequate space to accommodate cable overages normally provisioned for future re-connection.
7. Forced air cooling within the housing shall be provided if installation situation demands.
8. Viewing window in case of camera housings shall not introduce distortions or artefacts on the image.
9. Suitable arrangements to prevent misting within the housing shall be provided where ever necessary.
10. Further details are included in sections relevant to each type of ATMS equipment.

2.4.2 Ground Mounted Equipment Enclosures and Poles

2.4.2.1 Ground mounted enclosures and mounting arrangements

1. The ground mounted enclosure shall house telecommunications equipment, power and other related equipment necessary for the operation of ATMS equipment.
2. The equipment must continue to work within its normal operating parameters in this environment, regardless of location.
3. The ground mounted enclosure shall be weather resistant and conform to BIS requirements with an ingress rating of IP65, as a minimum. Where the ground mounted enclosure needs to be penetrated, such as to facilitate installation of cables, provisions must be made to the penetration(s) in order to maintain the enclosure rating.
4. The enclosure shall include a secure locking mechanism to make it tamper-proof. Further there shall be a provision to generate automatically an electronic signal on any attempted tampering that can be used to generate an audio-visual alarm at the control centre.
5. Each enclosure door shall be equipped with an adjustable doorstop to hold the door open.
6. Warning labels shall be provided for all electrical panels in accordance with BIS or BS 7671. Asset identification information shall be provided on the outside of the enclosure and shall be weather resistant.
7. All Internal connectors, components and wire terminations installed in the enclosure shall be labelled in accordance with the design drawings
8. Racks and shelves shall be provided in the enclosure to mount equipment as needed, including telecommunications devices and power assemblies. The rack

shall comply with: BIS requirements (or approved equivalent international standard).

9. The rack shelves shall be capable of sustaining a constant 10 kg load. For all enclosures utilizing telecommunications services from a telecommunications network provider, a nominal mounting space of 200mm x 300mm x 75mm shall be provided for interface modules used by the service provider. The enclosure shall provide an additional fused or breaker protected, UPS- powered receptacle for related power requirement.
10. The ground mounted enclosure shall include an LED lighting fixture, minimum rating 5 watts, complete with lens or shield and high-efficiency LED lamp driver.
11. Ground mounted enclosures shall be mounted on a concrete foundation of the concrete class and dimensions shown in the detailed project design drawings. A cabinet riser shall be included when the cabinet is located below grade to protect against water incursion.
12. All mounting arrangements for ATMS equipment shall also comply with the requirements of that equipment as detailed in this specification.
13. The foundation and the foundation bolts for Ground mounted enclosures, tilt and fixed poles etc. shall be fabricated using a suitable (site specific grade of steel) material. The assembly shall be galvanized to a minimum coating thickness of 100 microns.
14. Galvanized Nuts, locknuts, locking pins washers etc. shall be supplied as a part of the foundation.
15. Fixing templates with a placement accuracy of at least +/- 1mm shall be provided to allow for the correct orientation and installation of the steel foundation on to the concrete base.
16. The strength of the foundation assembly shall be suitable to hold the Enclosure/Pole while withstanding weather conditions of the site for a period of at least 25 years.

2.4.2.2 Poles

1. The poles shall be designed to offer a stable platform for the imaging equipment to operate. Each pole and its associated hardware shall be fabricated using material appropriate for its installation site.
2. Nominal mounting height may be assumed as 12 meters However, some situations may warrant different heights.

2.4.2.2.1 Tilt Pole

1. The poles shall be designed to offer a stable platform for the imaging equipment to operate. Each pole and its associated hardware shall be fabricated using material appropriate for its installation site (GI, marine grade SS, powder coated steel or enamel painted etc.)
2. Poles shall incorporate a mid-hinge tilt arrangement with a suitable counter weight to ensure a balanced tilt. The structural design shall conform to relevant standards and shall be certified by a statutory authority for structural integrity and maximum allowable vibration (typically caused by wind forces and other external stimuli) to ensure a stable image at full optical zoom of the camera mounted on it.
3. The design shall be tapering gradually over the whole length with the

minimum cross section at the top.

4. The design shall be base plate mounted with a matching foundation.
5. The poles shall be supplied with a mounting template, rag foundation bolts and other associated installation hardware.
6. An access door at the bottom of the pole shall be provided at a typical height of 0.5 meters from the base for the termination panel. The typical door dimensions shall be 125mm wide by 500 mm high or suitable size as required.
7. The design of the pole and hinge arrangement shall be such that the mounted equipment does not touch the base of the pole or ground when lowered.
8. Suitable eyelets, anchors, pulleys, etc. shall be incorporated in the pole design to allow for ease of raising the pole and to regulate the speed of lowering.
9. The design shall incorporate secure latching systems at the hinges to hold the two sections rigidly. There shall also be a provision to pad-lock the two sections to prevent unauthorized people from lowering the pole.
10. The base plate shall be designed to allow underground appropriate plastic /Galvanized Iron conduits to enter the base of the pole.
11. There shall be a tapered hole located not more than 150 mm from the top on the side of the pole to accept conduit fittings to route cables to the mounted imaging system components.
12. The assembly shall be of stainless steel/galvanized /Enamel Painted/powder-coated to an appropriate minimum coating thickness.
13. Deflection due to wind shall not exceed 0.1 degrees at a wind speed of at least 28m/s with the equipment mounted on the pole.
14. Suitably sized powder coated terminal box and terminal block assembly shall be provided and be treated as a part of the fixed pole. It shall be installed on the pole near the bottom end and the joint, cable entry/exit points (or glands) shall be sealed using a water proof sealant to avoid water ingress into the box or the pole base.

2.4.2.2.2 Fixed Pole

1. Fixed poles shall be used to mount flashing traffic lights and cameras in some of the locations.
2. Fixed pole cross section shall either be circular with a typical outer diameterof 150 mm or square cross section.
3. The joint(s) shall be seam welded.
4. The fully fabricated pole column shall be of stainless steel/galvanized /Enamel Painted/powder-coated to an appropriate minimum coating thickness.
5. The poles shall incorporate suitably designed holes on the sides to allow for electrical cables to enter or exit the pole undamaged.
6. The bottom portion of the pole shall be treated for corrosion resistance in accordance to the installation site.
7. The structural steel and design shall conform to relevant standards and shall be certified by a statutory authority for structural integrity and maximum allowable vibration (typically caused by Wind forces and other external stimuli) to ensure a stable image at full optical zoom of the camera mounted on it.
8. Deflection due to wind shall not exceed 0.1 degrees at a wind speed of at

least 28m/s with the equipment mounted on the pole.

9. Suitably sized powder coated terminal box and terminal block assembly shall be provided and be treated as a part of the fixed pole. It shall be installed on the pole near the bottom end and the joint, cable entry/exit points (or glands) shall be sealed using a water proof sealant to avoid water ingress into the box or the pole base.

2.4.3 Heating, Ventilation and Air Conditioning (HVAC) Subsystem

1. Where required, the ground mounted enclosure shall include an air conditioning system. The air conditioning system can be either passive or active. The design shall be submitted to the NHAI or NHAI's representative for approval.
2. Where a cooling system involving air conditioner or other heat-exchanger is used, the cooling system shall be mounted next to or on the exterior of the ATMS enclosure. Where the enclosure needs to be penetrated, such as to facilitate installation of pipes for coolant supply and return lines, provisions shall be made to the penetration(s) in order to maintain the enclosure rating.

2.4.4 Installation

1. The ground mounted enclosure shall be installed according to appropriate good engineering practices. All internal components and UPS (if required) shall be securely mounted.
2. For ground mounted enclosure installation, UV-resistant caulking material shall be applied along the joints of the enclosure. For mounting under a camera lowering system, the enclosure shall be positioned away from the space directly below related camera.
3. Provisions shall be made for all ducts (i.e. power, telecommunications, etc.), in accordance with the design drawings and/or specifications, that will facilitate the connection between the enclosure and the ATMS equipment.
4. Where cables enter the ground mounted enclosure, they shall be fixed and secured against movement and to relieve stress on the cable termination. All penetrations to the enclosure shall be sealed with silicone sealant to impede entry of gas, dust and water.
5. All wires/cables within the enclosure shall be secured and labeled. Earth wires from all electrical devices, including surge suppressors, shall be terminated directly to the dedicated earth terminal in the enclosure. Earth conductors shall not be daisy-chained from device to device.
6. All conductors carrying electricity at 60Vac or higher shall be segregated from all telecommunications, signal conductors and conductor carrying electricity lower than 60Vac. A minimum of 75mm shall be provided between these two conductor groups. Where conductors belonging to these two groups need to cross each other at distances closer than 75mm, the installer must ensure the conductors are at a 90 degree angle (perpendicular) to each other.
7. Each wire shall be identified on both ends of the wire with heat shrink, thermal transfer tube type wire markers in English. Adhesive labels are not acceptable. The wire markers shall be white with black lettering. Hand marking of the label is not acceptable.

2.5 Testing and Training

2.5.1 General Testing

Any test facility commissioned to carry out environmental, electromagnetic compatibility or optical performance tests or safety testing of telecommunications equipment shall have adequate accreditation meeting a relevant BIS standard or ISO standard or set up by a relevant government agency as a central facility.

1. Quality systems relating to the design, development, testing, supply and maintenance of software shall implement the guidance of ISO 9000-3.
2. The Service provider shall operate an Environmental Management System complying with the requirements of ISO 14001.
3. Any certification or accreditation necessary to comply with this specification shall have validity current at the time the Contract is placed and be maintained valid throughout the period of the Contract. Evidence of this certification or accreditation shall be provided.
4. The ATMS service provider shall be responsible for any testing and/or certification of equipment needed to meet or demonstrate compliance with statutory or regulatory instruments and requirements.
5. The ATMS equipment shall provide reasonable access and facilities for the NHAI or the NHAI's nominated representative to audit the operation of its quality systems and test facilities as deemed necessary by the NHAI or the NHAI's nominated representative.
6. The ATMS service provider shall accept all responsibility for the satisfactory quality, design and workmanship of the ATMS equipment being supplied and every part of the system and equipment whether manufactured by or supplied to the ATMS service provider by supply chain partners and whether specified or approved by name or not.
7. Documentation detailing the proposed schedule of tests to be undertaken at each stage of the test process for all ATMS equipment shall be provided. As a minimum, the tests shall include Factory Acceptance Tests (FAT), Site Acceptance Tests (SAT) and System Integration Tests (SIT). All costs for such tests shall be borne by the service provider.
8. All test equipment shall have a valid calibration certification.
9. The acceptance of each stage of testing does not imply that testing is complete at that stage. If problems are found at a later date or stage of testing, it may be necessary to return to an earlier stage of testing after repairs have been made to the system. If at a later stage of testing, an item of equipment is replaced, repaired, or significantly modified, the equipment shall be retested to the level necessary to isolate any problem and establish a course of action to remedy the situation.
10. Test procedures, checklists, test forms and data summary sheets shall be provided for each item. The proposed test procedures shall include a description of the test topics, applicable pass/fail metrics, planned test method and planned test instruments and tools. The NHAI and/or the NHAI's nominated representative shall be notified of the date, time and place of each test, as a minimum at least 28 calendar days prior to the date the test is planned to be conducted. The tests shall be conducted in the presence of the NHAI and/or the

NHAI's nominated representative unless specifically authorized in writing by NHAI otherwise.

11. The NHAI and/or the NHAI's nominated representative shall sign the trial test documents as proof of a successful trial test for each item of ATMS equipment and ancillary components. If the test trial is unsuccessful, the NHAI and/or the NHAI's nominated representative shall be given minimum seven (7) full business days' prior notification before rescheduling another test trial.
12. ATMS Equipment that fails to conform to the requirements of any test will be considered defective and the equipment will be rejected by the NHAI and/or the NHAI's nominated representative. In the event a defect is determined, it shall be determined whether it is limited to a specific unit or could be potential problems in all such units. Equipment rejected because of problems limited to the specific unit may be offered again for retest provided all issues of non-compliance have been corrected and re-tested and evidence thereof submitted to the NHAI and/or the NHAI's nominated representative. The evidence thereof shall include as a minimum a technical report detailing the investigation that has been undertaken to determine the cause of the failure. The report shall detail, as a minimum, the symptoms, cause and what action was required to remedy the failure. This report, shall be submitted and approved by the NHAI and/or the NHAI's nominated representative prior to a new test date being scheduled.
13. In the event that the ATMS equipment malfunctions during the test period, the NHAI and/or the NHAI's nominated representative may declare a defect and require replacement of all equipment at no additional cost. When a defect is declared, the test and test period shall be restarted from the beginning for that specific ATMS equipment.
14. If ATMS equipment has been modified or replaced as a result of a defect, a report shall be prepared and delivered to the NHAI and/or the NHAI's nominated representative for acceptance. The report shall describe the nature of the failure and the corrective action(s) taken. If a failure pattern, as defined by the NHAI and/or the NHAI's nominated representative, develops, the NHAI and/or the NHAI's nominated representative may direct that design and construction modifications be made to all similar units without additional cost to the NHAI. In the case of problems common to many units, all units shall be modified at no additional cost to the NHAI.
15. See relevant subsections below for a detailed description of each type of testing and what it involves.

2.5.2 Factory Acceptance Test (FAT)

1. The Factory Acceptance Test (FAT) shall be undertaken to ensure the ATMS equipment has been completed to the required functionality, safety and quality and meets all the contractual specifications.
2. The FAT shall be undertaken before shipping to site to ensure the equipment has been completed (constructed, programmed and pre-commissioned) to the required quality and is fully operational. This will include equipment assembled to its final deliverable state either inside or outside the ATMS project.
3. The FAT shall be undertaken on the equipment due to be shipped to the site to fulfil their operational requirement and not on an alternative product.
4. The factory acceptance test is used to:

a) Provide proof of functionality, quality and integrity with a comprehensive checking process against the product specifications
b) Verify all-important documents (manuals, instructions, plans, drawings) to ensure they accurately reflect the requirements and the equipment operation
c) Ensure that the equipment performs as expected under the testable range of foreseeable conditions, including misuse and errors.

5. The FAT may be witnessed by the NHAI or the NHAI's nominated representative.
6. Each FAT shall be specific to the product being tested but shall include the following as a minimum;
   a) Pre-inspection testing and inspection
   b) Pre-configuration of settings and software
   c) Preparation of a test register
   d) Review of drawings and documentation
   e) Adequate testing of functionality
   f) Interface testing
   g) Full communications testing
   h) Full cycle of powering up, logging on, logging off and powering down.
7. In the event of a test failing for any reason, the equipment provider must undertake an analysis of the fault. If the fault is considered to be irresolvable, then an exception shall be logged in the test register. At the end of the FAT, the completed tests should be evaluated with the test team including any test failures that occurred. An evaluation meeting shall agree on the nature of any faults encountered and discussing if the FAT should be continued.
8. One of the following actions shall be taken dependent on the extent of the fault:
   a) The FAT can be completed if the faults are minor, and the system shall be considered acceptable, subject to the fault being fixed before system commissioning at site. A FAT shall also be repeated on a new version of the system incorporating a fix for the fault.
   b) Testing faults resulting from test procedure error or operator error shall be repeated. The test may be repeated immediately if the error is detected at the time of the FAT.
   c) Major faults during the FAT shall lead to abandoning the FAT and rescheduling it for a later date pending the fault being resolved appropriately by the equipment provider.
   d) The FAT tests specified shall be repeated for the SAT.

2.5.3 Site Acceptance Tests (SAT)

1. A Site Acceptance Test (SAT) shall be undertaken at each ATMS equipment location to verify that it meets the requirements described in the detailed project design specifications.
2. Following the installation of equipment, but prior to the connection with other ATMS systems and subsystems, a SAT shall be conducted on each piece of equipment and witnessed by the NHAI and/or the NHAI's nominated representative.
3. The test shall exercise all standalone (non-network) functional operations of the ATMS equipment and ancillary components installed and shall demonstrate

conformance with the requirements described in the detailed project design specifications, relevant standards and manufacturer specifications.

4. The quality of equipment and its installation shall be judged and verified to ensure compliance to relevant standards outlining operational safety, Ingress protection, Surge/ lightning protection and Radio interference.
5. Equipment installation shall be inspected to confirm compliance to equipment manufacturer's installation good practice recommendations.
6. The ATMS equipment provider shall ensure that the required testing equipment, including a portable computer and test software is provided for the SAT.
7. If any ATMS equipment or ancillary component fails to pass its SAT more than twice, it shall be replaced with new ATMS equipment or ancillary component of same make and model and the entire SAT shall be repeated until proven successful.
8. The SAT shall be conducted for each and every piece of ATMS equipment and ancillary components.
9. Time extensions shall not be granted to perform the SAT due to any failures. Failures during the SAT shall be resolved at no additional cost to the NHAI.

2.5.4 System Integration Tests (SIT)

1. The SIT shall also incorporate the network-manageable portions of the ATMS system including the ATMS system interface to the Regional and Main Control centres. The SIT shall begin after earlier stages of testing have been successfully completed (i.e. FAT and SAT) and accepted by the NHAI and/or the NHAI's nominated representative. When possible, the SIT shall be conducted during the harshest environment period deemed for that particular equipment. The duration of the SIT will be agreed with the NHAI or the NHAIs nominated representative prior to starting.
2. In the event of a system, subsystem, ATMS equipment, or ancillary component failure, with the exception of consumable items such as fuses, the Project shall be shut down for purposes of testing and correcting identified deficiencies (System Shutdown). System Shutdown is defined as any condition which, due to work performed by the Service provider, results in the Project, or any system, subsystem, ATMS equipment, or ancillary component thereof to cease operation.
3. The SIT shall be re-started after the identified deficiency has been corrected.
4. If the total number of System Shutdowns exceeds three (3) due to the same system or subsystem, ATMS equipment, or ancillary component;
   a) The system, subsystem, ATMS equipment, or ancillary component shall be removed and replaced with a new and unused unit.
   b) All applicable FAT and SAT, as deemed necessary by the NHAI and/or the NHAI's nominated representative shall be performed and the SIT shall be restarted upon written approval from the NHAI and/or the NHAI's nominated representative.
5. Time extensions shall not be granted to perform the SIT due to any failures. Failures during the SIT shall be rectified at no additional cost to the NHAI.
6. Upon the successful completion of the SIT and all the required submittals, testing, training, and documentation have been successfully submitted to and approved by the NHAI and/or the NHAI's nominated representative, the NHAI and/or the NHAI's nominated representative shall provide written

noticeof Final Acceptance.

7. The notice of Final Acceptance implies that the system is ready for commercial operation subject to adequate training provided to the Operations and Maintenance personnel (Ref section 2.5.7).

2.5.5 Defects Liability Period (DLP)

1. Any defects in the system identified by the NHAI and / or the NHAI's nominated representative and provided to the Service provider in the form of a written notice during the Final Acceptance (Ref 2.5.4 above) shall be rectified during the Defects Liability Period. The above defects list shall also include any defects that surface during the DLP which shall also be rectified by the Service provider during the defined DLP itself.
2. Suitable tests for confirming the rectification of defects shall be performed by the Service provider to the satisfaction of the NHAI and/or NHAI's representative.
3. The DLP shall be in force for a period equal to the contract/concession period under the main Contract / Concession Agreement succeeding the notice of Final Acceptance.

2.5.6 Integration

1. Integration activities of the ATMS project shall be coordinated and undertaken such that all systems, subsystems, ATMS equipment and ancillary components are integrated with the ATMS Control Centre hardware and in accordance with the detailed project design specifications.
2. All integration activates shall be coordinated with the NHAI and/or the NHAI's nominated representative prior to commencement of any integration activities and shall be agreed in accordance with the project program.
3. Integration activities shall include the telecommunication nodes (i.e. Managed Ethernet Switches) with the existing and/or proposed fibre optic Ethernet telecommunications network for the design and connectivity of the ATMS Project.
4. All ATMS equipment shall be managed and operated by the ATMS Control Centre. The ATMS equipment shall be integrated as identified in the design drawings and/or specifications, into the ATMS Control Centre.

2.5.7 Training

1. Training shall be provided for the operation and maintenance of all the ATMS equipment and ancillary components.
2. Certification by the NHAI and / or the NHAI's representatives is mandatory for the Service provider to begin commercial operations of the system.
3. Training shall be designed to familiarize the Service provider's own Operations & Maintenance personnel and NHAI's representatives with the design, installation, operation and maintenance of the ATMS equipment and the overall system. The training shall also cover functionality, theory of operation, calibration, testing, performance and operating parameters.
4. A single organized training shall be conducted by the Service provider. A complete course outline and summary of the experience and qualifications of

the instructors shall be submitted to the NHAI and/or the NHAI's nominated representative for approval prior to commencement of training. Training sessions may be combined and/or shortened with the agreement of the NHAI. The training will be conducted at a location agreed with the NHAI.

5. The training materials shall be provided in English. The training materials shall include as a minimum:
   a. Course outline
   b. A Microsoft Office PowerPoint presentation showing detailed subject material
   c. Operation and maintenance manuals in both electronic and paper format
   d. Test equipment and tools
   e. Any other required information.
6. Training shall also include the imparting of practical 'hands-on' experience to the trainees during each training session.
7. At the end of each training session, a test shall be conducted on the trainees to gauge their learning and the effectiveness of the training.
8. If, at any time during a training course, the NHAI and/or the NHAI's nominated representative determine that the course is not being presented in an effective manner, the training session shall be suspended. The Service provider shall make the necessary changes to the course, resubmit the required training materials for approval and reschedule the training course.

2.6 System Operation and Maintenance

1. The Service provider shall perform System Operation and Maintenance (O&M) (after Final Acceptance of the system) meeting the requirements contained in the Terms of Reference.
2. The Service provider shall deploy adequate number of trained personnel at site and at their back office to ensure that the above requirements are met. The Service provider shall submit, to the NHAI, reports as required on their Operation and Maintenance.

2.7 Computer Software Requirements

These requirements include those that are required to ensure adequate availability& sustainability of the ATMS software during the contract period.

1. The software for the system shall be designed and developed for adequate scalability of existing system functionality, addition of new functionality and easy maintainability. The medium used for storage and loading of programs shall be suitable for the way they are likely to be handled and stored and shall not require closely controlled environmental conditions.
2. The software development methodology used should ensure the development of modular software.
3. The ATMS service provider shall ensure that the development environment is adequately maintained during the contract period to ensure adequate support for the maintenance of the software under use and further additions/modifications to its functionality as may be required.
4. All documentation, diagrams (including software schematics or automated tool output) and specifications, shall be produced to recognize Standards and, apart from where other standards are agreed, shall use conventions, symbols and terminology defined in the appropriate European or International standards.

5. There shall be at least two sets of all source programs held on the agreed medium. For reasons of security one set shall be kept remote from the other(s) and regularly updated as changes are made. By agreement the NHAI or the NHAI's nominated representative may hold one set.
6. The ATMS service provider shall hold at least two sets of all operational programs including, where appropriate, site-specific data and programs held in appropriate media..
7. All programs being deployed shall be clearly identified and include the appropriate issue details and date.
8. Modular Data & API Integrations: All the data generated for incidents, violations, traffic etc as collected by various sensors will be integrated with ATMS command centre software/data. This data may be required to be shared with NHAI HQ through API in raw or aggregated format as desired through APIs.
9. NHAI may require from time to time two-way API integrations with software/apps under control of NHAI HQ. These API integrations shall be part of existing ATMS contracts at no additional cost.
10. The documentation held at site shall be fully annotated with issue number, date and section reference and shall include the following:
    a) A concise description of the overall function of the software.
    b) Details of the computer hardware of the system, upon which the software in installed and any proprietary software products used, including databases,operating systems and their version/issue status.
    c) A complete list of all modules in the software with their functional description and interaction with other modules. .
    d) Clear operating instructions.

2.8 Information Security and Data Protection

1. Providers of ATMS system are required to ensure that the system being provided operates in a secure manner. The solutions offered shall be in accordance with Information Technology (Reasonable security practices and procedures and sensitive personal data or information) Rules, 2011 published vide Government of India Notification No. G.S.R. 313€ dated 11th April, 2011 or any other Government Order issued from time to time regarding security norms of video surveillance system or any other sub-system of ATMS.
2. The Service provider is expected to have familiarly with ISO 27001 or procure the necessary expertise in developing and delivering solutions in line with information system security best practice.
3. The Provider of the ATMS system shall ensure that the data collected throughout the contract period is securely kept and usage limited in purposeof that of ATMS. The SI shall be governed by the Digital Personal Data Protection Bill, 2023 and any relevant Government of India rules notified thereon.
4. The contractor shall carry out an IT security audit of the ATMS application software through STQC (Standardization Testing and Quality Certification)/CERT-in (Computer Emergency Response Team) empanelled vendors at least once in a year as per directions of NHAI from time to time.

2.9 Equipment Security

1. The contractor/concessionaire shall be sole responsible for safety of all the ATMS system, sub-system, equipments against theft, vandalism etc. Any equipment stolen/vandalised has to be replaced.

2. The contractor/concessionaire may use adequate manual safety measures or implement suitable electronic security mechanisms for same.

3. All the systems, sub-systems and equipments should be adequately insured to offset loss due to vandalism/theft etc.

2.10 Civil Design

The foundation of all the equipment shall be adequately designed as per relevant IS Codes using minimum M25 Grade of concrete and Fe500 grade steel reinforcement.

2.11 Work Area Safety and Traffic Control

2.11.1 General

a. Obstructions and excavations in the work areas shall be adequately fenced and guarded at all times and proper traffic control devices shall be installed to protect the workers and the public. Particular attention shall be paid to the positioning of traffic barriers and traffic cones. Unnecessary blocking of traffic lanes shall not be permitted. Roads and sidewalks shall not be used for the unnecessary storage of materials.

b. Adequate traffic control devices shall be in place before work begins and all such devices shall be removed immediately when the work is completed. As work progresses, warning devices which were appropriate at one time but are no longer applicable shall be removed immediately.

c. Signs, lights, barriers and other traffic control devices shall be maintained in good order and in the correct position day and night. Signs shall be neat, clear and legible at all times.

d. Compensation for meeting the requirements of this section shall be included in the various bid items and no separate payments will be made, therefore.

e. Penalties shall applicable as prescribed in the Penalty clause above, in case of any non- compliance or safety violation.

2.11.2 Highway Lane Closure

No lane closure shall be permitted on any road during peak hours except with prior approval of the NHAI. During non-peak hours, one or several traffic lanes may be closed provided that at least one lane in each direction is open for traffic at all times. On two-way, two-lane roads, any lane closure shall be first approved by the NHAI. Notwithstanding the provisions above, the NHAI and the police shall have the power to order the lane closure removed or to require better traffic control measures.

2.11.3 Warning Signs

a. All work area warning signs shall conform to the requirements in the relevant regulations in India.

b. A "LANE CLOSED AHEAD" and a "LANE CLOSED" sign shall be placed upstream of the lane closure site at a distance of approximately 100 meters and 50 meters respectively when one lane of the roadway is closed. These signs shall be placed further upstream of the work area if more than one lane of the roadway isclosed.

c. All work area warning signs shall be made of reflective sheet or material if thesigns are to remain in place during hours of darkness.

d. The design, specifications, quantity, location, placement of the Signages shall fully comply with IRC 67 2022, and/ or applicable international code.

2.11.4 Temporary Warning Flashers

Temporary warning flashers of Amber/red colour LED and minimum 500mm dia shall be used during the hours of darkness if traffic cones, barricades or other barriers are to remain in position at night. Lamps shall be kept alight at all times during the hours of darkness. The flashers shall clearly mark the site of obstructions and delineate the transition zone. Minimum 4 nos. waring flashers shall be kept alight at each such location.

2.11.5 Traffic Cones

Traffic cones and water filled barriers shall be placed on the roadway in advance of the work site to form a transition taper. The length of the transition taper shall be at least 30 meters so as to guide traffic smoothly from the full width section to the narrowed down section. Spacing between the cones shall be no more than 10 meters.

Chapter 3
Video Surveillance System/ Traffic Monitor Camera System (TMCS)

3.1 Scope

This specification lays down the general, functional and technical requirement of the Closed Circuit Television (CCTV) System to be used as a sub-system of ATMS implementation. TMCS shall include monitoring through pole mounted PTZ cameras.

3.2 Function

1. The system monitors vehicular and other road related activity along the highway stretch not more than interval of 1 km alternating side/median mounted on Poles. In case certain stretches include regular curves etc (hilly roads etc) not allowing central line of sight, then additional TMCS camera shall be put to ensure effective surveillance of the entire stretch.
2. CCTV system is required to ensure effective surveillance of the target road section and related surrounding areas and generate a tamperproof record for post event analysis.
3. The PTZ cameras shall be programmed such that they are able to cover 500m in each direction using presets.
4. This will cover the entire stretch and will be primary surveillance method. While primary usage will be manual surveillance, TMCS cameras shall have basic intelligence for "Accident Detection" and "Stalled Vehicles Detection".

3.3 Functional Requirements

1. The System shall provide an online display of video images. It shall be possible to use monitors with latest display technology or similar display devices located in ATMS Control Centre.
2. Proposed CCTV system shall follow an open standard and follow an IP based network centric architecture to provide a high-speed system implementation for best performance.
3. System shall use video signals from various types of CMOS colour cameras installed at road locations, process them for viewing on workstations/monitorsat ATMS Control Centre and simultaneously record all the cameras.
4. Footage should be used to conduct automatic detection of key events which are central to incident response and road safety. These events are coarse enough tobe identified through cameras even at a distance and hence separate from VIDES cameras. The key events are as follows:
    a. Accidents (collisions, crashed vehicles, smoke etc)
    b. Parked/Stationary Vehicles
5. It will be up to the service provider to conduct analytics on edge i.e. at the camera level and then convey the results to the command center or centrally at the ATMS software or cloud as long as events are detected automatically

and conveyed back to the ATMS software in <5 seconds of happening in reality.

6. Whenever any accident or stalled vehicle is detected by the TMCS camera the following will be sequence of events:
    a. The camera will pause in that location for the time being.
    b. Alarm will be initiated (audio and visual) in the command center and the view of this camera will be highlighted or brought to focus by the TMCS software.
    c. Operator will assess the information and take action:
        i. Accident (Notify Emergency Response teams)
        ii. Stalled Vehicle (Dispatch RPV, zoom into number plate and record evidence (photo, number-plate etc) for appropriate action incase parking is caused by avoidable reasons.
7. Video Footages should have been compressed using H.264 (MPEG 4 part 10/AVC) standard prior to recording.
8. Any new ATMS setup shall use Digital IP cameras only. Analog CCD/CMOS cameras with external encoders are only permitted if ATMS has already been setup before issue of this circular. Analog CCD cameras should connect to a Hardware encoder through a cable and the combination shall support minimum dual streams. The hardware encoder used shall be capable of producing streams at 25 FPS for each connected camera. If the camera is IP based, it should be UTP ready. The compressed video shall be streamed over the IP network. Any new setup shall have IP cameras only. If newer technologies of camera such as cloud-first etc are available, they can be piloted at risk of the SI and demonstrate that same functionalities as required by IP Cameras are being met.
9. Encoders shall have less than 200 ms of latency and shall support dual stream– H.264 (MPEG 4 part 10/AVC) or JPEG.
10. The recording resolution and frame rate for each camera shall be user programmable.
11. Surveillance TMCS/CCTV cameras shall operate on 230 V, 50 Hz single-phase power supply. If the camera or connected accessory operates on a different voltage or frequency, necessary conversion/correction device shall be supplied along with the camera.
12. Encoders shall be POE compliant and connected to Layer 2 or Layer 3 switch as per system design using UTP CAT 6 Cable or fibre optic cable and the required connectors as per standards.
13. The encoder shall be built on embedded processor, preferably with its own RTOS and should convert Analog Composite/S-Video input into good quality digital stream on real time basis. It shall be able to transmit as Unicast/Multicast IP packet with low latency (less than 200 m.sec) for live viewing as well as for recording.
14. The minimum video resolution should be 2 MP.
15. The encoder should generate H.264 (MPEG-4 part 10/AVC) or JPEG video stream Compliant with ISO/IEC 14496-10 standard. The encoder should be interchangeable with any standard encoder of any other make, which generates H.264 (MPEG-4 part 10/AVC) video stream Compliant with

ISO/IEC 14496-10 standard.

16. PTZ cameras shall support the feature of pre-programmed tours for easy customization to cover specific points of interest in a predetermined pattern.
17. The TMCS cameras can also be used to keep an eye on the illegal encroachment, broad O&M defects as visible from cameras, plantation etc. A dedicated operator with civil engineering background shall be deployed to scan/zoom the highway to identify O&M related defects and report them to NHAI One through dedicated login prepared for ATMS provider.
18. If Vehicle has been manually identified to be driving in wrong direction (contraflow) for more than 1 km (two TMCS) cameras then command centre should immediately dispatch RPV.

3.4 Technical Requirements

1. The rated resolution should be sufficient to view the target area in acceptable detail for all cameras. Vehicle characteristics and vehicle class shall be discernible from a distance of 500 meters from the camera (at full optical zoom) in day condition atleast.
2. All cameras shall have a minimum sensitivity of 0.02 lux for colour images at a shutter speed of 1/15.
3. AGC and Auto iris combination shall provide a light range adaptation of 10000:1 or better.
4. All cameras should be rated for outdoor use.
5. All cameras shall have day-night IR filter for brilliant daytime colour and excellent night vision under low light.
6. Cameras shall have inbuilt IR illuminator of 100 meters for night vision functionalities.
7. Ability to communicate using a choice of technologies (Either Wired ether-net, WIFI, OFC, 4G/5G etc.) to allow for system scalability and smooth integration, as the communication infrastructure is changed or upgraded.
8. PTZ cameras shall allow for 360 degree pan, 2 to 92 degree tilt and at least 35x optical zoom and 16x digital zoom to provide for coverage of a wide target area and yet maintain the required image detail. All PTZ cameras shall have Closed loop speed control with Integral pan / tilt motor drive to enable smooth, precise pan-tilt for fine control and accurate tracking, even at high zoom levels.
9. All cameras shall have Flat glass window with internal heater for better optical performance in rainy, humid environments.
10. All cameras housing should be waterproof, weather-sealed and corrosion resistant.
11. It shall be ensured that the Camera mounted on the pole provides an adequately stable image up to wind speeds of 200 km / h such that a vehicle's make and model can be clearly identified on the control room display, at full zoom. Such a stable image shall also be ensured when vibrations are encountered during the passage of heavy vehicles close to the CCTV pole.

12. **CCTV PTZ (TMCS) Cameras** shall comply with the following Physical and electricalspecifications:

a)	Image Sensor	1/3" or better
b)	Active Pixels	1280(H) x960 (V) or better (2 MP)
c)	Resolution	Minimum 2 MP
d)	Sensitivity	0.005 lux (B/W), less than 0.06 lux (Colour) or better
e)	Focus	3.5mm to 129mm or better
f)	Optical Zoom	35x or better
g)	Digital Zoom	16x
h)	Night Vision	upto 100m
i)	Signal to Noise	> 54 dB
j)	AGC	Automatic
k)	White Balance	Automatic
l)	Electronic Shutter	Auto/Manual, 1/1 ~ 1/30,000s
m)	Iris Control	Automatic
n)	Encoding	H.264 or H.265 or JPEG.
o)	Video Output	Ethernet 10/100 Base-T
p)	Pan Range	0 to 360 degrees, Auto flip at 180 degrees.
q)	Pan Speed	variable 0.2 degrees per sec. to 80 degrees per sec.
r)	Tilt Range	+10 to -92 degrees
s)	Tilt Speed	variable 0.2 degrees per sec. to 40 degrees per sec.
t)	Pre-set Positions	255 minimum.
u)	Housing	IP66 or better.
v)	Power	230V, 50 Hz domestic supply
w)	Protection	Class – D for data/signal lines and class B for power

3.5 Environmental Specifications

1. Cameras & connected outdoor equipment shall be suitable to work from -10°C to 55°C with Relative Humidity up to 95% non-condensing. If any additional equipment(s) is/are needed to achieve this range, it shall be supplied along with the camera/outdoor equipment.
2. Camera housing shall be of IP 66 or better rating.

3.6 Testing

Since each CCTV installation is different, it would be the responsibility of the manufacturer/Service provider to demonstrate the viability of his solution with a previous work of a similar capability or a pilot on the proposed ATMS site.

3.7 Installation Requirements

1. Power shall be obtained from 230V 50 Hz mains provided on site (or from a renewable energy power supply rated for a nominal voltage of 12V DC, where ever applicable).
2. Location of CCTV Cameras shall be within the ATMS stretch as verified by NHAI's representative.

3.8 Maintenance Requirements

1. The equipment supplied shall remain operable for at least the contract period from the date of commissioning.
2. The Service provider shall undertake to support/maintain and (or) provide

spare parts till equipment reaches end of life, which shall not be less than contract period from the date of supply.

3.9 Operational Requirements

The software supplied and installed at the ATMS Control Centre to operate the CCTV systems shall be able to integrate with/Export data to and import data from the ATMS unified database located in ATMS Control Centre.

Chapter 4

Video Incident Detection and Enforcement System (VIDES) – Video Based Incident Detection and Enforcement Systems

4.1 Scope

This specification outlines the general, functional, and technical requirements for video-based incident detection and enforcement systems. The primary objective of these systems is to not only detect accidents and incidents that may lead to accidents but also issue warnings to incoming traffic and deter violators through supporting evidence for generation of eChallans. The scope of the system includes the following major functionalities:

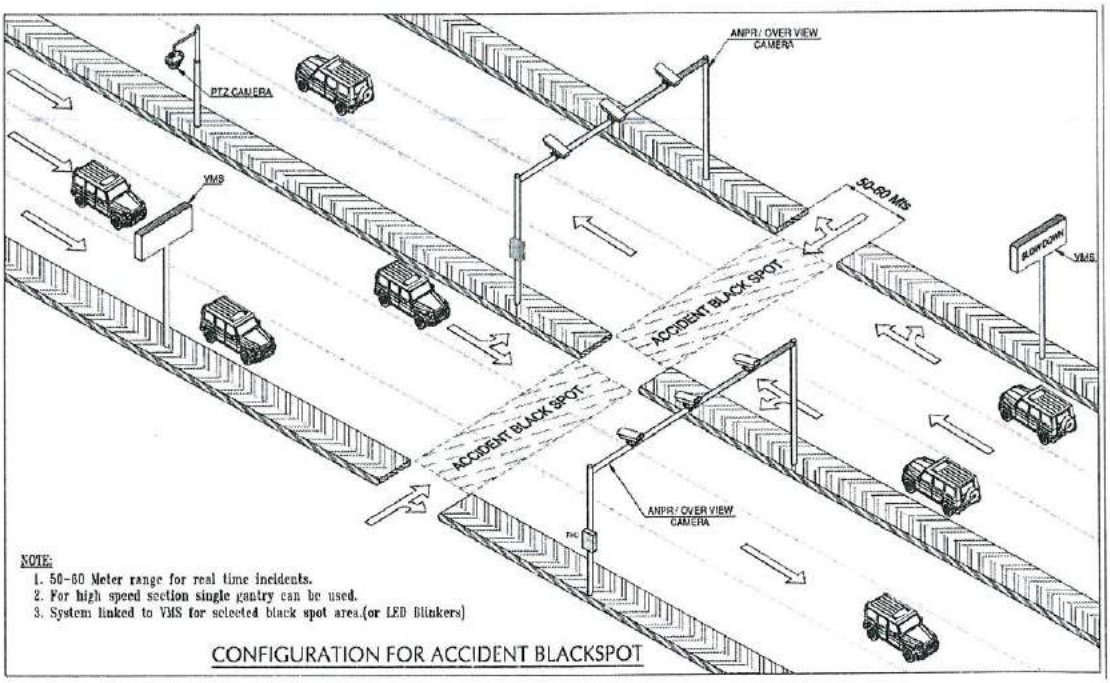
1. Detection of accidents/incidents:
    - The system should be capable of detecting accidents and incidents thathave the potential to cause accidents.
    - Incidents/Accidents so detected shall have the following uses:
        1. It should capture evidence to facilitate the generation of eChallans, discouraging such unsafe behavior.
        2. Immediate relay of information to associated Variable Message Signs (VMS) Flashing Lights, and the Rajmarg Yatra app should be provided to warn incoming drivers.
        3. Pop-up video feeds at the command centre and therefore allow quick dispatch of emergency response vehicles for resolution
2. Automatic Traffic Counting & Classification:
    - The system should have the ability to automatically count and classify traffic, providing valuable data for traffic management purposes.

The VIDES system will include software at ATMS command centre that will allow for validating of the incidents & number plates of violators for integration with stakeholders for eChallan generation. Any incident detected should be highlighted with necessary audio/visual alarm to the operator in the command center to take appropriate action (Dispatch RPV/Ambulance etc) The system offered shall have the capability to also operate in low light conditions normally experienced during night.In very poor visibility conditions such as during winter fog/smog, the system shall detect the condition of poor visibility and generate visual alerts.

Previously, separate mechanisms were in-place for VIDES, ATCC and Vehicle Speed Detection, each getting placed separately. Current specification provides for co-locating these functionalities on single VIDES Gantry. This will allow for optimization in use of sensors, economy, prudent re-use of camera footage and ease of consolidated maintenance.

The VIDES system shall include Gantry mounted ANPR Camera(s) and Overhead Overview Camera sufficient in numbers to cover all the lanes including shoulder portion on each side of Highway. The Gantry Mounted VIDES system shall be placed

at every 10km on both side of Highways. While choosing the location of a VIDES, it should be made to coincide with highway locations such as vulnerable merger points of Service road with the main carriageway, blind corners / turns on the main carriageway, road junctions, overspeeding and incident prone areas. The setup should be on main-carriageway and looking towards incoming traffic and accident prone areas.



Setup for VIDES & TMCS at Blackspot

4.2 Function

The VIDES, essentially consisting of fixed overview camera(s), ANPR camera(s) and an attached (co-located or centralized) Video Image processing unit, shall perform real- time remote incident detection at designated spots on the highway section, record information on violators at ATMS software end for generation of eChallans and immediately provide local warning to nearby travelers / road-users on detection of relevant incidents. It shall also communicate such detected incidents to the ATMS Control Centre for storage, analysis & reporting.

4.3 Functional Requirements

1. The system shall include gantry-mounted cameras connected to a co-located or centralized/cloud video image processing modules that can detect incidents based on video analytics and automatically trigger alarms on detection to specific VMS/Lights/App and Command Centre operator. The above equipment shall be suitably mounted on full gantry. A single unit of VIDES shall consist of the following:
   a) Video Image processing unit(s)
   b) Overview Camera (wide-range with 60-100m viewing) with IR or Thermal or other Night Vision Mechanism for 60-100m range.
   c) ANPR Camera (low-angle) along with IR Illuminator
   d) Distant Pole/gantry mounted flashing warning lights and/or VMS
   e) Surge Suppressor
   f) Audio/Visual Alerts for Operator at Command Centre to Bring Focus to camera feed

with violation

g) Back-office Software for Validation of Violation data captured and integration with Enforcement Agency (eChallan/Vahaan)
h) All other necessary equipment for operation

2. The system shall automatically detect incidents/analysis using video analyticsmentioned in 4.3.2 section:
3. A typical setup for a particular direction will have ANPR camera(s) facing the traffic covering all lanes and overview cameras which enable viewing 60-100m in each direction covering all lanes during both day & night.
4. A typical setup will include one ANPR camera for every lane and overview camera(s) suitably placed to cover all lanes and facing traffic in each direction. The setup maybe suitably modified depending on the situation as long as each lane is adequately covered to meet the functional requirements as per the performance standards specified in this section. The equipment setup should be designed to minimize total number of cameras/sensors/LPUs etc while maximizing the utilization of camera/sensor feeds/computation, enabling multiple functionalities without the need for separate cameras for each purpose. For eg. if SI is able to do number plate recognition across all lanes with lesser number of cameras without dip in performance and more economically, the same shall be encouraged. However, any deviation from typical setup as explained above shall require POC and prior approval of the Employer.
5. The number of cameras & positioning of each in this system should be such that incidents are detected in both direction across all lanes and the number plate is captured for all vehicles passing under the Gantry.
6. One complete VIDES system will comprise both LHS and RHS. To meaningfully cover a blackspot, it maybe sometimes necessary to separately position the LHSand RHS gantries but the distance should not be beyond 500 meters.
7. On detection of an incident the system shall activate appropriate flashing lightsor LED blinkers, and/or display appropriate incident message on nearby VMS to locally to warn road users.
8. In case of VIDES placed to cover MORTH Blackspot or an emerging high-risk accident spot identified by NHAI PD, VMS will be used to issue alarms and warnings in place of flashing lights.
9. Simultaneously the detected incidents shall be communicated to the ATMS Control Centre.
10. The ATMS Control Centre software will be responsible for immediately and programmatically broadcasting the location and type of incident to the RajMarg Yatra API in the standardized format. This information will be broadcasted to Rajmarg Yatra users in the vicinity of the incident. The ATMS Control Centre shall be responsible for informing the Rajmarg Yatra when the incident is no longer active as well. Basic SOP for the same as Section 10.3.6.
11. Not withstanding other provisions, a small video recording of select types of incidents (minimum 10 seconds before and after) will be recorded and kept at the ATMS software for at least 180 days or until SLAs have been assessed for that period, whichever is larger. In case of Accidents they will be kept for the entire period of the contract and for enforceable challans they will be kept till the data has been transferred to relevant local authority.
12. It shall also be possible to view on-line and record at the ATMS Control Centre,

the video images from cameras belonging the VIDES.

13. Gantry/Pole mounted flashing lights of 300mm diameter with a visibility of atleast 500m shall be used for local warning where VMS is not being used.

14. There shall be at least two such warning lights/VMS each mounted typically at a distance of 200meters and 300meters before the incident monitoring point (Gantry location) when seen from the direction of travel. The above distances shall be suitably optimized during detailed engineering.

15. The VMS shall be programmed to show appropriate message to the drivers pertaining to each incident point. Details are in 4.3.2. The specifications of VMS shall be dictated by the appropriate chapter on VMS.

16. The led blinker shall be inter-connected with the nearby incident detection system either by cable or by wireless.

17. During periods of poor visibility, as detected by the VIDES, the lights shall go into a flashing mode until visibility improves to a level for adequate incident detection.

18. The above lights stall stop flashing either on the event of the disappearance of the detected incident(s) or on the occurrence of a reset from the control room.

19. All VIDES overview feeds shall be displayed on the video-wall at all times and the VIDS software at the Command Centre shall ensure alarms related to detected incidents shall be also be enunciated on the above supervisory computer shall be audio-visual (blinking, alarms, highlighting the video on ATMS GUI etc).

20. Incase internet connectivity is lost intermittently, the VIDES shall continue functioning locally; when internet connectivity is restored, the VIDES shall send the data back to ATMS automatically for processing without manual intervention

4.3.1 Video Image Processing Unit

1. The Video Image Processing Unit shall combine indoor / outdoor traffic flow monitoring and automatic incident detection.
2. The system offered shall be modular and multi-functional.
3. The Video Image processing unit coupled to the overview camera shall have the capacity to detect the presence of vehicles in the entire field of view of the camera.
4. If the service provider wants to centralize the intelligence for detection of incidents at the command centre or on cloud, they need to ensure the inference times is <2 seconds , and that the centralized software is connected to the local warnings lights/VMS for issuance of warnings for incoming traffic. Further, in case of internet connectivity is lost, incidents will be automatically processed post-facto when data is streamed back on retaining internet connectivity.

4.3.2 Incident Detection

1. The VIDES (combination of ANPR and Overview) cameras will work in tandem tocover the incidents and enforcements listed below.
2. The system shall provide detection of the following incidents:

Incident Name and Description	Proposed Primary Camera	Precision & Recall	Actionables/ SLRs
Accident Collisions of vehicles, vehicles ramming into side rails, medians, vehicles with smoke/fire coming etc. *Real-time Detection & Alert* (Day and night)	Overview	97% Recall 90% Precision	RPV & Ambulance Dispatch Automated Message to VMS Automated Flashing Video to be saved.
Opposite Side Traffic Detection of vehicles coming from the direction opposite to the allowed direction of travel and vehicles traveling in a direction that is across the allowed direction of travel. *Real-time Detection & Alert*	ANPR/Overview	90+ Recall 90+ Precision	eChallanVMS Flashing Video to be saved.
Stalled or Stationary Vehicles Detection of stationary vehicles within 5sec *Real-time Detection & Alert*	Overview	90% Precision 90% Recall	eChallan (Manual Challan as in Section 3.3.6 and Section 10.3.2) RPV Dispatch Flashing Light VMS Message: Caution: Parked Vehicles Ahead Video to be saved.

Detection of fog, low visibility during day time or smoke in the view *Real-time Detection & Alert*	Overview	90% Precision 90% Recall	 Flashing Light VMS Message: Caution: Low Visiblity Ahead Rajmarg Yatra
Detection of debris/fall objects of size that can impact traffic or road safety. *Real-time Detection & Alert*	Overview	90% Precision 90% Recall	RPV Dispatch Flashlight VMS Caution: Drive Slowly Debris on Road
Pedestrian Crossing *Real-time Detection & Alert*	Overview	90% Precision 90% Recall	Flashing LightVMS: Caution: Drive Slowly Pedestrian Crossing.
Animals on the Carriageway *Real-time Detection & Alert*	Overview	95% Precision 95% Recall	RPV Dispatch Flashing Lights VMS: Caution: Animals Crossing. Drive Slow
Wrong Lane Driving Heavy vehicle moving in the fast lane *Real-time Detection & Alert*	ANPR	90% Precision 90% Recall	eChallan Video to be saved.
Seatbelt Violation *Real-time not necessary (back-office processing permitted)*	ANPR	80% Precision Day and Night 65% Recall except during direct sun glare on windshield, anti glare coatings etc.	eChallan Video to be saved.

No Helmet in Two Wheelers *Real-time not necessary (back-office processing permitted)*	ANPR	90% Precision 90% Recall	eChallan Video to be saved.
Triple Riding in Two Wheelers *Real-time not necessary (back-office processing permitted)*	ANPR	90% Precision 90% Recall	eChallan Video to be saved.
Two Wheeler or other Banned Vehicles on Expressway *Real-time Detection & Alert*	ANPR	95% Precision 95% Recall	eChallan Video to be saved.
Overspeeding *Real-time Detection & Alert* Detailed in Below	Overview and/or ANPR and/or Any Other Sensors	Minimum speed of 180 kmph with 98% accuracy, Day& Night Conditions	eChallan Video to be saved.
Traffic Flow Detailed in Below Section. *Real-time not necessary (back-office processing permitted)*	Tandem		Analysis/ Messaging

3. It shall be possible to define an output for each alarm. The field electronic modules shall save images in case of alarm and send them to a server in the ATMS Control Centre. Such an image sequence shall consist of number of images with the pre-incident information and number of images with the post –historical incident information. In addition to the above it shall also provide following alarms:
   a) Video quality bad / low
   b) No video signal
   c) Communication problem
4. In the event of communication problem with the central server the incidents

shallbe saved on the local field electronic module.

5. The central server shall clean the data on the local module once the details are transferred on to the server.
6. This Video Image Processor-Incident Monitor shall combine traffic incident detection and traffic flow monitoring in one single field electronic module.
7. There shall be facility during set-up, for alarms to be enabled or disabled for a specific type of traffic flow (e.g. no stopped vehicle alarms during queue conditions).
8. Each camera shall be calibrated specifically for the scene (lanes, junctions etc)
9. It should be possible to continuously (remotely or otherwise) update the cameras with improved AI models and with newer incident types if required by NHAI without any physical changes in the setup.

4.3.3 Flow Monitoring

1. The system shall be able to distinguish between minimum 5 types of traffic flows (levels of service) based on flow speed and zone occupancy.

4.3.3.4 ATCC

1. The ANPR cameras monitoring every lane shall be use for Automatic Traffic Counting and Classification.

2. Each Vehicle Passing from under the Gantry shall be recorded by the ANPR camera. The same will be used to classify the vehicle that is passing.

3. The indicative classification of common vehicles for the ATCC is given below:

    a. Two Wheelers

    b. Three Wheelers (Auto/Tempo)

    c. Four Wheelers (Cars, Jeeps, Vans etc)

    d. Light Motor Vehicles

    e. Trucks/Buses

    f. Multi-Axle Vehicles

4. The ANPR cameras shall be classifying vehicles in any case for speed violationand other incidents.

5. The vehicle wise traffic data from each Gantry shall be stored in a relational database in the command centre for a period of 180 days or until SLAs have been assessed for that period, whichever is larger. (Vehicle Type, Number Plate, Date/Time etc). Photo is only saved if any violation has been detected.

6. The data shall be passed to PD or representative of NHAI or IHMCL for comparison with data as received from NPCI for toll-collection on that stretch and identify vehicles that were identified using ATCC to be on the stretch but not found on that days transaction data from toll-plaza.

7. The ATMS software shall also identify vehicles whose Class as identified by the camera visually don't match the Class returned from the NPCI FASTag mapper API. These violations shall be passed on PD or IHMCL for futher

action.

4.3.3.5 Speed Detection

1. VIDES shall be able to do both spot speeding and section based speeding during the day and night. Spot based speeding means estimating the speed of the vehicle in the immediate area the Gantry is looking at and section based speeding will be calculating the average speed of the vehicle based on the timeit takes to travel between two VIDES gantries every 10 km.

2. The speed violation detection technique should be aligned with relevant MORTH and Traffic Police guidelines and notifications.

3. The accuracy of the speed detection technique should be 98% and capture up to minimum 180 kmph speeds during day and night for all types of vehicles.

4. Solution provider may employ visual speed detection (entry/exit frames) using cameras or through other sensors (radar etc) – choosing whichever is able to meet functional requirements the most economically.

5. The system should be able to differentiate/mark between multiple vehicles even if parallel driving, tail-gaiting, crowding etc and measure speeds for more than 90% of the vehicles passing under the Gantry.

6. Evidence collected during speed detection should be such that can stand scrutiny of court of law on challenge for both spot and section based speeding.

7. System shall be capable of enforcing separate speed limits for vehicle types. The Service Provider shall seek the specific speed limits to be enforced for the stretch from the NHAI PD in writing.

8. Section Based Speeding: If Vehicle A is at VIDES Gantry at time-stamp t0 and reaches VIDES Gantry at time-stamp t1, the average speed of the vehicle is distance between the two gantries divided by the time-taken by the vehicle between the two Gantries. This would mean that the ANPR cameras will be capturing the license plates of all vehicles and not just limited to the ones breaking spot-incidents mentioned in 4.3.3.2. If the average time so calculated is over and above the prescribed speed limit for that vehicle type for this highway, than this shall be considered an enforceable violation for purpose of eChallan.

9. The speed enforcement mechanisms shall be calibrated to the satisfaction of the local enforcement stakeholders (Traffic Police etc) and conformance to 167A of Motor Vehicle Act.

4.4 Video Camera (Overview)

1) The unit shall be a high resolution, 1/3 image format CMOS camera, designed for professional video surveillance systems. Incorporating the latest in technology, the video camera shall provide detailed video without lag, image retention, or geometric distortion.

   The camera shall have great low light sensitivity, electronic shutter, automatic

gain control and back –light compensation to enable camera to operate in wide range of lighting conditions. Apart from visual sensors, the camera shall accompany infrared illuminators or thermal sensors to ensure Overview Camera related incidents (debri, fog, accidents, pedestrian, animal crossing etc) are automatically detected in night conditions also in the range of 60-100m.

2) The IP Camera shall have the following specification:

a.	Rated input voltage	230 VAC, 50 Hertz
b.	Imager	Interline transfer 1/3" format CMOS
c.	Sync. System	Internal with Crystal External with Mains Synchronization or better
d.	Active picture elements	2 MP or higher if needed to meet functional requirements.
e.	Signal to noise ratio	>50 dB minimum
f.	Minimum Illumination	0.15 Lux (F1.2 , AGC On) at 50m IRE
g.	Electronic Shutter	Manual: 1/50 to 1/10000 sec, 8 selections possible. Automatic: AES 1/50 TO 1/100000 Sec.
h.	Back Light Compensation	6 Zones or through better technologies.
i.	Camera Text in Picture	16 Character title anywhere on screen.
j.	Encoding for integration with the ATMS control centre	H.264 (MPEG-4 Part 10(AVC)/JPEG
k.	Night VisionCapabilities	Through IR or Thermal or any other methods as long as Functional Requirements are met in the most economic manner.

Note: The bidder/SI may also offer a CCTV Camera system with a built-inVideo analytics feature meeting the requirements.

4.5 ANPR Camera

1) Each Lane will have an ANPR camera facing the traffic flow including hard shoulder. If there are camera configuration where less number of cameras can more economically cover all lanes and specified functional requirements, the same may be utilized after POC with prior approval of the Employer.

2) ANPR cameras will capture the number plate of *every* vehicle passing underthe gantry irrespective of whether any spot incident has been detected.

3) The ANPR camera should correctly link the vehicle number plate with the any incident (speed etc) as detected by the overview camera. They shall be operating in tandem where required.

4) The ANPR camera shall be able to capture both retro & non-retro reflective license plates.

5) The ANPR camera will identify incidents itself suitable for its viewing angle (seat belt, triple riding, no-helmet etc)

6) Success rate of ANPR shall be more than 90% during day/night time and capture plates from vehicles (including two-wheelers) with speeds up to 180 KMPH for standard or near-standard number plates. The solution provider will improve the model through the operation period to satisfactory levels andchanging number plate designs.

7) The ANPR camera shall be able to function in adverse weather conditions.

8) In case ANPR is unable to recognize the plate for a vehicle, the image will be captured by the software for manual number plate recognition. No predictions or low confidence recognitions will be manually annotated by staff at the command centre and fed back to improve the model. The software at the command centre will allow command centre operator to zoom in, correct number plate recognized from the snapshot.

9) Each challan related number plate recognition will be manually vetted by the command center staff before handing over to local enforcement agency.

10) The software and cameras should be calibrated and tested on a monthly basis by the proposed representative of NHAI.

11) The associated command centre software should have provision for being loaded with number plates alarms for stolen vehicles, hotlist etc and immediately notify traffic operator such that the operator can communicate the same the police/enforcement agency.

12) The IP Camera shall have the following specification:

a.	Rated input voltage	230 VAC, 50 Hertz
b.	Imager	Interline transfer 1/3" format CMOS with Full HD with Global Shutter
c.	Sync. System	Internal with Crystal External withMains synchronization
d.	Active picture elements	2 MP Per Lane of Coverage by Camera (Eg. if a Camera is to serve more lanes, higher MP to be used accordingly)
e.	Signal to noise ratio	>50 dB minimum
f.	Minimum Illumination	0.15 Lux (F1.2 , AGC On) at 50m IRE
g.	Electronic Shutter	Manual: 1/50 to 1/10000 sec, 8 selections possible. Automatic : AES 1/50 TO 1/100000 Sec.
h.	Back Light Compensation	6 Zones or through better technology
i.	Camera Text in Picture	16 Character title anywhere on screen.
j.	Encoding for integration with the ATMS control centre	H.264/JPEG (MPEG-4 Part 10(AVC)
k.	Night Vision Capabilities	IR Illuminator

4.6 Housing

Camera housing should have IP66 rating and following specifications:

a) Camera mounting siterequirement — Vandal-proof wall/pole/corner/hanging mount as per
b) Cable entry — IP66 compliant cable pass-through
c) Finish — Off-white semi-gloss
d) Construction — Aluminium or engineering plastic with optically clear UVprotected polycarbonate dome.
e) 24*7 fan assisted thermostatically controlled Heater/defogger/forced air cooler

4.7 Environmental Requirements

1. Cameras & connected outdoor equipment shall be suitable to work from -10°C to 55°C with RH up to 95% non-condensing. If any additional equipment(s) is/are needed to achieve this range, it shall be supplied along with the outdoor equipment.
2. Equipment housing shall be of IP 66 or better rating.

4.8 Testing

Since each installation is different, it would be the responsibility of the Service provider to demonstrate the viability of his solution with a previous work of a similar capability or a pilot on the proposed project site.

4.9 Installation Requirements

1. Power shall be obtained from 230V 50 Hz mains provided on site (or from a renewable energy power supply rated for a nominal voltage of 12V DC, where ever applicable).
2. Location of CCTV based VIDES shall be within the project highway stretch.

4.10 Maintenance Requirements

1. The equipment supplied shall remain operable for the contract period from the date of commissioning.
2. The Service provider shall undertake to support/maintain the equipment till the completion of the contract period.

4.11 Operational Requirements

The software supplied and installed at the ATMS Control Centre to operate the CCTV-based VIDES shall be able to integrate with/Export data to and import data from the ATMS unified database located in ATMS Control Centre.

Chapter 5

Vehicle Actuated Speed Display

5.1 Scope

This specification lays down the general, functional and technical requirement of the radar based Vehicle Actuated Speed Display to be used as a sub-system of ATMS implementation. The VASD system shall include gantry mounted Radar and Speed Display system to warn the road users. These speed displays shall be installed to warn road users of over speeding and thereby acting as a deterrent. They shall also have the capability to collect and relay real time data for subsequent analysis in the ATMS Control Centre. Eg. Which VASD locations are we seeing constant over-speeding or under-speeding in the fast lane. VASD in itself will not include any enforcement mechanisms other than showing users their speed and whether it is beyond limit or within limit.

5.2 Function

The speed display shall provide textual or graphical warning to the vehicles exceeding the preset speed limit The present limits can vary by lane. VASD comprising Display and Radar will be placed at every 20 km subject to minimum 2 in every Project Package. The positioning of this should be such that it is considerably separately from the VIDES Gantries as they are for enforcement while VASD are for warnings only.

5.3 Functional Requirements

1. The system shall perform during day and night as well as in adverse weatherconditions.
2. It shall have built in diagnostic functions to quickly asses the validity of speedcalibration.
3. It shall adjust display intensity automatically to suit the ambient light conditions.
4. It shall be modular in construction for ease of maintenance.
5. It shall display numeric speed data as well as graphical (standard IRC road warning sign)(preferably) / textual warning.
6. Measurement:
    a. Speed range : 1 km/h to 200 km/h
    b. Maximum Measuring errors: Up to 100 km/h → ± 3 km/h, Above 100 km/h →± 5 km/h
    c. Minimum Monitored section length : 500 m

5.4 Technical Requirements

1. The speed display shall be formed using individual modules.
2. Speed display must be constructed using corrosion resistant panel with LEDpixels in row: column matrix.
3. Scanning/Multiplexing ratio shall be 1/8 or better.
4. The LED Cluster shall consist of individual LED`s rated for out-door use.
5. Shall support an industry standard communication interface such as TCP/IP on copper, Wi-Fi, and/or fibre optic to help setting the preset speed and retrieve log data.

6. Shall maintain time stamped record (speed and vehicle image) of each case of over speeding in a log file that can be retrieved over the connected network or using a locally connected laptop.
7. It shall optionally be possible to configure the display to send real time violation event record (speed, vehicle image and time stamp) over the connected network while recording the same.
8. It shall be possible to control the brightness of displays automatically using built-in light sensors.
9. All PCB`s shall be of FR4 material, 1.6mm thick and LED matrix PCB shall be 2.4mm thick. PCBs shall be of the quality suitable for use in environment conditions specified.
10. The equipment shall allow local diagnostics via laptop connected to its communication port.
11. Fault diagnostics shall be provided to include the following as a minimum:
    a) Camera Failure
    b) Radar Failure
12. The equipment shall comply with the following Physical and electrical specifications:

Function	Specification
Display size in inches	15 high x 8 width per digit or character
Viewing Angle	15 to 30 degrees
Color and Wavelength (nM)	Red (625), Amber (590), Green(525)
Luminous Intensity	7500 candela per meter square.
Power Feed	230V AC @ 50Hz, with Battery backup and preferably solar chargeable
Mounting	Fixed over existing gantry or a separately erected pole
Humidity	0 to 95% Non-Condensing
Operating Temperature (Ambient)	-10°C to 55°C
Construction	Weatherproof outdoor non sealed ventilated
Communication	Ethernet on Copper, Fibre, Radio (3G/GPRS, blue-tooth and Wi-Fi)
Protocol	TCP/IP, NTCIP, SNMP
Operation	Software for VAS display sign configuration and log file retrieval.

5.5 Environmental Specifications

The VAS shall meet the following climatic and environmental requirements:

SN	TEST	REFERENCE
1.	Change of temp test	IS 9000 Part XIV Sect. II
2.	Dry heat test	IEC-571; IS: 9000 Part-III Sect 3
3	Cold test	IS 9000 Part II Sect. III
4.	Damp heat test (Cyclic)	IS9000 Part V Sect. 2 Variant 1
5.	Damp heat test (Steady state storage)	IS9000 Part IV
6.	Salt mist test	IS9000 Part XI procedure 3
7.	Dust test	IS 9000 Part XII
8.	Bump test	IS 9000 Part VII, Sec. 2

9.	Vibration test	TEC (IPT 1001A revised)

5.6 Testing

The equipment shall be tested for functional requirements as below:

1. Speed limit shall be programmed using the provided software over the networkor through a locally connected laptop terminal, as the case may be.
2. Brightness of pixels, ambient light sensor, radar accuracy and false positives.

5.7 Installation Requirements

1. Power shall be obtained from 230V 50 Hz mains provided on site or from on-board solar chargeable batteries.
2. Solar panels (if supported) shall be installed on the same fixture as the display(pole or gantry)
3. Location of speed display shall be within the project highway stretch.

5.8 Maintenance Requirements

1. The equipment supplied shall remain operable for at least the contract periodfrom the date of commissioning.
2. The Service Provider shall undertake to support/maintain the equipment till the completion of the contract period.

5.9 Operational Requirements

1. The software supplied to configure and retrieve logs shall export data that would integrate with ATMS unified database located in the ATMS Control Centre.

Chapter 6
Emergency Roadside Telephone System

6.1 Scope

This specification lays down the general, functional and technical requirement of the Emergency Roadside Telephone (also referred to as Emergency Call Box) to be used as a sub-system of ATMS implementation. The term "Emergency Roadside Telephone" or the term "Phone" covers the phone instrument, mounting hardware, pole or any other mounting structure along with grouting, the charging stations, secondary power source such as the batteries, and the solar modules in case the units are solar charged. The ECBS are advised to be installed on all access controlled Highways and Hilly roads at an interval of every 2 kms. For all other Highways, requirement of the system may be assessed by NHAI and system may be de-scoped as per provision of the Contract.

6.2 Function

Emergency Roadside telephones are to be used by the road users to make emergency calls to the local ATMS Control Centre to report incidents such as accidents and /or other emergency situations on the highway requiring immediate help / intervention.

6.3 Functional Requirements

1. Suitable for working on a Fibre Optic / dedicated copper transmission/ wirelessnetwork as per requirement.
2. Built-in speaker and microphone for hands-free operation.
3. Clearly labelled and distinctly identifiable "activate" button to initiate communication.
4. Audio and visual indication of communication status such as call placed, call acknowledged at the control centre, call in progress, or call on hold.
5. Multiple numbers shall be programmed (at least three) into the device so thatincidents of line busy are minimized.
6. The unit shall dial each number in sequence automatically till the line is connected or call is cancelled by the road user.
7. Shall provide a means to record the message in case all the lines are busy.
8. Provision to operate the phones in case of primary power failure. Batterybacked power source shall be used and preferably, it shall be solar charged.
9. The ERT Phones shall operate in duplex mode.
10. The ERT Phones shall have the front facia suitable for rugged outdoor use.
11. The ERT phone shall be designed to provide the following operation related functions:

    11.1 The user will push the call button to initiate a call from the phone.
    11.2 The calling user shall hear a ring tone if the call is successfully initiated. Alternatively if the line is busy, a busy tone accompanied by

a voice message both in English, Hindi & Local language shall sound. When the system is not functioning a suitable message shall sound along with a distinctive tone that is other than the ring tone or the busy tone.

11.3 The phone units shall have self –diagnostics to test themselves for correct operation. Any malfunction detected shall be reported to the control room system immediately along with the nature of the fault.

11.4 A scheduled test of all phone units shall be performed at regular intervals fpr correct operation of speaker and microphone.

12. The ERT system shall have automated start-up ability in the event of power outage and restoration.
13. All Alarms, results of self-diagnostics tests and data related to the ERT system shall be logged to a central database. Attempted damage as detected by the anti-tampering sensor shall be recorded separately for quick access.

6.4 Technical Requirements

1. Echo cancellation should be implemented in the phone.
2. The design should consist of a single PCB and minimal serviceable parts.
3. To prevent vandalism it is essential that the components and PCB shall not be usable as a regular phone even after modification.
4. The phones shall be remotely configurable using software at the control centre.
5. The phones shall also be locally configurable using a laptop and provided software.
6. The phones shall remain operable up to a noise level of 95dB
7. If using cables, there should be at least 20% spare capacity to replace faulty pairs without laying additional cables.
8. Configuration, Diagnostics and other communications shall not interfere with the voice communications. These signals and their significant harmonics should be beyond the audible range.
9. Protection from ESD and lightning should meet or exceed class – D for data lines and class – B for power lines.
10. Remote fault diagnostics shall be provided to include the following minimum:
    a) Power Failure/low/high voltage at Phone site
    b) Voice data transmission/reception/communication failure detection.
    c) Correct operation of speaker and microphone.
    d) Crosstalk detection.
    e) Storage battery condition information.
11. The ERT phone shall have a front panel locking arrangement which shall require a special tool / key to access the door.
12. In the event of any tampering (e.g. door open condition) the Emergency Roadside telephone shall generate an automatic electronic signal that can be detected and displayed (in the form of an audio-visual alarm) at the ATMS Control Centre.

6.5 Environmental Specifications

1. The housing shall be fibre-reinforced plastic sporting a prominent colour that can be easily recognized by road users.
2. The housing shall meet or exceed IP65 standards of water ingress protection.
3. Operating Temperature -10 ^{0} C to + 55 ^{0} C

4. Relative Humidity: Up to 95 % (Non-Condensing)
5. The electronic subassemblies shall be certified to meet or exceed the followingspecifications:

SN	TEST	REFERENCE
1.	Change of temp test	IS 9000 Part XIV Sect. II
2.	Dry heat test	IEC-571; IS: 9000 Part-III Sect 3
3	Cold test	IS 9000 Part II Sect. III
4.	Damp heat test (Cyclic)	IS9000 Part V Sect. 2 Variant 1
5.	Damp heat test (Steady state storage)	IS9000 Part IV
6.	Salt mist test	IS9000 Part XI procedure 3
7.	Dust test	IS 9000 Part XII
8.	Bump test	IS 9000 Part VII, Sec. 2
9.	Vibration test	TEC (IPT 1001A revised)

6.6 Testing

The equipment shall be tested for functional requirements as below:

1. Earth continuity
2. Insulation resistance
3. Call from phone to operator - Ringing tone
4. Check for the speech path
5. Check for hold tone
6. Check for busy message
7. Check for call back facility from operator station to phone
8. Check for phone test facility from operator station
9. Check for Programming of ECB address
10. Check for Tamper alarm

6.7 Installation Requirements

1. Zones of Telecommunication black spots shall be identified on the project highway for locating the Emergency Roadside Telephones(ERTs)..
2. On longer (> 2 km) stretches suffering from telecommunication blackspots, ERTs shall be installed at intervals of 2 Km (+/- 100m) on both sides of the highway such that a distance of 1km (+/- 50m) is the maximum one has to travel to reach the nearest available ERT..
3. Power shall be obtained from Solar PV charged on-board batteries rated to operate the phone for a minimum of 3 days in the absence of adequate solar radiation. .
4. Solar panels and chargers (if applicable and supplied) are to be installed in accordance with the site requirements.
5. The ERT phone shall be installed 2 meters away from the edge of the hard shoulder. It shall be mounted on a metal pole with a base that shall be grouted over a 1 m X 1 m X 0.3 m concrete platform provided with a handrail (with a suitable access opening) for protecting the user from vehicular collision. Further the direction of the ERT phone shall be such that the user can have a clear view of the arriving traffic during access and use of the phone. Further a minimum length of 10 meters of crash barrier shall be installed for protecting the ERT phone location from arriving traffic.
6. Illuminated guide signage shall be placed approximately 50 metres and 10 meters on either side of the phone.
7. Suitable mounting fixtures such as poles and other suitable/related equipment

shall be supplied and installed by the service provider.

6.8 Maintenance Requirements

1. The equipment supplied shall remain operable for at least the contract period from the date of commissioning.
2. The Service provider shall undertake to support/maintain the equipment till the completion of the Contract period.

6.9 Operational Requirements

The software supplied and installed at the ATMS Control Centre to operate the facility shall be able to integrate with/Export data to and import data from the ATMS unified database located in ATMS Control Centre.

Chapter 7
Variable Message Sign (VMS)

7.1 Scope

This specification lays down the general, functional and technical requirement of the Variable Message Signs (VMS) to be used as a sub-system of ATMS implementation. VMS shall include both Fixed (L & M Gantry) and Portable variable message signs including the trailer & anchoring mechanisms (for the Portable VMS).

7.2 Function

The VMS shall provide road users advance information of road conditions ahead and shall be controlled from the local ATMS Control centre. VMS system is one of the important and effective tool to manage traffic in response to road incidents, special events and construction or maintenance activities on the road. When drivers are to be warned of an incident, advised to opt for an alternate route, guided to reach a specific location or clear a lane as a response to an incident, the message posted should be appropriate and precise. The messages and the procedure for displaying them should be such that the information is grasped by a driver whose primary focusis driving his vehicle while ensuring his and his co-passenger's safety.

VMS boards envisaged are of 2 types: (i) Fixed VMS, and (ii) Portable VMS. The main function of a fixed VMS (located at the entries to the highway and typically before major junctions leading to alternate routes) is to display highway status and travel guidance information and warn vehicles of traffic congestion in the cities / villages immediately ahead. The Portable VMS (toll be temporarily commissioned near the incident location) will be used to warn road users of road works and incidents that affect traffic flow. Portable VMS shall be mounted at the back of mobile vehicle to show the sign of 'men at work' and / or speed limits in the construction zone and / or traffic lane restrictions. These shall be powered by solar energy and / or battery.

Under no circumstances shall VMS be used for advertising of any kind. It would be ina blank mode when traffic, roadway, environment or pavement conditions or public service announcements do not warrant the display of message or messages.

7.3 Functional Requirements

1. A VMS message should be effective. To ensure effective messages, the messagethemselves:
   a) Shall fulfil a purpose
   b) Shall command a short-span but definite attention.
   c) Shall convey Information that is unambiguous and simple to comprehend.
   d) Shall aim to elicit a definite and desired response from the driver
   e) Shall be displayed early enough to provide adequate time to respond to the event.
2. The display procedure shall be such that:
   a) The message accuracy is authenticated.
   b) Relevance of the message is maintained by continually monitoring the incident andupdating the display.
   c) Avoid stating the obvious.
   d) Credibility of the information is maintained and ensured.

3. Should have procedures to post alter, and delete messages interactively to ensure message relevance and credibility.
4. Should have an intuitive user interface for the operator to learn, operate and manage the system.
5. Should be modular in construction for ease of maintenance.
6. The VMS should have sufficient graphics capability to display multi-lingual messages (English, Hindi and the local language that will be specified by NHAI) and standard IRC road signs.
7. The modules shall be field replaceable.
8. The system design shall be such so as the display is legible from a distance of at least 250 metres.
9. Integration with adjacent VIDES for automated messages for select incident/accident types.

7.4 Technical Requirements

1. The display board shall be formed using individual modules.
2. Display panel must contain a corrosion resistant panel with LED pixels in row:column matrix (Full Matrix display).
3. Scanning/Multiplexing ratio shall be 1/8 or better.
4. The LED Cluster shall consist of individual LED rated for out-door use.
5. Failure of one Text row shall not affect the Other Rows. It shall also be possible to query the status of each row to determine its health and configuration status.
6. Shall use Unicode to display messages in English, Hindi and a selected local language.
7. Shall have built in test and monitoring facilities to ensure data integrity of the messages.
8. Shall adjust display intensity automatically based on ambient light conditions to ensure readability at all times.
9. The display background should be non-reflective and the display should be U.V. resistant. Shall support multiple industry standard communication interfaces, minimum being RS-422, TCP/IP on copper, Wi-Fi, and optionally fibre optic.
10. Shall support at least the NTCIP and any one of defined and documented communication protocol(s) such as NMCS2, MESSAGE CONTROL, TR2070D, Version 2 or other equivalent international protocol.
11. It shall be possible to control the brightness of displays automatically using built-in light sensors or remotely through the provided VMS control software.
12. All PCB`s shall be of FR4 material, 1.6mm thick or better and LED matrix PCB shall be 2.4mm thick. PCBs shall be of the quality suitable for use in environment conditions specified.
13. The controller shall allow local diagnostics via laptop connected to its communication port.
14. The equipment shall comply with the following specifications:

a)	Length(minimum)	1650 +/- 100 mm for Portable VMS Trolley Mounted
b)	Height (minimum)	1000 +/- 100mm for Portable VMS Trolley Mounted
c)	Length (minimum)	2400+/- 100mm for L Type Fixed VMS
d)	Height (minimum)	1500+/-100mm for L Type Fixed VMS
e)	Length (minimum)	5000 +/-200 mm for M Type Full Fixed VMS
f)	Height (minimum)	1800 +- 200 mm for M Type Full Fixed VMS
g)	Depth (minimum)	200 mm (for all types)

15. Fault diagnostics shall be provided to include the following as a minimum:
    a) Power Failure at VMS
    b) Processor PCB Failure
    c) Display line Failure
    d) Incoming data reception/communication error detection.
    e) Temperature within the enclosure information.
16. The technical specifications of VMS shall be as per the provisions given in latest edition of IRC 67 and IRC SP 85
17. VMS shall be provided at the start and the end of the project (Full Gantry), blackspot locations (L Type), junctions with NH/Expressway (Full Gantry) or any other location specified in the contract/Concession agreement. Minimum 2 Trolley Mounted Portable VMS shall be provided in each Project.

7.5 Environmental Specifications

The VMS shall meet the following climatic and environmental requirements:

1. Operating temperature: -10 ^{0} C to + 55 ^{0} C
2. Relative Humidity: Up to 95 % (non-condensing)

SN	TEST	REFERENCE
1.	Change of temp test	IS 9000 Part XIV Sect. II
2.	Dry heat test	IEC-571; IS: 9000 Part-III Sect 3
3	Cold test	IS 9000 Part II Sect. III
4.	Damp heat test (Cyclic)	IS9000 Part V Sect. 2 Variant 1
5.	Damp heat test (Steady state storage)	IS9000 Part IV
6.	Salt mist test	IS9000 Part XI Procedure 3
7.	Dust test	IS 9000 Part XII
8.	Bump test	IS 9000 Part VII, Sec. 2
9.	Vibration test	TEC (IPT 1001A revised)

7.6 Testing

The equipment shall be tested for functional requirements as below:

1. Messages shall be displayed using the central software& local terminal
2. Fault conditions shall be simulated. Messages / fault logs shall be checked for :
    a. Text Row Fault
    b. Communication failure
    c. Power failure
    d. Brightness of Pixels
    e. Rear Door open

7.7 Installation Requirements

1. Power shall be obtained from 230V 50 Hz mains / UPS/ Diesel Generator Set provided on site or from on-board lead-acid automobile batteries rated for a nominal voltage of 12V DC (for mobile VMS). If powered from an UPS the source of charging shall be preferably a renewable energy source (e.g. Solar PV, wind etc)
2. Fixed VMS shall be mounted on a sturdy and aesthetically pleasing gantry structure whereby the vertical clearance of at least 5.5m is available from the

road.

3. Safety barriers shall be provided at gantry support column(s) for their protection and for safety of road users.
4. The structure on which the VMS is mounted shall be sturdy and capable of bearing wind loads up to 200 kmph.
5. The concrete pedestal for support column should be flushed with ground but in no case should protrude more than 1.5m.
   Minimum distance of VMS on expressways should be 1.5 km prior to decision point and that for National Highways it should be 1 km. The signs should be visible from a distance of 250m. It should not be located on a curve and on a highway sections having grade exceeding 4 percent.

7.8 Maintenance Requirements

1. The VMS and its sub-systems shall test/diagnose on a regular basis as well on request & log event of any problem for each individual equipment, Such problems shall be automatically flagged at the ATMS control centre and also logged in the ATMS server .
2. The equipment supplied shall remain operable for at least the contract period from the date of commissioning.
3. The Service provider shall undertake to support/maintain till the completion of the Contract period.

7.9 Operational Requirements

The software supplied and installed at the ATMS Control Centre to operate the VMS shall be able to integrate with/Export data to and import data from the ATMS unified database located in ATMS Control Centre.

Chapter 8
Mobile Radio Communication System (MRCS)

8.1 Scope

Mobile Radio Communication system should be capable of providing wireless communication between ATMS Control Centre and Vehicle Mounted Units & Handheld units for Emergency response as well as routine Operations & Maintenance activities for the Highway.

The Mobile Radio Communication system should have Vehicle mounted units fitted on ambulances, Cranes and Patrolling Vehicles for facilitating instant communication even when these are on the move across the highway. In addition handled radio units will also be required for Maintenance activities on the highway. The vehicle mounted& handheld units shall communicate with the ATMS Control Centre as well as amongst themselves. The ATMS Control Centre besides having base/repeater Stations and Control equipment should have a provision for a voice logger to be attached with it for recording all communication. The MRCS are advised to be installed on all access controlled Highways and Hilly roads at an interval of every 2 kms. For all other Highways, requirement of the system may be assessed by NHAI and system may be de-scoped as per provision of the Contract.

8.2 General Requirements

The Mobile Radio communication system should be designed/engineered and implemented in such a way so as to have 99% of the highway area covered with coverage reliability of a minimum 95%. The system should provide crystal clear, static free communication even for vehicles moving at high speeds. The system should be based on a state of the art Digital technology. Ability of the system to operate in mixed (analog and Digital) mode, though not mandatory shall be desirable for reasons of additional flexibility. The System should be modular in design to aid quick diagnosis and efficient onsite maintenance. The systems shall neither induce radio interference to affect functioning of other telecom equipment in proximity, nor be susceptible to interference from adjacent mounted radio equipment. Each unit shall be uniquely addressable, and preferably, be ESN validated. Mobile Radio base station unit installed at the ATMS control center shall seamlessly integrate with the co-located Emergency Response integrated audio communication unit.

8.3 Technical Requirements

All components used in the assembly of equipment shall be of industrial grade specification. The equipment shall conform to ETS European standards and shall be suitably protected through shielding/grounding against external EMI/ESI Interference, and shall be immune to RFI, ESD and lightning. Detailed technical requirements of the Base unit (Repeater and base station) as well as the field unit(Hand held and vehicle mounted) of the Mobile radio system are as under:

Repeater/Fixed Base Station

1. The Base unit shall include a controller for switching and control function.

2. The Base unit shall connect to other repeaters if need be.
3. The Base unit shall have call logging and airtime accumulation facility.
4. The Base unit shall be configurable through the installed software on a locally connectedcomputer or over a TCP/IP link.
5. The system shall have capability to interface with the Public Switched Telephone Network (PSTN) for enabling remote access as well as Mobile/Handheld to telephone calls and vice versa.
6. It shall not be possible to program the repeaters without a hardware security lock.

Handheld/Vehicle Mounted Radio

1. The field unit shall have an alphanumeric display..
2. The Vehicle mounted radio shall support integration of GPS.
3. It shall not be possible to program the radios without software security key.
4. The radios shall have a Data Messaging Capability and shall have facility to receiveand send pre-defined status messages (at least 12 Character Messages).
5. The radios shall have the facility to store at least 24 addresses.
6. At least 16 status messages shall be selectable in the radio for sending to the other radios.
7. The caller shall be identifiable through display of the PTT ID (of the radio sending themessage) on the display of the radio receiving the message.
8. The radios shall have the capability to receive Short Messages (at least 40 Characters)from a Control centre.
9. The radios shall have enough memory to store minimum 6 received Status messagesalong with the sender's ID and 2 nos. Short Messages received along with the sender'sID.11.4 Functional Requirements

The system shall satisfy the following functional requirements:

1. The radio shall support a broadcast call or a group call or an Individual Call.
2. It shall be possible to establish an ATMS to field unit link, field unit to ATMS link orfield unit to field unit link for communication, as the need arises.
3. The mobile radio system shall be integrated via the Fiber optic communication system (e.g. Inter-tower communication).
4. The system shall have the facilities for waiting calls, holds calls and transfer calls.
5. Call queuing shall be supported in case all communication paths/ channels are busy.
6. Shall support multiple priority levels with pre-emption
7. Field unit to field unit calls shall auto-terminate if either of the party hangs up or theATMS control centre initiates a call to one of the parties or the conversation exceeds 5minutes.
8. Late entry feature
9. It shall be possible to bridge the regular PSTN network to the mobile radio networkin case of emergencies.
10. Base unit installed at the ATMS control center shall be capable of processing at least 3calls simultaneously.
11. In case of emergency, it shall be possible to exchange quick, short status/alarm messages.
12. The system shall have suitable voting system to select the better signal at base stations as well as mobile units.
13. Selection, positioning, planning and installation of equipment shall ensure that a localized failure does not collapse the entire communication. Redundant paths shallensure near total coverage even in such cases.
14. The system shall use frequencies to be obtained by the ATMS Service Provider from WPC in the complete stretch as per scope.

15. The system shall be protected against any damage due to power supply fluctuations,transients and surges.

16. Frequency & Power output Specifications

Sr. No.	Items	UHF	800 MHz
1	Frequency band	400-430 MHz or	806-825 MHz Base Station RX
		450-480 MHz or 480-512 MHz	851-870 MHz Base Station TX
2	Power Output		
2.a	Maximum power output of Base station/Repeater with Power amplifier	100 Watt	80 Watt
2.b	Mobile	30 Watt	5-15 Watt
2.c	Hand held terminal	5 Watt	3 Watt
3	Adjacent channel spacing	12.5 KHz/25 KHz (Analogue) 6.25 KHz/12.5 KHz (Digital)	12.5 KHz/25 KHz (Analogue) 6.25 KHz/12.5 KHz (Digital)
4	Duplex spacing	10 MHz	45 MHz

Chapter 9 Network Infrastructure for Data Communication

9.1 Scope

This Specification lays down the general, functional and technical requirements of Communication infrastructure to be used as a sub-system of the ATMS implementation.

9.2 Function

This system provides connectivity between ATMS Control Centre and outdoor equipment such as Emergency Roadside Phones, Variable Message Signs, Mobile and fixed CCTV cameras, Speed Displays, VIDES, , etc.

It also provides the external data connectivity required between the ATMS control centre and the NHAI ATMS Cloud as well as between the ATMS control centre and the NHAI ATMS Master & relevant Regional Control Centres.

9.3 System Configuration

1. The system shall comprise:
   a) Cable System
   b) Interface System
   c) Optical Fibre Transmission System
   d) Power Supply System

   Note: As part of optimization of the communication system high-capacity point- to-point wireless links may be included to support the Optical Fibre cable-based communication system. However such a wireless link shall never form a segment of the main Optical Fibre backbone. The communication backbone shall be preferred to be realised via optical fibre. The wireless link can however be included as a direct link from a device like a CCTV Camera to an appropriate node (including the end nodes) of the Optical Fibre backbone. Such an approach may be utilised to connect road-side equipment to the ATMS control centre that may be otherwise difficult to do so via only the optical fibre link. Further, keeping in view of recent developments in 4G/5G, direct to cloud and wireless technologies, and especially but not limited to areas or projects where setting OFC is not feasible, ATMS provider may suggest use of alternative backbone. However NHAI may approve and accept such wireless links, proposed by the service provider, as part of the ATMS system network infrastructure only after the successful carrying out of proof-of-concept tests by the Service provider and confirmation from the Service Provider that no functional or service requirements will be violated purely because of this decision. The costs for such proof-of-concept tests shall be entirely born by the service provider.
2. **Cable System:** The system shall comprise:
   a) Backbone OFC cables
   b) Auxiliary OFC Cables linking access points to the back bone and road

sideequipment to access points

c) Polythene insulated jelly filled outside plant Cat5e/Cat6 copper cable (PIJF OSPcable) linking various roadside copper based equipment to access points
d) Coaxial cables.

3. **Interface System:** The system shall comprise:
   a) Sensor interface equipment
   b) Optical fibre cable interface equipment
   c) Control Centre interface equipment
4. **OFC Transmission System**: The system shall comprise:
   a) Optical line terminals
   b) Interface Cards
   c) Network management
5. **Power Supply System:** The system shall comprise:
   a) 12/24V/48V DC power supply systems as per design requirements at variouslocations.
   b) 230 V AC, 50Hz power feed as per requirements at various locations.
   c) Solar PV –based power supplies for 230 V AC, 12/24 V DC as per requirements atvarious locations.
   d) UPS, batteries and battery chargers, solar panels and chargers (if applicable) atControl Centre.

9.4 General Requirements

1. The cable system along with interface equipment shall work satisfactorily underadverse conditions like storm, etc.
2. The jointing and other accessories shall be suitably housed and be of compact and rugged design with suitable accessibility for ease of maintenance.
3. The individual sub-systems shall perform their assigned functions and in no way affector influence adversely the performance of adjacent or associated sub- systems.
4. The backbone Fibre cable for safety and reliability shall be kept independent of othercommunication and power cables – such as
   a) Other OFC Cables used for interconnecting the field equipment to the back bone /main control centre, copper cable etc.
   b) Cables that carry power to the various ATMS field Devices.

9.5 Functional Requirements

1. PIJF OSP CAT5e/CAT6 Cable System
   a) Road side equipment such as Emergency Roadside Phones, Speed display, VMS Displays or other equipment shall be connected through the PIJF Cable and terminated at an Ethernet switch in the nearest Access point
   b) The PIJF Cable used shall electrically comply with Cat5e or Cat6 (preferred) standards.
   c) Suitable punch-down lightning and surge protectors shall be used at prior to terminating cables at both ends.

2. Optical Fibre Cable
   a) The backbone of cable system shall interconnect ATMS Control Centre with access points situated at suitable distances from the ATMS Control Centre. Other access points shall link to the backbone via auxiliary OF cables form theselocations.
   b) The OF Cable System shall carry signals from all outdoor equipment such as Emergency Roadside Phones, Variable Message Signs, ATCC Portable and fixed CCTV cameras, Speed Displays, through the network equipment at the access points to the Control Centre.
   c) The OF Cable system shall interconnect all the access points to the ATMS Control Centre and also if required with associated network devices for signal transmission without any impairment.
   d) The backbone communication OF Cable system shall not be broken anywhere inbetween to link access points or road side equipment. This cable shall be terminated only at the designated access points and the ATMS Control Centre. Itshall not be allowed to interface any other sub-systems in the field to this cable or any spare cores in the cable directly or through branching.
   e) The separate and independent OF Cable system shall be used for the transmission of video signals, data signals from the equipment locations toaccess points where the copper cable has limitations for transmission of signals.
   f) The OF cable shall provide for dedicated spare fibres to cater to any future needthat may arise.
3. Co-axial Cable System
   a) The Co-axial Cable System shall provide immediate interface to carry signals from analog CCTV Cameras (if used) to the encoders situated at the nearest access point.
   b) The OF Cable shall also be used with transmitters and receivers if the distance islarge and high quality signal transmission and reception is not possible using co
   -axial system.
   c) The signals shall, without any impairment, be routed to the ATMS Control Centre via the equipment at the access point, auxiliary OFC and the backbone OFcable.
4. Interface System
   a) The Interface System shall cover the PIJF Cable, Co-axial Cable and OF Cable System & transmit and process the composite signals to achieve the desired reliability/availability requirements.
   b) The Interface sub-systems shall be capable of handling the composite audio, video and data signals at various interface levels and process them.
   c) The Interface sub-systems shall be designed optimally at various levels i.e. from the individual sub-systems level to integrator through to the Control Centre.
5. Power Supply System
   1. The Power Supply System shall support the requirements of individual sub-systems.

2. The Power Supply System proposed for individual sub-systems shall take intoaccount the overall availability/reliability requirements.
3. The Power Supply System design shall take into consideration local poweravailability, temperature and other climatic variations, and easy maintainability.

9.6 Technical Requirements

1. PIJF OSP Cable
   a) The Cable shall be Cat6 manufactured by reputed manufacturers such as Lucent, Amp etc.
   b) The PIJF Cables shall be laid in suitable trenches with protection against corrosion, inadvertent cutting, flooding, rodents and termites.
2. OF Cable
   a) The Back bone OF Cable shall have a fibre count of minimum 12 fibres (24 cores).This cable shall not be used for any other connectivity.
   b) The cable used for short-haul connectivity between outdoor equipment & Access points, access point to backbone etc. shall have fibre count as per the design requirements (8/12 cores). These shall be based on the location of equipment along the highway.
   c) The fibre size, stranding, filling and associated technical and testing details shall also, as a minimum, comply with the TEC specifications approved by Department of Telecommunications, Govt. of India.
   d) Methodology for cable laying, installation, splicing and protection measures shall be described in detail by the Service Provider for approval of NHAI and shall conform to standard industry practices.
3. Co-axial Cable System
   a) The Co-axial Cable System shall connect the cameras with the Control Centre via the access points. It shall have capability to interface with the OF Cable network for signal transmission.
   b) The Co-axial Cable System shall conform to relevant ITU-T standards for signal transmission and protocols.
4. Interface System: The Interface System shall broadly operate at the levels as described below:
   a) Way side (Emergency) phone to access point via PIJF Copper Cable.
   b) VMS Signs to Access point via copper Cat 6 patch cord or OF Cable.
   c) CCTV System to ATMS Control Centre via Co-axial to encoder (if required) and further via OF Cable.
   d) Integration with the NMS equipment at different levels for monitoring, logging and control of individual sub-systems.
   e) Interfaces at appropriate system and sub-system levels shall follow the protocolsand standards of RS232, RS485, RS422 and ITU-T, IEEE, ITU-R or other approved international standards for transmission and networking of voice, video and datasignals. These shall be as per the detailed specification in the tender elsewhere.
5. Power Supply System
   a) The power supply arrangement at individual sub-system level shall be designed for their optimum and reliable operation.
   b) The design shall take care of availability of local utility power and

necessary backup to achieve the desired performance objectives.

c) Video Cameras and Variable Message Signs located on the roadside in particular shall be supplied backup power supply for operating in all types of weather conditions.

d) Diesel Generators and UPS (Solar PV-based or otherwise) as required shall be included as part of the system design as per the need for sub-systems/ Control Centre. Design calculations to establish the capacity of these subsystems shall be furnished by the Service Provider.

e) The power supply design shall take care of voltage and frequency fluctuations and redundancy to achieve the required system performance.

f) Suitable lightning protection and earthing shall be provided to guard against system malfunction.

9.7 Cable Laying and Installation

1. The cable laying, installation, termination and wiring shall follow standard international practices. The Service Provider shall be solely responsible for the properexecution of the work.
2. Cable Laying
   a) The Service Provider shall submit a cable route plan with distribution chart for theindoor and outdoor requirements.
   b) Excavation of cable trench shall be done in all kinds of soil to a minimum depth of 1.65m from the ground below the central median/ edge of ROW depending upon the availability of land along ~~of~~ the highway and to a width of not less than 0.3m and also provide proper protection as required by NHAI while crossing power cables, pipe lines etc. The bottom of trench shall be levelled and got rid of any sharp material.
   c) The cables shall be laid as far as possible on one side of the road. The Service Provider shall restore the road surface, diversion and other modifications as a result of the trenching to the original state after completion of this work. Wherever required depth is not achievable additional protection shall be provided in consultation with NHAI and with prior written approval of the NHAI and / or NHAI's representative.
   d) The optical fibre cables shall be laid in permanently lubricated HDPE ducts of appropriate dimension with protection against moisture ingress, termites androdents.
   e) The OF cable and the PIJF cable shall be laid in the same trench. There shall be twoor more ducts laid in the trench as per the requirement..
   f) Whenever power cables are to be laid in the trench along with other cables, brick separation of at least 5 bricks/per metre length-wise shall be provided.
   g) Right of way will be provided by NHAI.
   h) The trenching and cable laying activities shall cause minimum disruption to the traffic flow on the highway. The material, cable drums and the manpower used shall not inhibit the flow of vehicles in any manner.
   i) The excavation of trenches shall be done only in lengths that can be handled in a single day. The trenches shall not be left uncovered overnight.
   j) The trenching and cable laying shall take into account likely diversions on bridges, toll plazas, built-up area, ERT (Emergency Road Side

Telephone) pedestals,etc.

k) The cable laid along the bridges shall be suitably protected (via GI conduits) and clamped.
l) Adequate extra length shall be left at the end of the cables to meet future exigencies.
m) Cable across the road from the backbone of OF/PIJF cable for ERT's and other sub-systems along the route shall be laid in ducts below the bed using trenchless ductsthrough horizontal direction drilling. The procedure shall be deployed after written approval of the NHAI and / or NHAI's representative.
n) These shall be laid on one side of the highway. Crossings and cuts on the highway shall be provided with trenchless excavation. Suitable route markers every 500 metres shall be provided. Suitable no. of patch panels, joint boxes, termination boxes, pigtails and patch cords, etc. shall be provided.
o) Waste material such as unused ducts, cable cut-pieces, and other debris shall be cleaned and suitably disposed as per the relevant recycling and disposal standardsby the Service provider.
p) The service provider shall provide adequate perforated cable trays and/or cable supports as per industry best practices.
q) All cables shall be numbered with ferules in accordance with the universal cable numbering system.
r) All cables shall be ISI marked, fire retardant low smoke type and shall be terminated with proper lugs and joints as per best industry practices.

Handhole and Manhole

The indicative sizes of the standard type of Handhole and Manhole shall be as follows:

Type	Number ofDucts	Lengt h (m)	Width (m)	Depth (m)	Cable Bracke t
Handhole					
HH-1	1-8	1.20	0.60	0.85	One side
Manhole MH-1	1-9	1.80	1.00	1.50	One side

9.8 External data connectivity to the NHAI ATMS Cloud and the NHAI ATMS Master, Regional or Traffic Police Control Centers

A suitable leased-line (wired or wireless) supporting a minimum 100 Mbps data link shall be provided by the service provider for the purpose of connection to the NHAI ATMS Cloud, NHAI ATMS Master & relevant Regional Control Centres and Local Traffic Police Control Centre. Such a link shall make the ATMS system directly on-line accessible to the above NHAI facilities and shall provide the following information:

1) Video images & required data strings to the NHAI ATMS Cloud at pre-programmed intervals and on demand.
2) Providing streaming video data, streaming audio data and data strings on demand from the NHAI Master & relevant Regional & Traffic Police Control Centres.

Further this link shall also fully support the on-line access of the ATMS system by NHAI / NHAI's representative as described in Clause 2.2.8.3 of this document.

Chapter 10

ATMS Control Centre with ATMS Software

10.1 Scope

This Specification lays down the general, functional and technical requirement of the ATMS Control Centre. .

The Control Centre shall accommodate following equipment and software:

(i) Central Computer Server (with integrated ATMS Software including the trafficManagement and Rescue module, integrated audio communication unit & support for relevant Mobile smartphone applications)
(ii) Emergency call management system equipment and software
(iii) Integrated Traffic Management (ITM) console consisting of mainly the ITM workstation(s), the Integrated audio communication unit and further Integrated with the
   1. Large Display Board based on the Video-wall 3 x 2 meters
   2. CCTV Console,
   3. VIDES console and Dedicated Video-wall (Minimum 75" Smart TV)
   4. other equipment
(iv) ATMS software
(v) Mobile radio operator and configuration equipment and software
(vi) Backbone communication equipment and Network Management System for the same
(vii) Printer
(viii) Uninterrupted Redundant Power Supply with supply system and back up Firewall, IDS, IPS and other network security component and critical systems such as servers, storage etc.
(ix) TMC Central Processing Servers in hot standby configuration (Primary + Secondary)
(x) Backup Video Recording (Only Incidents) Server with adequate inbuilt storage and hot standby.

(xi) Mains Power supply system and Diesel Generator set equipment.

The ATMS Contractor shall also undertake any additional civil works, interior works, MEP works, for setting up the Command Center, including all additional related electrical, lighting, electrical connection, DG set, power backup, HVAC works, access control, building CCTV, PTZ cameras outside building, firefighting system, alarm, fire extinguishers, raised floor, housekeeping, building cleaning, maintenance, recurring charges including electricity bills, telephone bills, DG fuel, servicing, security.

10.2 Function & Architecture

ATMS Control Centre would be the facility from where all the activities of the ATMS would be controlled. ATMS Control Centre would primarily comprise of the in-door portion of CCTV, VMS, and other support systems. All the aforementioned sub- systems shall preferably reside in a dedicated permanent structure with adequate floor area to house the required man power and equipment. Where ever such a permanent floor/building/structure cannot be made available, the ATMS Control Centre shall be housed in temporary portable cabins.

A schematic of the ATMS control centre system is shown in figure 1 below:

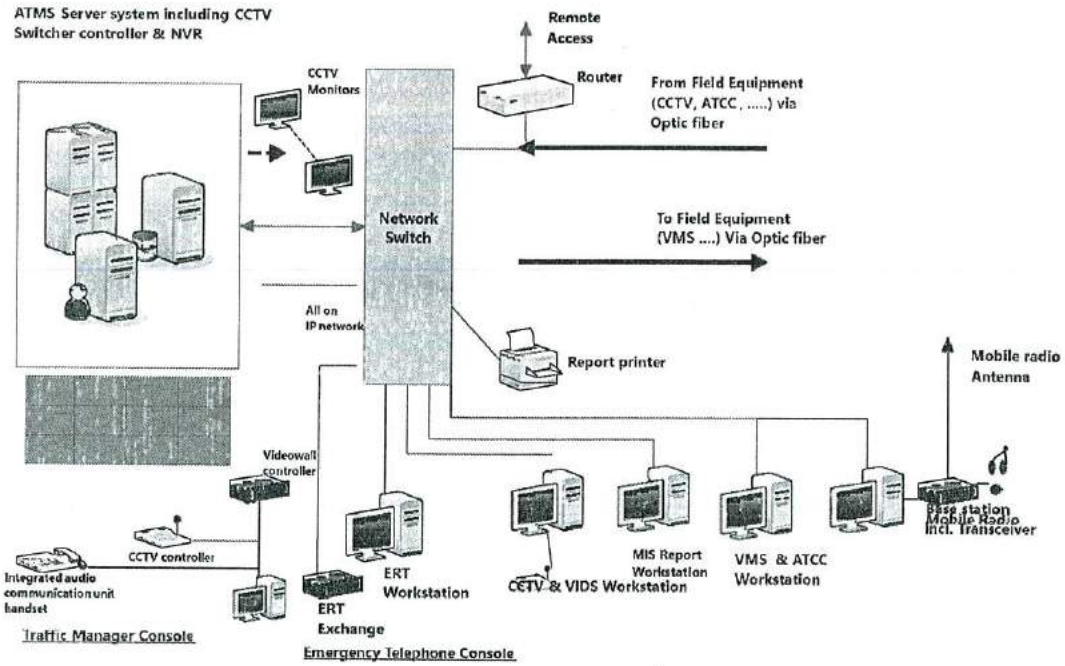


Fig 1 ATMS Control Centre system

Note:

a) **Even though specific workstations have been allotted to each specific functionality, each of the applications (e.g. VMS, ATCC, CCTV, VIDS etc) shall execute on any of the above workstations if required.**

b) **An additional workstation shall be used to present/depict all the speed displays. Additionally some of the CCTV Monitors may also be used.**

10.3 Functional Requirements

Since the ATMS Control Centre houses the in-door functional components of all the installed ATMS sub-systems(CCTV, VIDES, ATCC, VMS etc.), the following subsections describe the functional requirements including a brief specification for the temporary portable cabin.

10.3.1 General

1. Each sub-system shall be designed (storage capacities etc) with at least 10 years of traffic increase in the highway from the time of setup.
2. Each sub-system shall be expandable to account for increase or decrease in field installed devices. Minimum ±25% spare capacity (rounded off to the nearest higher whole number) should be ensured.
3. All the supplied equipment shall operate on 230 V, 50 Hz single -phase power supply. Power for all the equipment will be regulated using on-line UPS with minimum 30 minutes or more back up. If any equipment operates on any voltage other than the supply voltage and supply frequency, necessary conversion/correction device(s) for such requirement shall be supplied along with the equipment.
4. All the control equipment e.g. fileservers, database servers, NVR/CCTV CAMERA SERVER, Video Analytics NAS/Raid backup device, decoders, networking equipment etc. shall be provided in standard Racks.
5. System shall have provision of WAN/5G connectivity for remote monitoring.
6. Online backup should be maintained to protect against storage failure.
7. The system provider shall provide all technical details regarding data formats, communication protocols, packet formats, etc. to NHAI.

8. All sub-system software modules shall be available in all the workstations, so that, with minimum intervention of System Maintenance, one user-group can perform their operations on a different workstation. However, for security reasons, only the functionality based on the expected user-group who is utilizing the workstation for day-to-day operation shall be available for immediate use.
9. All Sub-systems shall generate and report alerts when a pre-defined event occurs.
   (a) **Safety related alerts / reports:** Further all the software modules of the sub-systems installed (CCTV, VMS, Speed display, Roadside Communication etc.) shall deliver safety-centric reports (e.g. fatal collisions in a given stretch, violation of regulation etc.), enforcement-centric (number of tickets issued, comparison of violations on monthly basis etc.);
   (b) **Equipment related alerts / reports:** Failed packets, number of repairs carried out on field devices, down time on account of major faults etc..
   (c) All sub-system (e.g. CCTV, VMS, VIDES, VASD etc) related alerts & events shall also be communicated to the Traffic Management console for display on the Video wall / Traffic management console workstation.
   (d) Further each sub-system shall also accept commands / messages from the Traffic Management console for ensuring the achievement of an Integrated ATMS system.
10. The system shall provide detailed reports related to the System Operations (including the actions of various stakeholders during Incident Management) and operations. The format for the same shall be finalized by the service provider in consultation with NHAI and / or the NHAI's authorizedrepresentative. Maintenance reports, at the minimum, shall include the current operational status of each equipment, actual events of down-times of each equipment, actual events of Mean time to Repair of each equipment and actual events of Meantime between failure of each equipment and the preventive & repair maintenance log.
11. The system shall also provide a method to log and report road highway incidents. Data used for logging and reporting shall be 'picked-up' automatically from the road-side / field equipment and other sensors as applicable.
12. Further the system shall provide a facility of generating user-formatted reports that can, for example, bring together the occurrence of highway incidents, values of various sensors and the operational status of various equipment on acommon time line / scale.

13.System Security

a) It shall be possible to control / restrict all functions / sub-functions (can be menus, submenus, buttons to perform specific operation), etc. available in each module based on the user group in general and in certain special user groups viz., Project Manager / Administrator, the control shall be possible at the user level.
b) The Access control shall have 3 levels of access, Read, Write, and Modify. It shall be possible that any user / user group can be assigned none / all fromthe above levels for a specific function.
c) All the manual override options shall be considered separate functions and it shall be possible to disable these functionalities by simply not allowing access to these functions for any user/ user group.
d) Detailed list of Access rights shall be evolved during detailed engineering .
e) At the end of session, the operator logs out from the application and the logout shall be recorded in the database.
f) It shall not be possible for a different user to open a separate instance of the

application without the current user logout in the same workstation.

g) It shall be possible to exit the application only with Administrator authentication including username and password.

10.3.2 CCTV & VIDES

1. There shall be a Supervisory Monitoring & Control System with Digital Video Surveillance Control Software to manage all the video surveillance devices.
2. The Supervisory Monitoring and Control System shall consist of at least a Camera Switcher controller, Joystick, Camera server, NVR, & adequate numberof workstation (CCTV & VIDES workstation). The system shall be able to provide streaming video images to the video Wall and / or the above monitors and / or workstation.
3. The supervisory monitoring and control software should be capable enough to display and manage the entire surveillance system. It shall support a variety of devices such as cameras (PTZ, Fixed & VIDES), video encoders, video decoders, PTZ controller, NVR, NAS boxes/Raid backup device etc.
4. The manufacturer of the CCTV Switcher Controller /NVR /Camera Server shall be
   a) A well-known and established company worldwide in the field of Information Technology.
   b) Has established and appointed representative or authorized agency nearproject location.
   c) Capable of providing adequate after-sales service and support on 24X7basis.
5. The software shall operate on open architecture and integrate/ co-exist with other subsystem software that are installed to manage VMS, WIM, Speed Display, and Roadside Communication etc.
6. The software shall store configuration of encoders / decoders and cameras. There shall be options to generate reports of stored device configuration.
7. The control software should provide for alarms and alarm log. Alarm settings need to be individually configurable for each alarm and each camera prerecord duration. The duration shall be selectable from a list of values ranging between 2 seconds or less to 5 minutes or more. There shall be provision to achieve, print and display the log using device filter, device group filter and/or a time window.
8. The administrator should be able to create, add, edit & delete users. He should be able to administer access rights to system resources and functionality as well as access permissions to a list of camera a user can view and control.
9. The administrator should be able to place users in a hierarchy. The higher priority user should inherit the rights of a lower priority user automatically when he is taking overriding control of cameras, which are already being controlled by a lower priority user. There should be minimum 3 hierarchical levels of security for providing user level log in.
10. The system shall provide User activity log (audit trail) with user id, time stamp, and action performed, etc.
11. For monitoring purposes, Video walls (For TMCS and VIDES) shall be setup with suitable mounting arrangements, as described in section 13.3.2.1. Facility for viewing and controlling all the cameras at various other locations e.g on CCTV monitors (supporting HDMI, RGB & IP-based), as required, shall be provided in addition.
12. The Area under surveillance shall be monitored and controlled from ATMS Control Centre through workstations and Joystick controllers with the help of Digital Video Surveillance Workstation Frontend Software as part of the Supervisory monitoring and control system Software.
13. The Workstation Frontend Software should also be working on a browser based system

for remote users to allow any authorized user to display the video of any desired camera on the monitor with full PTZ and associated controls. This provision may also be used to provide access to NHAI HQ, PD/RO and local Traffic Police representative.

14. The software should Support flexible 1/2/4 Windows Split screen display mode or scroll mode on the PC monitor or on preview monitor as per requirement.
15. The software should be able to control all cameras i.e. PTZ control, Iris control, auto / manual focus, and colour balance of camera, Selection of pre-sets, Video tour selection etc.
16. The user shall have the facility to request for view or control of any camera outside his rights for a reservation period. Control of camera is released after the reservation period (Request enhanced control rights for a short duration).
17. ATMS Control Centre may have one or more Operators simultaneously controlling the installed field video hardware.
18. The recording resolution and frame rate for each camera shall be user programmable.
19. Recording modes such as continuous, manual, or programmed date-time- duration modes, camera, group of camera-wise. All modes may individually be disabled or enabled using scheduled configuration. It should also be possible to search and replay the recorded images on date, time basis as well as camera basis. It should provide onscreen controls for remote operation of PTZ cameras. It should have the facility for scheduled recording. Different recording speeds (fps) and resolution for each recording mode for each camera should be possible.
20. The NVR / CAMERA SERVER can be an embedded-type or server-based or cloud based if meeting all functional requirements. However, the NVR /CAMERA SERVER software shall run on off-the-shelf available servers (Camera server & Database server). Each NVR / Camera Server shall be able to handle 36 or more cameras.
21. Network Video Recorder shall offer both video stream management and video stream storage management. Recording frame rate & resolution in respect of individual channel shall be programmable.
22. System should ensure that once recorded the video cannot be altered: Ensuring that audit trail is intact for evidential purposes.
23. System shall store all camera recordings (TMCS/VIDES/Command Centre CCTV etc) for a period of 180 days or until SLAs have been assessed for that period, whichever is larger. Storage should be sufficient such that video can be stored @ 25 FPS, at 2 MP or better quality using necessary compression techniques for all cameras (extended capacity of cameras i.e. present capacity + 25%).
24. 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.
25. All camera recordings shall have Camera ID & location/area of recording as well as date/time stamp. Camera ID, Location/Area of recording & date/time shall be programmable by the system administrator with User ID & Password.
26. Facility of camera recording in real-time mode (25 FPS)/15/12.5/10 or lower FPS as well as in any desired combination must be available in the system.
27. Facility of Camera recording in 720p/1080 or in any combination i.e. any camera can be recorded in any quality – Selective or Group of cameras must be available in the system.
28. Video shall be compressed using MPEG-4 or better standard and streamed over the IP network. Once on the network, video can be viewed on a Control room workstation or over the internet remotely or on analog monitor using a hardware decoder (MPEG-4/compatible standard Receiver) and shall be recorded on NVR/CAMERA SERVER and shall be backed up on NAS/RAID Backup device.

29. System shall be triplex i.e. it should provide facility of Viewing, Recording & Replay simultaneously.
30. The offered system shall have facility to retrieve/export/ backup (on Pen Drive, External HDD, CD, DVD etc.) the desired portion of clipping (from a desired date/time to another desired date/time) through the search functionality of the application software. Viewing of this recording shall be possible on standard PC using standard software like windows media player etc. Log of any such activity should be maintained by the system for audit purposes.
31. Redundancy/Fail-over feature is required i.e. in case of failure of an NVR/CAMERA SERVER the relevant cameras shall automatically switch over to the redundant NVR/CAMERA SERVER.
32. Database Server shall keep track of all configurations, error data, configuration events, usage events and error events.
33. Video stream from individual cameras shall be recorded on respective NVR/Camera Server &, subsequently, archived to NAS box/RAID backup device.
34. The Necessary script/algorithm for the above must be available in the Application.
35. All the workstations in LAN should be provided with software to view and control the cameras, encoders and retrieve the recorded video images from the NVR/CAMERA SERVER/NAS/Raid backup device seamlessly.
36. A similar such dedicated workstation shall be provided for the usage of representative of Traffic Police or other Enforcement Agency as required.
37. VIDES
    a) It shall be possible to switch and view video streaming images on-line from all VIDES Overview cameras on the CCTV monitors and VIDES Videowall and the CCTV , VIDES workstation
    b) The supervisory software (executing on the VIDES Supervisory computer) shall determine the following parameters related to traffic flow monitoring
        (i) Traffic volume(No of vehicles detected during the time interval);
        (ii) Occupancy (Lane occupancy measure in percentage of time);
        (iii) Vehicle classification, Flow rate (vehicle per hour per lane);
        (iv) Headway (Average time interval between two vehicles);
        (v) Speed, Level of Service;
        (vi) Space occupancy &
        (vii) Traffic Density from both the ATCC and the VIDES data captured from the respective field equipment.
        (viii) All incidents and analysis as defined in Chapter 4.
    c) The allowed errors on count and detection will be as mentioned in Chapter 4.
38. Violation Verification Module and Vaahan Database Integration:
    a) VIDES software shall be integrated with Vahaan Database for creation of eChallans for all cases where violations have been detected automatically or manually.
    b) Primary source for violations will be the VIDES (Overview + ANPR) cameras which will be integrated with this module.
    c) The module shall allow for registering of violations as detected manually though RPVs or through TMCS Cameras. Such events as received from ground staff/enforcement agency shall be verified by control room manager and upon authentication from the manager, the operator shall create the event in the application.
    d) Each event/violation should have necessary evidence and data as required by Vaahan database for eChallan generation.
    e) The module will allow operator to verify the number plate as captured by the ANPR and incase the number is wrongly read, there will be an option to edit the same. Each edit shall be saved in the database for 100% audit by manager.

10.3.2.1 Video Wall (large display board)

1. The video wall shall typically be a matrix of 3x3 but the controller shall be capable and flexible enough to accommodate varied different monitor matrix geometries as dictated by space availability or constraints.
2. The typical video wall display size shall be 3x2m.
3. Video wall controller shall be capable of capturing and displaying video information from different sources such as DVI, DisplayPort, VGA, IP streaming etc.
4. The monitors used in constructing wall display matrix shall have bezel edge sizes less than 6 mm.
5. The video wall shall be an integrated package of control room display management and configuration software, display controller capable of handling at least 48 monitors, and the required number of slim bezel monitors.
6. The video wall system shall support hot-plugging and redundancy.
7. Video wall controller shall support auto calibration and auto colour balancing.
8. Mounting arrangements for individual monitors within the wall matrix shall be designed to allow for easy replacement and hot plugging.
9. The manufacturer of the Video wall shall be
   a) A well-known and established company worldwide
   b) Have an established and appointed representative or authorized agency in projectlocation.
   c) Capable of providing after-sales service and support on 24X7 basis adequately.
10. The target image on the Video wall shall be freely resizable and re-positionableon any part of the Screen.
11. The Video Wall shall be capable of accommodating multiple displays in multiplerows and columns behaving as single logical screen.
12. Separate Video Wall shall be provided for VIDES with minimum 75" smart TV

10.3.3 VMS

1. There shall be a Control System with Variable Message Sign Control Software tomanage all the VMS Boards within the installation.
2. The software should be capable of managing at least the number VMS's designed for the package. It should support VMS boards of varying sizes.
3. The software shall operate on open architecture and integrate/ co-exist with other subsystem software that are installed to manage CCTV, VIDES, WIM, Speed Display, and Roadside Communication, apart from the Traffic Management module (where applicable) etc.
4. The software shall store configuration (VMS ID, its actual location, brightness levels, horizontal pixel size, number of lines supported, Regional Language supported etc.) of each VMS that it controls. There shall be options to generate reports of stored device configuration.
5. The VMS boards associated with the VIDES should be integrated with the VIDES such that incidents identified by VIDES that need to be warned to incoming traffics are automatically relayed without any manual intervention. Details of which incidents require automated warning messaging are in the relevant section in VIDES.
6. The system should support adaptive display brightness to adjust readability to the changing outdoor environment.

7. The control software should support some form of CRC[1] on display data and control command packets for device error reporting.
8. The administrator should be able to create, add, edit & delete users. He should be able to administer access rights to system resources and functionality as well as access permissions to a list of VMS a user can control.
9. The administrator should be able to place users in a hierarchy. The higher priority user should inherit the rights of a lower priority user automatically when he is taking overriding control of VMSs, which are already being controlled by a lower priority user. There should be minimum 3 hierarchical levels of security for providing user level log in.
10. The system shall provide User activity log (audit trail) with user id, time stamp, and action performed, etc.
11. ATMS Control Centre will have a workstation for VMS operation. Facility for controlling all the VMSs at various other locations, as required, shall be provided.
12. The VMS to be controlled shall be accessed from ATMS Control Centre through workstations with the help of VMS Control Workstation Frontend Software. Further the above software shall also accept messages for display from the Traffic Management console programmed on GUI interfaces provided by this software.
13. As the VMSs can be configured to display messages in a chosen regional language, the software should be able to control VMS configured for any regional language.
14. The user shall have the facility to request control of any VMS outside his rights for a reservation period. Control of VMS is released after the reservation period (Request enhanced control rights for a short duration).
15. ATMS Control Centre may have one or more Operators simultaneously controlling the installed VMSs.
16. As stated earlier, all data and command packets shall have a suitable CRC attached to them. All packets sent would be acknowledged by a response packet from the respective display with its own CRC.
17. The response packets from VMSs shall include status (command executed or not) as well as error codes to indicate the nature of error.
18. The system should support multicast (broadcast to a predefined group of displays) and broadcast. Multicast or broadcast packets shall have no response packets from VMSs.
19. A single message may be shown as a static sign or a group of messages may be shown in a round robin fashion till a new set of messages are not relayed to a particular VMS.
20. The time duration for which a message is displayed while in round robin mode will be programmable from 1 second to 255 seconds.

[1] Cyclic Redundancy Check

21. VMS and the associated software shall support the following text animations:
    a) Scroll right to left
    b) Flashing (For example, this would be to attract attention to speed limits)
    c) Typing
    d) Curtain top to bottom
    e) Curtain bottom to top
    f) Replace left to right
    g) Replace right to left
    h) Text without any effect (for example, this would be default for most text)
22. The use of text effects shall be strictly a policy of NHAI road safety experts dictated by situation and hence, should not be a fixed global parameter. It shallbe dynamically assignable and remain valid for a text string for the current instance alone.
23. It shall be possible to send ten strings in round robin mode.
24. Database Server shall keep track of all configurations, error data, configuration events, usage events and error events.

10.3.4 ATMS software

a) The ATMS software integrates the field equipment like CCTV cameras, VIDES, & VMS with the Integrated Traffic Management (ITM) console to ensure the availability of an effective system for Traffic monitoring & incident / accident management
b) The ATMS software shall be based on a modern architecture and shall optimally execute on the ITM workstation and the ATMS server to ensure that
    i. The system response are instantaneous to support effective Traffic Management (i.e. Traffic monitoring and incident / accident management) actions on the ITM workstation.
    ii. No information (data, video stream & audio stream) from any source is lost. Further all such information is made available on the Integrated Traffic Terminal, with no delay, precisely at the time they are required.
    iii. Effective integration with the CCTV system, VIDES system, VMS system and other relevant ATMS equipment is carried out in a seamless manner with no disruption of / disturbance to the Traffic management function (i.e. Traffic monitoring and incident / accident management). For such integration, standard interfaces (e.g. NTCIP) shall be used wherever available.
    iv. All information (Data, video and audio streams) collected from various sources shall be archived in the ATMS server for quick retrieval by authorized personnel. However the performance of the ATMS software in terms of response times shall not be affected during such a retrieval process.
c) The ATMS software shall be a modular system comprising of at least the following modules:
    A. Data acquisition module for acquiring data, video streams and audio streamsfrom field equipment
    B. Highway Traffic Monitoring module
    C. Incident / Accident Management Module

D. Integrated audio communication module
E. Report generation module and Dashboard
F. System Administration module
G. Communication module for authorized access by external systems (e.g. NHAI'sRegional control centre & the Main control centre)
H. API Integrations with Vaahan, NPCI FASTag Mapper, NHAI's ERP (Datalake atthe time of this notice), 1033 CAD, Rajmarg etc.
I. Network Management Software

A. Data Acquisition module

i. The Data Acquisition enables the acquiring of data from the various field equipment in the form of data strings, video streams and audio streams. Examples include
- Data strings from VID system, ATCC system, WIM system, VAS system
- Data strings of Date and Time and details of events (e.g. the time an Emergency Call was attended to on the 1033 telephone line or on the ERT phone system), alarms and faults related to any part of the system.
- Video Streams from CCTV Camera, VID Camera
- Audio Streams related to conversations on the 1033 Emergency Telephone , Road-side Emergency Telephone

ii. The module allows the user to configure the acquisition conditions as follows:
- At regular intervals of time with the interval being user specified (e.g. from the ATCC system)
- On the occurrence of Traffic related events in the field (e.g. data from the VIDsystem, instances of calls from Emergency Telephones)
- On demand (e.g. Video stream from a CCTV Camera)
- On the occurrence of system related events like equipment failure andrestoration, user login / logout

iii. The above information thus acquired shall be stored in the ATMS server using an established database package like Oracle or MS SQL.

B. Highway Traffic Management module & GIS Dashboard

i. This module shall support effective Traffic monitoring on the highway. The targeted road section or the entire stretch shall be depicted on the Large display (video wall) and ITM workstation, in the form of animated screens including Graphic User interfaces not limited to specified under Clause 816.1 to 816.17 of Specifications for Road and Bridge Works of MoRT&H.

ii. An interactive GIS map (free and open source such as OpenStreetMaps etc or proprietary) shall be available for all workstations and on the video wall. The GIS map should include:

iii. Icons for which CCTV, VIDES, VMS and other devices.

iv. On clicking the device it should open up the video feed of the cameras or show the message being displayed on the VMS and allowing for modifying the message from there if user has permission.

v. It should be possible to update the message on the VMS from here.

vi. Any incident triggered from VIDES of TMCS shall appropriately modify the icon of the camera on this GIS map to call attention of operators.

vii. When the video stream for VIDES or TMCS is clicked and pulled up, it should be possible to "create an event" for the dispatch. This would automatically capture the photo from the stream, location and allow to choose type of incident detected if manual. This event in one-click should be possible to be dispatched to nearby emergency vehicle if ICAD has been setup.

viii. The map should show at all times the live location of the Crane, Ambulance and RPVs through data received from AIS140 or ICAD solution.

ix. Section of the highway stretch should highlight to show traffic flow as identified by VIDES (different colours for different flows, separated by direction).

x. If any device is not functioning, the same shall also be easily seen from this GIS map if the icon of the device is appropriately changed during malfunction.

xi. The GIS map shall show if any event has been passed to ATMS through 1033, iCAD or Rajmarg Yatra based on the location of the incident. .

xii. It should be possible to click on an incident either from VIDES, TMCS, ICAD, 1033 or Rajmarg or Manually on Any location of the Map and create an event for emergency response dispatch.

xiii. The GIS map shall have an equivalent strip chart interface.

xiv. The map shall allowing zooming into relevant sections with no loss to definition.

xv. The details of the project-specific composition of the GUI will be finalized during the project execution phase between the Service Provider and NHAI (or its authorized representative).

C. Incident / Accident Management module

This module shall support Incident / Accident Management by:

i. Allowing the Traffic Management console operator to locate and mark (with a mouse) an accident / incident on the GIS map of the highway and initiate the Incident management actions.
Displaying a contextual on-line checklist for the operator to follow in sequence. Further the clicking on each item of the checklist shall automatically activate the related ATMS equipment to aid in the management viz.
   a. Seamless audio connection for the Traffic Management console operator, via the integrated audio communication unit, irrespective of the communication media (Mobile radio, Mobile phone/landline, road-side Emergency telephone), to the ambulance, Trauma Care Centres, Patrol & other O&M vehicles.
   b. Automatic Pan, Tilt and Zoom of the nearby camera to view the accident
   c. Bringing on the VMS –wise message edit screen (by interfacing with the VMS Control software to create and dispatch messages to VMS

boards and mobile apps of registered road users). The checklist itself shall bederived from the relevant Traffic Management and rescue procedures captured either in the Operation (O&M) manual of the highway or based on world-classbest practices.

ii. Logging the time-stamp of the operator operating each element of the checklist to aid in 'post-facto' analysis of the operator's performance towards establishing his /her efficiency and further training needs and SLA monitoring needs.

iii. Automatically performing pre-defined actions related to each of the above elements (e.g. Identification of the accident spot on the road shall control the nearby CCTV cameras to 'look' in the direction of the accident spot)

iv. Aiding on-line tracking (via GPS) of the various O&M vehicles like the Ambulance, Tow-vehicle and the Patrol vehicle supported with dynamic display of information like shortest route, travel time to the accident spot, Trauma Care Centre etc.

v. Providing a user-programmable facility, as an aid, for the automatic generation of VMS messages depending on incidents based on e.g. information measured by the MET sensors and sensors installed on then highway (e.g. the generation of a Visibility Alert signal in the event of visibility going below 1 km). This module shall alert the operator on generating the message which shall then be deployed on the operator's approval.

vi. The detailed workflow of this module involving various checklists, shall be finalized between the service provider and NHAI during the project execution phase.

vii. The module should be able to have complete functionalities as given under Chapter -4 including incidence response and facilitating generation of e-challan through NIC.

D. Integrated audio communication module

This module shall interface with and control the integrated audio communication unit to aid the operator seamlessly communicate with various stakeholders via a host of communication media like telephone landlines, mobile telephony, mobile wireless etc.

E. Report generation module & Dashboards

i. This module shall generate periodic as well as on-demand statistical reports using data received from VIDES, TMCS, Automatic Traffic counter cum Classifier for traffic planning and management, as well as traffic forecasting. There shall also be a provision to generate reports to aid planning and strategizing enforcement.

ii. While tabular reports are necessary, the ATMS software shall include visually appealing and useful dashboards and charts for efficient day to day management, monitoring and operations.

iii. Further, the Database/Data Analyst in the ATMS shall on their initiative and on request conduct statistical analysis on the data being generated and provide insights to the manager and NHAI PD on a monthly basis.

iv. The reporting module shall provide a range of reports on demand including those

- o related to the acquired data,
- o VMS messages edited and sent,
- o System generated Equipment availability and downtime.
- o System malfunction and restoration
- o User login – logout
- o Daily Accidents that happened on the highway and their action takenreport.
- o Manually detected and Automatic VIDES events detected by location, vehicle type, and action taken, end to end response time etc.
- o eChallans generated (manual vs automatic) and sent to Vaahan.
- o Mobile App messages received
- o Traffic flow volume (No of vehicles detected during the time interval),Occupancy (Lane occupancy measure in percentage of time), Vehicle classification, Flow rate (vehicle per hour per lane), Headway(Average time interval between two vehicles), Speed, Level of Service, Space occupancy & Traffic Density from both the ATCC and the VIDES data captured from the respective field equipment.

v. The ATMS Software shall have provision to select end of day reports through API automatically to NHAI's Data Lake or equivalent.

vi. The module shall further provide detailed performance reports on all aspects ranging from detection of incidents, through the field Operations team (Patrol vehicles, Break-down cranes and Ambulances) actions, Traffic Management Console operator and other ATMS Control Centre operator actions. Automatic system generated reports supporting the service provider's claim of meeting the service level requirements with respect to operations, shall also be provided.

vii. The Report Generation Module will ensure that all the metrics mentioned in the SLA in Annexure are easily available and automatically generated. Incase manually verification of random footage is required in SLA calculation, the reporting module will provide easy module to fetch footage in any time period/equipment as needed.

While, Detailed formats of each report shall be finalised by the Service Provider in consultation with NHAI – formats for select key standardized reports has been added in the Annexure.

F. System Administration module

This module shall essentially enable the definition and maintenance of useraccounts.

G. Communication module

This module will manage authorized access to the ATMS system by

1. Authorized NHAI personnel / representatives
2. Other authorized NHAI systems like the Regional office Control Centre ATMSsystem and the Main Control centre ATMS system
3. Any other system authorized by NHAI

Based on requests from the above entities the communication module shall provide the following information to the requesting entity:

i. Video Streams (Live and Archived)
ii. Audio streams (Live and Archived)
iii. Data strings and Data elements (Live and Archived)

The standard data exchange protocols for the above will be shared by NHAI with the Service Provider.

H. Integration with Vaahn Database, NPCI FASTag Mapper, Police ControlRooms, Dial 112, DataLake, 1033 ICAD, Rajmarg etc.

ATMS software shall be required to be integrated with IT systems from NHAI or other Government Agencies from time to time basis. This shall be possibleat no additional cost whether during installation or O&M phase of the contract.

I. Equipment/Network Management System

The Solution should provide fault & performance management of the infrastructure and should monitor IP/SNMP etc enabled devices like Cameras, Routers, Switches, ATMS Software, Emergency Call Boxes, Sensors, etc. (i.e., all devices supplied as part of scope). This system shall also help monitor key KPI metrics like availability, in order to measure SLAs. It shall include key functionalities that are required to assist administrators to monitor network faults, uptime & performance degradations in order to reduce downtimes, increase availability and take proactiveactions to remediate & restore equipment services. The Contractor will provide a real-time dashboard for monitoring equipments/network for which NHAI will have access to check and monitor SLAs at any time. The Network Management System should ensure that the items mentioned in the SLA in Annexure are automatically calculated and reported in the requisite format thereby making it easy to monitor the SLAs at glance.

10.3.5 Integrated Audio Communication Unit

The Integrated Audio communication unit enables the Traffic Manager / operator to communicate with all stakeholders in a seamless manner irrespective of the medium of communications. Using a hardware like a digital telephone exchange that supports software control, this unit allows the Traffic manager wearing a headset with a microphone (or a handset) to seamlessly communicate with the stakeholders in traffic operations using various audio communication media like Mobile wireless radios, Mobile (GSM) telephones, Telephone landlines as well as the road-side Emergency Telephone. The communication is initiated on selection of a context sensitive checklist element or by selection of suitable icons on the ITM workstation screen during the Traffic monitoring or accident / incident management. This unit shall support communication between the Traffic manager and a single stake holder or a group of stakeholders. As a back-up option this unit shall also enable such communication via physical push-buttons located on the unit. All calls will be logged and recordings kept for a period of 180 days or until SLAs have been assessed for that period, whichever is larger.

Note: All calls to the command centre and from the command centre to stakeholders will be recorded in the system and logged automatically through the Integrated Audio Communication Unit. These call logs will play an important role in monitoring of SLAs.

10.3.6 Interface with Mobile Phone Apps

1. **Rajmarg Yatra App for Road Users:** The ATMS control centre system shall seamlessly interface with NHAI's Rajmarg Yatra through standardized API interfacesor through module on Rajmarg prepared for ATMS. The integration should be regarding the following but not limited:
   a) Getting live information from incidents reported by highway users on the particular stretch. The ATMS system should be able to generate an incident event in similar fashion and alert operator about location of incidents as reported by User through Rajmarg App. The API shall the location, photo and incident type etc. The nearest TMCS camera should be identified automatically based on the incident location for the operator to confirm the incident and dispatch necessary support.
   b) ATMS software and its sub-systems (VMS, VIDES and TMCS) should be ableto send information regarding traffic, congestion, maintenance work, identified incidents, accidents and manual messages to Rajmarg Yatra users through either API or through module prepared for ATMS Manager on Rajmarg webportal. These messages will be geo-tagged and broadcasted by Rajmarg to users in the vicinity of the incidents. For events like construction etc, the ATMS software shall also inform to Rajmarg when the event has closed.

2. **App for Enforcement Agencies/Highway Traffic/Route Patrol Agencies:** In the event a centralized integrated computer aided dispatch (ICAD) system is utilized by NHAI, the ATMS Software shall be integrated with it:
   a. Any incidents as identified by 1033 shall be communicated to the ATMS Command Centre by creating logins for Operators on the iCAD or through API integration with the ATMS GIS Map or relevant modules such as VIDES etc.
   b. Incidents as identified by command centre through VIDES or Manually that required emergency vehicles (RPV, Ambulance, Crane etc) being dispatched should be communicated to response teams through the centralized ICAD. A module will be created on ICAD or ATMS software which would allow sending tickets/events to dispatch vehicles and thereon tracking by operators and closure of events by emergency vehicle app users.

10.3.7 Emergency Telephone console

1. There shall be a Control System with a Control Software to receive all Emergency Communication from the NHAI 24 X 7 National Highways helpline and the Emergency Road-side telephones (shortcode '1033').
2. The software shall operate on open architecture and integrate/ co-exist with other subsystem software that are installed to manage CCTV, VMS, WIM, and Speed Display, apart from the Traffic Management module (where applicable) etc.
3. The software shall store configuration Emergency Roadside Telephone ID, Location on the highway stretch etc.) of each Emergency Roadside Telephone it controls. There shall be options to generate reports of stored device configuration.
4. The system shall record all calls on to a dedicated server with adequate

indexing to retrieve the same on a later date.

5. The help desk will be manned by call managers / operators. The administrator should be able to create, add, edit & delete users (call managers/ operators). He should be able to administer access rights of the entire highway or a section thereof to the call manager.
6. The administrator should be able to place call managers in a hierarchy. The higher priority manager should inherit the rights of a lower priority manager automatically when he is taking overriding control of Emergency Roadside Phones, which are already being controlled by a lower priority manager. There should be minimum 3 hierarchical levels of security for providing user level log in.
7. The system shall provide activity log (audit trail) with user id, time stamp, and action performed, etc.
8. The system shall perform communication health check (link quality check) on all the connected field communication devices and report errors if any on the administrator console.
9. ATMS Control Centre shall have dedicated workstations for Call management. For monitoring purposes, Video monitors shall be setup and would show the location of originating and on-hold calls clearly on relevant map sections of the highway using Roadside communication Frontend Software.
10. The Roadside Communication Frontend Software shall allow disconnection/ termination of the call by call manager only after the call is answered.
11. The user shall have the facility to request for control of any section of highway outside his rights for a reservation period. Control of the said section is released after the reservation period (Request enhanced control rights for a short duration).
12. ATMS Control Centre may have one or more Operators simultaneously logged in to the Roadside communication software to manage their respective sections of the highway.
13. Each workstation and the associated software should allow up to nine calls to be maintained on hold while the current call is being serviced.
14. Call manager/operator logoff shall be allowed only when no call is in progress or on hold.
15. System should ensure that once recorded, the audio cannot be altered; ensuring the audit trail is intact for evidence purposes.
16. System shall provide sufficient storage of all call recordings for entire period of the contract.
17. The call manager/operator shall have the facility to call back any Emergency Roadside Telephone.
18. The call manager/ operator shall also have the facility to patch any call from the Emergency Telephone to an external telephone line (fixed and mobile), local intercom at the ATMS Control Centre and the local mobile radio network
19. The call manager/operator shall have the facility to initiate communication health check on any device within his section of the highway.
20. It shall be possible to switch calls. That is, if a call # 1 is in progress, the call manager can open any other call that is in hold status. Call # 1 shall go hold status.
21. The offered system shall have facility to retrieve/export/ backup (on CD, DVD

or Blu-ray recorders) the desired portion of call record (from a desired date/time to another desired date/time) through the search functionality of the application software.

22. It shall be possible to archive old call records and logs on CD, DVD, Blu-ray recorders, or RAID backup devices. Log of any such activity should be maintained by the system for audit purposes.
23. Database Server shall keep track of all configurations, error data, configuration events, usage events and error events.
24. All the workstations shall be provided with software to play recordings, archive and manage calls. However, managers would require sufficient access rights to use play and archive modules.

10.3.8 Speed Display

1. There shall be Software to acquire and manage data from all the Speed Displays within the installation.
2. The software should be capable of managing any number of Speed displays.
3. The software shall operate on open architecture and integrate/ co-exist with other subsystem software that are installed to manage CCTV, VMS, WIM, and Roadside Communication, apart from the Traffic Management module (where applicable) etc.
4. The software shall store configuration (Current Preset Speed limit, Maximum configurable speed limit, etc.) of each Speed Display in the installation. There shall be options to generate reports of stored device configuration.
5. The administrator should be able to create, add, edit & delete users. He should be able to administer access rights to system resources and functionality as well as access permissions to a list of Speed Displays a user can access.
6. The administrator should be able to place users in a hierarchy. The higher priority user should inherit the rights of a lower priority user automatically when he is taking overriding access rights of Speed displays, which are already being accessed by a lower priority user. There should be minimum 3 hierarchical levels of security for providing user level log in.
7. The system shall provide User activity log (audit trail) with user id, time stamp, and action performed, etc.
8. The software shall receive and process packets of real time online data arriving from all the Speed Displays if such a feature is supported by the speed display.
9. The Speed Displays shall be accessed by ATMS Control Centre operators through workstations with the help of Speed Display Control Workstation Frontend Software.
10. The user shall have the facility to request access rights of any Speed Display outside his rights for a reservation period. Access right of Speed display is released after the reservation period (Request enhanced control rights for a short duration).
11. ATMS Control Centre may have one or more Operators simultaneously accessing the installed Speed displays.
12. The Speed Display Software shall have options to check configuration information, remote diagnostics, data/violation record download etc.
13. Database Server shall keep track of all configurations, error data,

configuration events, usage events and error events.

10.3.9 Communication medium and Infrastructure

1. The communication medium and cabling depends primarily on bandwidth requirement, which in turn is driven by the following three major factors:
   a) Equipment type
   b) installation topology and
   c) Volume (Quantity) of equipment.
2. Since factors a, b, and to some extent c is dependent on vendor solution, a prescriptive specification may be counterproductive. However as a general guideline the following is expected as a bare minimum.
   a) ATMS Control Centre Internal Cabling – combination of Multimode FO and cat-5E or cat-6 Ethernet
   b) CCTV – Single mode FO backbone or dedicated point to point RF links (where FO is not possible) with single mode FO, Cat-5e/Cat-6 or copper coaxial links between switches, camera, encoders etc.
   c) VMS, Speed display and WIM – Low volume traffic can share backbone and switch ports with CCTV. Switch to device may be FO, Cat-5e/Cat-6 or copper coaxial/Twisted pair links. In case the equipment communicates through RS –485 or RS – 422, suitable Ethernet to 485/422 converters need to be provided.

10.3.10 Container Office Cabin

1. It shall be a modular and Pre-fabricated for use as ATMS control centre on site where no concrete building is made available on RoW by NHAI.
2. While being light in weight, it shall possess a high structural strength.
3. It shall be spacious enough to house all the ATMS Control Centre equipment (including the Video wall) as well as the operations and maintenance personnel considering the required seating area (as per ergonomic requirements) for each person and appropriate furniture required. Further it shall be possible to ensure the optimal viewing distance for the video wall size required as per specifications provided in the F&T specifications document.
4. It shall provide adequate space for a conference room (with projection facility)to seat minimum 10 persons. There shall further be provision to include two cabins within the facility for use by senior personnel.
5. It shall be provided with appropriate Fire detection, alarm and Fire extinguishing systems.
6. It shall be provided with a suitable access control system.
7. It shall provide adequate Toilet / washroom facilities for the personnel and visitors.
8. The Power supply equipment (generator, UPS etc.) may be housed in an adjacent cabin suitable for the same.

10.4 Key Hardware Technical Specifications

Servers and Storage should be on 10 GbE LAN network. Firewall is mandatory for field hardware and internet connectivity.
Detailed minimum technical specifications of the key ATMS Control Centre hardware components are as under:

1. NAS Storage:

CPU	Latest Intel or equivalent AMD Processor with fastest speed available in the market
On-board Memory	8 GB RAM or more as per requirement
Number of HDDs Supported	12x 2.5" or 3.5" SATA 6Gb/s, 3Gb/s hot swappable
HD Drive	As per system requirement
Host Interface	2x 4Gbps Fibre, 2x 1Gbps Copper and 2x 6Gbps SAS Ports
RAID Support	RAID levels 0, 1, 5, 5+, 6, 6+
Network Adapter	Dual-port 10GbE network expansion card
Network Transport Protocols	TCP/IP
Network File Protocols	CIFS, NFS, HTTP/HTTPS, FTP, NTP, SNMP, SMTP, DHCP and DNS
Drive Status /Space Monitoring	Supported
OS	MS Windows or Linux with on-site support
Power supply	Hot pluggable Redundant Power Supply

2. Workstation:

CPU	Latest Intel Processor or AMD with fastest speed available in the market (i7 or above or equivalent in AMD)
Mother Board	Intel Original Mother Board
Memory	16 GB DDR RAM or more as per requirement
Hard Drives	1 TB SSD or more as per requirement
Video Card	2 Nos hardware accelerated for connecting 2 monitors
RAID	Supported
Network Adapter	Integrated 10/100/1000 Base –T
Sound Card	Built-in
Disk writer	CD, DVD and Blu Ray
Monitor/Keyboard/Mouse	21" LED TFT/Multimedia/Optical
OS	MS Windows OS Latest version at the time of tender
Anti-Virus Software	Latest software at the time of tender

3. Camera/File/Database Server

On Board CPU	Latest Intel Processor or equivalent AMD with fastest speed available in the market
Memory	32 GB RAM or more as per requirement
Hard Drives	4 TB SSD or higher as required by design of ATMS with RAID 5 Support (As per requirement in case of camera server)
Disk writer	CD, DVD and Blu Ray
Network Adapter	Dual-port 10GbE network expansion card
Video Card	Hardware accelerated(CUDA based GPU or equivalent incase AI models are centralised)
Screen	21" LED TFT/Multimedia/Optical
OS	MS Windows or Linux Latest version at the time of tender

Anti-Virus Software	Latest software at the time of tender
Power Supply	Hot pluggable Redundant Power Supply

4. NVR

Channels Supported	48
CPU	Latest Intel Processor with fastest speed available in the market
Flash	512Mb (DOM)
LED Indicators	Status, LAN, eSATA, 10GbE
LCD or Better Display	Supported
Number of HDDs Supported	8 x 3.5-inch SATA ; SATA 6Gb/s (backward compatible with SATA 3GB/s)
HDD Capacity	32 TB or more as per requirement
HD Drive	As per system requirement
Hot Swap	Supported
RAID Support	RAID levels 0, 1, 5, 5+, 6, 6+
Gigabit LAN port	4
Recording Modes	Continuous, Scheduled, Manual, Alarm
Pre-event and Post eventRecording	Up to 300 seconds pre and post
Audio recording	Supported
Maximum Resolution Supported	Full HD 1080P (HDMI/VGA output)
Drive Status /Space Monitoring	Supported
OS	MS Windows or Embedded Linux with on-site support
Power supply	Hot pluggable Redundant Power Supply

5. Video Wall Controller

Processor	Intel core-i7 @ 3.4GHz or better
Memory	16GB or More
Hard Disk	2 x 500GB or more in RAID-1 supporting hot-plug and redundant
Ethernet	2 or more Gigabit Ethernet ports
Resolution	Support up to 32768 x 32768 pixel desktop
Graphic card(s)	Multichannel (4 or more) cards 2560 x 16008 @ 60Hz on DisplayPortand 1920 x 1200 @ 60 Hz on DVI
Video Inputs	DVI, DisplayPort, composite, RGB analog, IP Streaming
Input Standards supported	PAL, NTSC, VGA, MPEG2, MPEG4, H.264, MJPG, V2D
Power supply	Dual 230V @ 50 Hz input redundant hot-swap compatible.
Form factor	19" Rack mount
OS	MS Windows or Linux with on-site support

10.5 Environmental Specifications

All the control equipment shall be suitable for operation from 0°C to 45°C and relative humidity up to 80 % non-condensing.

10.6 Testing

1. Functionality testing of all the subsystems
2. Verification/Inspection of servers, switches and other hardware.

10.7 Installation and Power Requirements

1. Power shall be obtained from 230V 50 Hz mains provided on site supported bya minimum 2 x 10 kVA (typical) 3 phase UPS of a standard approved make anda 25 kVA 3 phase Diesel Generator set of a standard approved make These power back up systems shall provide power of adequate quality and durability to the system in order to meet the service level requirements.
2. Cabling shall be as per standard structured cabling norms.
3. All Server racks to be backed up by suitably rated exclusive on-line UPS of adequate capacity with a backup time of 2 hour or more. The UPS shall be of a standard approved make.

10.8 Maintenance Requirements

1. The equipment supplied shall remain operable for at least 10 years from the date of supply/Installation.
2. The supplier/Service provider shall undertake to support/maintain and (or) provide spare parts till equipment reaches end of life, which shall not be less than 10 years from the date of supply.

10.9 Operational Requirements

Functional software modules supplied and installed at the ATMS Control Centre to handle different operations like CCTV, VMS etc. shall be able to integrate with/Export data to and import data from the ATMS unified database located in ATMS Control Centre servers.

Chapter 11 Other Relevant Standards and Codes

11. Standards

Equipment and equipment installation shall comply with the latest revision of the applicable Bureau of Indian Standards (BIS). Where no BIS exists for any aspect of equipment manufacture, supply, installation, identification, protection, testing or operation, then the relevant IEC or ISO standard shall apply. CEN or CENELEC standards shall apply where no BIS, ISO or IEC standards exist.

With respect to the above some of the specific standards / Code of Practices include the latest versions of the following:

Sl No	Standard	Relevant to
1	IRC SP 85/ IRC67	For Variable / Changeable message signs
2	IS / IEC 61508	Functional safety
3	IS 14700, CENELEC EN 50081-1: CENELEC EN 50082-1:	EMC compatibility/ EMC Emission compliance/ EMC Immunity
4	BIS 732 or BS 7671	Electrical wiring installation (BIS 732) or Wiring Regulations (BS 7671)
5	IS 2309	Lightning protection
6	IS 3043	Electrical Earthing
7	IS 5216	Safety procedures and practices in Electrical works
8	IS 7689	Control of undesirable static electricity
9	IS 694, IS 1554	PVC Insulated Cables
10	EN 61280-4-1	Fibre-Optic field test related
11	IS 14927	Cable Trunking & Ducting systems
16	EN 50173	Generic/structured cabling
17	IEC 60529	Degrees of Protection provided by Enclosures
18	IS 9000 Part XIV Sect. II	Change of temperature test
19	IEC-571; IS: 9000 Part-III Sect 3	Dry heat test
20	IS 9000 Part II Sect. III	Cold test
21	IS9000 Part V Sect.2 Variant 1	Damp heat test (Cyclic)
22	IS9000 Part IV	Damp heat test (Steady state storage)
23	IS9000 Part XI procedure 3	Salt mist test
24	IS 9000 Part XII	Dust test
25	IS 9000 Part VII, Sec. 2	Bump test
27	BS1363	240V Power Outlet

Sl No	Standard	Relevant to
28	IEEE C62.41 CLASS A or BS EN 62305	Surge Protection
29	IEC 60297 or DIN 41494	Mounting Racks and Shelves
30	ISO 14001	Environment Management System
31	IS456, IS13920, IS1893	Civil Works

Chapter 12 Use of ATMS during Disaster Management

12.1 Introduction

A disaster may be defined as an incident that:

a) Directly affects life and/or health of many people,
b) Adversely affects the environment resulting in an altered environment proving tobe detrimental to human wellbeing
c) Damages material assets on a large scale.

Disasters may broadly be of three types:
a) Natural disasters such as floods, earthquakes etc.
b) Human systems failures such as a dam collapse, building collapse and more importantly those related to Chemical, Biological, Radiological and Nuclear (CBRN)emergencies.
c) Conflict based disasters such as war, terrorism etc.

As the consequences of a disaster invariably are on a larger scale, the standard tools and operating procedures for managing emergencies at facilities like hospitals, highways etc. may turn out to be inadequate. Thus quickly allocating additional resources commensurate with the scale of the event and establishing procedures to enable its coordinated use by services and agencies of different disciplines would assume paramount importance in disaster management.

A very important goal of a good Disaster Management (DM) strategy is to ensure sustainable mobility during disaster events, as only this in turn can ensure the realization of important goals of saving lives and reducing economic damage. Thus the relevance of a highway in Disaster Management arises from this context i.e. as an invaluable lifeline for evacuation of those affected by a disaster and for reaching relief supplies to the affected areas. Further highways themselves are vulnerable to disasters in the form of floods, earthquakes etc. Any disaster that befalls a human settlement also affects the highway(s) connecting it to the rest of the world.

The highway ATMS with its capability to 'sense and capture' the conditions on the highway and its environment, its ability to support structured decision making and implementation, as well as its versatile road-user communication via on-road equipment and mobile devices, becomes a valuable tool to strongly enable the highway's role as the core lifeline.

12.2 Disaster management framework in India

The National Disaster Management Authority (NDMA) is the apex agency having the responsibility for laying down policies, plans and guidelines for Disaster Management and coordinating their enforcement and implementation for ensuring timely and effective response to disasters. The above guidelines assist the Central Ministries, Departments and States to formulate their respective DM plans to be subsequently approved by the NDMA. The National Executive Committee (NEC) playing the role of the executive committee of the NDMA, the State Disaster Management Authority (SDMA), the District Disaster Management Authority (DDMA), the National Disaster Response Force (NDRF) and the National Institute of Disaster Management are the associated institutions that play important roles in disaster management in India.

12.3 Phases in Disaster Management

The phases include Mitigation, Preparedness, Response and Recovery. During the Mitigation phase, although not time critical, it is important that all related organizations get interconnected with adequate data / information transfer. During the preparedness phase, which is however time-critical, the warning data regarding the disaster is shared among theabove organizations. The response phase requires the establishment of critical on-line communication between the organizations and the affected public for achieving quick response to the disaster events. The recovery phase, again not time critical, involves the sharing of large amount of data between organizations for the acts of reconstruction, lessonslearnt etc.

12.4 Highway management agency's perceived role vis-à-vis the Disaster Management framework

It can be seen that the Highway Management Agency has to play the role of an organization actively involved in all phases of the Disaster Management listed above. Specifically, among the above institutions related to Disaster Management in India, the DDMA(under the leadership of the District Collector / District Magistrate) acts as the planning, coordinating and implementing body for DM at the District level and takes all necessary measures for the purposes of disaster management in accordance with the guidelines laid down by the NDMA and SDMA. Thus it logically follows that it is with the DDMA and its associated institutions each highway management agency has to interact with to derive and play its coordinated part in disaster management. Further the highway management agencyshould actively support the NDRF with adequate information (visual and other) when actively engaged in responding to a disaster situation.

With the DDMA a three phase interaction is required. In the initial planning phase thespecific role of the highway management agency in DM is evolved along with the checklists required to be included in the ATMS for implementation during DM. The second phase includes the on-line sharing of highway status and other important information collected byATMS. The third phase, after the DM phase is concluded, is an interaction to evaluateperformance and generate lessons learnt to help enhancement of the checklists.

A schematic of the envisaged interaction is shown in figure 1 below.

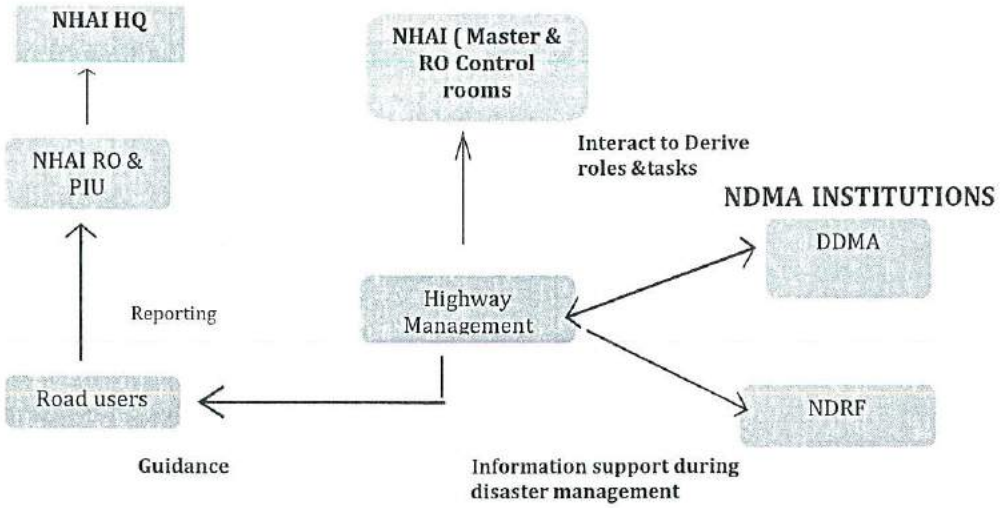


Figure 1 Envisaged interaction of Highway Management for DM

12.5 Role of ATMS during Disaster Management

The ATMS is the single most important tool for use by the highway management agency during disaster management. Table 1.0 below lists out the services that can be provided by the ATMS.

S. No	Beneficiary	ATMS service	Delivery Media
1	Road User	a) Highway status information including i) Flooding and potential flooding of highway locations, bridges ii) Traffic Status / congestion on various sections of the highway and other highways / roads connecting to it. iii) Estimated Travel times iv) Highway ride quality v) Adverse weather conditions vi) Alternate roads open / closed status vii) Law & order issues on specific locations	a) Variable Message Signs b) NHAI Mobile App
2	Road User	Specifics of above information in the form of Question / Answers	Support via the National highway Emergency help line
3	NDRF	a) Road status as above including Estimated travel times b) Best routes to reach affected areas	a) Specific NHAI Mobile App b) Via direct audio communication with the ATMS Control Centre c) Via visit to the ATMS Control Centre to examine the highway status and discuss plan of action(s).

Table 1.0 Services provided by the ATMS for Disaster Management

12.6 Enhancement of ATMS for Disaster Management

In order to play an effective role during DM the ATMS shall be enhanced at least withthe following facilities.

a) Satellite telephone at the ATMS Control Centre to communicate with the NDRF and related agencies. This is expected to be provided by NDMA.

b) Establishing a temporary Satellite data link at the ATMS control centre to transfer dataon-line to the NHAI RO and Master control rooms in case of failure of the existing data link (e.g. MPLS) at the control centre.

c) Portable high bandwidth (Microwave) wireless communication equipment to re-establish data links where the Fibre optic connectivity has failed (due to physical cable damage) due to flooding / earthquake etc.

d) Establishment of an automatic software driven checklist for disaster management as part of the Incident management module of the ATMS software. The checklist shall be generated for the highway in consultation with the DDMA for various types of disasters.

Appendix – A - GUIDELINES / RATIONALE FOR LOCATING - ATMS DEVICE / SYSTEM

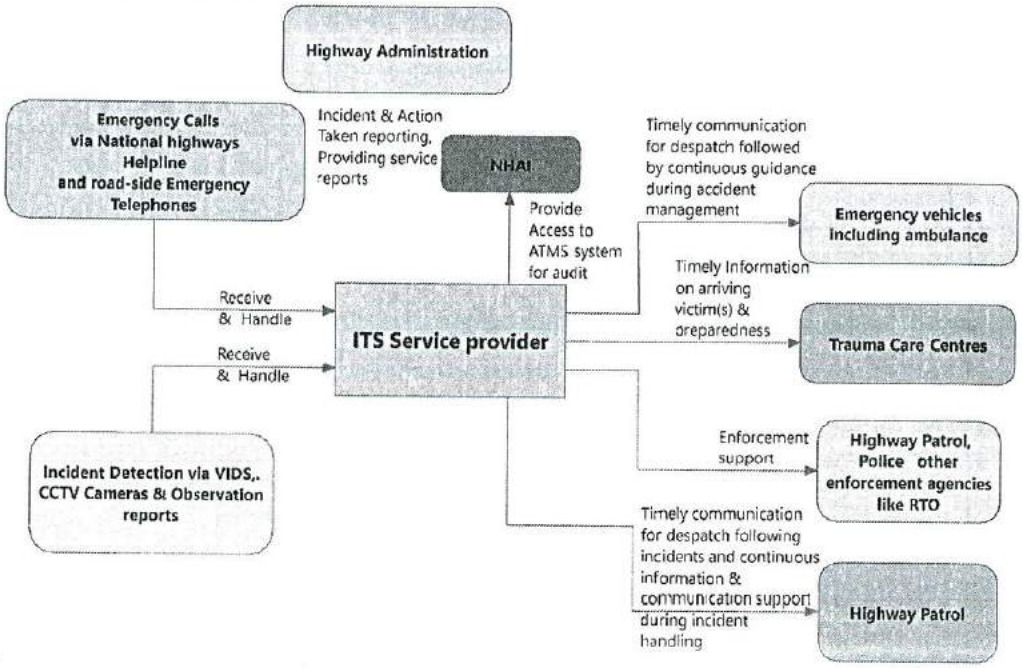
S. No	ITS Device / System	User Need / Application	Rationale for Equipment location
1	PTZ CCTV Camera for TMCS with basic analytics	To monitor traffic conditions (Day & Night) on the highway stretch including junctions, curves, ramps	Min. 1 camera per km, alternating on both sides or on median. Additional cameras to be put up depending on non-linear structure, clovers, interchanges etc such effective surveillance of the entire highway stretch is achieved.
2	VIDES (Overview andANPR Cameras) for VIDES with videoanalytics, enforcement and supported with local warning lights/VMS and e-challans generation	To automatically detect violations of traffic rules and collect evidence for eChallan Generation. Further, monitor (Day and Night) and warn road users on the main carriageway about dangerous traffic conditions (e.g. Contraflow, stopped traffic at Service road merger points, blind turns on the main carriageway & junctions with considerable traffic	Min. 1 VIDES at every 10 km covering each side of Highway. Exact location of the VIDES should be such that it is placed facing accident and incident prone areas (blackspots, potential accident spot locations, clovers, interchanges, busy junctions etc). Additional VIDES can be put up depending on number of such locations as per audit by NHAI or Road Safety Experts or Recommendation of Local Traffic Police. Provision of warning with flashing lights: 150 m before the area of detection 250 m before the area of detection to warn arriving vehicles. Provision of VMS linked to VIDES on Blackspots or high accident prone locations decided by PD, NHAI: 150 m before the area of detection 250 m before the area of detection. If warning VMS is used then warning flashing lights may not be used on that location.

S. No	ITS Device / System	User Need / Application	Rationale for Equipment location
3	VMS Displays (Full Gantry in 4/6 Lane Highways/ Expressways and L Type in 2L+PS Highways, Blackspot Locations, Major Junctions with NH/Expressways)	To inform/warn/guide road users at start of highway stretch & important junctions on highway conditions for travel planning	At entry and exit of Project stretch, Blackspot locations, Major Junctions with NH/Expressways Minimum visible distance on the highway: 250 m Message languages: Hindi, English & Local language
4	VMS (Portable)	To provide local guidance to road users at locations of traffic incidents & road works	Minimum 2 in each Project to be Temporarily deployed before locations related to road works and incidents affecting traffic movement. Message languages : Hindi, English & Local Language
5	Emergency Roadside Telephone	To enable a caller from the highway to provide urgent messages on Accidents/ Incidents and road congestion for supporting the Emergency response System	Only for Zones experiencing telecom blackspots along highway need to be provided by ERT. On long highway stretches (> 2 km) suffering from telecom blackspots, ERT to be located at every 2 Km on both sides of the highway stretch.
6	Vehicle Actuated Speed detection and warning system	To warn road users on over speeding	Gantry Mounted System to be located after every 20km with minimum 2 in each package. Exact of Location of VASD shall be such that it is at maximum distance from nearby VIDES to avoid duplication as VIDES takes care of speed violation as well whereas VASD is just for warning. Further, overspeeding prone areas may be considered for exact placement.
7	Mobile Communication System	To support the O&M team in traffic management and system maintenance	Mobile wireless towers (towers for the main base station and repeater stations) to be appropriately designed and quantities arrived at depending mainly on the highway terrain. Handsets with relevant members of the O&M team along with Portable/Mobile wireless sets on O&M vehicles
8	ATMS Control Centre	Using a suitable electronic and IT system (hardware and software) integrated with the ATMS field equipment, it	Typically at 1 location per 100 km for a highway or one per project depending upon the scheme

S. No	ITS Device / System	User Need / Application	Rationale for Equipment location
		supports centralized Monitoring of highway stretch, receiving emergency calls and active management of accidents including providing system aided guidance and supervision of rescue and traffic Management activities	

Appendix B - Service Level Agreements and Penalties During O&M Period

ATMS SERVICE PROVIDER's MAIN OPERATIONAL FUNCTIONS AND INTERACTION WITH OTHER STAKEHOLDERS



Operational functions

1. Routine monitoring of Highway Traffic to detect abnormal traffic and incidents
2. Receiving Emergency Calls via road-side Emergency Telephones and 24X7 National highways help line
3. Management of Incidents received via the Video Incident Detection Systems & reports from agencies like Highway patrol and others (e.g. damage to road, chemical spilling on road etc)
4. Accident Management on the Traffic Management console including
   - Accident evaluation & timely communication for Despatch of Emergency vehicles and Highway patrol vehicles
   - Selection of and timely communication to selected trauma care centre(s)
   - Timely Communication to Road Users via on-road(VMS) and personal devices (Mobile Apps) to the road users on the accident and related traffic guidance
   - Continuous monitoring of progress of Emergency vehicles
     * Progress of Ambulance(s) towards trauma care centre(s)
     * Progress of vehicles involved in Traffic Normalization
   - Providing relevant information to all stakeholders when required and on demand including information for enforcement with evidence like captured video and data
   - Reporting to Highway Administration and NHAI
     - Time and place of accident
     - Time of communication to Emergency Vehicles
     - Time of victim(s) reached to the trauma care centre(s)
     - Time of traffic normalization
     - Adequately meeting Service levels

Service Level Agreement (SLA) shall become part of Agreement between Employer and the SI. SLA defines the terms of the SI's responsibility in ensuring the timely delivery of the deliverables and the correctness of the same based on the agreed Performance Indicators as detailed in this section. The SI has to comply with Service Levels requirements to ensure adherence to Project timelines, quality and availability of services.

It will be the responsibility of the SI to supply software/automated tools to monitor all the SLAs mentioned below. Unless otherwise specified, calculation of SLAs should be automated through system generated reports.

Note: Penalties shall not be levied on the SI in the following cases:

1. There is a Force Majeure event effecting the SLA which is beyond the control of the SI including natural disasters, adverse weather conditions or network issues attributable to the ISP (to be determined through investigation by the concerned authority).
2. The non-compliance to the SLA has been due to reasons "beyond the control of the SI". Theft cases by default would not be considered as "beyond the control of SI" and will be decided on a case-to-case basis. Damages due to any accident/mishap shall be consideredas "beyond the control of SI". However, Power shutdown or deliberate damage to field devices such as Cameras, Audio Systems etc., would not be considered as "beyond the control of SI".
3. If there is power-outage in the main grid beyond the necessary backup time, the same may be considered as "beyond the control of SI" after due case and intimation has been made toNHAI regarding the same.

The purpose of this Service Level Agreement (hereinafter referred to as SLA) is to clearly define the levels of service which shall be provided by the SI to the Employer for the duration of this Agreement.

Payment Terms:

The SLA metrics provided specifies performance parameters as scoring method, termination trigger and measurement mechanism. Irrespective of payment duration, all SLA calculations, breach conditions and deductions thereon will be done considering quarterly time period. The SLA also specifies the liquidated damages for lower performance and breach conditions. Payment during the O&M phase is linked to the compliance with the SLA metrics. The matrix specifies three levels of performance, namely,

1. The contractor will get 100% of the Contracted value due for the period (as per the 'Payment Schedule' section of the Terms of Reference) if all the baseline performance metrics are complied with and the cumulative credit points are 100
2. The contractor will get lesser payment in case of lower performance. (For e.g. if SLA pointscore is 80 then the SI will get 20% less on the periodic O&M payment – The formula calculating the deductions is "(100 – SLA Point Score)%").
3. Incase the overall performance is less than 50% in the quarter, no amount will be paid forthe entire quarter.
4. In case the score falls below 50 for two consecutive quarters, the Authority can invoke thetermination clause.
5. If the performance of the Agency in respect of any parameter falls below the prescribed termination trigger (in terms of performance metric for a specified time period), the concerned authority will have the right to invoke the termination clause. The periodic payment during O&M phase shall be made after deducting for lower performance as mentioned above. The aforementioned SLA parameters shall be measured as per the individual SLA parameter requirements and measurement methods, through appropriate SLA Measurement tools to be provided by the Contractor and audited by NHAI or nominated representative for accuracy and reliability.

NHAI shall also have the right to conduct, either itself or through any other agency as it may deem fit, an audit / revision of the SLA parameters. The definition of SLAs, shall be reviewed by NHAI on anannual basis after consulting the SI, Project Manager and other experts.

Performance Area	Scoring	Termination Trigger	Measurement Mechanism
Emergency Calls All calls from 1033 or Emergency Telephones are to be answered in less than 30 seconds of calling.	5 points if all emergency calls are picked in less than 30 seconds in first attempt 0 points if 1 or more calls have been missed.	If 0 points in any two quarters in a 12 month period.	Daily shift-wise logs accounting for handling of ALL calls and action taken, time to resolve etc. Authority may take report from 1033 Call Center for actual or mock calls to assess whether SLA has been agreed upon. The same can be used for calculation of penalties.
VIDES Automatic detection of all incidents (categorized as real-time in 4.3.2) in areas under camera surveillance	10 points for 0-5 missed incidents 5 points if >5-10 missed incidents 0 points if more than 10 missed incidents	If 0 points in any two quarters in a 12 month period.	Manual detection of select incident categories on the stretch which is not logged by the Command Centre software automatically through VIDES or TMCS software. NHAI may randomly audit videos collected under VIDES camerasto check this SLA.
VIDES Incident Detection Precision below acceptable limits	10 points if all Incident Types meet their required Precision Criteria 5 points if only 2 or less incident types are not meeting required Precision Criteria 0 points if more than 2 Incident Types are not meeting Required Precision Criteria	If 0 points in any two quarters in a 12 month period.	By randomly assessing automatically detected incidents and manually assessing through video whether they were correctly flagged or not (*Eg. VIDES says wrong-lane driving but on manually checking video it is correct lane*).
VIDES Uptime Hours All cameras in a VIDESunit have to be functioning for the VIDES unit to be considered up. (irrespective issues with power, network etc)	10 points if >= 95% 5 points if >-90% and <95% 0 points for <90%	If 0 points in any two quarters in a 12 month period.	Network Management System with real-time access provided to NHAI or nominated representative.

Performance Area	Scoring	Termination Trigger	Measurement Mechanism
TMCS Uptime Hours cumulatively i.e. total number of hours each TMCS camera has been up/(number of cameras x total hours in billing period)	10 points if >= 95% 5 points if >-90% and <95% 0 points for <90%	If 0 points in any two quarters in a 12 month period.	Network Management System with real-time access provided to NHAI or Nominated Representative.
TMCS Automated or Manual Detection of all accidents and stalled vehicles in areas under camera surveillance in less than 90 seconds of occurance of event	10 points if 0 accidents or incidents missed in detected in less than 90 seconds 5 points if >1 and <=5 accidents/incidents missed in detection in less than 90 seconds 0 points if >5 accidents/incidents missed in detection in less than 90 seconds	If 0 points in any two quarters in a 12 month period.	By manually assessing recorded videos of TMCS and comparing with the ticketing system where each and every accident/incident is logged. If accident/incident is not logged, it will be considered a violation.
ANPR Accuracy of ANPR cameras	10 points if >=95% 5 points if 90-95% 0 points if <90%	If 0 points in any two quarters in a 12 month period.	SI will auto-generate reports on number of number plates that were wrongly read and/or missed completely from reading. Further, NHAI or nominated representative can conduct random audits on the recorded footages from any ANPR cameras
eChallan Validating and Uploading evidence on Government's eChallaan software for processing in less than 48 hours of Violation Occurring	5 points if zero offences have been missed in uploading 2.5 points if >0 and =<5 offences have been missed in uploading 0 points if more than 5 offences have been missed in uploading	If 0 points in any two quarters in a 12 month period.	By auditing the incident generation time on the VIDES software with the eChallaan upload receipts/time.
Incident Response Dispatch of Ambulance/RPV in less than 90 seconds of occurrence of accident/incident	5 points if zero instances of dispatches took more than 90 seconds. 2.5 points if 1-3 instances of dispatches took more than 90 seconds minute 0 points if >3 instance of dispatches took more than 90 seconds	If 0 points in any two quarters in a 12 month period.	By auditing the incident generation time on the VIDES software the time in which the RPV/Ambulance was notified about the incident through call/radio any other accepted mechanism as logged. NHAI may conduct mock-drills as well to check this SLA

Performance Area	Scoring	Termination Trigger	Measurement Mechanism
Video Wall 99% uptime in the billing period	5 points if >= 99% 2.5 points if >=95% and <99% 0 points for <95%	If 0 points in any two quarters in a 12 month period.	Network Management System with real-time access provided to NHAI or Nominated Representative.
ATMS Command Centre Overall application availability at Command Centre	5 points if >= 99% 2.5 points if >=95% and <99% 0 points for <95%	If 0 points in any two quarters in a 12 month period.	Network Management System with real-time access provided to NHAI or Nominated Representative.
Variable Messaging System Uptime Target Uptime = Number of VMS x Number of Hours in Billing Period	5 points if >= 95% 2.5 points if >-90% and <95% 0 points for <90%	If 0 points in any two quarters in a 12 month period.	Network Management System with real-time access provided to NHAI or Nominated Representative.
Variable Messaging System Usage Whether VMS was updated with relevant information when relevant incident was detected in proximity of VMS (Chapter 4 VIDES).	5 points if 0 instances where incident was detected by VIDES butnot updated on nearbyVMS. 2.5 points if >0 and <=5 instances where incident was detected by VIDES but not updated on nearby VMS 0 points if more than 5 missed instances	If 0 points in any two quarter in a 12 month period	By auditing system generated VIDES andVMS logs.
Vehicle Actuated Speed Display Target Uptime = Number of VASD x Number of Hours in Billing Period)	5 points if >= 95% 0.5 points if >-90% and <95% 0 points for <90%	If 0 points in any two quarters in a 12 month period.	

Instance Based Deductions

These deductions are to be levied for each violation that occurs. These deductions are applied to the periodic O&M bill over and above the SLA based payment calculation above. Instance baseddeductions are incremental and cumulatively add up.

Instance	Criteria	Penalty
API based Data Sharing with NHAI ERP/MIS System	API or Upload based sharing of reports from ATMS software to NHAI ERP as prescribed in the contract and any notification/circulars issued from time to time.	5000/- per instance of data sharing missed by SI at prescribed schedules.

Instance	Criteria	Penalty
Remote Video Check NHAI should be able to access any Remote TMCS or Overview camera through IP and authentication details provided by Command Centre at all times.	If for any reasons (wrong IP/password, network downtime etc) the footage is not visible then it will be considered a violation. Simple screenshot with datetime visible shall be enough to prove violation by NHAI. If SI has not uploaded/registered camera details on ATMS Module on NHAI ERP/MIS it shall also be considered violation as part of this.	5000/- per camera per day. Same camera will not be checked again in the same day if violation found and recorded.
Non-availability of video recording of accident occurred in surveillance zone of TMCS or VIDES	Self-explanatory	Rs 25,000/- per instance

Note: Any downtime for maintenance should be within the SLA periods and with written intimation to NHAI. Only in special circumstances and in written consideration of the PD that thedowntime may extend SLA period.

All SLAs (instance based on percentage based) are mutually exclusive. For eg. If 2 incidents go unnoticed during unplanned downtime of the VIDES cameras, it will still be considered a breach ofSLA regarding incident detection.

Non Compliance to Safety Standards at Site

Failure by the System Integrator's personnel in maintaining the safety standards at the site at anytime shall attract penalty on every instance noticed by NHAI (or its representatives).

- Staff working without safety gears – penalty of INR 10,000 per instance. In case of repeated instance by the same staff member of the System Integrator, the penalty shall be doubled per instance. The System Integrator shall have to replace the repeated offenders /sub-System Integrator (safety lapses more than 3 times) with immediate effect.
- Improper safety measures at site / safety hazard to the commuters due to poor workmanship, etc., / System Integrator's vehicle wrongly parked at site / System Integrator's vehicle moving in wrong direction / working during low visibility hours or atnight time without proper safety measures warning signages and lighting/ improper trafficdiversion / nonstandard warning signages etc. / unauthorized lane closure / traffic rule violation – minimum penalty of INR 1,00,000 per instance shall be imposed on recommendation of NHAI (or its representatives). In case of repeated instance, the penaltyshall be doubled per instance. The System Integrator shall have to replace the repeated offenders / sub-System Integrator (safety lapses more than 2 times) with immediate effect. NHAI or its representatives shall also take legal action against the errant staff / sub-SystemIntegrator of the System Integrator, as such safety lapses may lead to major safety concern/ hazard for the road users as well as the workers.

Penalty for Delay in Staff Mobilization and/or Absence Post Mobilization

Delay in submission of detailed written statements and/or mobilization of Key Personnel in O&M period (Section 1.1 in Appendix C) shall attract penalty @ INR 5000/- (Rupees Five Thousand) per day per Personnel. In case the delay is more than 3 weeks, NHAI reserves the right to invoke the Bid Securing Declaration and PBG towards the aforesaid penalty and may proceed with the revocation of LOA or termination of the project, as the case may be. Incase of post-mobilization mobilization,the same penalty will be applicable for each day of absenteeism. Service Provider has to have replacements at all times and ensure 100% staff

availability. Replacements have to be be informed to PD in writing beforehand and to be well trained and meeting qualification requirements. Attendance of all staff and replacements is to be monitored through biometric system.

Penalty for Data Manipulation, Fudging or Other Fraudulent Practices

If the System Integrator is found manipulating any data that it reports or stores (including SLAreports but not limited to), a penalty of Rs 10,00,000 will be imposed with an warning and the ifthe fudging was related to SLAs the entire due amount for that quarter will be deducted. For any repeat instance of data fudging or manipulation, NHAI may consider termination of the contractand forfeiture of performance bank guarantee.

Penalty for Data Breach or Mis-use of Data

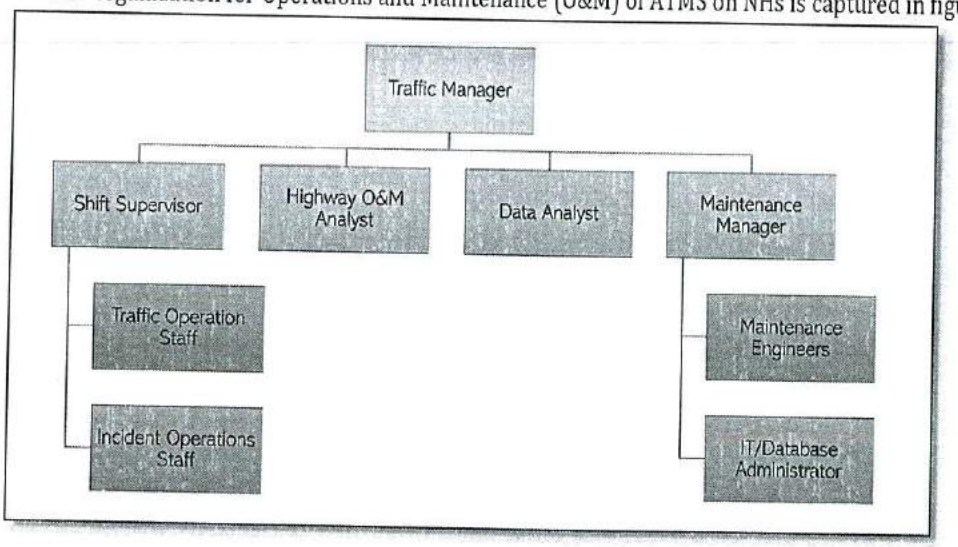
As per provisions of Digital Personal Data Protection Bill, 2023 or any other relevant acts or rulenotified by the Government. The ATMS provider will be governed as a Data Fiduciary and the principles so prescribed under the DPDPB'23 Act.

Appendix C – ATMS Control Centre Organization and Staffing

1. ATMS Control Centre Organization and Staffing

1.1 The Organization

The organization for Operations and Maintenance (O&M) of ATMS on NHs is captured in figure below.



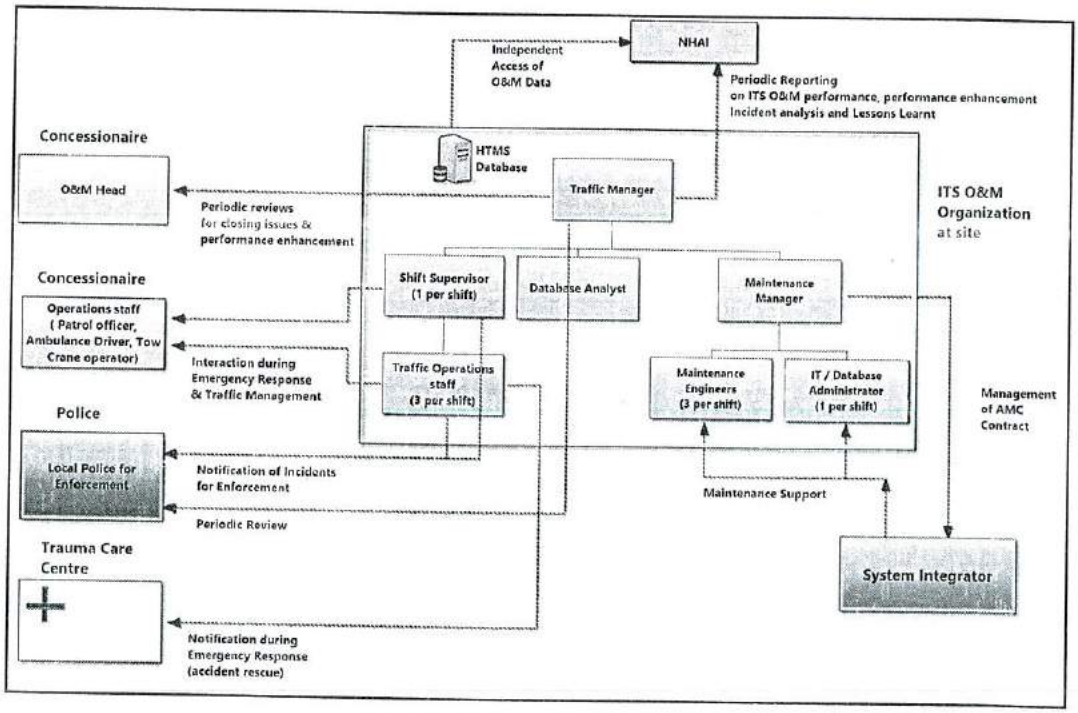
Minimum educational qualifications and experience of the ATMS Control Centre personnel is summarized below.

No	Role / Position	No of Personnel	Minimum Qualifications	
			Educational	Work Experience
1	Traffic manager	1	Engineering Graduate in Civilengineering with Traffic Management Elective	Minimum 5 year experience in managing Control room operations inHighway Traffic management
2	Shift Supervisor	3 (1 per shift)	Graduate (preferably Science)	Minimum 3 year experience in a similar position in Highway TrafficManagement
3	Traffic Operations Staff (One person shouldn't be seeing more than 15 TMCS cameras)	(Number ofTMCS Cameras/15)People per shift) Total 3 shift.	Graduate (preferably Science)	Minimum 2 year experience in a similar position in Highway Traffic Management.
4	Incident Operations Staff	1 per 5 VIDES per system	Graduate	3 years of experience
5	Maintenance Manager	1	Engineering Graduate in Electronics	Minimum 5 years in maintenance

				management of similar systems
6	Maintenance Engineers	9 (3 per shift)	Diploma in Electronics and Certificate course in NetworkManagement	Minimum 3 year experience inmaintaining similar systems.
7	Database / IT admin	3 (1 per shift)	MCA or Graudate inEngineering	Minimum 6 year experience in maintaining Similar systems, Databases, IT setups (hardware and software)
8	Data analyst	1	MCA or Graduate inEngineering	Minimum 3 year experience in Data analysis, visualization and BusinessIntelligence.
9	Highway O&M Analyst	1 (only day shift)	Graduate or Diploma (Civil related)	Minimum 3 years of experience in Highway O&M Inspections

1.2 Stakeholder Interaction

Proposed interaction between members of the O&M organization and their interaction with the stakeholders isshown in figure below.



O&M Team – Stakeholder Interaction

1.3 Dedicated Vehicle should be deployed 24x7 for attending maintenance requirement of ATMS.

1.4 Aadhaar biometric based attendance system should be there for all staff and monthly system generated attendance reports should be submitted. Any change in personnel has to be reported by the Concessionaire to Authority in writing before the change has taken place. If any staff other thanreported staff is found present in the command centre, it will lead to penalties pertaining to absenceof expected staff.

2 Operations of the ATMS

2.1 Essential operations

The essential operations related to the proposed ATMS include a) routine monitoring of the highway and b)Managing accidents / incidents on the Traffic management and rescue console. They are required to be appropriately carried out by the Traffic Operator with suitable support from other staff.

2.2 Roles of members of the Operations team

2.2.1 Highway O&M Analyst

TMCS cameras provide view of the entire highway. The role of the Highway O&M analyst will be to scan the TMCS feeds to identify Highway O&M defects (potholes, illegal enchroachments, illegal median openings etc) on the highway that can lead to road-safety concerns and report them toNHAI's O&M Module/App through dedicated login created for the ATMS system.

2.2.2 Traffic Operator

a) Routine monitoring of the highway including

i. Handling Emergency Calls on the Emergency Call console(s) for calls originating from roadside emergency telephones and those received from '1033' National Highways Incidence Management Helpline Number, making incident reports and alerting the Traffic operator manning the Traffic management and rescue console.

ii. Traffic monitoring
   a) Visual monitoring using CCTV cameras located along the highway.
   b) Data evaluation of traffic flow measured by the Incident detection systems.

iii. Monitoring of movement of utility vehicles (Ambulance, Patrol Vehicles and breakdown cranes) via GPS tracking, supported by CCTV monitoring.

iv. Monitoring of the status of the ATMS system including the operational status of each ATMS system / subsystem (in the field and in the ATMS Control Centre). This also includes receiving and recording any third-party (e.g. road user) complaints on system malfunction (e.g. VMS display).

v. Monitoring the road maintenance works currently in progress and the deployment of suitable ATMS for road safety countermeasure. This will also include disseminate necessary precaution against road damage(s) and prone to potential accidents.
   a) Suitably locating mobile VMS near maintenance sites
   b) Selecting and enabling the sending of appropriate messages via VMS and Mobileapps

vi. Logging of the above activities on a log book with adequate details including the Dateand time, detailed system status including major / minor faults, if any.

vii. Generation of following shift-wise reports
   a) Incident report (e.g. those detected by the Incident detection system).
   b) Emergency Call report with incident details.
   c) Event report related to system status and system operation.
   d) Traffic count report at specific locations.
   e) Report of messages displayed on Variable Message Signs.
   f) Weather status report.

g) Accident report including details of action taken in rescue of victims and trafficrestoration.
h) Traffic movement report of Utility vehicles (Patrol vehicles, Ambulances and breakdown crane.
i) Asset status report including the status (whether present and the operational status) of all ATMS assets down to each equipment.
j) System performance report in terms of adequate quality and speed of response. This report shall integrate the status of individual equipment from the network management system.
k) Operations personnel Attendance report.1.

b) Managing accidents / incidents:

i) Operation of the Traffic management and rescue console and facilitate guidance to highwaypatrol perform their role on the ground.
ii) Facilitate decision making based on the information provided by the ATMS system andadequate communication with the stakeholders participating in the rescue and traffic normalization. Communicate with the stakeholders by providing them with the necessary information (e.g. providing accident details to the police) in a timely manner and taking in essential information for effective decision.
iii) Ensure that the rescue and traffic normalization actions are logically concluded.

2.2.3 Shift Supervisor

a) Oversee and provide guidance to the Traffic operators in carrying out their functions.
b) Interact with the stakeholders in a manner to support Traffic operators.

2.2.4 Data Analyst

This is essentially a supportive role and involves following:

a) Perform analysis on 'Big Data' collected and stored in the ATMS database and provide insights on the highway's performance (Traffic volume, disruptions, accidents, repeat incidents, Operational effectiveness, etc.) to the Traffic Manager.
b) Generate and provide specific 'on-demand' analytical reports to the Traffic Manager and NHAI PD for process improvement.

2.2.5 Traffic Manager

The Traffic manager oversees the complete operations at site. The role mainly includes

a) Monitoring the operational efficiency of the team. This includes the analysis (based on system reports and direct observation) of theteam's performance and determining the gaps for improvement.
b) Improving Operational procedures based on the above analysis
c) Planning and implementing training programs for the team based on the above analysis.
d) Interaction with stakeholders
   i) As a matter of support during routine operations and accident management
   ii) For evaluating team performance and planning improvement strategies and actions forrescue, traffic normalization and traffic enforcement.
e) Play the role of the administrative head at site.
f) Reporting to the O&M top management on team performance

2. Maintenance

2.1 Maintenance Functions

The Maintenance function consists of the following activities:

2.1.1 Scheduled/Routine Maintenance Service - This involves the provision of routine maintenance service on all systems, system components and ancillary equipment to meet the service level requirements.

2.1.2 Breakdown/Corrective Maintenance Service –This involves the provision of maintenance service in case of breakdown (i.e. repair) on all minor/ major systems, system components and ancillary equipment to meet service level requirements.

2.1.3 Software Upgrades – This involves the implementation of new versions of software released time to time by the system integrator.

2.1.4 Verify System Calibration - Calibration will be performed periodically and / or as per manufacturer's requirements on each relevant equipment.

2.1.5 Software Support Service & Network Solution Service – This involves Data management, Software And Network Solution Support Services;

2.1.6 Technical Support – This activity is to provide engineering and technical support as and when required;

2.1.7 Provide Spare Parts Supply and Management. It is important to hold, at any point oftime, adequate spares to enable meeting the service level requirements.

2.2 Routine Maintenance Function

The objective of electronic equipment maintenance shall be to ensure reliability, to enhance its economic life and toimprove its efficiency. Routine maintenance consists of a fixed set of checks, measurements, cleaning and calibration. These activities shall be based on Equipment Service Provider's specifications and general maintenance practices that include but not limited to:

2.2.1 Checking the condition of components, e.g. check connections for signs of deterioration.

2.2.2 Preparation of planned yearly/ monthly routine maintenance schedule.

2.2.3 Perform the maintenance works as per agreed schedule. Any Changes to the schedule shall be notified to NHAI by submitting the Change Routine Maintenance Schedule.

2.2.4 Provide timely information to the operations team on the planned maintenance work so that adequate advance communication can be provided to the road user and proper traffic guidance actions taken.

2.2.5 Check voltage levels: Power supply levels are crucial to the effective operation of electronic equipment. Borderline levels could lead to intermittent faults and damage to components.

2.2.6 Voltage level changes are caused by the deterioration of capacitors, transformers and semiconductor components.

2.2.7 Certain measurements can also be performed to check the status of elements of the system, i.e. Impedance and isolation tests.

2.2.8 Mechanical components need routine cleaning and lubrication to ensure their effective operation.

2.2.9 Preparation and submission of monthly performance report.

- Summary of rectification of notified problems.
- Maintenance schedule and actual date of maintenance works.
- Records of communication on the occurrence of delay of routine maintenance and rectification works.

2.2.10 Rapid rectification of defects found during routine maintenance.

2.2.11 Necessary safety procedures / guidelines shall be followed during routine maintenance.

2.3 Data Management and Software Support Services (including software housekeeping)

This essentially includes

(a) Continuous monitoring of the data and software performance at the field equipment, the communication system and the ATMS Control Centre system (e.g. Server) level to ensure data and software system stability at all times.
(b) Immediate rectification of any problem and data recovery
(c) Provide periodic housekeeping works on PC, Servers, Data, and Software related to the ATMS. They include inspection and update of related applications and operating system software.

2.4 Repair / Corrective Maintenance

This covers 24-Hours on site service to respond and rectify any fault on the ATMS reported by the Operations team or detected on own inspection, to meet the uptimes defined in the Service Level Requirements. The maintenance team will solve all issues and will provide corrective maintenance Services for all break down related to Data, PC, Servers, and Data Software Systems. The team will also manage all requests, questions, and enable off-site teams to trouble shoot via online links. The team will also support back and restore functions related to all ATMS equipment.

2.5 Roles of Members of the Maintenance Team

2.5.1. Maintenance Engineer

The maintenance engineers will be normally engaged in routine maintenance activity as per the maintenance schedule. However as a top priority they will switch over to corrective services in case of receipt of complaints about equipment failure / malfunction. A timely and quality work on routine maintenance will normally reducethe need for corrective services.

2.5.2. IT / Database Administrator

The Database administrator is responsible for data management and software support services taking thesupport of maintenance engineers wherever required.

2.5.3. Maintenance Manager

The maintenance manager is responsible for meeting the maintenance service level requirements. Her / Hisrole specifically includes

2.5.3.1. Monitoring the operational efficiency of the team with respect to meeting the service level requirements. This includes the analysis (based on system reports and direct observation) of the team's performance and determining the gaps for improvement.
2.5.3.2. Improving maintenance procedures (including the spares holding policy) based on the above analysis
2.5.3.3. Planning and implementing training programs for the team based on the above analysis.
2.5.3.4. Interacting with stakeholders along with the Operations team in evolving better maintenance practices, optimal maintenance schedules and contribute towards improvements in operations.

2.5.4. Traffic Manager

2.5.4.1. Play the role of the administrative head at site.

2.5.4.2. Evaluate the performance of the maintenance manager and support her / his initiatives on process improvements and training.

2.5.4.3. Reporting to the O&M top management on team performance.

Appendix D - Reporting requirements and Details Regarding Integration with Data Lake

1. Systems Registration

System	Chainage and Direction	Lat/Long	Additional Details #1	Additional Details #2
VID/VMS/TMCS/VASD				

When SI registers each equipment on DataLake, a unique **EQUIPMENTID** will be generated for each and provided back to ATMS. All future reporting regarding those systems will contain the unique ID. In-case, the equipment is no longer active or the location has been changed then a new ID shall be generated for the equipment.

2. Camera Registration

EQUIPMENTID	Camera ID	Camera Public IP with Authentication Included	Type of Camera	Lane/Direction/
			Overview, ANPR, TMCS, Internal Command Centre	

System Registration and Camera Registration on Data Lake should be completed before the Go-Live of the Project and Sign-off.

3. Equipment System Uptime (100% System Generated)

EQUIPMENTID	Date	Uptime Minutes	Downtime Minutes	
			Overview, ANPR, TMCS, Internal Command Centre	

For Equipments with more than one Camera (VIDES), downtime of even single camera will be considered downtime for the equipment as a whole.

4. Automated Incident Log Report (Partly System Generated)
To assess the healthy functioning of key incident management activities.

Type of Incident	Detection Datetime	Source of Incident	Type of Vehicle	Number Plate	Action Taken
Based on Section __		VIDES, TMCS or Manually Detected by Ground Team or Other	Identified through ATCC		RPV Dispatch, eChalaan, None etc.

5. Vaahan Integration and Challan Report

Incident ID	Incident Type	Datetime of Incident	Automatic/Manual	Chalaan Forwarded Datetime	Number Plate ofVehicle
				Overview, ANPR, TMCS, Command Centre	

6. Emergency Call Report
Number of calls received from 1033 or Local Enforcement Agencies and Action Taken.

Datetime	Call Source (1033, Local etc)	Type of Incident	Time of Dispatch of Vehicle	Time of Reaching of Vehicle	Time for Resolution