



Advance Traffic Management System (ATMS) on National Highways

Functional and Technical Specifications



National Highways Authority of India

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

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**Abbreviations**

The following abbreviations shall refer to the words presented hereunder throughout Particular Technical Specifications:

Acronym	Definition
ANPR	Automatic Number Plate Reader
ANSI	American National Standards Institute
API	Application Programming Interface
ATCC	Automatic Traffic Counter and Classifier
ATMS	Advance Traffic Management System
ATS	Automatic Transfer Switch
CCD	Charge Coupled Device
CCTV	Closed Circuit Television
CIF	Common Intermediate Format
CMOS	Complementary Metal-Oxide-Semiconductor
CSMA/CD	Carrier Sense Multiple Access with Collision Detect
D/D	Detailed Engineering Design
DC Power	Direct Current Power
DCT	Discrete Cosine Transform
DDR	Dual Data Rate
DEG	Diesel Engine Generator
DLP	Defects Liability period
DSF	Dispersion- Shifted Fibre
ECC	Error Correcting Code
ECS	Emergency Call System
EIRP	Equivalent Isotropically Radiated Power
EIRR	Economic Internal Rate of Return
ETC	Electronic Toll Collection
ETSI	European Telecommunications Standards Institute
F/S	Feasibility Study
FOC	Fibre Optic Cable
FON	Fibre Optic Node
FTP	File Transfer Protocol
GBIC	Gigabit Interface Converter
GPRS	General Packet Radio Service
GSM	Global System for Mobile Communications
HDTV	High-definition Television
HTTP	Hypertext Transfer Protocol
IC	Interchange
IC Card	Integrated Circuit Card (ICC)
IHMCL	Indian Highway Management Company Limited
IP	Internet Protocol
IP-PBX	Internet Protocol - Private Branch Exchange
ISO	International Organization for Standardization
IT	Information Technology
ITS	Intelligent Transport System
IMS	Incident Monitoring System
ITU-R	International Telecommunication Union – Radio communications Sector
ITU-T	International Telecommunication Union - Telecommunication Standardization Sector
JPEG	Joint Photographic Experts Group
LAN	Local Area Network

Acronym	Definition
LED	Light-emitting Diode
MCBF	Mean Cycle Between Failures
MoRTH	Ministry of Road Transport and Highway
MPEG	Moving Picture Experts Group
MTBF	Mean Time Between Failures
MTTR	Mean Time to Repair
NH	National Highway
NHAI	National Highways Authority of India
NTP	Network Time Protocol
VRS	Video Recording Server
O&M	Operation and Maintenance
OD	Origin/Destination
ONVIF	Open Network Video Interface Forum
P/Q	Prequalification
PA	Parking Area
PBX	Private Branch Exchange
PCS	Physical Coding Sublayer
PCU	Passenger Car Unit
PDB	Power Distribution Board
PIU	Project Implementation Unit
PMU	Project Management Unit
PPP	Point – to – Point Protocol
PTZ	Pan, Tilt, and Zoom (function)
PVC	Polyvinyl Chloride
QCIF	Quarter Common Intermediate Format
RAID	Redundant Array of Inexpensive Disks
RFP	Request for Proposal
SDH	Synchronous Digital Hierarchy
SDTV	Standard-definition Television
SIM	Subscriber Identity Module
SNMP	Simple Network Management Protocol
SNTP	Simple Network Time Protocol
TCP	Transmission Control Protocol
TEDI	Transport Engineering Design, Incorporated
TMCS	Traffic Monitor Camera System
TMC	Traffic Management Centre
TMS	Toll Management System
TOR	Terms of Reference
TTMS	Travel Time Measurement System
UDP	User Datagram Protocol
UPS	Uninterruptible Power Supply
VIDS	Video Incident Detection System
VoIP	Voice over IP
VSDS	Vehicle Speed Detection System



Section 01 General Requirements

1. Background

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, Ministry of 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:87-2013 (Manual of Specification and Standards for Six-laning of Highways through PPP), IRC:SP:84- 2014 (Manual of Specification and Standards for Four-laning of Highways through PPP), and MoRTH manual prescribing Specification for Road 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 to serve the desired purpose of Intelligent Transportation Systems meant to deliver tangible service to address the road safety.

An efficient and integrated Advance Traffic Management System shall be a proactive tool to assist NHAI in achieving MoRTH's vision **"To make the transport on roads efficient, safe, and sustainable. To reduce the fatalities on roads by half compared to 2010 reported deaths."**

The Ministry is also working to improve the quality of accident data collection with use of IT based systems which would also help in getting the real-time causative analysis of the road accidents. It will be prudent to implement Intelligent Transportation system to enhance road safety and effective incident management.

The ATMS system envisaged by the National Highways Authority of India (NHAI) is to make use of Intelligent Transportation System (ITS) as an effective tool to enhance road / user / commuter safety by:

- Early detection of incidents and provide early warning to road-users for accident prevention,
- To save lives by enabling the victim to be rescued within the golden hour, and
- Efficient traffic management during incident management.
- Maximizing traffic throughput on the highway

The objective of ATMS envisaged by the Authority to make road travel efficient and sustainable by enabling rapid clearance of traffic congestion with efficient incident detection & management, provide real-time valuable travel advisories and enhancing traveller journey experience, and provide Stress-free travel by supporting effective and reliable accident / incident management, reliable enforcement, and useful travel advisories.

The ATMS system has been designed to assist the Authority in substantial reduction in accidents due to early incident detection and warning, saving of human lives within the 'Golden hour'. The ATMS system shall assist in reduction of traffic congestion incidents there by improvement in average travel time (within speed limit) by 20-30% and high level of enforcement leads to significant reduction in over-speeding.

The basis of selection of Sub-systems & placement of Key ATMS Components shall be based on the multiple site surveys that shall be conducted by the Concessionaire with ITS Consultant and NHAI team in coordination with the concerned Police department and other stakeholders. Black-spots shall be identified during the surveys and crucial sub-systems to monitor & alert the users shall be proposed.

The system shall intelligently monitor the entire stretch of the expressway with the help of PTZ surveillance cameras and video incident detection system. The system shall automatically detect any incident on the highways/expressways and alert the route patrol team/rescue team about the incident, hence the incident management module of the system shall be able to reduce the response time and help the rescue team to provide the required assistance to the accident victims within the Golden hour. Early detection of incident shall enable the rescue teams in providing appropriate warnings to the road users



about the incident and early action to clear the obstacles from roads to prevent further incidents and reduce congestion due to the incidents.

The work shall include Design, Supply, Installation, Testing, Commissioning, Configuration, System Integration, Operations and Maintenance of Advance Traffic Management System (ATMS) on the National Highway.

The project shall be a complete turnkey solution with provision of skilled resources at all locations for operations.

This Document describes functional requirements envisaged by NHAI. In addition, the minimum technical specifications have been prescribed in this document, wherever indispensable. The Concessionaire is responsible for the design of complete project and the system architecture as per the best industry practices, to deliver state-of-the-art solution to NHAI. Any consideration affecting safety, security, redundancy, and compliance to stipulated provision prescribed by government authorities is the responsibility of the Concessionaire and shall be duly taken care of to ensure adherence to minimum functional and technical requirement stipulated in this document as well as the SLA parameters.

2. Scope of work

- a. The 'Concessionaire' hereafter may be called as 'Contractor' or 'System Integrator' shall conduct the field survey, preparation of design drawings and supply of ATMS equipment and materials, spare parts, test equipment, tools and materials, factory inspection (inspection of equipment & materials upon delivery), training, transportation and site delivery, construction and installation, preparation of as-built drawings, testing and commissioning, Operations and Maintenance of the ATMS project.
- b. The scope of the works under this Document is deployment of Advance Traffic Management System (ATMS) including the Digital Transmission System, on Turnkey basis by the Concessionaire and Operations and Maintenance period as specified in the concession agreement.
- c. The Concessionaire shall set up the control center and sub-centres in the space provided by NHAI for the same. The control center and sub-centres, having minimum 250 sqm plinth area, shall include Operation room (suitable to accommodate the video wall and ATMS operators workstations such that the minimum distance between video wall and first row of workstation is minimum 3 meters), Server room, UPS room, Spare room, Incharge cabin, NHAI cabin, Independent Engineer cabin, pantry, toilet, etc of suitable size to accommodate the equipment and staff required for the project. The scope of civil works, interior works, MEP works, for construction and setting up the Control centre and sub-centres, including all 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, etc. shall be decided by the Concessionaire.
- d. The Concessionaire shall also undertake the works that are not specifically mentioned in this Document and in the reference Drawings but essential for the efficient implementation and operations of the ATMS.
- e. The requirements stated herein shall be construed as minimum requirement and meeting the respective requirements shall not relieve the Concessionaire from the responsibility of supplying the ATMS that functions efficiently as a system and carry out its Operation & Maintenance for a period of five years as stipulated.
- f. The Concessionaire shall check and review the design and this document prepared by the NHAI, and execute the supplemental and/or additional and/or detailed design work as necessary at the Concessionaire's cost and time, so that the Concessionaire will supply and deliver the workable Advanced Traffic Management System (ATMS) which will suit the intended purpose when completed. The Concessionaire shall promptly notify the NHAI and the Independent Engineer (appointed by NHAI for supervision of the ITS/ATMS works), of any error, omission, fault or any other defect in the design of or this Document for the Works which he discovers when reviewing the Contract Documents or in the process of execution of the Works or during the Operation & Maintenance Phase.



- g. The Concessionaire shall provide the entire system and facilities on a “single responsibility” basis such that the Contract Price covers all Concessionaire’s obligations mentioned in or to be reasonably inferred from this documents in respect of the design, manufacture, procurement, construction, installation, adjustment and testing of the Works and remedying any defect therein. This includes all requirements under the Concessionaire’s responsibilities for testing and commissioning of the systems and facilities, and where required by this document, the acquisition of all permits, approvals and license, etc.; the training services and such other items and services as may be specified in this document.
- h. The Concessionaire shall be responsible for Integration of ATMS system and sub-systems with the NHAI Mobile App for the road users as per the requirement raised from time to time by the IT Division of the NHAI or its authorized agency.
- i. The Concessionaire shall be responsible for Integration of ATMS system and sub-systems with the NHAI Command and Control Centre at NHAI HQ, RO, PIU, ATMS TMC/Control Centre of other NH/SH projects connected to the project, 1033 control centre, Dial 112/100, Smart City ICC, Disaster Management Centres, Police Control room, NIC ITMS, Vahan database, Enforcement Agency, etc. for seamless flow and exchange of data and information from project to NHAI offices / control centres/ command centres as per the requirement raised from time to time by the IT/Electronics division of NHAI or its authorized agency.
- j. The component systems comprising ATMS to be constructed under the Contract shall include but not be limited to the following component systems:

Section 01	General Requirements
Section 02	Design Requirements
Section 03	Central Processing System (CPS)
Section 04	Traffic Monitor Camera System (TMCS)
Section 05	Video Incident Detection System (VIDS)
Section 06	Vehicle Speed Detection System (VSIDS)
Section 07	Adaptive Traffic Signal Control System (ATSC)
Section 08	Power and Other Cables, Power conditioning equipment
Section 09	Digital Transmission System (DTS)
Section 10	Facility Monitoring System (FMS)

3. Work Demarcation between ATMS works and Civil works

- a. Work Demarcation between ATMS works and Civil works are the following.
- b. The Concessionaire shall coordinate with civil contractor and shall consider detail demarcation.

1. Highway

Item	ATMS Project	Civil Project
Power Cable	Cable, Conduit and Manhole at equipment location	ROW
OF Cable	1. Cable and Conduit to Equipment from Handhole/ Manhole 2. Conduit and Handhole/ Manhole along with Highway/ Expressway	ROW
Equipment	1. Foundation 2. Earthing at each location	ROW

2. Buildings

Item	ATMS Project	Civil Project
Traffic Management Centre/ Sub-Centre	Civil works	Suitable space for setting up the Control Center and Sub-Centre on the project stretch. (In case the building suitable for setting



Item	ATMS Project	Civil Project
		up the control center/sub-centre is provided by the Civil, the scope of ATMS shall be reduced accordingly)
	Electrical, HVAC, DG set, Access Control, Surveillance System, Fire Fighting System, Building Management System, Power backup, Control console, Technical Furniture including all necessary racks and housings for ATMS system for Traffic Management Centre and Sub-Centre (as applicable), housekeeping, building cleaning, maintenance, recurring charges including electricity bills, telephone bills, security, etc.	<ul style="list-style-type: none"> - Scope shall be decided by the EPC Contractor/ Concessionaire. - Nil, in case of work awarded by NHAI.
	Raised floor for Control/Server room	Not Applicable
	Complete Control Room Interior works, lighting, Distribution board Power socket, Earthing, etc.	Not Applicable
	Network system and telephone exchanges / intercom at Traffic Management Centre	Not Applicable
	Cable duct for ATMS Cable and power cable	Not Applicable

4. Standards

- All equipment's of the Concessionaire (included by the Concessionaire in the proposal), supplies shall be new and subject to the Factory Acceptance Test (FAT) to the satisfaction of the Independent Engineer. Unless other standards are specifically required to be complied with herein or in the Contract, all materials and components used under the Contract and all design calculations and tests shall be performed in accordance with Indian standards.
- In the absence of such standards in India, relevant clauses of international standards including but not limited to International Electro technical Commission (IEC), Institute of Electrical and Electronic Engineers (IEEE), International Organization for Standardization (ISO), International Telecommunication Union Telecommunication Standardization Sector (ITU-T) shall be applied.
- In the absence of such standards in India and the international standards mentioned above, industry standards generally accepted and approved in one of the major industrialized countries such as Great Britain, Japan, U.S.A, and Germany shall be applicable.
- Whenever in this Document reference is made to the Japanese Industrial Standards (JIS), British Standards (BS), American Association of State Highway Transportation Officials (AASHTO) standards, American Society for Testing and Materials (ASTM) standards, and American National Standards Institute (ANSI) standards, and the like, it shall be understood that equivalent internationally acknowledged standards will be accepted.
- If Concessionaire offers materials, equipment, design calculations or tests which conform to the standards other than those specified standards, full details of the differences between the proposed standard and the specified standards shall be submitted when required by the Independent Engineer.

4.1 Digital Transmission System

The following standards or de-facto standards shall apply to the digital transmission system:

No.	Item	Standards
1.	BER/CER/DER	ISO/IEC 8825-1:1995 Information technology - ASN.1 encoding rule - Part 2: Specification of Basic Encoding Rules (BER), Canonical Encoding Rules

		(CER) and Distinguished Encoding Rules (DER)
2.	Ethernet	8802-3:1995(ISO/IEC) [ANSI/IEEE Std 802.3, 1995 Edition] Information technology -- Telecommunications and information exchange between systems -- Local and metropolitan area networks -- Specific requirement -- Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications. 8802-3:1996(ISO/IEC) [ANSI/IEEE Std 802.3, 1996 Edition] Information technology -- Telecommunications and information exchange between system -- Local and Metropolitan area networks -- Specific requirement -- Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications. EIA/TIA568B (AT and T-258A) Commercial Building Telecommunications Wiring Standard, 1991
3.	Fast Ethernet	IEEE 802.3u-1995 IEEE Standards for Local and metropolitan area networks: Supplement to Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications: Media access control (MAC) Parameters, Physical Layer, Medium Attachment Units, and Repeater for 100Mb/s Operation, Type 100BaseT (Clauses 21-30) (ANSI) EIA/TIA568B (AT and T-258A) Commercial Building Telecommunications Wiring Standard, 1991
4.	FDDI	ANSI X3.166-1989 (R1995) Fibre Distributed Data Interface (FDDI) Physical Layer Medium Dependent (PMD) ANSI X3.148-1988 (R1994) Information Systems - Fibre Distributed Data Interface (FDDI) - Token Ring Physical Layer Protocol (PHY) ANSI X3.139-1987 (R1997) Information Systems - Fibre Distributed Data Interface (FDDI) - Token Ring Media Access Control (MAC) ISO/IEC 9314-3:1990 Information Processing systems - Fibre distributed Data Interface (FDDI) - Part 3: Physical Layer Medium Department (PMD) ISO 9314-2:1989 Information processing systems - Fibre Distributed Data Interface (FDDI) - Part 2: Token Ring Media Access Control (MAC) ISO 9314-1:1989 Information processing systems - Fibre Distributed Data Interface (FDDI) - Part 1: Token Ring Physical Layer Protocol (PHY)
5.	FTP	RFC 959 File Transfer Protocol, J. Postel, J.K. Reynolds, Oct-01-1985
6.	Giga Ethernet	IEEE 802.3ab: Physical coding sublayer (PCS), physical medium attachment (PMA) sublayer and baseband medium, type 1000BASE-T IEEE 802.3z: Media Access Control(MAC) Parameters, Physical Layer, Repeater and Management Parameters for 1000 Mb/s Operation
7.	G.703a	TTC JT-G703-a Leased Line Secondary Rate User-Network Interface Layer1
8.	HTTP	RFC 1945 Hypertext Transfer Protocol -- HTTP/1.0. R. Fielding, H. Frystyk, T. Berners-Lee, May 1996 RFC 2068 Hypertext Transfer Protocol -- HTTP/1.1. R. Fielding, J. Gettys, J. Mogul, H. Frystyk, T. Berners-Lee, January 1997 (Status: PROPOSED STANDARD) RFC 2616 Hypertext Transfer Protocol /1.1 June 1999 RFC 2617 HTTP Authentication: Basic and Digest Access Authentication, June 1999
9.	H.261	ITU-T Recommendation H.261 (1993), Video codec for audio-visual services at p x 64kbit/s
10.	IP	RFC 791 Internet Protocol. J. Postel. Sep-01-1981
11.	I.430	TTC JT-I430 ISDN Basic User-Network Interface Layer1
12.	I.431	TTC JT-I431-a ISDN Primary-Rate User-Network Interface Layer1
13.	MPEG 2	ISO/IEC 13818-1:1996 Information technology - Generic coding of moving pictures and associated audio information: Systems ISO/IEC 13818-2:1996 Information technology - Generic coding of moving pictures and associated audio information: Video



		ISO/IEC 13818-3:1998 Information technology - Generic coding of moving pictures and associated audio information - Part 3: Audio ITU-T Recommendation H.222.0(07/95) - Information technology - Generic of moving pictures and associated audio information: Systems ITU-T Recommendation H.262(07/95) - Information technology - Generic of moving pictures and associated audio information: Video
14.	MPEG 4	ISO/IEC 14496-1:2010 Information technology – Coding of audio-visual objects –Part 1: Systems ISO/IEC 14496-2:2004 Information technology – Coding of audio-visual objects –Part 2: Visual ISO/IEC 14496-3:2009 Information technology – Coding of audio-visual objects –Part 3: Audio
15.	PER	ISO/IEC 8825-2:1996 Information technology - ASN.1 encoding rule - Part 2: Specification of Packed Encoding Rules (PER)
16.	PPP	RFC 1661 The Point-to-Point Protocol (PPP), W. Simpson, July 1994
17.	SNMP	RFC 1157 Simple Network Management Protocol (SNMP), J.D. Case, M. Fedor, M.L. Schoffstall, C. Davin, May-01-1990
18.	TCP	RFC 793 Transmission Control Protocol. J. Postel. Sep-01-1981
19.	TFTP	RFC 1350 The TFTP Protocol (Revision 2), K. Sollins, July 1992
20.	UDP	RFC 768 User Datagram Protocol. J. Postel. Aug-28-1980
21.	V.24/V.28	ITU-T Recommendation V.24(10/96) - List of definitions for interchange circuits between data terminal equipment (DTE) and data circuit - terminating equipment (DCE) ITU-T Recommendation V.28(03/93) - Electrical characteristics for unbalanced double - current interchange circuits
22.	X.21	ITU-T Recommendation X.21(09/92) - Interface between Data Terminal Equipment Data Circuit - terminating Equipment for synchronous operation on public data network

4.2 Local Area Network

The following standards shall apply to the local area network:

No.	Item	Standards
1	ANSI/TIA/EIA-568B	Commercial Building Telecommunications Cabling Standard

4.3 ATMS System / Sub System

The ATMS systems / sub-systems implementation on the Project shall meet the applicable latest versions of the international/national standards, included herein:

No.	Sub-system	Items	Designed to conform	Certified to standard
1	Video Surveillance System (CCTV) /TMCS / Video Incident Detection System (VIDS)/ VSDS Camera	CCTV Fixed Camera	PAL, BS EN 62676 1-2, ONVIF specifications profile S & G,	EN 61000, EN 60529(IP66) BIS, UL, RoHS
		PTZ Camera	BS EN 62676-2-2, BS EN 62676-2-3	
		Road-side Housing and Support Structure	BS EN 12767	EN 60529 (IP56)
2	VADS	Display		EN 12966 EN 60529 (IP56)
		Road-side Housing and Support Structure	BS EN 12767	EN 60529 (IP56)
3	ATMS Control Centre		EN 50132-7, Relevant NTCIP standards, IEC 12207	

	Ergonomic design of Control rooms	ISO 11064	ISO 11064
	Ingress design of the projection of Graphics display		IEC-60529

4.4 Cable Installation Work

The following standards shall apply to the cable installation work:

No.	Item	Standards
	BS 2484	Specification for straight concrete and clay ware cable covers
	BS 4121	Specification for mechanical glands for rubber and plastic insulated cables
	BS 6121	Mechanical cable glands
	BS CP 1013	Code of practice for maintenance of electrical switchgear and control gear for voltage up to and including 1 KV.
	BS EN 12613	Plastic warning device for underground cables and pipelines with visual characteristics
	ISO/IEC 14763	Information Technology: Implementation and operation of customer premises cabling

Note: If Concessionaire offers materials, equipment, design calculations or tests which conform to the standards other than specified standards, full details of the differences between the proposed standard and the specified standards shall be submitted when required by the NHAI.

4.5 Other Standards

The following standards shall apply as and where applicable:

No.	Standard	Relevant to
1	IS/ IEC 61508	Functional Safety
2	IS 14700, CENELEC EN 50081-1, CENELEC EN 50082-1,	EMC Compatibility / EMC Emission compliance / EMC immunity
3	BIS 732 / BS 7671	Electrical wiring installation / wiring regulations (BS 7671)
4	IS 2309	Lighting protection
5	IS 3043	Electrical Earthing
6	IS 5216	Safety procedures and practices in Electrical works
7	IS 7689	Control of undesirable static electricity
8	IS 694, IS 1554	PVC installed cables
9	EN 61280-4-1	Fibre-optic test related
10	IS 14927	Cable trunking and ducting systems
11	EN 50173	Generic/ structured cabling
12	IEC 60529	Degrees of protection provided by Enclosures
13	IS 9000 Part XIV Sect. II	Change of temperature test
14	IEC-571; IS: 9000 Part-III Sect. 3	Dry heat test
15	IS: 9000 Part II Sect. III	Cold test
16	IS: 9000 Part V Sect. 2 Variant 1	Damp heat test (Cyclic)
17	IS: 9000 Part IV	Damp heat test (Steady state storage)
18	IS: 9000 Part XI procedure 3	Salt mist test
19	IS 9000 Part XII	Dust test
20	IEC 61643-1	Anti-lightning and surge protection
21	OHSAS 18001:2007	OEM compliance for health and safety measurement system
22	14001: 2015	OEM compliance for environmental management
23	ISO 27001	OEM compliance for information security standard

No.	Standard	Relevant to
24	IRC:SP:110:2017	ITS System for Urban Roads
25	IRC: 93-1986	Guidelines on Design and Installation of Road Traffic Signals
26	IRC: 103-2012	Guidelines for Pedestrian Facilities

5. Project Management

5.1 Concessionaire's Personnel and Their Responsibilities

- The Concessionaire shall provide all personnel necessary for the execution of the Works, such as the Project Manager and senior personnel to fulfil the Concessionaire's obligations under the Contract. These personnel shall be able to read, write and converse in English.
- The Concessionaire 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 of this Contract. 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.
- The Concessionaire will make available technical person who is adequately skilled enough to independently resolve any operational issues in the complete system and regularly interact with NHAI. **Aadhar enabled Biometric Fingerprint machine** shall be installed at each location / TMC unit by the Concessionaire for daily attendance management of the Project and O&M staff.
- The Concessionaire shall submit the attendance record with each service invoice and Independent Engineer shall have the access to the logs of biometric attendance management system for verification of the actual manpower working days in a month.
- The Manpower proposed shall be dedicated for the project and shall not be proposed for any other project or assigned any other project. The resource cannot be change for at least two years. In case of any variation or change in the manpower / person proposed in the Technical Proposal and manpower / person deployed upon successful award of the works, minimum 20% remuneration of the proposed role for the total contract period shall be deducted. The substitute proposed by the Contractor must have more experience than the proposed candidate in all respect (no. of years of relevant experience, no. of similar projects executed, qualification of the replacement candidate, etc.).
- Detailed requirement of technical resources for control centre organisation and staffing is mentioned below.

5.1.1 Senior Personnel

The Concessionaire shall assign one (1) Project Engineer (ATMS) and one (1) O&M Manager (Operation and Maintenance, Installation Engineering) with minimum 10 years of relevant experience in same field as a full time participant to the Project during the course of the Works. They may be stationed at the Project site. The senior engineer shall be involved in technical discussions and shall conduct the training courses and all testing procedures. The senior engineer shall also be involved in the installation works as necessary.

They shall be Graduate (BE/ B/Tech or higher) in the field of traffic engineering, electrical engineering, electronics, computer, IT, instrumentation, telecommunication, or communication.

5.1.2 Project Meeting

The Concessionaire shall be available for progress meetings which will be called for by the NHAI. The notice of such meetings shall be given by the NHAI in writing and delivered to the Concessionaire via email at least two (2) days in advance of the planned meeting date.

5.1.3 Progress Report

The Concessionaire shall prepare three (03) copies of monthly progress report every month and submit to the NHAI. The format of the report shall be agreed upon by the NHAI and the Concessionaire.



5.1.4 Operations and Maintenance Personnel

The Concessionaire shall provide adequately skilled technical and operations personnel during the O&M phase for operating and maintaining the ATMS system and sub-systems, as listed in operations and maintenance section of the RFP.

- a. The personnel shall address any down time/ trouble shooting as and when required at any location of service.
- b. The resources shall be available on full time basis 365 days in the year at control centres.
- c. Final deployment of the skilled technical resources shall be subject to interview or concurrence the Independent Engineer.

5.1.5 Curriculum Vitae

Within a month after the date of the Contract execution, the Concessionaire shall submit to the NHAI, detailed written statements including the names, duties, curriculum vitae of all foreign and local personnel candidates to be employed. Where subsequent changes or additions in foreign personnel are proposed, these replacements or additions shall have at least equivalent experience and qualifications, and detailed written statements of their experience and qualifications shall be submitted to the NHAI prior to their assignment.

5.1.6 Removal and/or Replacement of Personnel

- a. Except as NHAI/ Independent Engineer may otherwise agree, no changes shall be made in the above Key Personnel. If, for any reason beyond the reasonable control of the Concessionaire, it becomes necessary to replace any of the Personnel, the Service Provider shall forthwith provide as a replacement a person of equivalent or better qualifications.
- b. If NHAI/ Independent Engineer (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 written request specifying the grounds therefore, forthwith provide as a replacement a person with qualifications and experience acceptable to the Independent Engineer.

5.1.7 Sub-Contracting / Assignment

- a. If any activity / services / infrastructure and / or any obligations in whole or in part under this project is required to be / subcontracted/ outsourced by the Concessionaire, the Concessionaire shall inform and seek approval of the same from the Independent Engineer including the terms and condition set-forth by the Concessionaire in its sub-contracting agreement. For avoidance of any doubt the Concessionaire shall remain solely responsible for all the works / delivery of services to NHAI under the scope of this project.
- b. The Concessionaire shall inform and seek approval of the same from the Independent Engineer to sub-contract the non-key services such as civil works, interior and furnishing of control centre to any agencies specialised to do such work.

5.1.8 Performance standards

- a. The Concessionaire shall undertake to perform the services with the highest standards of professional and ethical competence and integrity.
- b. 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 project that NHAI/ Independent Engineer considers unsatisfactory.

6. Time Schedule

1. System Design : within 1.5 months from the date of signing of the Contract



2. Procurement : within 3 months from the date of approval of the System Design
3. Installation : 3 months from the start of delivery of material at site
4. Testing & Commissioning : 1 month from the date of Installation of the system
5. Trial run : 1 month from the date of commissioning
6. O&M period : 60 months from the date of issue of Commissioning Certificate

7. Liquidated damages/ Penalties

7.1 Delays in setting up the system

Failure by the Contractor to complete the works or completion of punch points of SIT/SAT within 30 days of issuance of notice by the Independent Engineer or delay in completion of work for any of the milestones i.e. beyond the stipulated time as mentioned in the above Time Schedule and in case of any failure to have remedied all reported defects within the time prescribed by the Independent Engineer / NHAI, i.e. as per the cure period of up to 15 days shall result in the application of the penalties for delays. The penalty will be applicable @ 0.5% of the total contract value of the ATMS works per week of delay in system commissioning or delay in completion any of the above six milestones (system design, etc.) up to a maximum of 10% of the Contract value of the ATMS works.

1. Once the liquidated damages reach maximum limit, NHAI shall consider termination of the contract and forfeiture of the performance bank guarantee. NHAI shall also debar the Contractor from further participation in NHAI's subsequent tenders / projects due to its non-performance for a period decided by it.
2. Upon termination of the Agreement due to service defaults, NHAI may choose to allocate the said site to any other Contractor, at its sole discretion and at the risk and cost of the defaulting Contractor.
3. In case of delay due to reasons beyond the control of the Contractor, upon such request from the Contractor and recommendation from the Independent Engineer, NHAI may, in its sole discretion, consider suitable extension of time (EOT) without imposing any liquidated damages upon the Contractor. However, the Contractor shall submit such request at least 30 days before the completion schedule / timeline/ milestone. In case of the delay in submission of the request for EOT, the penalty will be applied @ 0.5% of the total contract value of ATMS works per week of delay in submission of request for EOT.

7.2 Non-Compliance to Safety Standards at site

Failure by the Concessionaire's personnel in maintaining the safety standards at the site at any time shall attract penalty on every instance noticed by the Independent Engineer / NHAI.

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

7.3 Penalty for Delay in Staff Mobilisation

Delay in submission of detailed written statements and/or mobilization of aforesaid Key Personnel shall attract penalty @ INR 1,00,000/- (Rupees One Lacs) per day per Key Personnel. In case the delay is more than 3 weeks, NHAI reserves the right to encash the Bid Security and PBG towards the aforesaid penalty and may proceed with the revocation of LOA or termination of the project, as the case may be.

7.4 Other Penalties

Penalty of INR 10,000 to INR 1,00,000 shall be levied on the Contractor for delay of each working day from the due date of submission / expiry: i) the insurance policy documents, ii) design documents, iii) manuals, iv) monthly /periodic reports, v) Bank Guarantee, vi) Schedule, vii) testing, viii) any other documents report directed by NHAI/Independent Engineer, to be submitted during the entire period of the Contract, etc.

8. Selection of Concessionaire, Sub-Contractor and OEM

1. The firm as determined non-performing or having been terminated from any project during last three years by Ministry of Road Transport & Highways, Government of India or its executing agencies like NHAI, NHIDCL etc. or any other Ministry / PSU / State / Central Government or its Department/ Enforcement agencies/ Autonomous Body etc. will not be eligible.
2. A Company will not be eligible for ATMS works, in case the penalty for SLA/SLR non-compliance during O&M period have reached the maximum penalty limit on any ATMS/ITMS/ITS project.
3. The Concessionaire must have experience of successfully executing the Project having similar nature of work during last 10 financial years
Similar works: Establishment of state-of-the-art ITS/ ATMS/ HTMS/ ITMS system with at least 1 Traffic Management Centre/ Integrated Command and Control Centre on the National/State/Urban Highway or Expressway or stretch of equal to or more than 40% length of this Project involving at least 5 key activities that have been satisfactorily completed within last 10 years as a prime contractor (single entity or JV member) under reputed PSUs / Central Government or its Department/ Enforcement agencies/ Autonomous Body etc.
 - i. Traffic Monitoring Camera System
 - ii. Vehicle Speed Detection System
 - iii. Automatic Number Plate Recognition System
 - iv. Video based Incident / Violation Detection System
 - v. RLVD (Red Light Violation Detection) System
 - vi. Adaptive Traffic Signal Control System
 - vii. Digital Transmission System with OFC Connectivity
 - viii. Central Processing System
 - ix. Video Analytics / Management System
4. The OEM of each component/ equipment should have direct presence in India from last 10 years having own service and support offices to ensure smooth after sales service support on site.
1. The Concessionaire must submit the datasheet of each component in the Technical Submission as part of the Technical proposal and design document, clearly mentioning the make, model, country of origin, and end of life of each component/ equipment in the MAC.
2. To ensure seamless integration, the Contractor shall deploy equipment of same OEM having seamless interoperability for each categories of the solution components as mentioned below:
 - i. Computing – Workstations, Servers and storage
 - ii. Network – Router and switches
 - iii. Graphics Display, its Controller and Software
 - iv. Surveillance & Access Control – Cameras, VRS, Video Analytics & Management Software, Box Camera Housing etc.
 - v. Security – Firewalls and any other security solution
 - vi. Interior works and technical furniture at control centres



3. The Concessionaire must submit the documentary proof for the above-mentioned requirement and non-compliance matrix for the Functional and Technical Specifications in the Technical Submission as part of the Technical proposal and design document.
4. Subcontractors/manufacturers for the sub-systems and major items of supply or services must meet the following minimum criteria:
 - i. Subcontractor and manufacturers shall have at least two similar contract experiences within 10 years.
 - ii. Subcontractor and manufacturers shall be Indian OEM/ Manufacturers or Class-I local supplier as per DPIIT Order no. P-45021/2/2017-PP (BE-II) dated 04.06.2020 (revised "Public Procurement (Preference to Make in India) Order 2017").
 - iii. Subcontractor and manufacturers shall have direct presence in India having own service and support offices to ensure smooth on-site after sales service support.
5. The requirement mentioned in the ToR / Technical Specification document are the minimum requirement. The Contractor shall provide the latest standards or higher specification to meet the functional and technical requirement. In case any specification mentioned in the document are obsolete, he shall provide the latest equipment of higher specification, fully meeting the functional and technical requirement. The Contractor must promptly highlight the compatibility issues in the Non-Compliance Matrix in the technical proposal and design document. Any Non-Compliance or Compatibility issue raised by the Contractor after the award of the Work shall not be acceptable in any circumstances. The Contractor must take prior written approval from the Authority before supplying any alternate solution proposed for any obsolete /end of life component, by submitting the proof and undertaking from the OEM proposed in the Technical proposal and design document.
6. **Undertaking for Country of Origin:** The Concessionaire shall ensure that none of the key component or its sub-component such as PTZ / TMCS Cameras, VIDS system, Vehicle Speed Detection System, Control Centre / Command Centre / TMC equipment including security devices are procured / sourced from the OEM from any of the region and / or company barred / banned / blacklisted / having territory dispute / threat to sovereignty and integrity / restricted by the any of the Defense Department / any of the Government Department / Authority / PSU / Ministries etc. in India. The technical proposal and design document shall be considered as non-compliance in case this requirement is not fully met by the Concessionaire. The Concessionaire shall submit an undertaking fully complying to this requirement.
7. **The Concessionaire must comply with the Office Memorandum no. F. No. NH-35014/20/2020-H, Government of India, Ministry of Road Transport & Highways dated 04.08.2020, regarding Department of Expenditure (DoE), Ministry of Finance, Govt. of India O.M. No. 6/18/2019-PPD dated 23.07.2020, vide which Rule 144 of the general Financial Rules 2017 entitled "Fundamental principles of public buying" has been amended by inserting sub-rule 144 (xi) in the General Financial Rules (GFRs), 2017.** As per the new rule "Any bidder from a country which shares a land border with India will be eligible to bid in any procurement whether of goods, services (including consultancy services and non-consultancy services) or works (including turnkey projects) only if the bidder is registered with the Competent Authority." This condition shall also be applicable on sub-contracting of any works / goods / services, etc.
The Concessionaire shall furnish the registration status of the sub-contractor/ supplier with Competent Authority (for the items / goods proposed to be procured from any country which shares a land border with India).
8. **Preference shall be given to Indian OEM/ Manufacturers and "Make in India" as per DPIIT Order no. P-45021/2/2017-PP (BE-II) dated 04.06.2020 (revised "Public Procurement (Preference to Make in India) Order 2017").** All ATMS/ITS equipment shall be procured from Indian OEM/ Manufacturers and preference shall be given to "Make in India" preferably to "Class-I local supplier" as defined in the revised order by DPIIT. The Contractor shall submit the proof of non-availability of the products/ items/ goods/ services in India which are proposed to be procured from Non-Local supplier or imported.



9. Factory Tests, Inspection and Certification

9.1 General

All equipment, components, spare parts, and software to be delivered or installed under this Contract shall be tested, inspected, and certified prior to delivery in accordance with these specifications.

9.2 Test Procedures

- a. For off-the-shelf or routinely manufactured equipment or components, a test or inspection certificate shall accompany each delivery and no Factory acceptance test (FAT) shall be required. The Concessionaire shall submit the factory's routine testing procedures for each key component.
- b. The FAT for equipment, components or software requiring special order, tooling or development is mandatory and shall be conducted by the Independent Engineer at the factory/manufacturing unit. The Concessionaire shall submit to the Independent Engineer proposed factory test items and test procedures for review as soon as the System Detailed Design is accepted. The test items shall include as a minimum the following:
 - 1) Functional tests (all equipment and software)
 - 2) Power supply tests (all equipment)
 - 3) Input voltage fluctuation (Sampling test)
 - 4) Instantaneous interruption (Sampling test)
 - 5) Environmental tests for temperature and humidity ranges as specified (sampling test)
 - 6) Insulation resistance (sampling test)
 - 7) Dielectric strength (sampling test)
 - 8) Rainproof test for field equipment (sampling test)
 - 9) Equipment Interface Tests -- Equipment interface tests shall be conducted for all servers, database, network switches, network adapters, toll collection equipment and communication equipment in the factory.

These tests shall be executed by interfacing as many different kinds of equipment as possible so as to ascertain their suitability as system components. Where there is no appropriate equipment at that particular time to connect to certain equipment, the test shall be executed by connecting to a simulator.

- c. Mandatory Factory Acceptance Tests
Due to the high number of equipment estimated for the project and stringent performance requirements, only the customised equipment (special order), fabricated items, and ATMS software shall undergo Factory Acceptance tests in presence of Independent Engineer, NHAI personnel and / or NHAI's representatives.
- d. The Concessionaire shall notify the NHAI at least 07 days in advance of each factory acceptance test to be undertaken and shall make arrangements for the NHAI to attend the tests if requested. The Concessionaire shall also bear all expenses of such tests including travel (including any travel abroad), boarding and lodging expenses of Independent Engineer and up to 4 NHAI personnel and / or their representatives.
- e. In case of equipment other than those identified under c) above, should Independent Engineer decide not to attend any of the tests, the tests shall be carried out by the Contractor, and the duly certified copies of the test results shall be submitted by the Contractor.
- f. If the Independent Engineer is satisfied with the test results, he shall notify the Concessionaire in writing to that effect, and the Concessionaire may then ship the equipment. If the Independent Engineer decides that equipment is defective or produced not in accordance with the Contract, he may reject the equipment, and will inform the Concessionaire of the reasons in writing within 30 days.

9.3 Defects

Should a defect be detected during one of the tests, the cause of the defect shall be ascertained and documented. For minor defects which do not require re-design of the equipment, the defect shall be rectified, and the test be repeated. If a design change is required, the Independent Engineer shall be so informed, and the revised design shall be submitted to the Independent Engineer for review and approval.

9.4 Test Certificate

Test certificates will be issued only for the actual equipment that has passed the tests. For sampling test of equipment, if any defect is detected in any one sample, the entire lot shall be tested, and the results shall be reported to the Independent Engineer for his review.

9.5 System Integration Test (SIT)

- a. The SIT shall also incorporate the network-manageable portions of the ATMS system including the ATMS system interface to the TMC, sub-centres and NHAI HQ Command centre.
- b. The SIT shall begin after earlier stages of testing have been successfully completed (i.e. FAT and SAT) and accepted by the Independent Engineer. 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 Independent Engineer prior to starting.
- c. 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 Concessionaire, results in the Project, or any system, subsystem, ATMS equipment, or ancillary component thereof to cease operation.
- d. The SIT shall be re-started after the identified deficiency has been corrected.
- e. If the total number of System Shutdowns exceeds three (3) due to the same system or subsystem, ATMS equipment, or ancillary component.
 - (i) The system, subsystem, ATMS equipment, or ancillary component shall be removed and replaced with a new and unused unit.
 - (ii) All applicable FAT and SAT, as deemed necessary by the Independent Engineer shall be performed and the SIT shall be restarted upon written approval from the Independent Engineer
- f. 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.
- g. 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 Independent Engineer, the Independent Engineer shall provide written notice of Final Acceptance.
- h. 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.

9.6 Inspection

All equipment shall be inspected before delivery and upon arrival at the site. The inspection shall be performed on the following items:

- 1) Painted surfaces and colour
- 2) Condition of assembly
- 3) Design and dimensions
- 4) Parts arrangement

9.7 Cost of Test and Inspection

The testing cost as allowed, shall cover full cost of providing all facilities, labour, consumable parts, and appliances required in connection with all inspection and tests of completion on the site or on the manufacturer's premises, and all other expenses as may be required by the NHAI or Independent Engineer to attend the test.

9.8 Tests on Completion

9.8.1 General

The Concessionaire shall keep a clear record of all tests conducted. The record shall include time, place, equipment, procedure, functions, persons attending, and faults or problems encountered. The test results, even if they are not satisfactory, shall be documented and submitted to the Independent Engineer and NHAI for review.

9.9 Tests on Completion for a Portion of Works

9.9.1 Procedure

- a. The Concessionaire shall give due notice to the Independent Engineer and NHAI of atleast seven (7) days in advance of the proposed date and contents of the Tests on Completion for a Portion of Works.
- b. Tests on Completion shall be performed for the portion of Works completed in the previous one-month period.
- c. When the Independent Engineer has received satisfactory test results, he shall notify the Concessionaire in writing that the equipment is ready for trial operations. If the Independent Engineer decides the equipment is not in accordance with the Contract, he may reject the equipment, and he shall inform the Concessionaire as to the reasons why the equipment was rejected in writing within a reasonable time.

9.9.2 Test Items

- a. After the delivery and installation of the equipment at the site, tests on completion for that portion of Works shall be conducted for each of equipment.
- b. Appearance of the equipment and required operations in standalone mode shall be examined in this test. Test items to be tested at Tests on completion are specified in the section of component systems in these specifications.

9.9.3 Testing apparatus

- a. Each equipment shall be provided with indicator, lamp, monitor or other means to confirm normal operation of the equipment.
- b. Alternatively, the Concessionaire shall supply suitable number of portable testing apparatus or computer as part of equipment. Control of monitoring the equipment shall be possible through the testing apparatus.
- c. All test equipment shall have a valid calibration certification from certified government lab.

9.10 Tests on Completion for the Whole of Works

9.10.1 General

During the Test on Completion, all the functions of the equipment required under the Contract shall be tested. The test shall be conducted with the attendance of the NHAI and Independent Engineer.

9.10.2 Procedure

- a. The Concessionaire shall submit, at least 14 days in advance, to Independent Engineer the date(s) on which the Tests on Completion for the Whole Works are to be undertaken.
- b. The Concessionaire shall forward to the Independent Engineer duly certified copies of the test results when the tests have been successfully completed. When the Independent Engineer has received the test document and is satisfied with the test results for trial operations, he will notify the Concessionaire in writing that the whole works are ready for trial operations.
- c. If major defects are uncovered in the tests, the Concessionaire shall prepare and submit to the Independent Engineer for review and approval a proposal to remedy the defects. The Concessionaire shall not take corrective actions before the proposed remedies have received the Independent Engineer's approval. Minor faults and defects detected during the Tests on Completion may be corrected during the trial operation period.

9.11 Test Conditions and parameters

The following conditions and parameters shall be applicable for each stage of testing i.e. FAT, SAT, SIT, and Additional tests:

- a. 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.
- b. The Independent Engineer 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

Independent Engineer shall be given minimum seven (7) full business days' prior notification before rescheduling another test trial.

- c. ATMS Equipment that fails to conform to the requirements of any test will be considered defective and the equipment will be rejected by the Independent Engineer. 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 re-test provided all issues of non-compliance have been corrected and re-tested and evidence thereof submitted to the Independent Engineer. 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 Independent Engineer and NHAI prior to a new test date being scheduled.
- d. In the event, the ATMS equipment malfunctions during the test period, the Independent Engineer 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.
- e. If ATMS equipment has been modified or replaced as a result of a defect, a report shall be prepared and delivered to the Independent Engineer 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 Independent Engineer, develops, the Independent Engineer 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.
- f. The Test procedures and guidelines mentioned in the RFP are the minimum requirement to be fulfilled by the Concessionaire. In addition to the minimum tests prescribed in the RFP, the Independent Engineer shall instruct the Concessionaire to conduct the test he deems relevant for any subsection at the Factory and / or at site, as applicable.
- g. Time extensions shall not be granted to perform the FAT/ SAT / SIT / Additional tests due to any failures. Failures during any test shall be resolved by the Concessionaire at no additional cost to the NHAI.
- h. The SAT shall be conducted for each and every piece of ATMS equipment and ancillary components.
- i. If any ATMS equipment or ancillary component fails to pass its test more than twice, it shall be replaced with new ATMS equipment or ancillary component of same make and model and the entire test shall be repeated until proven successful.
- j. The ATMS equipment provider shall ensure that the required testing equipment, including a portable computer and test software is provided for the SAT.
- k. Equipment installation shall be inspected to confirm compliance to equipment manufacturer's installation good practice recommendations.
- l. 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.
- m. The FAT / SAT 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.

10. Defects Liability Period (DLP)

1. Any minor defects in the system identified by the Independent Engineer and provided to the Concessionaire in the form of a written notice during the Final Acceptance 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 Concessionaire to the satisfaction of the Independent Engineer.
3. The DLP shall be in force for a period specified in the Concession Agreement succeeding the Completion Certificate.



11. Power Supply

- a. Provision for power supply and DG sets (excluding UPS) at the TMC (Traffic Management Centre) and Sub-centres shall be in the scope of the Civil Contractor (EPC/ HAM/ Concessionaire, as applicable). The provision of DG set and power supply arrangement and recurring costs shall be completely in the scope of Concessionaire, in case the work of ATMS is awarded by NHAI. The Concessionaire shall examine the power supply status during the site survey and submit the additional requirement to the Civil Contractor along with the proposal in case of any additional requirement. The additional power and DG requirement shall be finalised within the design phase. Any additional requirement raised by the Concessionaire post design approval may not be considered and the Concessionaire shall be responsible to make the arrangement at its own cost.
- b. The Concessionaire shall perform all the necessary application procedures to the Power Company required for the power to be supplied for the field equipment. All the expenses charged by Power Companies regarding such applications shall be borne by the Concessionaire unless until specified by the Civil Contractor. The work to be undertaken by Power Companies shall be up to the boundary of property and the responsibility shall lie between the NHAI/ Civil Contractor and Power Companies, as well as the expenses incurred there from, shall be in the scope of the Concessionaire.
- c. The Concessionaire shall make all necessary arrangements for the electricity requirement, for the execution of the Works and as well the O&M period. for the entire period of the Contract for the field equipment.
- d. The fixed charges, installation charges, recurring charges, electricity bill, DG set fuel, maintenance etc. for each field equipment, Concessionaire's site office, or any other facility being used by the Concessionaire under the scope of the Contract shall be completely in the scope of the Concessionaire for the entire Contract period i.e. Design phase, procurement, installation, testing, trial-run, commissioning, operations and maintenance period. The Authority shall not be responsible for any provision for power supply during implementation as well as operations and maintenance period.
- e. All UPS required for ATMS system for TMC, sub-centres, field equipment shall be in the scope of the Concessionaire.

12. Work Area Safety and Traffic Control

12.1 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 during the 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 be applicable as prescribed in the Penalty clause above, in case of any non-compliance or safety violation.

12.2 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.

12.3 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 is closed.
- c. All work area warning signs shall be made of reflective sheet or material if the signs are to remain in place during hours of darkness.
- d. The design, specifications, quantity, location, placement of the Signages shall fully comply with latest version of IRC 67 2012, IRC SP 99:2013 and/ or applicable latest international and IRC codes.

12.4 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. warning flashers shall be kept alight at each such location.

12.5 Traffic Cones and barriers

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.

12.6 Plant and Equipment

- a. In all cases where traffic is permitted to use the whole or a portion of the existing road before the work is completed, all plant items and similar obstructions shall be removed from the road at night, if at all possible. Otherwise, they shall be delineated at night if they stay within 2 meters of the edge of the roadway by two red lights suspended vertically from the point of obstruction nearest to the roadway. The lights may be omitted in cases where there is permanent obstruction, such as trees being less than 2 meters from the edge of roadway and the plant or equipment are not closer to the road than the permanent obstruction.
- b. During the day, a red flag shall be projected beyond the extremity of all plant items (other than vehicles) adjacent to the traffic lane.
- c. The Contractor shall take all the safety measures as per the site requirement and prescribed by NHAI/ Independent Engineer.

12.7 Vehicles

Vehicles which are used to carry out operations on the roadway and which are required to travel slowly or to stop frequently shall be made as conspicuous as possible. This shall be achieved by painting them in a distinctive colour or painting the rear portion with diagonal stripes of a contrasting colour or providing flashing lights on the top of the vehicle. They shall also have a plate of sufficient size on the rear side with the words "**Slow Moving**" and shall be visible from 100 meters.

13. Documentation

13.1 General

- a. The documentation shall contain complete details of how the System was actually built, and how it works, together with complete operating and maintenance information. The documentation shall consist of the following manuals and drawings:
 - 1) System design manual
 - 2) Software manual
 - 3) Hardware manual
 - 4) Installation manual
 - 5) Operator's manual
 - 6) Maintenance manual



- 7) Product 'End of Life' Plan
- 8) As built drawing
- b. The documentation shall be a detailed presentation with text and illustrations. All documentation shall be in English and shall be subject to the approval by the Independent Engineer.
- c. The documentation process shall include the preparation, editing, submittal for approval, publication, delivery and acceptance of the documentation in accordance with the requirements of the Contract.
- d. Documentation shall use SI units in accordance with ISO 80000-1
- e. 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 Independent Engineer for approval after due certification by a Licensed Structural Engineer. The design calculations shall be carried out in accordance with relevant MoRTH/IRC standards where applicable.
- f. 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.
- g. Power schematic diagrams for all ATMS installations shall be submitted to the Independent Engineer for approval.
- h. Telecommunications schematic diagram shall be submitted to the Independent Engineer for approval. The telecommunications diagram shall include all systems, subsystems and components, including connections to modems, devices and the telecommunications access and backbone network.
- i. 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.
- j. Documentation should be organized so that unnecessary repetition is avoided. Topics likely to be frequently referenced by the Concessionaire (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 Independent Engineer should be consulted for its agreement on the presentation and layout of the documents to be provided.
- k. 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.
- l. 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.
- m. The format and extent of electronic media and/or hardcopy presentation of technical documents shall be agreed upon by the Independent Engineer before final versions are produced.

13.2 Submittals

- a. 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.
- b. Systems and subsystems that minimizes the possibility of either the failure of any single component or the complete module failure shall be provided by the Concessionaire in Technical Proposal and later in Design Document. Failure of one component or module shall not cause the failure of any other component or module.
- c. Product data, design and construction drawings for all of the components shall be submitted to the Independent Engineer for approval.
- d. Heat-load calculation sheets accompanied by related manufacturer's data sheets to support justification of proposed cooling systems shall be submitted to the Independent Engineer for approval. Power consumption calculations to support proposed power distribution type and size shall also be submitted.

13.3 Presentation of Documentation

- a. All documentation shall be prepared in a clear, concise manner with appropriate illustrations. Except otherwise specified by the Independent Engineer / NHAI, all documentation except drawings shall be **double side printed** on A4 size sheets. All documentation shall carry an issue number, revision number and date. A uniform style and format shall be followed as much as possible.
- b. The draft of all the reports and documents shall be submitted to the Independent Engineer in electronic form (PDF) only, for review and approval before submission of printed copies.
- c. Three (3) printed copies (double side printed) and three (3) sets of electronic files on CD-ROM or DVD of all documentation, manuals and drawings of as built conditions shall be submitted. Electronic file shall be in the latest version of portable document format. In addition, as-built drawing in the latest version of AutoCAD at the time of submission of Technical Proposal must be included on CD-ROM or DVD.
- d. In order to maintain liaison between parts of the Concessionaire and the NHAI, documentation concerning each part of the Contract shall be produced as part of each component job and not left until the preparation of the final manuals. Effort may be saved, and familiarity with the presentation of information will be maintained by writing the documentation during the Contract in a form suitable for inclusion in the relevant final manuals.
- e. All system manuals shall be available at the beginning of classroom training. Re-issues shall be provided if site commissioning and testing makes this necessary.
- f. If changes or modifications are required in any of the documents previously submitted, the Concessionaire shall fully describe the changes or modifications, and immediately submit them to the Independent Engineer for approval.

13.4 Standard Documentation

Standard documentation shall be provided for the computer and peripherals (hardware and software), programming manuals including the languages to be used, transmission equipment, air conditioner, power supplies, and other standard products to be supplied under the Contract.

13.5 System Design Manual

- a. The intent of the system design manual is to give an overall description of the ATMS including the digital transmission system and associated systems supplied under the Contract. The manual may be divided into sections to cover all and every aspect of the systems. The description shall be plain, and the detail of operation shall be left to other manuals with adequate reference to them. The manual should provide cross references to the appropriate manuals of the system when necessary to do so.
- b. The system design manual shall completely define all functions, inputs, and outputs including methods of entering inputs, methods of obtaining outputs, data structure and content, format, sequence, and timing. The system structure and organization shall be described including all the data flow paths through the system and all the data files in the system. This description shall clearly present the functional relationship of the computer program modules with one another and with all peripheral, monitor display, control desks, central controllers, transmission equipment, detector, control centre equipment, office equipment, field equipment or other equipment. An overall system flow diagram shall be provided.

13.6 Software Manual

The software manual shall be project oriented. The software manual shall therefore include the application programs and database details.

13.6.1 Structure

The manual shall describe the overall software structure with particular attention to the points at which further user programs can be interfaced. It is essential that the relationship of program modules, their priority, and their calling sequences are explained in such a manner that it may be clearly understood, especially by any competent programmer who wishes to specify or interface a new program into the system.



13.6.2 Program Logic/Function

Operational objectives for each program shall be described. All logic and transformations on the input data in order to generate output data and accomplish system functions shall be described, together with their interaction, sequencing and time requirements. Derivations of any mathematical equations shall be stated if appropriate.

13.6.3 Flowcharts

Each major section of the programming logic as described above shall be presented in greater detail. The detail shall be developed into a format of flowcharts or other graphical methods using statement and decision blocks to show the flow of information. Within each statement and decision block sufficient information shall be presented to describe what is being accomplished. Mathematical or engineering terminology and equations shall be incorporated when necessary to fully describe the operations to be performed.

13.6.4 Output Formats

Sample output formats both printout and monitor display shall be provided from actual printer output and monitor display with explanation for each item on the output format.

13.6.5 Data File in Database

The format of all data in the database shall be given together with the structure, type, format, length, default value, and range of allowable value, if any. For constant file that contains system parameters and constant, their value shall also be shown.

13.7 Hardware Manual

- a. This manual shall provide a complete description of the hardware of all the system equipment and components to be supplied under the Contract. Documents regarding component systems shall be bound in separate volume for convenience of use.
- b. The following information shall be provided for each applicable equipment or component:

13.7.1 Functional Descriptions

All information necessary to fully explain the basic function or use of the equipment shall be provided. It shall include a block diagram presentation of the equipment.

13.7.2 Operating Procedure

- a. The operating procedure shall be fully described in a simple and clear language. Appropriate illustrations shall be provided. Explanation and use shall be given to all the keys and switches. Meaning of all meters and indicators shall also be explained.
- b. A list of applicable test instruments and tools required to perform necessary measurements shall be included. Setup tests and calibration procedures shall also be described if applicable.

13.8 Installation Manual

- a. This manual shall provide a complete description of the installation procedures of all the system equipment and components to be supplied under the Contract. Documents regarding component systems shall be bound in separate volume for convenience of use.
- b. The following information shall be provided for each applicable equipment or component:

13.8.1 Installation instructions

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

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

13.8.2 Commissioning instructions

Set-up details of addresses, operating parameters, control ranges and limits, etc. Commissioning procedures and tests.

13.9 Operator's Manual

- a. This manual shall comprise a concise set of procedures, the system operator may require operating the system with a minimum of detailed technical description of the internal working of the various parts of the system. Cross references to the appropriate manuals for detailed technical descriptions however shall be provided.
- b. The manual shall list specific procedures to be followed for both hardware and software operations, which may have to be followed either by programmers or hardware engineers. Instructions shall therefore be basic and detailed. A step by step procedure shall be given for switching on and off power, controlling the equipment and for starting up and shutting down the system. This shall include loading of the operating programs, checking that they are running correctly, operation of variable message signs, TMCS camera, monitor display, graphic display, and use of utility programs through keyboard and monitor display.
- c. In addition to the routine operation, procedures shall be given for fault diagnosis. Typical symptoms shall be listed, with corresponding corrective or emergency action to be taken.

13.10 Maintenance Manual

This manual shall describe both preventive and corrective maintenance procedures in such detail that maintenance personnel can perform the proper maintenance work by reading this manual.

13.10.1 Preventive Maintenance

The manufacturer's recommended procedures for proper preventive maintenance shall be indicated to ensure reliable equipment operation. Specifications including defined tolerances for all electrical, mechanical and other applicable measurements and adjustments shall be listed. Periodical repainting servicing shall also be described. List of parts that require periodic replacement shall be included.

13.10.2 Corrective Maintenance

- a. This section shall provide the information necessary for isolation and repair of failure and malfunctions. Accuracies, limitations and tolerances for all electrical, physical and other applicable measurements shall be described. Instructions for disassembly, overhaul and reassembly, including workshop performance requirements shall be provided.
- b. Fully detailed step by step instructions shall be given where a failure to follow special procedures would endanger the life of the operating or maintenance personnel, damage to the equipment, improper operation, etc. Instructions and specifications shall be included for such maintenance work that may be accomplished by specialized technicians and engineers in a modern electro-mechanical workshop. Instructions concerning special test set up, component fabrication, use of special tools, jigs and test equipment shall be included.
- c. Maintenance procedures shall cover the diagnosis of faults, testing and setting up adjustments, replacements of units and operation of test equipment.

13.11 Product 'End of Life' Plan

- a. Instructions for dismantling the equipment without causing damage
- b. Details of re-usable/recyclable components, materials and the coding system used to identify them,
- c. Details of any precious metals
- d. Details of any hazardous substances, heavy metals or other pollutants with instructions on their safe handling and disposal.

13.12 As-Built Drawings for Whole Works

- a. The Concessionaire shall submit three (3) copies of as-built plans and drawings to the NHAI within reasonable time after the Tests on Completion for the Whole Works but not later than three (3) months prior to the Completion. As-built plans and drawings to be submitted by the Concessionaire shall include but not be limited to:
 - 1) Detail drawings of all equipment,
 - 2) Variable message sign support, TMCS camera pole, detector pole (if any), etc. with fittings (civil structure plans and drawings),
 - 3) Equipment layout,



- 4) Communication cable network diagram, fibre assignment diagram and final BOQ for the cable work
 - 5) Conduit route diagram, handhole, manhole layout and final BOQ for the conduit work
 - 6) Traffic Management Centre operator room and machine room layout,
 - 7) Data cable connection diagram at Traffic Management Centre and other ,
 - 8) Power distribution diagram,
 - 9) Traffic Management Centre and sub-centre building,
- b. These plans and drawings shall incorporate changes made during the installation and training. A uniform legend shall be used throughout the documentation.

13.13 Programs on CD Disk

As part of the documentation, The Concessionaire shall provide a copy of all source programs which have been coded for this system on a CD-ROM or DVD ready for compilation. The source programs shall be written in English and compatible with the flowcharts and program listings. In addition, a copy of the operating system, utility programs and other programs used in the CPU shall be provided on a CD-ROM or DVD which can be readily loaded.

14. Quality Assurance

- a. The ATMS equipment provider shall have in place a quality system complying with ISO 9001, for the activities of design, development and production of the ATMS equipment to be supplied unless otherwise agreed by the Independent Engineer. The quality system shall cover each and every location where such activities are undertaken.
- b. The Independent Engineer shall audit the potential supplier's quality system and test facilities before approving use of the proposed supplier. NHAI reserves the right for the same.
- c. The following requirements must also be considered:
 - i. The design and installation of Electrical Installations shall comply with the requirements of the Bureau of Indian Standards.
 - ii. The Concessionaire 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.

15. On-line Access Facility during the Operations & Maintenance phase

- a. The systems commissioned by the Concessionaire shall provide, during the entire period of the Contract, adequate remote access (via-internet) to the Independent Engineer and NHAI for on-line evaluation of the functioning of each equipment / sub-system, including all field equipment. The Concessionaire shall also provide the Independent Engineer and NHAI a suitable tool for the same. In the case of TMCS, VIDS, ANPR 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 Independent Engineer in the achieved service levels for the period under evaluation.
- b. The toll shall also provide the real-time access of the ATMS Dashboard, GIS Map, NMS, FMS, Report module for entire stretch as well as each sub-centre, etc.
- c. 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).
- d. The above tool shall also include a feature by which the NHAI and Independent Engineer can generate detailed performance, violation, event, incident, operation and maintenance reports without the need for any support / intervention from the Concessionaire's personnel.
- e. The tool shall also provide the feature to playback any video without affecting the Control Room operations.
- f. The limited access shall also be provided in the Police Control Rooms, Dial 112, and City ICC. The access shall be provided to other enforcement agency also only upon approval of NHAI. The agencies shall be able to view ATMS dashboard, GIS Map, live and recorded feed from all the cameras, reports relevant to the department. The reports to be provided shall be finalised in consultation with Independent Engineer and concerned agency and shall be approved by NHAI. The Police and enforcement department shall have the option to search any vehicle details by entering the vehicle number, along with date time location filters, as applicable. The authorised



users shall also have the option to download / save any video recording, image, relevant report (as per the permission), etc.

- g. The ATMS central processing system shall keep the logs of each and every activity of the users on the On-line Access Facility, included IP address, username, data access, downloaded video / clip logs, etc.

16. Integration

- a. 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.
- b. All integration activities shall be coordinated with the Independent Engineer prior to commencement of any integration activities and shall be agreed in accordance with the project program.
- c. 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.
- d. 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.
- e. The ATMS System shall be integrated with the AFS (ANPR cum FASTag System) deployed by NHAI under a separate contract for user fee collection system on the project / NH Stretch.
- f. Concessionaire shall integrate the VIDS system installed on the project / NH stretch by NHAI under a separate contract for blackspot monitoring.
- g. The ATMS System shall be integrated with the RO Control Centre (RCC), Incident Management System (IMS) deployed at PIU, and ITS Command Centre (ICC) at NHAI HQ for seamless streaming of data / video of all cameras installed on the project by the Concessionaire, incident monitoring / management, facility management system at each of these locations, as per the requirement of NHAI.

17. Training

17.1 General

- a. A training program as specified herein shall be provided for the management, operation, and maintenance of the Highway/expressway management system, digital transmission system and associated systems. All training shall be conducted either in Project City or at site.
- b. The objectives of the training are for the Independent Engineer and NHAI officials to understand the functions and the operation of the various systems, and to make them familiar with the proper use of the equipment, software supplied, traffic management operation under the contract.
- c. The Concessionaire shall develop all materials required for training in English and furnish three (03) copies of each manual, class note, visual aid, and other instructional materials to the Independent Engineer and NHAI for distribution to the attendants. The manuals, instructions, and training notes shall be in loose-leaf binder form.
- d. The outline of the lectures or demonstrations and a sample or description of all training aids shall be submitted to the Engineer for review at least thirty (30) days prior to their proposed presentation or use. Written approval by the Independent Engineer of these materials shall be required prior to the scheduling of training sessions and/or the production in quantity of any training materials.
- e. The minimum content and duration (contact hours) of classroom training sessions shall be as specified herein, plus such other topics as are necessary, to ensure effective training. Notwithstanding the contact hours specified herein, all training shall be effective and shall be completed by the Concessionaire to the satisfaction of the Independent Engineer and the NHAI.

17.2 Management and Operations Training

- a. The management and operations training shall include classroom instructions, on site demonstrations, and follow-up reviews. The training shall be designed for the Engineers and control centre operators (up to 20 persons) and shall cover all operating procedures and database management of all equipment comprising the ATMS.



- b. The initial classroom instructions and on-site demonstrations shall be completed during trial operation for whole works and the follow-up reviews shall be completed during the first two (2) months of the guarantee period. The contents of this training shall include as a minimum the following:

17.2.1 Training program - System Management (Minimum of 12 contact hours)

- 1) System operation
- 2) Operations overview
- 3) Data requests and data displays
- 4) Functions and duties of control centre personnel

17.2.2 Training program - Control Procedures (Minimum of 24 contact hours)

- 1) Server, operator console and peripheral equipment operations
- 2) Orderly start-up and shut-down
- 3) Use of diagnostic programs and procedures
- 4) Response to alarms, errors and faults
- 5) Interpretation of alarms and fault messages
- 6) Operation of TMCS equipment
- 7) Operation of the VIDS equipment
- 8) Operation of the ATCC application
- 9) Operation of the TTMS application
- 10) Operation of the Probe data system
- 11) Operation of the VSDS equipment
- 12) Operation of Graphic Display and monitor display

17.2.3 Training Program - Analyst Procedures (Minimum of 24 contact hours)

- 1) Data requests and data displays of operator console
- 2) Data base management
- 3) Coding input
- 4) Edit checks
- 5) Insertion, deletion and alteration of data
- 6) Modifications
- 7) Addition, deletion or alteration of default values and parameters
- 8) Interpretation of displays and reports

17.2.4 Training program - Maintenance Training

- a. The maintenance training shall cover trouble shooting and maintenance procedures for all newly installed equipment and the use of maintenance tools, equipment, and test instruments. It shall be completed within six (6) months of the issuance of the Certificate of Completion for the Whole Works.
- b. The training shall include at least 80 contact hours of classroom instructions and hands-on workshop sessions, and on-the-job training:
- c. The classroom lectures shall cover at least the following:

17.2.5 Training program - Traffic Management Centre

- 1) Central Processing System Server and operator console
- 2) Peripherals
- 3) Graphic Display
- 4) Data gathering processor
- 5) TMC server
- 6) ATMS Software
- 7) ATCC application
- 8) TTMS application
- 9) Probe data system
- 10) VSDS server
- 11) Communications and Ethernet
- 12) Layer switch, router, and hub if applicable



- 13) Wireless communication system
- 14) Facility monitoring central controller
- 15) Metallic and optical fibre cable
- 16) Power supply and distribution

17.2.6 Field equipment

- 1) TMCS equipment
- 2) VIDS equipment
- 3) VSDS equipment
- 4) Facility monitoring equipment

17.2.7 Workshop

A workshop shall be conducted on

- 1) Test equipment
- 2) Test procedures
- 3) Repair procedures

Further,

- a. Hands-on training shall focus on the diagnosis of the fault and malfunction and include but not be limited to the following:
 - 1) Diagnosis of TMCS
 - 2) Diagnosis of VIDS
 - 3) Diagnosis of ATCC application
 - 4) Diagnosis of TTMS application
 - 5) Diagnosis of VSDS
 - 6) Diagnosis of Ethernet
 - 7) Diagnosis of data transmission system
 - 8) Diagnosis of facility monitoring system
- b. On-the-job operation and maintenance training shall be provided for NHAI operation and maintenance staff or staff of concessionaire (up to 15 persons) and shall commence on the conclusion of the classroom and workshop training sessions and continue until Taking Over Certificate of the Works. Indian counterpart staff will be designated for this purpose. Salaries overtime pay and cost of allowances of these staff will not be the responsibility of the Concessionaire, but the Concessionaire shall be fully responsible for providing all necessary instructions, manuals and tools, and for all other non-salary related cost. The Concessionaire shall specify the equipment, tools, and other items to be provided in the Technical Proposal.

17.2.8 Training program – Operations

- 1) Introduction to the Operations and Maintenance procedures for the highway (based on the O&M manual)
- 2) Routine monitoring of the Highway
- 3) Incident Management procedures
- 4) Incident detection and validation
- 5) Incident logging
- 6) The use of checklists for fail-safe incident management
- 7) Communication with other stakeholders of incident management
- 8) Active monitoring of Incident management
- 9) System performance monitoring
- 10) Routine monitoring
- 11) Logging failures / events
- 12) Communication with maintenance engineers

18. System Operation and Maintenance

- a. The Concessionaire shall perform System Operation and Maintenance (O&M) for a period specified in the Concession Agreement meeting the requirements provided in the relevant Schedules.



- b. The Concessionaire shall deploy adequate number of trained personnel at site and at their back office to ensure that the above requirements are met. The Concessionaire shall submit, to the Independent Engineer and NHAI, weekly reports on their Operation and Maintenance.

19. Information Security

- a. The Concessionaire is 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(E) dated 11th April 2011.
- b. The Concessionaire is required to ensure that the system being provided shall adhere to the model framework of cyber security requirements set for Smart City (K-15016/61/2016-SC-1, Government of India, Ministry of Urban Development).
- c. The Concessionaire shall have familiarity with ISO 27001 or procure the necessary expertise in developing and delivering solutions in line with information system security best practice. **At least one of the System Maintenance Engineer/ Manager deployed at site shall have relevant information security certification from any renowned institute.**

20. Spares, Consumables and Maintenance Equipment

20.1 General

The Concessionaire shall furnish the specific spare parts, consumables and maintenance equipment as indicated in the Tender Schedule.

20.2 Recommended Spare Parts and Maintenance Equipment

- a. The Concessionaire shall provide in his Technical Proposal detailed information on spare parts and consumables necessary for the continuous operation and maintenance of the equipment to be installed under this Contract through the guarantee period and five (05) additional years following the system acceptance. The information shall include identification, source of supply, and availability for the next 10 years. Recommended quantities for five years of maintenance for these spare parts and consumables shall be listed in the Technical Proposal "Spare Parts and Maintenance Equipment".
- b. The Concessionaire shall also identify maintenance equipment, tools, testers, and measuring apparatus which will be required to effectively maintain the highway/expressway management system and provide all necessary details in his Technical Proposal. The costs of furnishing the equipment shall be quoted in the "Proposed Rates and prices of Recommended Spare Parts and Maintenance Equipment." The recommended maintenance equipment should include, among others, the following:
 - 1) Maintenance computer (workstation type)
 - 2) Field maintenance computer (Industrial Grade Laptops)
 - 3) Digital multi meter
 - 4) Level meter
 - 5) Insulation resistant meter
 - 6) Dielectric strength meter
 - 7) Ground resistance meter
 - 8) Oscilloscope



9) Network analyser

- c. Operation, simulation and diagnosis software developed specifically to the equipment to be supplied under the CONTRACT shall be supplied in CD-ROM or DVD. They shall be also installed in the maintenance computer.
- d. The NHAI reserves the option to require the Concessionaire to furnish any or all of the recommended spare parts, consumables, and maintenance equipment.

20.3 Parts Supply Guarantee

- a. The Concessionaire (Concessionaire), his legitimate successor or his designate, shall guarantee for a period of seven (7) years from the date of commencement of the O&M period and that he will supply promptly upon the written request from the NHAI any parts, components or equipment incorporated in the System even after completion of the Contract period. This Clause shall not necessarily be construed to read that the Concessionaire be required to maintain the inventory to cover the entire items for anticipated requirement for such purpose through the 7 years' period. Because of discontinuation of production of such particular items or because of any reasons beyond his control, if the Concessionaire fails to supply the requested parts, components or equipment, he shall satisfy the need of the NHAI by whatever appropriate substitutes available with consent and approval of the NHAI, but always in such a manner and outcome that the substitutes can maintain or improve the Works' performance or capabilities as a whole.
- b. The Concessionaire shall be paid as per the rates mentioned in the Indicative list of key components or as determined by the Authority, for supply of parts requested by NHAI after completion of the Contract period.



Section 02 Design Requirements

1. General

- a. The Concessionaire shall undertake the detailed design of Advance Traffic Management System (ATMS), Digital Transmission System and associated facilities and works, hereinafter collectively referred to as ATMS. The ATMS shall meet all the design criteria stipulated in the System Specifications. The component systems comprising ATMS to be constructed under the Contract shall include but not be limited to the component systems:
- b. All systems to be installed under this Contract shall be capable of continuous, unattended, 24 hours a day, 7 days a week operation under the environmental conditions prevailing on the Project Highway. Should the design require periodic replacement of any equipment or component, the replacement schedules of such equipment or component shall be described in the Technical Proposal and in the maintenance manual.

2. Technical Proposal

The Concessionaire shall shortlist the ATMS Sub-contractor and shall submit the Technical Proposal of the ATMS Sub-contractor to NHAI for review and approval of the Independent Engineer before awarding the work.

The technical proposal shall comprise of the following:

- a. The Concessionaire shall describe the proposed works in sufficient detail in his Technical Proposal to enable the NHAI to evaluate the technical adequacy of the proposed system. The Technical Proposal shall include the statement of compliance with the Specifications indicating whether the proposed equipment comply with the specified requirements. If the proposed system does not comply with the Specifications, the details of differences shall be described together with the alternative features of facilities offered. The NHAI may reject the non-compliant proposal.
- b. The Concessionaire shall propose and describe in detail in his Technical Proposal the approach, methodology, technology and procedure of the detailed design of the expressway management system, traffic management system, digital transmission system and associated works. Expected output of the detailed design shall be described together with the submission schedule for review and approval by the NHAI.
- c. For the items for which type, procedure, method, or configuration is left to the supplier's design, The Concessionaire shall clearly indicate in the proposal the type, procedure, method or configuration he chooses with reason.
- d. The Technical Proposal shall describe in detail how the system requirements defined in the Tender Documents will be achieved with block diagram, data flow, and timing chart.
- e. The Concessionaire shall not submit an alternative proposal. NHAI shall reject such alternative proposal.
- f. The Technical Proposal shall be written in the same sequence as the Specifications. Where the supporting documents are provided, a cross reference shall be prepared. The Technical Proposal shall be written in English.
- g. The Technical Proposal shall include the description of system as a whole and equipment comprising the System. The description shall include how the requirements of the Specifications are achieved. If necessary, block diagram, flowchart, timing chart or other explanatory documents shall be attached.
- h. Equipment comprising the system shall be defined. For each equipment, the following items shall be stated:
 - 1) Electrical and/or mechanical specifications
 - 2) Specifications of interface with other equipment
 - 3) Human-machine interface, if applicable
 - 4) Environmental conditions
 - 5) Physical dimensions
 - 6) Power consumption
 - 7) Operation console layout
 - 8) Brand, make, model, and/or type (only one for each component)*
 - 9) Catalogue, brochure, or other supporting document (if any)



**Technical proposal with more than one make/model for each component shall be rejected.*

- i. The Concessionaire shall submit the layout plan of the Operation Room in the Technical Proposal for reference
- j. The Concessionaire shall include in the Technical Proposal the software quality assurance program that he intends to adopt in developing the software.
- k. The Concessionaire shall propose in the Technical Proposal the feasibility and ease with which such applications (additional software packages to run concurrently with the software provided under the Contract) might be implemented using the Advance Traffic Management System proposed by him and shall advise the spare memory capacity and processing power which could be available, but not necessarily provided, within the proposed computer to allow such applications to be implemented.
- l. The Concessionaire shall state in the Technical Proposal, the third-party software that he proposes. If the Concessionaire proposes the third-party program that is of limited use, he shall explain the reason for using it in the Technical.
- m. Systems and subsystems that minimize the possibility of either the failure of any single component or the module which may cause total system failure shall be provided by the Concessionaire in Technical Proposal and later in Design Document. Failure of one component or module shall not cause the failure of any other component or module.
- n. The Concessionaire shall describe in his Technical Proposal application software to be provided to the servers and workstation in the Traffic Management Centre required hereunder.
 - 1) Graphical presentation of module and components comprising application of servers and workstation.
 - 2) Data processing flow in the form of class diagram, use case diagram, sequence diagram, or data flow diagram
 - 3) Scale or size of the module and components, and programming language used
 - 4) Extent of the development required for the Project
- o. Attested copy of the Certifications, test reports, etc. specified in this Document.
- p. Any other item / document / information specified in this Document for submission in Technical Proposal/ design document or sought by the Authority/ Independent Engineer.

3. Detailed Design

3.1 Design Briefing

Within 15 days of commencement date of the Works, the Concessionaire shall conduct a design briefing session in the development centre of the Concessionaire. The design briefing shall cover all the system components and civil works included in the Contract. The main objective of the briefing is to acquaint the Independent Engineer and NHAI with the design concept and outlines of the proposed systems, and to allow them to examine whether or not the Concessionaire's design complies with the Contract.

3.2 Design Review and Approval

- a. Within 1.5 months of commencement date of the Works, the Concessionaire shall submit a Final System Detailed Design to the Independent Engineer for his review and approval. The System Detailed Design shall provide detailed information of the proposed system, including system configuration, block diagrams, input and output, flow charts, interface, inter-connections, design calculation and manufacturer's specification sheets for all systems and shall cover all necessary hardware, software, database and operating procedures.
- b. The Concessionaire shall submit System Detailed Design for each component system as it is completed. The Concessionaire shall further focus on completing the design of all components to expedite the project implementation. If design change is necessary for the portion of the detailed design that has been submitted and approved due to the design of other portions, revised detailed design shall be submitted with the modification noted for approval.
- c. The Concessionaire shall not, without specific approval in writing by the Independent Engineer, place any material, part or component on order, nor commence manufacturing of any equipment or software coding until the System Detailed Design has been approved by the Independent Engineer. The Concessionaire shall not implement any changes on the approved system design without prior approval of the Independent Engineer.
- d. The approval of the System Detailed Design by the Independent Engineer, however, does not relieve the Concessionaire from delivering a fully operational and reliable system.



3.3 Hardware System Design

The hardware portion of the System's detailed design shall include among others the following:

- 1) Functional and physical system block diagram of each component system.
- 2) Connection and interface between the blocks in the block diagram.
- 3) Functions, capacity, input, output, and method of operation.
- 4) Response time, delay, allowance, attenuation, loss and other figures as appropriate for applicable equipment.
- 5) Environmental and physical design specifications of the equipment. Manufacturer's product specification sheets may be accepted for standard products.
- 6) Power consumption of each equipment.
- 7) Cable network diagram.
- 8) Cable work plane plan.
- 9) Conduit line plan.
- 10) Equipment layout in the machine room at the Traffic Management Centre, at Service Area, and Toll Plaza Office.
- 11) Layout in the control room at the Traffic Management Centre including civil works, interior works and lighting plan.
- 12) Manner of installation.

3.4 Software System Design

Software portion of the System Detailed Design shall include, as a minimum, description of module, identification of tasks, priority level, execution schedule, input and output, algorithms and parameters, database structure and contents, parameter update procedures, data flow, calling sequences, error detection, backup and recovery and programming languages.

Structure of software shall be simple and straightforward. Interdependency and interaction between modules shall be clear and kept to minimum to prevent defect in one module from affecting many modules. Data and parameters shall be separate from the program and kept in the database.

3.5 Operating Procedures

Operating procedures for all systems and equipment of ATMS shall be identified and described in detail in the System Detailed Design. Frequently used operating sequences shall be described in a step by step manner.

Full proof mechanism shall be incorporated in the operation procedure to prevent any inadvertent mistake to cause serious damage to the system, highway/expressway operation and driver's safety.

4. System Configuration

The Concessionaire may adopt a system configuration as long as the functionality and performance of the system meet the system requirements specified herein. It is the Concessionaire's obligation to show that the proposed system will satisfy all the requirements in the system specifications.

4.1 Traffic Management Centre System Network

It is required that the Traffic Management Centre server system employs an open network architecture consisting of several servers, operator consoles and central controllers connected through a standard local area network based on TCP/IP. To ensure a high level of reliability and operational flexibility, it is required that the operator console connected to the network shall complement each other and shall not be dedicated to a specific function. Breakdown of an operator console shall not affect the normal operation of the system and in any aspect. Database server shall have a redundant configuration of RAID system or similar highly reliable configuration.

4.2 Component Systems

1. The ATMS to be constructed on this highway/expressway composes of many component systems as described above. Some of them are closely integrated with other systems, while others are stand-alone system with no data exchange with other systems. All of them shall be designed with a consistent design policy and concept to achieve the overall objectives of the total system. Functional and performance requirements for each component system are defined in these specifications. The Concessionaire shall undertake the detailed design of each system in such a way that the total system is efficient, reliable and user friendly in operation. The system design



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shall incorporate the latest technology in each field but propriety technology available from a single vendor only shall be avoided.

2. All ATMS equipment shall work 24 hours a day on all days of the year.
3. All type of cameras shall support ONVIF profile S/G and shall be FCC Class A, UL, CE, BIS certified. The cameras shall be provided with minimum 128GB internal/local storage (Class 10 or better SD card).
4. All Servers, Storage, Computing, LPU, Networking, Security devices etc. shall be BIS certified.
5. The MAC (Machine Authentication Code) address of all the equipment shall only be registered in the OEM's name.
6. All modules except ATMS CPS application shall be third-party COTS (Commercially available off-the-shelf) enterprise edition software and only third-party COTS enterprises edition software shall be provided for the software/ solution/ application / module specified as COTS in the ToR/BOQ and no customised or proprietary software/ module of the Contractor shall be provided for applications such as NMS, VMS/VAMS, GIS, etc., as approved by NHAI/Independent Engineer.

4.3 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 used in 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 through an exclusive ATMS Facility Management system (FMS) that shall be continuously maintained for audit by NHAI or its authorized representative.

4.4 Digital Transmission System

Digital transmission system for data exchange between field equipment and central equipment shall use IP based transmission system complying with the established international standards such as ITU/ IEEE. All data transfer between the central equipment and the field equipment including video streaming and image shall be made in digital format except the section between local controller and the terminal device. Internet based and wireless transmission system shall also adopt digital form.

In addition, the ATMS shall support communication with Internet of Things (IOT) equipment/ systems utilizing the associated standard protocols like MQTT

4.5 Traffic Management System

The Traffic Management System shall have high reliability, accuracy and security in design. Stoppage of the total system shall not be allowed under any circumstances. Redundant hardware configuration shall be adopted for key components to ensure continuous operation. Data backup mechanism shall be used to prevent data loss. Operation log shall be kept to allow tracing of operation in case of any dubious event. Mechanism shall be incorporated in the system design to prevent illegal or fraudulent activities by the Control room operators.

5. Space for ATMS Facility

Suitable space for the Control Centre (i.e. Traffic Management Centre) and Sub-Centres, will be provided by the Civil Contractor for setting up of the Control Centre and Sub-Centres. The building shall be designed by the Civil Contractor in consultation with the Concessionaire such that it is sufficient to accommodate the entire system along with further scope for extension.

5.1 Traffic Management Centre and Sub-Centres

A Traffic Management Centre shall be constructed at the site near the Highway on the top floor of the Toll Plaza Control Building or any other suitable building on the project stretch with sufficient space for setting up TMC. All central equipment including server network, multi-screen wall map, data communication system, voice communication system and associated equipment will be accommodated in the office. System operator will station at the office and manage the traffic on the highway. One TMC shall be provided for each project stretch. Sub-Centre shall be provided at every toll plaza other than the Toll Plaza that accommodates TMC, such that entire stretch is proportionately divided in sections of up to 80 kms between the TMC and sub-centres.



In case toll plaza building is not available, the TMC and sub-centre (as applicable) shall be constructed by the Concessionaire on the project stretch to fulfil the above requirement.

6. Power Supply

- a. The input power supply of any equipment shall not be connected to any electric components except arresters without connecting first through fuses, power switches and circuit breakers.
- b. All equipment shall be provided with a clearly visible label indicating the input power supply type (AC or DC) and voltage. All equipment shall operate with the power supply of 230V plus or minus 10 percent, and 50 Hertz plus or minus 3 percent. All field equipment shall operate normally under instantaneous power supply interruption of 20 millisecond or shorter.
- c. The power supply voltage available in the field will be 230V AC. Unless specified otherwise or with the approval of the NHAI, all field equipment shall be designed to operate directly on 230 V AC. The Concessionaire shall be responsible for arranging the terminal devices necessary to receive the power supply.
- d. System enclosures shall include a power distribution subsystem for supplying power to each component within the enclosure and related / inter- connected equipment. The circuit breakers shall be properly sized according to the expected loads of the concerned equipment and to meet relevant electrical code requirements.
- e. 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.
- f. 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.
- g. The enclosure shall be earthed in accordance with the relevant BIS and NBC 2016 regulations.
- h. The enclosure shall include a 230Vac 15 Amps 3-pin dual socket power outlet conforming to BIS standard.
- i. The power sockets shall be installed in accordance with relevant BIS standard.
- j. **Surge Protection Devices (SPDs)** shall be provided at main's entry level (LT Panel level / Entry panel – 230/400 V AC or at UPS level) 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 at equipment location and building. The SPD shall be rated in accordance with IEC 61643-11 and NBC 2016, the latest and valid standards. It shall be non-exhausting metal encapsulated, spark gap-based technology. The SPD shall be tested as per IEC 61643-11:2011 (or equivalent EN 61643-11:2012) from KEMA or VDE international independent test labs. The SPD shall be rated for 255 V. It shall be capable to discharge Lightning current (10/350 μ s) of 25 kA for L-N and 100 KA for N-E. The device shall have voltage protection level of device shall be ≤ 1.5 KV including inbuilt fuse. The SPD shall have current extinguishing capability [L-N]/[N-PE] : 100 KArms / 100 Arms. The device shall have followed current limitation/Selectivity resulting in no tripping of a 35 A gL/gG fuse up to 50 KArms. The device shall have built in fuse and operation of SPD shall be independent of Line current. No requirement of additional overcurrent protection. The device shall have mechanical indication-based health indication for L-N and N-PE SPD along with the common potential free contact / changeover contact for remote monitoring.
- k. **Network Surge Protection Device (SPD):** The different components of system shall be installed with surge protection device in accordance with IS/IEC 62305-4, the selection/location shall be decided depending upon the criticality of the application. The communication interfaces shall be installed with suitable SPD. SPD for POE shall meet the latest standards and suitable SPD for 12V DC supply and 5V DC supply, as applicable and complying to IEC 61643-21 / EN 61643-21 shall be installed and shall be UL approved.

7. Design Life

All components and materials used in this Contract, excluding consumable items such as lamps, shall be of a design life of 10 years or longer, used for ATMS, and unless specifically stated otherwise in the System Specifications. The NHAI may approve components with a shorter design life if they are easily replaceable and a 10-year design life is generally considered infeasible or uneconomical. The replacement of such equipment shall be possible without displacing other component.



8. Environmental Conditions

8.1 General

All equipment shall be designed to operate properly under the environmental conditions normally encountered at the site of the equipment and shall conform to the minimum requirements specified herein.

8.2 Environmental Conditions

- a. Unless specified otherwise, indoor equipment shall be designed to operate in the temperature range of 0 to 35 degree Celsius, and the relative humidity range of 5 to 85 percent, whereas outdoor equipment shall operate in the ambient temperature and relative humidity ranges of -10 to +55 degrees Celsius and 40 to 90 percent non-condensing humidity, respectively. Adequate protection from moisture condensation, fungus, rust, insects, rodents, and dust shall be provided.
- b. All equipment shall be adequately treated to prevent rust and corrosion due to high humidity or moisture condensation. All galvanized steel surface shall have a minimum plated zinc amount of 350 g/m². Any signs of rust or corrosion occurring within the guarantee period shall be deemed a defect and the Concessionaire shall be responsible for correcting, at his own expense, the defect to the satisfaction of the NHAI.

8.3 Wind

All outdoor equipment and their support, individually and fully assembled and installed as a whole, shall withstand an instantaneous wind velocity of at least 30 m/sec. or the wind velocity recorded on the Project Stretch till date, whichever is higher. The Concessionaire shall also obtain the certificate from the concerned Metrological Department regarding the maximum recorded wind velocity on the highway/expressway stretch.

9. Cabling and Wiring

All cables and wires shall be of good quality, conforming to normally accepted industry standards, and shall be of the proper type and have sufficient ratings for the particular application.

- a. All exposed ends of unconnected cables and wires shall be coated with watertight sealing compound or sealing tape to avoid damage to conductors. All communication cables used shall have a clearly marked label securely fixed near each end in accordance with the cable network diagram.
- b. All cables and wires shall be adequately protected from the edges of equipment housing or other surrounding objects. All of the cables and wires shall be neatly arranged and securely placed in such a way that all terminals are relieved of the weight of the cables. Terminals shall be coded, identified and labelled according to wiring diagrams. Live metal shall be recessed or protected to avoid accidental contact.

10. Grounding

- a. All exposed metal not forming part of the electrical circuitry, including equipment enclosures, cable supports, structure and pole shall be grounded to the earth.
- b. Equipment which is supplied with voltages of 100 volt or more shall be provided with grounding terminals insulated from their frames. Control centre equipment shall be equipped with a grounding terminal of earth resistance of 10 ohms or less. Field equipment shall be equipped with a grounding terminal of earth resistance of 100 ohms or less.
- c. Compensation for furnishing and installing grounding equipment shall be included in the prices of various BOQ items and no separate payment shall be made, therefore.

11. Protection against Lightning

- a. All outdoor equipment shall incorporate gap arresters or other suitable device approved by the Independent Engineer to prevent lightning damages which may enter through input AC lines, communication cables, signal cables, detector feeder cables or other metallic elements exposed to the open air.
- b. Compensation for furnishing and installing lightning protection equipment shall be included in the prices of various BOQ items and no separate payment shall be made, therefore.
- c. Earthing of all equipment shall be made by using UL listed 3-meter copper bonded rod (minimum 250 micron) with 17 mm dia, complying with **NBC 2016, IS 3043 and IS/IEC 62305-1/2/3&4**



standards. The resistance value shall be as low as possible in every case. Above ground metal piping in the process/valve area (subject to non-Cathodic protected) shall be Earthed.

- d. From the viewpoint of lightning protection, a single integrated structure earth-termination system is preferable and is suitable for all purposes (i.e. lightning protection, power systems and telecommunication systems). The earthing system of a number of structures shall be interconnected so that a meshed earthing system is obtained. This will give low impedance between buildings and has significant lightning electromagnetic pulse (LEMP) protection advantages. Thus, different earthing systems like lightning protection earthing, electrical earthing, safety earthing, electronics earthing etc shall be interconnected.
- e. **Isolating spark gaps (ISG)** shall comply to IEC 62561-3, used at the places where direct interconnection is non-permissible to create equi-potential bonding throughout the earthing system at the event of lightning with lightning impulse current (10/350 μ sec / Iimp) up to 100 kA and rated impulse sparkover voltage of ≤ 1.25 KV with IP 67 degree of protection.

12. Cabinets

- a. All equipment cabinets for outdoor uses shall be of rainproof and rustproof construction with smooth exterior and adequate protection against moisture condensation and shall be made of high-quality steel or stainless-steel plates of adequate thickness. Steel plate cabinets shall be treated with sand blast before painting or equivalent rustproof measures.
- b. Past experience has indicated that condensation may develop inside a completely enclosed outdoor cabinet connected with underground conduit due to breathing effect which is caused by a change in ambient temperature even when the conduit is sealed by foamed sealant. The Concessionaire shall state in his Technical Proposal how he will overcome this problem.
- c. Cabinet doors shall permit complete access to the interior of the cabinet and shall encompass essentially the whole area of the front surface of the cabinet. All door hinge pins shall be of stainless-steel construction.
- d. All outdoor equipment cabinets shall be equipped with a build-in lock and door open alarm integrated with the Control centres. All cabinets for the same type of equipment shall have an identical lock. The specified number of keys for each type of cabinet shall be furnished to Independent Engineer.

13. Pole

- a. 12-meter poles shall be used to mount TMCS and VIDS cameras.
- b. Pole cross section shall either be circular with a typical outer diameter of 150 mm or square cross section.
- c. The joint(s) shall be seam welded.
- d. The fully fabricated pole column shall be of stainless steel/galvanized /Enamel Painted/powder-coated to an appropriate minimum coating thickness.
- e. The poles shall incorporate suitably designed holes on the sides to allow for electrical cables to enter or exit the pole undamaged.
- f. The bottom portion of the pole shall be treated for corrosion resistance in accordance to the installation site.
- g. 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.
- h. 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. The access door shall of sliding type, top to bottom direction, so that it remains closed even when the clamp /hook to hold it is removed. The sliding rail shall be welded inside the pole.
- i. 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.
- j. Suitably sized powder coated terminal box and terminal block assembly shall be provided and be treated as a part of the 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 waterproof sealant to avoid water ingress into the box or the pole base.

**14. Mounting Arrangements**

- a. All mounting arrangements for ATMS equipment shall comply with the requirements of that equipment as detailed in this specification.
- b. The foundation and the foundation bolts for Ground mounted enclosures, 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 for poles, plates etc and up to 55 microns for the bolts and other accessories.
- c. Galvanized Nuts, locknuts, locking pins washers etc. shall be supplied as a part of the foundation.
- d. Fixing templates with a placement accuracy of at least ± 1 mm shall be provided to allow for the correct orientation and installation of the steel foundation on to the concrete base.
- e. 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.

15. Ground Mounted Equipment Enclosures and Poles**15.1 Ground mounted enclosures**

- a. The ground mounted enclosure shall house telecommunications equipment, power and other related equipment necessary for the operation of ATMS equipment
- b. The equipment must continue to work within its normal operating parameters in this environment, regardless of location.
- c. 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.
- d. 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.
- e. Each enclosure door shall be equipped with an adjustable doorstop to hold the door open.
- f. 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.
- g. All internal connectors, components and wire terminations installed in the enclosure shall be labelled in accordance with the design drawings.
- h. 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:
 - (i) BIS requirements (or approved equivalent international standard).
- i. 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.
- j. 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.
- k. 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.

16. Heating, Ventilation and Air Conditioning (HVAC) Subsystem

- a. 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 Independent Engineer for approval.
- b. 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.



17. Installation

- a. The ground mounted enclosure shall be installed according to appropriate good engineering practices. All internal components and UPS (if required) shall be securely mounted.
- b. 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.
- c. 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.
- d. 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.
- e. All wires/cables within the enclosure shall be secured and labelled. 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.
- f. 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.
- g. 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.

18. Radio Interference

All data processing and transmission equipment shall be designed to prevent radio interference with the satisfactory operation of other equipment regardless of whether the interference be due to radiation, induction or conduction.

19. Metering

All electrical and electronic equipment shall be provided with waveforms and voltage test points or voltage meters as necessary for indicating circuit conditions.

Section 03 Central Processing System

1. General

- a. The ATMS for the Project is composed of many components systems. These systems are expected to perform their functions to achieve overall objective for the efficient, safe and smooth traffic on the Highway/Expressway.
- b. The Concessionaire shall provide and construct a central server system that manages various systems comprising the Highway/expressway-traffic surveillance and control system in an efficient manner, provides user-friendly human machine interface for the operator and records all events and incidents related to the Highway/expressway.
- c. System shall be expandable to account for increase in field installed devices. Minimum 25% spare capacity (rounded off to the nearest higher whole number) should already be part of the quoted system.
- d. All the supplied equipment shall operate on 230 V, 50 Hz single -phase power supply. Power for all the equipment will be conditioned using on-line UPS with minimum 4 hours or more back up. If any equipment operates on any voltage other than the supply voltage and supply frequency, necessary conversion/correction device for supply shall be supplied along with the equipment.
- e. All the control equipment e.g. file servers, database servers, video recording server, SAN/NAS/Raid backup device, decoders, networking equipment etc. shall be provided in standard Racks.
- f. System shall have WAN connectivity for remote monitoring.
- g. Online backup should be maintained to protect against storage failure.
- h. Concessionaire shall provide all technical details regarding data formats, communication protocols, packet formats, etc. to enable Independent Engineer and NHAI to formulate national standards on successful implementation of the highway stretch.
- i. All the modules supplied (CCTV, Speed display, Roadside Communication etc.) shall deliver data and reports that are safety-centric (fatal collisions in a given stretch, violation of regulation etc.), enforcement-centric (number of tickets issued, comparison of violations on monthly basis etc.) as well as equipment-centric (failed packets, number of repairs carried out on field devices, down time on account of major faults etc.)
- j. The system shall provide detailed reports related to the System Operations (including the actions of various stakeholders during Incident Management) and Maintenance. The format for the same shall be finalized by the service provider in consultation with Independent Engineer. 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.
- k. 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 and other sensors to the maximum extent possible.
- l. 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 a common timeline / scale.

2. Main Function

- a. The central server system shall constantly monitor the operation of component systems and their subsystems. It shall be possible through the supervisory server to define/ modify the system configuration and add/remove any device connected to one of the component systems. It shall also be possible to change any system parameters defined and stored in the database.
- b. Provision shall be made with preventive measures against inadequate change to the system parameters. Access to the system configuration function must be restricted to the authorized personnel and error check function shall be incorporated as much as possible. The configuration and parameters of the system shall be backed up to allow recovery.
- c. Seamless data exchange (including incident/event management/ monitoring, video streaming of all cameras, access to reporting modules, facility management system, NMS etc.) between

TMC, RCC at NHAI Regional Office, IMS at NHAI PIU, and ITS Command centre at NHAI HQ.

3. Equipment Location

- a. The Concessionaire shall design the layout of the Operations Room and Server Room in the Traffic Management Centre. The Operations Room is the room where Graphic Display, TMCS monitor display, and console will be placed, and the operation of the Project will be monitored. The Server Room will be the place where the server, network equipment and other devices will be installed.
- b. The layout shall be designed taking into consideration the function of the server and workstations to be placed in the room, the role of the staff and operators stationed in the room, position of Graphic Display and TMCS monitor screen, cable routes, viewing by visitors and other factors to establish a functional Operations Room and Server Room. The layout shall be approved by the Independent Engineer.
- c. The Concessionaire shall submit the layout plan of the Operation Room in the Technical Proposal for reference.

4. System Functions

4.1 Event input and management

The central processing unit must have at least the following system and functions:

4.1.1 Basic concept of event management

Considering further information reuse for the Traffic Management and Traffic Information Provisioning, the system shall provide function to allow input and register the traffic data/events with location information in the specified management unit.

And also taking the actual O&M into account, the system shall cover all items which should be managed as traffic events.

4.1.2 Event generation

- a. Judgment of traffic situation

i. Automatic event generation

- 1) Using the traffic data measured by appropriate field systems like ANPR data in real time, and live video data from VIDS and ANPR, the system shall be able to detect traffic jam situation automatically by using a user specified velocity parameter.
e.g. Judged as traffic jam in case of traffic velocity less than 20km/h.
- 2) Using the live video data monitored by VIDS in real time, the system shall be able to detect an abnormal situation (e.g. car incident) automatically.
- 3) Using the live video data from VIDS, TMCS, and ANPR data analysis, the system shall be able to detect the traffic violations (eg. Over speeding, wrong direction driving, wrong lane driving – bus/truck driving in car lane or car continuously deriving in overtaking lane/truck lane, zig zag driving, dangerous driving, etc.) automatically.
- 4) Using the live video data from VIDS, TMCS, and ANPR data analysis, the system shall be able to detect the Faulty / non-standard number plate of the vehicles.
- 5) Using the live video data from VIDS, TMCS, and ANPR data analysis, the system shall be able to detect the faulty tail light (when the rear of the vehicle is within the viewing zone of the camera) and head light of the vehicles.
- 6) Automatic validation request generation and E-Challan generation for above violations post validation by the operator.

ii. Manual event registration

After confirming events by the following method, the operator shall be able to register events manually.



- 1) Incident reported by Highway emergency call (e.g. 1033)
- 2) Incident reported by Patrol vehicle
- 3) Incident found in camera for TMCS, VIDS, ANPR, VSDS, etc.
- 4) Incident reported by other sources, etc.

iii. Priority management of event (Seriousness and Distance)

Based on the pre-defined seriousness of events and the distance between event location, the system shall have function to prioritize information to be provided automatically.

iv. Association (connection) function

The system shall have function to associate the traffic situation and the causal traffic event automatically.

e.g. “Traffic Jam” caused by “Car Accident”

v. Complementing of missing data

The system shall provide function to the operator who is monitoring TMCS in O&M centre, for manual complementing/correction of the missing data or odd traffic information.

e.g. Even if the traffic jam was not detected by system, the operator shall be able to register as traffic jam by his own judgment.

b. Tuning of setting

For the above-mentioned event generation, threshold parameter shall be adjustable (i.e. can be tuned) for the daily operation.

e.g. Threshold velocity for traffic jam detection (20km/h → 30km/h)

e.g. Information delivery distance for non-serious event (within 5km → within 10km)

Note: For any / all of the above related to Event generation the ATMS service provider may utilise relevant Artificial Intelligence and / or Machine Learning algorithms built into the ATMS system. The Concessionaire shall indicate these features in the Technical Proposal.

4.1.3 Event management method

1) Event entry and release

The system shall have the function to associate the location (Up/Down lane), the event type, and the event detection time with TMCS camera which detect event. And it also shall provide event management method to register and release traffic events.

e.g. Register and Release events by pull down operation, specifying the type of event and the number of cameras which detected the event.

2) Supporting function

In general, the events (e.g. car incident) are supposed to be released by the operator manually. But to prevent neglecting release of events, the system shall provide notification function to ask confirmation of operator for events which keeps ongoing after specified time period.

e.g. Alarm is raised for the event which keeps ongoing more than 30 min

4.1.4 Relationship with another agency

1) Integration on related information of another agency

Supposing that the same level traffic information as Project in the future from the connected roads, traffic information status both for Project and the connected roads shall be integrated as one seamless traffic information.

e.g. Traffic jam which begins from other projects and ends in Project shall be merged into one information.

2) Increased capacity of connecting roads

The system shall be prepared for the expansion of the connected roads and information service area.

4.1.5 Call recording

Conversation of all Emergency calls including the call transferred to other telephone shall be automatically recorded in the storage device of the Emergency Telephone Console workstation with time stamp and operator details. It shall be possible to assign type of call for each record and search the recorded messages with type of call, date, operator, and location.

4.2 Internet Server and Project website

- a. Information of road and traffic condition will be disseminated to the public via Internet. A website of Highway/expressway-traffic-information will be set up and the Concessionaire shall design the website layout and prepare the contents.
- b. The site shall present the Highway/expressway graphically and the existing events such as congestion, maintenance work, lane closure and others that affect normal operation. They shall be indicated on the map by icons and colour. The map shall be updated, when there is any change in the event status without delay.
- c. The highway map shall show also camera-icon at the installation points of TMCS camera. If a camera-icon is clicked, the site shall be designed to display in another window, live video taken by the selected camera with clicking. Resolution and frame rate of live video shall be variable to reduce the bandwidth required to access the site.
- d. The Website shall be hosted on the NIC only and the link of this website shall be provided on the NHAI and MoRTH websites. The Concessionaire shall be responsible for coordinating with the concerned agencies and the cost of hosting and development charges shall be in the scope of the Concessionaire.
- e. At least following information (Road and Traffic condition) shall be provided via Internet:
 - 1) GIS Map
 - 2) Live Video from TMCS camera
 - 3) Traffic Condition like congestion
 - 4) Traffic Event using Image Icon (Type and Location)
 - 5) Traffic Violation details with an option to search by vehicle number
 - 6) Traffic guidance in the form of alternate routes
- f. SMS Server shall be set up for sending the SMS alerts to the road users and violators. The mobile number of the user shall be obtained from the NPCI FASTag Mapper and/ or Vaahan database. In case the mobile number is available / fetched from both mapper and database, the number obtained from NPCI FASTag Mapper shall be preferred. All the messages sent shall contain the emergency helpline number '1033' and other details specific for the project. The Concessionaire shall coordinate with the telecom service providers for sending the welcome message to the commuters entering the project stretch. The format shall be finalised in consultant with the Authority and Independent Engineer.

4.3 Information Exchange with Another agencies

Traffic information must be created including road traffic condition of other agencies. For that purpose, Concessionaire must introduce dedicated device to make information exchange with other organizations. Moreover, the system must include conversion/integration functions of data formats in order to recognize exchanged data as of continuous roads for the integrated traffic information provision.

5. Software

5.1 General

- a. The ATMS software integrates the field equipment like CCTV cameras, VIDS with the Integrated Traffic Management (ITM) console to ensure the availability of an effective system for Traffic monitoring & incident / accident management. In addition, it shall also have the capability to integrate and exchange data (using standard protocols) with multiple IoT (Internet of Things) devices that have been temporarily / permanently located on the project highway for Traffic study / Traffic management / Road safety purposes.
- 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 time should be 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, VIDS 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:
 - i. Data acquisition module for acquiring data, video streams and audio streams from field equipment
 - ii. Highway Traffic Monitoring module
 - iii. Incident / Accident Management Module
 - iv. Integrated audio communication module
 - v. Report generation module
 - vi. System Administration module
 - vii. Road surface / condition monitoring module
 - viii. Communication module for authorized access by external systems (e.g. NHAI's Regional control centre & the HQ ITS command centre)
- d. The Concessionaire shall provide a set of software to operate on the servers, workstations, terminal equipment, and other components and devices to be provided under the Contract. The software shall function as a system to provide end results required in the Contract.
- e. The software will be either the software that the Concessionaire has, modification of the existing software, or the new software to be developed for the Project. The copyright of the software specifically developed for the project shall remain with the Concessionaire.
- f. The set of the software to be provided shall consist of those provided by third party and those specifically developed for the project. All third-party software shall be legally licensed and there shall be no restriction on the use in the Advanced Traffic Management System. They shall be registered under the name of NHAI and any supports and services provided by the software developer including update and revision shall be available to the NHAI.
- g. The software to be specifically developed for the Project shall be fully tested and shall be free from bugs. The Concessionaire shall include in the Technical Proposal and design document the software quality assurance program that he intends to adopt in developing the software.
- h. The programming of the applications shall be arranged in such a way that maximum flexibility is afforded by the design to allow the NHAI to implement modifications or additional equipment which may become available or desirable during the working life of the system. Such future modifications or changes shall not be the part of the current scope of the contract and shall be estimated and paid time to time by the NHAI if required but comprehensive documentation of the software and source codes shall be provided under the Contract to allow such changes to be implemented by the NHAI without recourse to the Concessionaire.
- i. The NHAI may wish to implement additional software packages to run concurrently with the software provided under the Contract. These packages may include but will not be limited to the following:
 - 1) Programs allowing the TMC system to operate with other systems such as Toll Management System / ETC/ HES / AFS interfaced to the data network and involving bi-directional transfer of files.
 - 2) Analytical and statistical program to process the data collected by the system.
 - 3) Software that offers new service to the road users through Internet.

- j. The Concessionaire shall propose in the Technical Proposal the feasibility and ease with which such applications might be implemented using the Advance Traffic Management System proposed by him and shall advise the spare memory capacity and processing power which could be available, but not necessarily provided, within the proposed computer to allow such applications to be implemented.
- k. The Concessionaire shall be responsible for Integration of ATMS system and sub-systems with the NHAI Mobile App for the road users as per the requirement raised from time to time by the ITS department of NHAI or its authorized agency.
- l. The Concessionaire shall be responsible for Integration of ATMS system and sub-systems with the NHAI Command Centre in NHAI HQ as per the requirement raised from time to time by the Electronics department of NHAI or its authorized agency.
- m. The video stream captured and displayed at any location under this project shall be authenticated through Digital Watermarking containing NHAI logo with date and time stamping. The purpose of Digital Watermarking is to ensure following:
 - 1) Copyright protection
 - 2) Source tracking
 - 3) Broadcast monitoring
 - 4) Video authentication

5.2 Third Party Software

- a. The third-party COTS software to be provided shall include but not be limited to the following:
 - 1) Server operating system
 - 2) Storage device operating system
 - 3) Client operating system
 - 4) Database management software
 - 5) Video Management and Analytics Software
 - 6) Firewall and antivirus program
 - 7) Network Management System
 - 8) GIS enterprise edition platform
 - 9) Facility Management System
 - 10) Network Video Management Software
 - 11) Microsoft office Pro 2016 or latest license for all workstations
- b. All third-party programs to be provided shall be widely used and suitable for the application of Advanced traffic management system in terms of functions, capacity, speed, and interface with other software, maintenance and user friendliness. The Concessionaire shall state in the Technical Proposal of the Tender, the third-party software that he proposes. If the Concessionaire proposes the third-party program that is of limited use, he shall explain the reason for using it in the Technical Proposal of the Tender.
- c. If the third-party software is provided in CD or DVD, the original CD or DVD shall be submitted as part of documentation. The requirement is not applicable to the software preinstalled in the server or workstation.
- d. **If the cost of the operating system is included in the Server and Workstation hardware price, the same may not be mentioned in the BOQ/commercial proposal/ schedule of prices.**

5.3 Advance Traffic Management Centre software

- a. The Concessionaire shall develop new software or modify the existing software to provide the Advance traffic management system functions specified herein and as per the General Technical Specifications and Particular Technical Specifications.
- b. The software to be provided as Advance traffic management system software shall include but not be limited to the following:
 - 1) Core Advance Traffic Management Centre software
 - 2) Utility software
 - 3) Maintenance activity tracking and logging software
 - 4) Integration with Enterprise web enabled GIS and Image Processing module

- 5) Integration with other third party COTS modules
- 6) Road condition monitoring module
- c. The actual configuration of software modules may not be limited to as listed above; but it shall fulfil the General Technical Specifications and Particular Technical Specifications.
- d. All software shall be of modular construction and the interaction between the modules shall be kept minimum. They shall be designed to operate continuously, and no periodical maintenance of the software shall be required.
- e. All the display on the display monitor and printed report shall be in English.
- f. The utility software shall include but not be limited to the system backup and restoration, database backup and restoration, and access control and operation log functions. Usage of the server and workstations shall be controlled by log in/out procedure and different levels of access control shall be provided to restrict the use of certain software by unauthorized persons. All operations shall be recorded as log together with staff identification number.
- g. The software that interacts with the system operator shall be provided with fault tolerant functions and access control functions. They shall be designed in such a way that any operation error shall not cause damage to the system, loss of data or system shut down.
- h. All software shall be tested under the different conditions and cases including incorrect operation by the system operator and erroneous data to verify the sturdiness of the software. The software testing shall also include appropriate load and stress testing.
- n. The ATMS software shall be a modular system comprising of at least the following modules:
 - 1) Data acquisition module for acquiring data, video streams and audio streams from field equipment
 - 2) Highway Traffic Monitoring module
 - 3) Incident / Accident Management Module
 - 4) Integrated audio communication module
 - 5) Report generation module
 - 6) System Administration module
 - 7) Road Condition Monitoring module
 - 8) Communication module for authorized access by external systems (e.g. NHAI's Regional control centre & the Main control centre)

Data Acquisition module

- a) 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, VSIDS system
 - Video Streams from TMCS Camera, VID Camera
 - Audio Streams related to conversations on the 1033 Emergency Telephone, Road-side Emergency Telephone
- b) The module allows the user to configure the acquisition conditions as follows:
 - At regular intervals of time with the interval being user
 - On the occurrence of Traffic related events in the field (e.g. data from the VID system, instances of calls from Emergency helpline number and 1033)
 - On demand (e.g. Video stream from a Camera)
 - On the occurrence of system related events like equipment failure and restoration, user login / logout
- c) The above information thus acquired shall be stored in the ATMS server using an established database package like Oracle and MS SQL.

Highway Traffic Management module

- a) This module shall support effective Traffic monitoring on the highway including the display of the road on the Large display and Integrated Traffic Management (ITM) workstation, in the form of animated screens including Graphic User interfaces specified under Clause 816.1 to 816.17 of Specifications for Road and Bridge Works of MoRTH and including locations of all ATMS field devices on a GIS map with the ability to display alongside the current information (e.g. CCTV

video Images, etc.) relevant for each field device, either permanently or on selecting the device with a mouse. The details of the project-specific composition of the GUI will be finalized during the project execution phase between the Concessionaire and Independent Engineer in consultant with NHAI.

- b) The module shall display the events acquired by the system (Traffic related, and system related) on a window at the bottom of the ITM / Graphic display, with the window size in terms of the number of events displayed being user configurable. Further the system shall provide a feature for the user to acknowledge such events and subsequently shall display the same.
- c) In addition to the above, the module shall also display the related event (where relevant e.g. a road-side emergency helpline call, VIDS event) on the GIS map using suitable animated icons. The animation shall suitably change when the event has been acknowledged and when the condition causing the event has disappeared.

Incident / Accident Management module

This module shall support Incident / Accident Management by

- a) 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.
- b) 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.,
 - i) 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
 - ii) automatic Pan, Tilt and Zoom of the nearby camera to view the accident
 - iii) Bringing on the message edit screen to create and dispatch messages to mobile apps of registered road users. The checklist itself shall be derived from the relevant Traffic Management and rescue procedures captured either in the Operation (O&M) manual of the highway or based on world-class practices relevant for the highway.
- c) Logging the timestamp of the operator, who is operating each element of the checklist to aid in 'post-mortem' analysis of the operator's performance towards establishing his /her efficiency and further training needs.
- d) Automatically performing pre-defined actions related to each of the above elements (e.g. Identification of the accident spot on the road, further shall control the nearby cameras to 'look' in the direction of the accident spot)
- e) 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.
- f) Providing a user-programmable facility, as an aid, for the automatic generation of messages depending on incidents based on e.g. information measured by the cameras and sensors installed on the 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.

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.

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 pushbuttons located on the unit.

Report generation module

- a. This module shall generate periodic as well as on-demand statistical reports using data received from WIM, Automatic Traffic counter cum Classifier and Met sensors for traffic planning and management, accurate forecasting. There shall also be a provision to generate reports to aid planning and strategizing enforcement.
- b. The module shall provide a range of reports on demand including those
 - related to the acquired data,
 - Messages edited and sent,
 - Equipment availability,
 - System related events including those related to
 - System malfunction and restoration
 - User login – logout
 - VIDS events detected
 - Mobile App messages received
- c. 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.
- d. Detailed formats of each report shall be provided by the Independent Engineer during Detail Design Phase.

System Administration module

This module shall essentially enable the definition and maintenance of user accounts.

Road Condition Monitoring module

- a. This module shall be capable of detection and monitoring of the road condition, potholes, etc using the cameras installed on the Highway and Route patrolling / maintenance vehicles.
- b. This module shall generate periodic as well as on-demand statistical reports using data received from cameras and sensors for planning, management, and forecasting. There shall also be a provision to generate reports to aid planning and strategizing road maintenance activities.
- c. The module shall generate alert as soon as any bad road conditions such as cracks, potholes, damaged surface, road furniture, fencing, signage, plantation, dead animal, etc. are detected by the system.
- d. The Module shall further provide the feature to manually logging/reporting the road condition at the control centres or through mobile app and website.

Communication module

This module will manage authorized access to the ATMS system by

1. Authorized NHAI personnel / representatives / Independent Engineer

2. Other authorized NHAI systems like the Regional office Control Centre ATMS system 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 successful Concessionaire.

- i. **Enterprise web enabled GIS and Image Processing module** shall be deployed at the TMC and sub-centres that shall form the part of the Dashboard and shall have following functionalities:

- a. Map analysis of ATMS planning and operations.
- b. Asset Management of ATMS like TMCS, VIDS, VSDS, Route Patrol, Maintenance, Recovery vehicle location, and Route to reach the incident spot.
- c. Identify surrounding development by other Authorities or illegal development which can potentially be a hazardous to road using temporal satellite imagery for example detection of queue length at the toll plazas, detecting the changes around highway like unauthorised structure built nearby highway or unauthorised occupancy on ROW/buffer area, nearby water body analysis, agriculture land and green belt analysis etc. This will help the NHAI to identify gaps and improve those by implementing various strategies like position of barricading at unauthorised access points, identifying the congestion at toll plazas, identifying water logging probability, removal of illegal encroachment, positioning of CCTV surveillance etc.
- d. Demarking area of highway which is more susceptible to potential hinderances on highway like by cattle, wildlife, prohibited vehicle entry from etc. from nearby inhabitancies.
- e. Road condition analysis on Map and satellite imagery for regular monitoring, improvement planning and implementation. Along with monitoring of implementation / upgradation works.
- f. GIS based road maintenance planning and monitoring by marking them on Map and monitoring the activity through GIS enabled mobile app by tagging location and photographs of respective location of road asset and work in progress.
- g. GIS enabled planning of diversions for safety of vehicle movement on maintenance area, installation area, and work in progress. This feature shall be made available by the Concessionaire to NHAI and Independent Engineer before the start of the installation of roadside equipment at the site, for planning of the diversion and monitoring of the work in progress.
- h. The Software should have capability of visualising GIS layers, attribute integration and analysis of layers.
- i. The software should support GPS data for showing emergency and maintenance vehicle on Map
- j. The web module should have out of box standard GIS functions like: Pan, Zoom, Identify, Measurement (Line, Area), Search, query, etc.
- k. The software should have tool for creation of topology. Symbolology tools for visualizing the spatial data as per the defined colour scheme and annotation tools facility for visualizing the spatial data as per defined label placements or placing the labels from attribute table.
- l. Software should have facility of advanced rule base labelling for dynamic placement of labels as per the extent, defined position and priority of layers by defining the different classes and should have the option to set the scale labels at specified scale.
- m. Geo-Processing feature and functions like Buffer, Union, Intersection, Identity, Update, Eliminate, Dissolve, Clip/Erase, Convex Hull, Thiessen, Merge, simplify should be available.

- n. It should have CAD tools for 2D & 3D GIS data conversion, CAD tool for Raster to vector (R2V) and topology creation.
- o. The software CAD functionality should support native drawing file formats like DWG, DXF, DGN and should have capability to render photo-realistic 3D rendering.
- p. The software should be COTS based and OGC certified.
- q. It should have Image processing capability georeferencing, visual interpretation of the satellite imagery and classification tools to helps in classifying images in user defined classes. image enhancement algorithm such as Linear, Logarithmic, Histogram Equalize, Histogram Matching, Density Slice, Gaussian, Squire root, Tone Balancing, and Raster Vector Analysis,
- r. The software should have image filtering, vegetation indices calculation, linear algebraic combination, band Math, change detection, image extraction, mosaicking, image visualization, filtering, georeferencing, atmospheric correction, transformation tools, change management, feature extraction, classification etc.
- s. The software should support all type of Standard GIS Data format, Imagery formats, and RDBMS.
- t. GIS Tools functionalities such as Data creation, Import/Export tools, Transformation Techniques, Theme management, Geometric correction.
- u. The software should have feature to identify and query/question various spatial Data.
- v. The software should have Map composer, report module and Map print layout functionality.

5.3.1 ATCC and TTMS Modules of ATMS Control centre software

ATCC and TTMS modules shall be provided with ATMS Control centre software. The ATCC functionality shall be provided for collection of traffic data and TTMS functionality shall be provided for estimation and calculation of traffic data. No additional hardware or field equipment shall be installed on the Project for ATCC and TTMS functionalities. The ATMS Software shall processes the data from ANPR and VIDS cameras for traffic counting and classification, and travel time estimation.

5.3.1.1 Automatic Traffic Counter and Classifier (ATCC) Module

The ATCC module shall be provided in the ATMS Software for automatic traffic counting and classification of vehicle class, based on the data collected through ANPR camera and VIDS camera.

The system shall identify and record all types of vehicles on the highway for effective monitoring and data collection at ATMS Control Centre. Besides, the system shall be capable of classifying any other vehicle category as per user needs. Vehicle classification should be user selectable based on length of vehicle and / or detuning of the loop inductivity. The software module shall be robust and be capable of operating with minimum maintenance.

Software and manuals to analyse the data from output of vehicle counts, classifications speeds and headways shall be provided. Capability of graphic/tabular presentation of analysed data shall also be offered.

System Accuracy Requirements

Parameter	Accuracy	Conditions
Average Speed	10 percent	There are at least 25 vehicles in the group, individual vehicle speeds are between 10 kmph and 195 kmph and the vehicles conform to normal highway driving behavior.
Average Headway	10 percent	There are at least 25 vehicles in the group, individual vehicle speeds are between 10 kmph and 195 kmph, individual vehicle headways are between 1 and 10 seconds and the vehicles conform to normal highway driving behavior.
Flows	5 percent	There are at least 100 vehicles of each category in group and vehicles conform to normal highway driving

		behavior.
Vehicle classification	5 percent	Out of a group of 100 vehicles, conforming to normal highway driving behavior, at least 95 shall be accurately classified as per the classification scheme as per MoRTH guidelines.
Occupancy	10 percent	There are at least 25 vehicles in the group, individual vehicle speeds are between 10 kmph and 195 kmph, individual vehicle headway are between 1 and 10 seconds and the vehicles conform to normal highway driving behavior.

The ATCC module shall be able to cross-verify the vehicle class, fetched by the VSDS system integrated with the Vahan Database. In case of any discrepancy, such transactions shall be audited by the operator using the ANPR image / video available in the ATCC central system.

The data shall be segregated and provided in the report format on the bases of Section-wise, direction-wise, class-wise, etc. as approved by the Independent Engineer.

5.3.1.2 Travel Time Measurement System (TTMS) Module

Travel Time Measurement System (TTMS) module shall be provided for measuring required travelling time between major section of the project. The ANPR cameras shall be installed at VSDS locations on the entire stretch. TTMS shall use these ANPR data to detect the current vehicle location. Using this location data, TTMS module shall calculate the actual travelling time per section for each vehicle and derive the average travelling time by the statistics process.

The ANPR cameras will capture the image of each vehicle crossing the VSDS location and shall extract the vehicle number. The image and vehicle number shall be stamped with time and location for the purpose of section speed calculation of each vehicle. The same data shall be used for travel time estimation.

TTMS module shall calculate the actual travel time and velocity (speed) of each vehicle between every checkpoint (VSDS location). Speed data from all vehicles shall be processed statistically by TTMS module to calculate the average travel time between two consecutive check points (VSDS location), to calculate the average speed and average travel time for each section and the entire project stretch in both the directions. Route Travel Time Estimation Models in IRC:SP:110-2017 shall be referred for estimation of travel time.

5.4 Integration with Vahan Database, NPCI FASTag Mapper, Police Control Rooms, Dial 112, Smart City ICC

The ATMS Software shall be integrated with Vahan Database and NPCI FASTag Mapper for fetching the Vehicle owner contact details of errant commuters detected by the ATMS System (ANPR, VIDS, TMCS, etc.) or reported by the route patrolling team with an evidence under violation of any traffic and safety rule / law on the project stretch.

In case the incident/ violation is reported manually, the evidence received from the ground staff / enforcement agency shall be verified by the control room manager and upon authentication from manager, the operator shall create and event in the ATMS application.

The data fetched from the Vahan database or NPCI FASTag Mapper shall be done only at the backend through the ATMS software and only the relevant fetched result shall be displayed on the operator screen or in the reports. The ATMS software shall fetch the data for events generated and audited by the operator. The vehicle numbers shall be audited by the operator by matching the system generated vehicle number with the vehicle number on the image captured by the camera. The operator shall have the option to edit the vehicle number. The logs shall be

maintained for each such correction done by the operator and shall be 100% audited by the manager for each operator to minimize human and system errors.

Following actions shall be taken automatically by the ATMS Software after the violation is detected and audited.

- i) Generate e-challan
- ii) Send SMS regarding violation on the registered mobile number of the vehicle fetched from Vahan database and NPCI FASTag mapper.
- iii) Email the daily e-challan report to the concerned enforcement agency(ies) as applicable for each state, district, etc. the project crosses through, so the e-challans shall be sent accordingly to the concerned enforcement agency under whose jurisdiction the incident / violation detection point / spot / section falls.
- iv) To avoid any discrepancy in section based overspeed enforcement, the VSDS (ANPR camera) location shall be selected such that any one section is not falling in jurisdiction of two different agencies. In case if the same can't be avoided, the section based overspeed e-challan shall be sent to the agency under which the end point/2nd checkpoint of the section falls.

The formats of e-challan, warning/ information messages (SMS), emails, etc shall be finalised in consultation with Independent Engineer / NHAI and concerned enforcement agency.

ATMS Software shall be integrated with police control rooms of the state, district as applicable, as well as the ICCC of smart city projects (as applicable), and National Disaster Management Authority (NDMA), State Disaster Management Authority (SDMA), the District Disaster Management Authority (DDMA), etc.

The police control room shall be provided with the limited access of the ATMS application through On-line Access Facility and shall be able to perform the functions are described in the On-line Access Facility section. The functions specified there are the minimum requirement and the application shall be designed to meet the actual requirement of the Police and Enforcement agencies in consultation with Independent Engineer and the concerned agency and any additional information shall be approved by the NHAI.

5.5 Outline of TMC Software

The Concessionaire shall describe in his Technical Proposal, application software to be provided to the servers and workstation in the Traffic Management Centre required hereunder.

- 1) Graphical presentation of module and components comprising application of servers and workstation.
- 2) Data processing flow in the form of class diagram, use case diagram, sequence diagram, or data flow diagram
- 3) GIS and Image Processing module
- 4) Scale or size of the module and components, and programming language used
- 5) Extent of the development required for the Project.

6. Advance Driver Advisory System (ADAS)

Advance Driver Advisory System (ADAS) shall be provided in each patrol, ambulance, and maintenance vehicle.

The ADAS system shall consist of following components fitted in each vehicle:

- i. GPS tracker,
- ii. Industrial grade rugged (Waterproof) dashboard mounted 10" Tablet,
- iii. Dashcam (dual camera) with video calling and inbuilt recording feature,
- iv. Body cam 1 nos. for each vehicle,
- v. Front view varifocal cameras (mounted on vehicle),
- vi. Rear view varifocal cameras (mounted on vehicle),
- vii. LPU with Storage mounted in vehicle,
- viii. UPS,
- ix. High speed wireless connectivity

x. Buzzer for call / incident alert

The ADAS shall provide real time connectivity of TMC and sub-centres with the patrol and maintenance vehicles. Separate high speed multi operator embedded SIM shall be provided for GPS tracker, industrial grade rugged waterproof 10" tablet, Dashcam, body cam, and LPU.

The LPU and storage shall be compact in size and only fan-less industrial grade controller shall be provided.

The system shall provide live monitoring of all cameras installed in patrol and maintenance vehicles (including body cam) from TMC & sub-centres.

The ADAS shall aid the TMC/Sub-centre in disseminating the required information to the patrolling / maintenance team in real-time. The tablet shall have GPS map to assist the driver in identifying the incident location with estimated travel time, route, alternate route, etc.

The ADAS shall also provide the option to the driver of one vehicle to connect with other emergency / maintenance services vehicles of the stretch and also provide option to conduct video conference call among them and with TMC/Sub-centre.

The vehicle staff shall be able to log the incident/event details through the tablet.

The vehicle staff shall have the option to select any and all of the cameras simultaneously to view in the tablet.

The ADAS application on the tablet shall be locked and the users shall not be able to access other features/applications of the tablet.

The tablet shall go in sleep mode when not in use to save the battery and optimize the usage.

The LPU shall sound an alert / alarm in the TMC & Sub-centre in case any of the component is turned off / removed / disconnected / low battery / faulty / etc.

The Dashcam and other cameras shall be ON at all the time and recording shall be stored in local storage of the camera as well as the LPU for a minimum period of 30 days. The TMS & Sub-centre shall have the option to retrieve any video from the LPU wirelessly and the live feed of all the cameras of all the vehicles shall be available in realtime. There shall be option to record the live video of all the cameras in the TMC and Sub-Centres.

The cameras shall be integrated with Road Condition Monitoring module for collection of road condition data and statistics.

6.1 ADAS Camera Specifications

6.1.1 General

- The IP camera shall be POE/POE+ powered bullet type with inbuilt IR of 60 meters.
- The Camera shall have inbuilt SD card slot and shall be provided with at least 128 GB class 10 SD card.
- The shutter speed of the camera shall be 1/4 second to 1/100000 seconds for capturing the motion detection even during low light condition and provide proper image.
- The face detection function shall be activated as soon as the motion detection is triggered.
- The camera shall detect any object addition, object removal, and line crossing.
- Whenever any event is triggered, the camera shall record the event on SD card also.

6.1.2 Lens

2 MP Full HD motorized varifocal lens with minimum 5-45 mm motorized auto-focus function having optical defog feature and auto focus covering suitable range of focal length shall be provided and mounted on the camera. The range of the camera shall be minimum 60 meters. The resolution shall be full HD at 60 FPS.

6.1.3 Night vision capability

Cameras shall have inbuilt IR illuminator of 60 meters for night vision functionality. External IR illuminator shall be acceptable in case of box cameras, however inbuilt IR shall be preferred. The minimum illumination shall be of 0.01 lux for colour image with automatic gain control on in auto/ manual mode. The camera shall be capable of recording black and white video even in 0.001 lux with IR up to a distance of 60 meters.

6.1.4 Image enhancement capability

Camera shall have hue light compensation, back light compensation, and three-dimensional digital noise reduction features. The camera shall support true wide dynamic range of minimum 120 dB.

6.1.5 Camera Housing

The camera shall be housed in a suitable housing to protect them from solar radiation, UV, dust and rain. The field of view of the camera shall not be obstructed by the housing. Picture quality or optical performance shall not be degraded by the housing. The Housing shall have IP-67 or higher rating for Weather-proof, and NEMA 4X-rating or IK10 or higher rating for Vandal-proof.

6.2 ADAS LPU and Cabinet

- a. ADAS LPU shall be a fan-less industrial grade rugged compact CPU housed in a compact cabinet together with power supply and network equipment. The cabinet shall be suitable for mounting in the vehicle.
- b. The cabinet shall be electrically and mechanically isolated and shall have a degree of protection of IP 55 or higher specified in IEC 60529. If necessary, the cabinet may be provided with a ventilation fan for controlling internal temperature, but the protection code requirements shall be met.
- c. A right hinged door shall be provided on the front to realize easy maintenance work.
- d. The turning direction of the handle shall be counter-clockwise.
- e. The power supply unit shall be provided with a circuit breaker.
- f. The anti-lightning and surge protection complying with the IEC 61643-1 shall be provided.
- g. The cabinet shall be finished with the anticorrosive treatment.
- h. The Concessionaire shall state the details of the anticorrosive treatment and painting.
- i. The Cabinet shall have door open alert feature and alarm to be sounded locally as well as the Central Control Centre.
- j. The Cabinet shall have suitable built with appropriate locking arrangements to protection from theft, vandalism etc.
- k. The cabinet shall be of suitable size to accommodate the equipment to be housed in the cabinet and shall be designed to meet the environmental conditions at the site and cooling, heating, ventilation requirement for the equipment, etc.

7. Incident Monitoring System (IMS)

Incident Monitoring System (IMS) shall be deployed at each PIU office and RO office (as applicable) of the project.

The IMS shall include following minimum components:

1. Workstation (1 nos. at each location),
2. All-in-one color A4 printer,
3. 100" 4K UHD LED display (commercial grade),
4. UPS as per site requirement,
5. Networking devices, switches,
6. Connectivity with TMC & Sub-centres,
7. CCTV camera,
8. DG of suitable rating as per site requirement,
9. MPLS etc.

The Concessionaire shall establish seamless connectivity between IMS and TMC & sub-centres such that the PIU officials are able to monitor the TMC and ATMS system in whole. The IMS shall be customised as per the requirement raised by the PIU/NHAI/ Independent Engineer from time to time.

The IMS shall provide function to monitor any camera of the stretch. It shall provide access to the reporting modules, NMS, FMS, SLA monitoring, GIS, ADAS, etc.

The standard / default screen of the IMS display shall be the live view of the TMC / sub-centre (option to select / toggle automatically) Graphic display screen content being displayed at the TMC / Sub-centre and shall be configurable without any requirement of support from Concessionaire.

The incident / event pop-up and alerts shall be configurable as per the PIU requirement.

IMS system shall be manned by the Concessionaire's operator during the O&M period as per the working hours of PIU/RO office.

8. Video Analytics and Management System (VAMS)

- a. The Video Analytics and Management System (VAMS) software shall be provided to view live and recorded video from all the cameras connected to local and wide area network.
- b. The VAMS software shall have a client/server-based architecture that can be configured as a standalone VAMS system with the client software running on the server hardware and/or the client server running on any network-connected TCP/IP workstation. It shall support all major operating systems (windows, Linux, Mac). It shall support web client interface and shall operate without requirement of installation of any software.
- c. The contractor shall obtain the license for the total number of cameras to be provided for the project based on the MAC address of each NIC. The VAMS shall have a single page that displays the status of all servers and cameras currently connected. This page shall display any alarms, events, MAC addresses, camera configuration, format and frame rate from each individual camera.
- d. The VAMS system shall have the ability to record an audit trail of when users login, which further shows what changes they have made, what video they have viewed and what they have exported.
- e. The VAMS shall allow for the configuration of what drives to use for recording video. Those drives may be local drives, direct attached storage drives or iSCSI drives.
- f. VAMS shall support the mobile application for both iOS and Android platform capable of viewing multiple simultaneous live video streams and playing a recorded video stream.
- g. The VAMS software shall have an open architecture supporting IP cameras and encoders from multiple manufacturers providing high-resolution megapixel features.
- h. Multiple control room consoles/workstations shall be able to simultaneously view live video and audio and/or recorded video and audio from the storage/video server. All storage / video servers shall also be able to simultaneously provide live and/or recorded video to one or more consoles. Its operator shall be able to push the video to another operator console seamlessly.
- i. The VAMS software shall be able to send a predefined email based on an event trigger. The VAMS software shall also support SSL and TLS connections for transmissions of the mail.
- j. The VAMS shall be capable of multi streaming on all connected workstations/ consoles in the entire network of the project stretch as well as minimum 20 remote users simultaneously. The remote users shall have full functionalities as are available for the control centre operators.
- k. It shall be possible to configure multiple monitors on one workstation / console i.e. multiple VAMS application simultaneously on one workstation.
- l. Recording of all video transmitted to the VAMS shall be continuous, uninterrupted and unattended.
- m. The VAMS system shall have video motion detection recording, such that video is recorded when the VAMS detects motion within a region of camera's view.
- n. VAMS shall have Suspect Tracking feature to configure camera links between cameras, to follow a suspect between different camera scenes.
- o. Inactivity timeout feature shall be provided to save the bandwidth
- p. Archive bookmarks feature shall be available to specifically archive bookmarked video and create a second copy of important video.
- q. VAMS shall automatically generate alarm / alert in case of any video loss or failure and shall have failover/redundancy feature without any manual intervention.
- r. The VAMS software shall be used to connect different types of events, such as input triggers, to a desired action such as recording video or triggering an alarm. The VAMS software shall

recognize the following event types: video motion, video loss, input trigger, health monitoring, IP camera connection, software trigger and analytics, camera preview style, hovering, server disconnect, archive alarm - failure on archiving target, such as bad mount point. The VAMS shall provide the search and display analytic meta data when searching analytic event linkages etc.

- s. The VAMS shall be integrated with Road Condition Monitoring module for collection of road condition data and statistics.

9. Emergency Telephone console

- a. There shall be a Control System with a Control Software to receive all Emergency Communication from the NHAI 24X7 National Highways helpline and Route Patrol.
- b. All the Calls coming on NHAI 24x7 helpline for this section shall be automatically routed to the TMC. The required integration with the telecom operator and 1033 helpline services shall be in the scope of the Concessionaire.
- c. The Software shall be integrated with all the Telecom operators for obtaining live location of the caller and the same shall be plotted automatically on the GIS Map, so that the location of the caller can be identified automatically for providing required service. This will also enable the software to identify the fake callers and the caller calling outside the Highway ROW.
- d. The software shall operate on open architecture and integrate with other subsystem software that are installed to manage Cameras, and Speed Display, apart from the Traffic Management module (where applicable) etc.
- e. The software shall store configuration Emergency call ID, Location on the highway stretch etc. of each Emergency call received. There shall be options to generate reports of stored device configuration.
- f. The system shall record all calls on to a dedicated server with adequate indexing to retrieve the same on a later date.
- g. 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.
- h. 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 calls, 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.
- i. The system shall provide activity log (audit trail) with user id, time stamp, and action performed, etc.
- j. The system shall perform communication health check (link quality check) on all the connected communication devices and report errors if any on the administrator console.
- k. ATMS Control Centre will have dedicated workstations for Call management. For monitoring purposes, Video monitors shall be setup and should show the location of originating calls clearly on GIS map sections of the highway.
- l. 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).
- m. ATMS Control Centre may have one or more Operators simultaneously logged in to the communication software to manage their respective sections of the highway.
- n. Each workstation and the associated software should allow up to nine calls to be maintained on hold while the current call is being serviced.
- o. Call manager/operator logoff shall be allowed only when no call is in progress or on hold.
- p. System should ensure that once recorded, the audio cannot be altered; ensuring the audit trail is intact for evidential purposes.
- q. System shall provide sufficient storage of all call recordings for the entire Contract period or more.
- r. The call manager/operator shall have the facility to call back the caller.
- s. The call manager/ operator shall also have the facility to patch any call on Emergency helpline to an external telephone line (fixed and mobile), local intercom at the ATMS Control Centre, sub-centre, and the local mobile radio network (if applicable).



- t. The call manager/operator shall have the facility to initiate communication health check on any device within his section of the highway.
- u. 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.
- v. 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.
- w. 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.
- x. Database Server shall keep track of all configurations, error data, configuration events, usage events and error events.
- y. 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. Probe Data System

- a. A probe car system is envisaged that receives and processes location data from the project vehicles equipped with GPS device and show the location of GPS devices attached to patrol vehicle or another management vehicle as one of the components of ATMS.
- b. The system will use the vehicle location data of maintenance, patrol and emergency vehicles fitted with GPS device and deployed on the project.
- c. The probe data system shall utilize the data from the GPS devices fitted on the vehicles by the vehicle operator as well the sub-components of ADAS system provided by the Concessionaire.
- d. The supply and installation of GPS devices is not under the scope of this Contract except for the maintenance vehicles to be provided by the Concessionaire on the project during O&M period of this Contract. The Concessionaire shall only be required to establish the data communication system between vehicles and Probe Data System console in TMC under the scope of work of this Contract.
- e. However, the Concessionaire shall provide the GPS devices for the vehicles provided by the Concessionaire.
- f. It shall be the responsibility of the Concessionaire to furnish all necessary hardware, software and database, install equipment at the specified location, provide necessary cabling, integrate all system components, and deliver a complete operational system including such works as required for the transmission of the probe data on 24/7 basis.
- g. The probe car system will be prepared for generating traffic condition information and utilising the cumulated data as statistics for the measures on transport such as traffic management etc.
- h. It collects vehicle location information dynamically. A probe sensor installed in vehicle consists of Global Positioning System (GPS) unit, processor unit, communication unit and power supply unit.
- i. The satellites send time signals. The time signals are received by the GPS unit on the earth. The GPS unit receives the signals from several satellites and identifies its location on the earth.
- j. The accuracy of the location generally ranges 10 to 100 m, depending on such factors as quality of GPS unit, high-rise buildings around etc. The probe sensor periodically sends the recorded data such as vehicle location in terms of longitude/latitude and recording time to the TMC.
- k. The vehicle locations shall be displayed on the GIS map in real-time in TMS and all sub-centres.
- l. The probe data will be received periodically at the TMC and shall be analysed to show the location of maintenance vehicle on the road network of digital road map.
- m. The analysed data is converted into traffic congestion information and provided to the road users. The cumulated probe data is processed as historical data for higher accuracy of congestion information.



- n. **Data List** - The vehicle location data shall be generated at an interval of 10 seconds in each GPS device on board vehicle. The probe car system shall receive all vehicle location data as they are sent from vehicles. The data includes the following items:
 - 1) Device ID
 - 2) Vehicle type
 - 3) Location (Longitude and Latitude)
 - 4) Date & time of data
 - 5) More detailed structure of the GPS data will be provided to the Concessionaire.
- o. **Data validation:** The system shall scrutinize the data received and any abnormal data such as data without time stamp, data value outside of the range, and data with longitude and latitude outside of the vehicle coverage area shall be removed from the data.
- p. **Map matching:** The system shall have map matching function to project the location of vehicle onto the nearest point along the vehicle route. If the distance between original point and projected point is longer than the pre-set threshold, the data shall be disregarded.
- q. **Data storage and retrieval function**
 - i. All data shall be recorded and stored in the probe car server for analysis and future usage. The raw vehicle location data sent from GPS device and processed location data after map matching shall be kept for three (3) months.
 - ii. Data retrieval and presentation software shall be provided that shows the original location data, location data after map matching.
- r. **Screen Display Functions**
 - i. The information display shall be schematic map-based interface and as well in the form of a list. The schematic map-based display shall cover the entire Project and be able to enlarge individual locations on the map when selected. The enlarged view shall be able to display the details for each selected location.
- s. **Reporting functions**
 - i. Probe Data System Server shall publish/print as a minimum the reports listed below. The reports shall be produced as pre-scheduled or on-demand by system operator. It shall be possible to produce the reports in a portable file format.
 - ii. Operation and error log List of roadside equipment, which are operational or malfunctioned
 - iii. Error record
- t. **Communication Network**
 - i. The data transmission of vehicle tracking data shall be made through IP based network provided by communication provider. The network equipment of the system shall have highly reliable and secured connectivity.
- u. All the third-party GPS on board Unit shall be subjected to test before Acceptance test, during installation work and upon completion depending on the test item.
- v. Three types of test, i.e. function test, performance test and general test shall be conducted. They include (as a minimum):
 - i. Communication and performance of GPS On Board Unit.
 - ii. Probe Data System Server application and reports.
 - iii. Locating function on map.
 - iv. Data logging function.

11. Hardware for Central Processing System

The Central Processing System shall comprise of following minimum components:

1. TMC Central Processing Servers in hot standby configuration (Primary + Secondary)
2. Video Recording Servers with 360 TB inbuilt storage
3. Backup Video Recording (Only Incidents) Server with 240 TB inbuilt storage
4. Internet and SMS Server
5. Operations Laser Printer (Colour)
6. Operations Laser Printer (Black)
7. Operator Consoles each with 4 nos. 21" touchscreen monitors
8. Emergency Telephone Console 2 nos. 21" touchscreen monitors
9. ATSC Console 2 nos. 21" touchscreen monitors
10. RLVD Console 2 nos. 21" touchscreen monitors

11. Graphic Display with Graphics Display management software and Controller
12. Firewall, IDS, IPS and other network security components
13. Core Switch
14. Routers
15. Network Equipment – Layer 3 Switch, Layer 2 Switch etc.
16. Network Management System (NMS)

11.1 TMC Central Processing Servers and Sub-Centre Servers

The Traffic Management Centre (TMC) application server system shall consist of two servers with cluster configuration, one primary server and one stand-by server. Each of the two servers in the cluster shall meet or exceed the minimum requirements stated hereunder.

The TMC server and workstation computer hardware shall be standard models manufactured by organizations of international repute. Custom built or non-standard equipment will not be acceptable. All the servers and computing shall be UL, CE, FCC, BIS certified.

Full maintenance support services and ready availability of consumables, spare parts or replacement units shall also be assured from a third party, based in India, who is not connected with the Concessionaire and his agent.

The specifications in this section are provided as reference. The workstations to be provided by the Concessionaire shall materially comply with these specifications and shall be subject to the approval by the Independent Engineer.

- b. Each server shall have a minimum of two numbers of latest generation Intel/AMD 16-Core processor 2.8 Ghz CPU of 19.25 MB Cache, 105W.
- c. The server shall have 256 GB RAM memory using 32GB Module scalable to at least up to 1.5TB, using DDR4 2666MHz DIMM (RDIMM) memory modules.
- d. Server shall have 4* 1.6 TB SSD HDD bays with each SSD having minimum endurance of 3 DPWD
- e. One optical drive DVD-RW shall be provided in each server.
- f. Server should have RAID controller with 4GB Lithium-ion battery backed write cache (onboard or in a PCI Express slot).
- g. Server should support 1Gb 4-port network adaptor supporting advanced features.
- h. The power supply shall be Redundant 800W Platinum hot plug and redundant hot-plug system fans. The display controller should support VGA.
- i. The server should be provided along with the out-of-band remote management and maintenance capability. Remote management should be possible by using API and Web based GUI.
- j. The server should support all industry leading OS / Hypervisor like Windows, Linux, VMware, KVM etc.

11.2 Video Recording Server (VRS)

The Video Recording servers shall be provided at TMC and sub-centres for recording the live video feed from all the cameras (TMCS, VIDS, ANPR). The VMS (Video Analytics and Management System) software shall be installed on the VRS. The inbuilt storage prescribed for VRS herewith are estimated for 60 days @ 25 FPS, 2 MP at 80% load. The Concessionaire shall propose the storage capacity of VRS as per its own calculation and proposed solution to provide video recording of all the cameras for minimum of 60 days keeping 20% buffer. The specified storage here is the minimum requirement to be provided by the Concessionaire. Minimum 2 nos. VRS shall be provided at each location (TMC and sub-centres).

- a. Each server shall have a minimum one latest generation Intel Xeon 4-Core processor 3.5 Ghz CPU of 8 MB Cache, 256 SSD in RAID 1 for operating system and video management software. Each server shall support at least 128 channels at full HD along with 2-way audio feature.
- b. The server shall have 16 GB RAM memory DDR3 memory.
- c. Server shall have 20* 12 TB SSD HDD bays such that minimum 240 TB useable internal storage space is available after applying RAID 6 configuration. Additional storage shall be added to achieve 360 TB useable storage.

- d. One optical drive DVD-RW shall be provided in each server.
- e. Server should support 1Gb 4-port network adaptor supporting advanced features
- f. The power supply and fan shall be Redundant
- g. The display controller should support VGA, HDMI, DVI.
- h. The server shall support minimum 1200 Mbps bandwidth for read and write the video recording and shall support 8 input and 4 output alarm.

Note: Total number of servers required at each location / Sub-system shall be as per the solution design of the Concessionaire. The Quantity mentioned in the BOQ is the minimum requirement and shall be provided by the Concessionaire.

All the Servers shall come with 5 years OEM Warranty with 24X7 support and Next Business Day (NBD) resolution.

11.3 Graphic Display for TMC

- a. The Concessionaire shall provide Graphic Display cubes with DLP based technology with Laser light source or Active LED based display of 0.9 mm or less pixel pitch. Graphic Display shall show large-scale presentation of central server monitor screen and live video streaming from the all the cameras (TMCS, VIDS, ANPR), ATMS Dashboard and GIS Map.
- b. It shall be able to show multiple screens at a time and the number of screens on the display shall be flexible.
- c. It should have a life of atleast 7 years in 24x7 operations.
- d. The Graphic Display shall be made up of several units. It should have automatic and continuous color calibration and uniform brightness amongst all cubes. Each cube should be able to take full HD signal. The Laser DLP based graphic display shall be provided in 3x4 or 2x6 matrix of 70" cube or bigger, suitable to display minimum 30 cameras along with GIS Map and ATMS dashboard in full high defination. The size of the Active LED based display shall be calculated such that it achieves the size equalvalent to laser DLP display of 70" cube in 3x4 or 2x6 configuration, such that at least 30 nos. TMCS cameras can be viewed in full high definition at same time along with GIS Map and ATMS dashboard.
- e. The brightness of the cube shall be 400 nits and should be adjustable for lower or even higher brightness requirements with brightness uniformity of more than 95%. The dynamic contract ratio shall be 1000000:1 or more.
- f. The ingress design of the projection unit shall confirm to IEC-60529 standard. Test certificate shall be submitted by the Concessionaire in the Technical Proposal.
- g. The depth of the cube/ Videowall for Laser DLP / active LED shall be as per OEM and shall be minimum possible to avoid wastage of space in the TMC and sub-centres. The control room layout shall be considered accordingly, such that minimum viewing distance is achieved..
- h. Graphic Display Controller and management software shall be from the same OEM. The number of output shall be capable to drive number of cubes to achieve the resolution.
- i. The Operator shall be able to see multiple source in one window and shall be able to specify time interval and sequence. The software shall provide the option to split the entire display in multiple sections and layouts. The operator shall be able to define multiple layouts that can be launched based on time schedule or sequence as defined by the operator or control room Manager. The layouts shall be finalised in consultation with the Independent Engineer and NHAI.
- j. The software shall have self health diagnostics function and shall raise alert or popup in case of any error is diaganosed in the graphic display. The operator shall notify the maintenance engineer regarding such alerts through FMS.
- k. At least following information (Road and Traffic condition) shall be provided on Graphic Display:
 - 1) GIS Map of the Stretch with each lane
 - 2) TMCS Camera live video streaming
 - 3) VIDS live video streaming and Incident Pop-ups
 - 4) ANPR and speed radar live data
 - 5) Traffic Condition
 - 6) Traffic count and classification



- 7) Travel time
- 8) Traffic Event using Image Icon (Type and Location)
- 9) Emergency call status
- 10) Status of each equipment plotted on the GIS Map
- 11) NMS
- 12) ADAS
- 13) Road condition
- 14) ATSC Status
- 15) FMS
- 16) Mobile App pop-ups

11.3.1 Graphic Display for Sub Centre

- a. The information terminal to be installed at all the three sub-centres shall be a Laser DLP or Active LED based display of 0.7 mm or less pixel pitch Graphics Display made of 70" or bigger diagonal cubes in 2x3 matrix. The size of the Active LED based display shall be calculated such that it achieves the size equivalent to laser DLP display of 70" cube in 2x3 configuration.
- b. The Concessionaire shall supply and install the information terminal at the specified location in the sub centre and connect it with the central server system through the digital transmission system. Software required to operate the information terminal shall also be provided.
- c. Information (Road and Traffic condition) as below shall be provided on Display as same as in main centre but **only of the stretch and equipment covered under that Sub-Centre:**
 - 1) GIS Map of the Stretch with each lane
 - 2) TMCS Camera live video streaming
 - 3) VIDS live video streaming Incident Pop-ups
 - 4) ANPR and speed radar live data
 - 5) Traffic Condition
 - 6) Traffic count and classification
 - 7) Travel time
 - 8) Traffic Event using Image Icon (Type and Location)
 - 9) Emergency call status
 - 10) Status of each equipment plotted on the GIS Map
 - 11) NMS
 - 12) ADAS
 - 13) Road condition
 - 14) ATSC Status
 - 15) FMS
 - 16) Mobile App pop-ups

Note: For the ergonomic design of the TMS and the Sub Cent, res ISO 11064 shall be followed.

11.4 Network Equipment

11.4.1 General

- a. The Concessionaire shall supply and install network equipment at each location to connect each peripheral to the TMC systems. The Concessionaire shall supply and install all equipment, cables, connectors, terminals and other miscellaneous materials necessary to establish a working local area network connecting these systems.
- b. The network between the TMC and sub-systems shall either use the optical fibre cable network or high-end Wireless Access Points along the stretch and a data communication network shall be established using layer 3 switch to be supplied by the Concessionaire. The Concessionaire shall supply and install the network equipment suitable for interfacing the layer 2 switch to the layer 3 switch.
- c. The type and the number of the network equipment proposed by the Concessionaire as per the network design shall be mentioned by the Concessionaire in the BOQ. The network configuration shall be determined by the Concessionaire. The cost of the network devices and

materials that is not explicitly listed in the BOQ of the Bid submitted by the Concessionaire or supplied by the Concessionaire during the installation works but deemed necessary for the system during any stage of this Contract shall be included in the cost of appropriate items and the Contract Price, and no separate payment shall be made.

11.4.2 Network design

- a. The Concessionaire shall undertake the detailed design of the digital transmission system. The design work shall include but not be limited to transmission protocol, network and transmission equipment, type and size of cable, cable splicing, conduit and cable installation work, manhole, hand-hole and pull box at bridge and earth sections.
- b. Digital transmission system shall adopt IP. Suitable media and transmission protocol at Layers 1 and 2 shall be decided, type of digital station equipment shall be selected. In developing the design, various factors such as amount and type of data, transmission distance, quality of service (QoS), reliability, latency, and changeover time to backup route shall be considered. Type of optical fibre cable shall also be considered in the design. Packet based transmission system will be preferred than circuit-based transmission system such as Gigabit Ethernet.
- c. Loop topology based on resilient packet ring (RPR) shall be adopted for local line transmission system for redundant operation. A cut in the communication at a point in the loop shall not affect the normal operation of the communication system.
- d. Physically separate optical fibre cables shall be used for a ring topology and for back up route in the future trunk line transmission system. Compressed image data and data from other devices must be separately allocated to the optical fibre core.
- e. Layer 2 switch will be used at each node to connect local network or device to the local line network. Layer 2 switch will also be used to connect devices to the local network. The switches used at the field nodes shall only be of industrial grade for operations under extreme weather and outdoor conditions.
- f. In addition to the equipment listed above, the system requires fibre distribution frame and main distribution frame for cable termination, surge arrester or similar surge protection device to protect the equipment from the lightning, and accessories necessary for cable installation. The Concessionaire shall supply and install these devices and accessories.

11.4.3 Reliability

Digital transmission system shall have high reliability to ensure continuous operation of the system. Bit error rate for the end to end data communication must be 1×10^{-6} or better.

11.4.4 Capacity and Quality of service

- a. The digital transmission shall have a sufficient capacity in terms of speed and bandwidth to meet the demands to be decided based on the estimated amount of data including digitized voice data at each facility such as Traffic Management Centre, and service area. Video signal from the TMCS camera shall be transmitted in H.264/H.265 format and the digital transmission system shall provide sufficient capacity for it. The Concessionaire shall estimate the type, amount and location of data transmission need and design the system, equipment and cables that satisfy the demand.
- b. Quality of service (QoS) capability shall be provided to the digital transmission system to ensure smooth and uninterrupted delivery of data for voice and video image transmission required for emergency telephone system and TMCS camera system.

11.4.5 System supervision

The digital transmission system shall be equipped with a supervisory function which continuously monitors the system operation and issues an alarm in case malfunction is found. The supervisory shall have the following functions:

- 1) Management of occurrence and recovery of malfunction
- 2) Registration and modification of system configuration
- 3) Registration and modification of network configuration
- 4) Testing of equipment and circuit
- 5) Logging of equipment operation and cable performance
- 6) Changeover between primary and backup routes

12. Closed Circuit Television (CCTV) and Access Control System (ACS) for TMC and Sub-Centre Building and Security

12.1 General

- a. This part of the RFP covers the equipment and services to be supplied under this Contract for CCTV equipment and Access Control System (ACS) to be installed at the Traffic Management Centre and Sub-Centres. The CCTV and ACS equipment shall be categorized as two types, CCTV and ACS for Building and CCTV for Security.
- b. All the cameras shall be IP based and shall be connected to the Video server. The cameras shall support ONVIF profile S/G and shall be FCC Class A, UL, CE, BIS certified. The NVMS installed on video server shall provide the facility to control the cameras at the Supervision workstation in the Control room Buildings. The video recording of each camera shall be stored at the Video server/storage for a period of minimum 60 days at 2MP (full HD), and 25 FPS and incident video clips shall be stored for the entire Contract period.
- c. All Cameras shall have inbuilt IR illuminator for night vision functionality. External IR illuminator shall be acceptable for box type cameras, however inbuilt IR shall be preferred for these types of cameras also.
- d. The Video Server of each location shall be interfaced to TMC system and NHAI HQ Command Centre to be able to watch and control the cameras for the PTZ activities from the TMC control room, NHAI HQ Command Centre, and On-line access facility. The priority shall be given to the local control room staff.
- e. The functionality of the CCTV cameras provided by the Concessionaire shall be described as follows:
 - i. Building Surveillance CCTV cameras – These cameras installed on a sufficient height mast shall be intended for general surveillance of the building area and field activity outside the building and walkways. These cameras shall also be linked for remote monitoring. As both the traffic control room staff and sub-control room staff can control the pan, tilt and zoom function, the priority shall be given to the local control room staff.
 - ii. Building Security CCTV cameras – These cameras shall be intended for monitoring of security areas such as the building compound, general parking area, Control Room, supervisor room, building lobby, walkway, server room, UPS room, and emergency vehicle parking area.
 - iii. These cameras shall have voice recording and Class 10 SD memory card of minimum 128GB for local storage of videos and voice recordings.
 - iv. These cameras shall be of two types
 - 1) Motorised Bullet/Box colour cameras.
 - 2) Motorised Dome colour cameras
 - v. The box cameras installed outdoor shall be installed in the weatherproof enclosure.
- f. The design of the CCTV system shall consider the following: -
 - i. Provide effective supervision and control
 - ii. Easy to use
 - iii. Self-contained system
 - iv. Increase span of management
 - v. Reduce unnecessary travel
 - vi. View / evaluate situations quickly
 - vii. Motion detection
 - viii. Savings on time and manpower
 - ix. Easy access to video information and quick playback
 - x. Minimize the use of security guards
 - xi. Eliminate unnecessary responses to false alarms
 - xii. Provision for future scalability
- g. The camera and VAMS shall be capable of triggering alarms in case of Video motion detection, manual trigger, digital input, periodical trigger, system boot, recording notification, camera tampering detection and audio detection. The triggering alerts can be controlled by the control room operator.

- h. The system should support intelligent video motion detection to track objects, learn the scene and adapt to a changing outdoor environment. Environmental changes such as rain, hail, wind, swaying trees and gradual light changes should have minimum effect on the settings.
- i. 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.
- j. 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 cameras, a user can view and control.
- k. The system shall provide User activity log (audit trail) with user id, time stamp, health monitoring, etc.
- l. ATMS Control Centre will have workstations along with controllers for Camera operation.
- m. The Workstation Frontend Software should also be working on a browser-based system and mobile application 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.

12.2 CCTV Specifications

12.2.1 Dome Camera

- a. A surveillance camera of 2MP at 25 FPS shall be provided. The IP camera shall be POE powered dome type with inbuilt IR of 30 meters with illumination at 0.005 lux for colour image and black & white at 0 lux with IR. The lens shall be of 2.8-12 mm motorised varifocal with true WDR, 3D DNR, BLC, AGC and triple streaming (i. live viewing, ii. analytics, & iii. recording). The Camera shall have inbuilt SD card slot and shall be provided with at least 128 GB class 10 SD card. The shutter speed of the camera shall be 1/3 second to 1/100000 seconds for capturing the motion detection even during low light condition and provide proper image. The housing shall be IP 67 rated with IK10 protection against vandalism. The camera shall support one alarm I/O port and audio I/O.
- b. The face detection function shall be activated as soon as the motion detection is triggered.
- c. The camera shall also detect any object addition, object removal, and line crossing.
- d. Whenever any event is triggered, the camera shall record the event on SD card.

12.2.2 Bullet Camera

- a. A surveillance camera of 2MP at 25 FPS shall be provided. The IP camera shall be POE powered bullet type with inbuilt IR of 50 meters with illumination at 0.005 lux for colour image and black & white at 0.001 lux with IR. The lens shall be of 2.8-12 mm motorised varifocal with true WDR, 3D DNR, BLC, AGC and triple streaming (i. live viewing, ii. analytics, & iii. recording). The Camera shall have inbuilt SD card slot and shall be provided with at least 128 GB class 10 SD card. The shutter speed of the camera shall be 1/3 second to 1/100000 seconds for capturing the motion detection even during low light condition and provide proper image. The housing shall be IP 67 rated with IK10 protection against vandalism. The camera shall support one alarm I/O port and audio I/O.
- b. The face detection function shall be activated as soon as the motion detection is triggered.
- c. The camera shall also detect any object addition, object removal, and line crossing.
- d. Whenever any event is triggered, the camera shall record the event on SD card.

12.2.3 Access Control System

- a. Door / premises entry Access control system shall be provided in each TMC and sub-centre building and rooms including server room, UPS room, generator room, etc.
- b. The system shall provide an integral software tool designed to reduce or eliminate tailgating.



- c. Restricting or denying access to a card holder shall happen automatically if they have entered a zone without a valid card transaction.
- d. The access control system should be modular in nature, with the below mentioned modules-
 - i. Card Management and enrolment module
 - ii. Alarm Management Module
 - iii. Rolling Transaction Display Module
 - iv. Web Dash Board
 - v. Zone Management and Broadcast
 - vi. Time & Attendance Module
 - vii. Visitor Management System Module
 - viii. Reporting module
- e. The dashboard shall display data in multiple formats such as bar, line, and pie charts, and tabular formats and shall provide following information:
 - i. Card Swipes & Zones Swipes
 - ii. Cards Parked
 - iii. Zone Occupancy & Muster zone swipes
 - iv. Type of Cards Issued and their status
 - v. Licensing
 - vi. Diagnostics
 - vii. Users logged on
 - viii. Invalid Swipe Analysis
 - ix. Average Alarm Acknowledgement/Cancel Locked Out Accounts
 - x. Top current alarms
 - xi. System and capacity & software licensing information
 - xii. Alarm acknowledgment analysis
 - xiii. Locked out workstation user accounts
 - xiv. Users currently logged on
 - xv. System Time and Date
 - xvi. Last backup status and Backup history report
- f. Reporting Module shall provide the following information:
 - i. Access Level changes
 - ii. Alarm Reports
 - iii. Transaction Reports
 - iv. First & Last transaction report
 - v. Device Reports
 - vi. Device Access Report
 - vii. Device configuration reports
 - viii. Personnel Reports
 - ix. Card parking Reports
 - x. Absentee Report
- g. The ACS shall have following features:
 - i. Record cardholder personal and access information.
 - ii. Control card verification (i.e. the recording of cards on the system).
 - iii. Control data flow to the Ethernet Reader Controllers - card and configuration information.
 - iv. Provide automatic updates of Ethernet Reader Controllers and field device changes, so that the system is continually updated.
 - v. Pass alarm and status information in real-time to client PC workstation computers being used for system monitoring.
 - vi. Pass alarms to an integrated Short Message Service (SMS) for a text messaging service to user defined recipients.
 - vii. Issue broadcast messages to the Ethernet Reader Controllers.
- h. The ACS shall be integrated with following sub-systems of the building
 - i. Video Analytics and Management System (VAMS)
 - ii. Fire Systems (FS)
 - iii. Intrusion Detection Systems (IDS)
 - iv. Perimeter Intrusion Detection Systems (PIDS)
 - v. Generic Lift or Elevator interface



- vi. Building Management Systems (BMS)
 - vii. Time and Attendance (T&A) Module
 - viii. Visitor Management System
-
- i. The ACS system shall be CE certified and designed for UL294, with IP 20 rating. The readers shall be RS485 OSDP compliant, communicate through encrypted OSDP RS485 Wiegand, and encrypted host communications with TLS and AES encryption.
 - j. The single door and true four door ACS shall have touch screen terminals for easy access with 12 keys (10 numeric keys, 2 context sensitive function keys), capacitive, light touch and 10/100 Mbps ethernet port.
 - k. The system shall have sufficient offline data storage capacity of minimum 500,000 cardholders transactions and 75,000 offline events (transactions and alarms).
 - l. Shall have inbuilt battery and charging system. It shall automatically switch over on detection of power supply.
 - m. The system shall have tamper detection capabilities and shall raise alarm that shall be configurable as per site requirement.



Section 04 Traffic Monitoring Camera System (TMCS)

1. General

The Concessionaire shall provide and construct Traffic Monitor Camera System (TMCS) as a closed-circuit television system that meets the requirements stated herein for the surveillance of the traffic and vehicle on the project. Digital type system shall be used and video signal output from the camera shall be digitized and compressed to reduce the bandwidth requirement for digital transmission system. The system and its component devices shall be of rugged construction for outdoor industrial use capable of continuous operation.

2. System Configuration and Main Function

The system shall consist of camera at site, and control equipment and VMS at the Traffic Management Centre / Sub-centres, and digital transmission system shall transmit video signal from the camera to the TMC/Sub-centres.

The Traffic Monitoring Camera System shall be used for monitoring the project corridor, junctions and interchanges. The cameras with Pan/Tilt/ Zoom (PTZ) facility shall provide a 360-degree field-of-view to enable the operational objective of full coverage of the highway/expressway, at-grade roads, junctions, service road, entry/exit ramps and related spaces within the corridor/ ROW. Operationally, the main function of the camera is to provide surveillance of the transportation system and enhance situational awareness and enable operations staff to perform a number of valuable monitoring, detection, verification functions.

The camera shall also perform the automatic incident detection functions (defined in next section) in each pre-set position. Under normal condition of the Project, the TMCS cameras shall be set at home position and shall periodically to other pre-set positions to enable automatic incident detection.

The cameras shall be integrated with Road Condition Monitoring module for collection of road condition data and statistics.

3. Equipment Location and Type

- a. TMCS camera shall be installed in the median or shoulder (as per the availability of space and OFC cable and chamber location) approximately at every 1 Km such that the monitoring of the entire route is ensured. The number of cameras shall be sufficient to monitor the key location, accident prone areas, junctions, major median openings, major structures, urban areas, major villages junctions etc. through entire journey of every vehicle on the road.
- b. The Concessionaire shall propose the actual locations to satisfy the above requirement. The exact location will be determined based on the alignment, geometry, viewing area (based on site visit) and shall be approved by the Independent Engineer.
- c. The TMCS camera shall be supplied power from the solar panel attached to Camera Pole. The UPS and Lithium-ion battery bank shall be able to provide the power backup for minimum of 72 hours.

4. System Function

4.1 Camera

Camera shall be for industrial use, capable of continuous operation under harsh environment on the highway. Camera shall be IP based full HD colour type with 1/1.9" image sensor (CMOS) or better. It shall have frame rate of up to 60 frames per second in all compression mode and shall have 3 simultaneous streams and live view for more than 5 users.

4.1.1 Lens

Motorized zoom lens with minimum 36x Optical zoom and minimum 16x digital zoom having optical defog feature and auto focus covering suitable range of focal length shall be provided and mounted on the camera. The lens size shall be approx. 5-200 mm suitable to achieve the required optical zoom.

4.1.2 Night vision capability

Cameras shall have inbuilt IR illuminator of 500 meters for night vision functionality. External IR illuminator shall be acceptable for PTZ cameras, however inbuilt IR shall be preferred. The minimum illumination shall be of 0.002 lux for colour and 0.0002 lux for black and white image with automatic gain control on in auto/ manual mode. The camera shall be capable of recording black and white video even in 0 lux with IR up to a distance of 500 meters.

4.1.3 Image enhancement capability

Camera shall have electronically image stabilisation, hue light compensation, back light compensation, and three-dimensional digital noise reduction features. The camera shall support true wide dynamic range of minimum 120 dB.

4.1.4 Camera Housing

The camera shall be housed in a suitable housing to protect them from solar radiation, UV, dust and rain. An inbuilt wiper shall be provided with the housing to permit cleaning of the camera gimble during a rainstorm/ dust etc. The field of view of the camera shall not be obstructed by the housing nor by the wiper, which shall automatically park out of view. Picture quality or optical performance shall not be degraded by the housing. The Housing shall have IP-66 or higher rating for Weather-proof, and NEMA 4X-rating or IK10 or higher rating for Vandal-proof. The housing shall have inbuilt heater and blower function.

4.1.5 Pan-tilt Head

Camera housing shall be mounted on a motorized pan-tilt head. The angles of the head and rotating and tilting speed shall be as follows:

Rotating angle: 360 degrees endless with pre-set pan and tilt speed of minimum 200° per second faster.

4.1.6 Camera Control

- a. The following control functions shall be provided to the system to cover wider area and longer distance:
 - 1) Pan (right – left)
 - 2) Tilt (up – down)
 - 3) Zoom (wide – telescope)
 - 4) Focus (near – far)
 - 5) Wiper (on – off)
- b. The Concessionaire shall state the angle range of pan and tilt movements and their speed.
- c. The TMCS Camera shall support H.264, H.265 video compression and shall support latest ONVIF S&G protocol. The camera shall have auto motion detection and shall be capable of auto tracking the moving object, wrong direction detection, stationary object detection, face detection, 250 plus pre-set, patrolling mode, audio I/O ports, alarm I/O, multiple privacy masking features.
- d. The Camera shall have applicable CE, UL, BIS and FCC.

4.2 Quality

- a. TMCS camera system shall be designed to operate 24 hours a day and 7 days a week without shutdown. Thus, high reliability and availability shall be achieved.
- b. Design target of MTBF shall be 3×10^4 hours or better except the mechanical part of pan-tilt head. Expected MTBF shall be calculated based on the announced reliability of parts and component, or operation record of similar products.
- c. Availability of the system and each camera shall be 99% or better.

4.3 Motion Detection surveillance camera, hooter alarm with beacon, and all-in-one solar streetlight

- a. A surveillance camera of 2MP at 25 FPS shall be provided at each equipment location along with hooter alarm and beacon. The IP camera shall be POE powered bullet type

with inbuilt IR of 50 meters with illumination at 0.005 lux for colour image and black& white at 0.001 lux with IR. The lens shall be of 2.8-12 mm motorised varifocal with true WDR, 3D DNR, BLC, AGC and triple streaming. The Camera shall have inbuilt SD card slot and shall be provided with at least 128 GB class 10 SD card. The shutter speed of the camera shall be 1/3 second to 1/100000 seconds for capturing the motion detection even during low light condition and provide proper image. The housing shall be IP 67 rated with IK10 protection against vandalism. The camera shall support one alarm I/O port for activation of Hooter and beacon.

- b. The function of this camera is to monitor the cabinet and pole surrounding for pilferage and vandalism attempts. The motion detection feature shall raise the alert in the control centre as soon as any movement is detected nearby the cabinet and camera pole to alert the control centre operators regarding any possibility of pilferage and vandalism attempt.
- c. Hooter shall be controlled locally by the camera and shall sound when the motion detection period is greater than 5 seconds. The alert in the TMC/Sub-centre shall be raised by VMS/ATMS software as soon as hooter is activated.
- d. The face detection function shall be activated as soon as the motion detection is triggered.
- e. The camera shall also detect any object addition, object removal, and line crossing.
- f. Whenever any event is triggered, the camera shall record the event on SD card also.
- g. The camera and hooter beacon alarm shall be installed at height of 8 meters to prevent vandalism.
- h. The camera shall be mounted on 1-meter cantilever arm attached to the pole.
- i. All-in-one solar streetlight of 15W 2000 Lumens with inbuilt motion detection sensor and auto on-off and auto dimming function shall be installed at each location at a suitable height.

4.4 Power supply system

- a. A solar power supply system consisting of a solar panel, a controller, a UPS and Lithium-ion battery bank shall be provided at each TMCS camera location that operates on solar power. Solar power equipment except solar panel shall be accommodated in the same cabinet as TMCS camera controller or in a separate cabinet. The solar panel shall have sufficient size to generate the power required. The Concessionaire shall provide the support for solar panel and connection between the panel and the controller, which shall not be exposed. A mechanism shall be provided to adjust the angle of solar panel to the solar panel support and prevent pilferage. The solar panel shall be installed at the minimum height of 8 meters.
- b. The Lithium-ion battery shall be custom built so that it cannot be used for any other application / purpose. It shall be designed such that the terminals/ cells get damaged upon unauthorised removal of battery from the enclosure / cabinet to prevent pilferage.
- c. The Lithium-ion battery shall provide power for Camera at least for 3 days even if solar power cannot be generated due to the weather condition. The Concessionaire shall present the calculation of power consumption and capacity of solar power supply system to be used for the TMCS system. The Concessionaire shall also consider the power requirement of network devices, wireless access points, PoE switch, SPD etc. suitably during the calculation.
- d. Proper earthing shall be provided at each equipment location.

5. Installation

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



6. Acceptance test

- a. Camera, camera housing, pan-tilt head, TMCS camera station, Solar power system, and TMCS camera system central equipment shall be subjected to test at all stages of Acceptance tests i.e. Factory Acceptance Test, during installation work and upon completion depending on the test item. Three types of test i.e. function, performance test and general test shall be conducted.
- b. Details of the test item, test procedure and criteria to judge test result shall be proposed by the Concessionaire subject to the approval by the Independent Engineer / NHAI.
- c. In principle, function and performance requirement stated above shall be tested. More specifically, the following tests shall be conducted as minimum:
 - 1) Resolution
 - 2) Colour
 - 3) Wiper control
 - 4) Maximum pan and tilt angle and speed
 - 5) Control desk and remote control
 - 6) Video switching function
 - 7) Video recording
 - 8) Solar Power system charging and backup performance

Section 05 Video Incident Detection System (VIDS)

1. General

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

The cameras shall be integrated with Road Condition Monitoring module for collection of road condition data and statistics.

2. System Configuration

- a. The VIDS system shall consist of the following components:
 - 1) VIDS image sensor cameras and LPU at roadside
 - 2) Cabinet
 - 3) Solar and UPS
 - 4) Network equipment, etc.
- b. No periodical manual adjustment shall be required in camera and local processing unit.
- c. The VIDS application shall be provided to the Traffic Management Centre and Sub-centres for receiving pre-processed data from VIDS LPU on the Project. The data collection interval shall not be more than 60 seconds.

3. Equipment Location

- a. VIDS shall be installed at the location to identified by the Concessionaire and approved by the Independent Engineer. The VIDS shall be installed at a suitable location from the connecting / merging road to monitor the sectional traffic volume on the main carriageway.
- b. The Concessionaire shall examine and select the VIDS location and obtain the approval from the Independent Engineer.
- c. The VIDS shall be installed on a dedicated pole to be provided by the Concessionaire. The clearance of 8 meter shall be secured.
- d. The VIDS shall be supplied power from the solar panel attached to Camera Pole. The UPS and Lithium-ion battery bank shall be able to provide the power backup for minimum of 72 hours.

4. System Function

VIDS system shall be provided with the functions described below.

4.1 Monitoring function

- a. The road and traffic condition video and images taken by VIDS cameras on the project shall be transmitted as video signal to the Traffic Management Centre through the communication network. The ATMS Software shall be capable of selecting video signal from any VIDS camera to be displayed on the monitor and graphics display.
- b. Sequential display function shall be provided to the ATMS Software. The sequential display function shall allow the video image from the multiple cameras to be sequentially displayed at a pre-set interval. It shall be possible to select the cameras for sequential display and to set the display time of the image from each camera.
- c. The VIDS console and graphics display shall have multiple screen capability and shall display either one image or four images at a time. The image on the Graphics Display shall be controlled by the ATMS Software.

4.2 Incident detection

- a. The VIDS system shall have an incident detection function and automatically detect incident occurred within its viewing area when the camera is set at home position. Incident refers to those occurrences of slow-moving vehicle, stopped vehicle, reverse traffic, fallen object, poor visibility, vehicle running in opposite direction, etc.
- b. If an incident is detected, ATMS Software shall issue an alarm and incident image shall be automatically displayed on the VIDS operator console monitor display and Graphics Display. The GIS Map shall show the location of the incident with a red dot and popup of the video.
- c. The Concessionaire shall describe the incident detection mechanism in the Technical proposal that the Concessionaire proposes together with its limitation.

4.3 Image recording and retrieval

All images shall be automatically recorded in the VRS at TMC/Sub-centre with camera ID and time stamp. Frame rate of the video signal can be configured to one frame to 60 frames per second to optimise the storage capacity as per the site requirements. Images shall be stored for minimum 60 days.

4.4 Diagnosis

- a. The VIDS system shall have a diagnosis function.
- b. The ATMS Software shall check the connection with the VIDS camera and the status of VIDS camera by sending the diagnosis signal every minute. If VIDS camera fault signal is received or there is no response from the VIDS camera, the ATMS Software shall issue an alarm on the Graphics display and operator console.
- c. The fault shall also be recorded in the log.
- d. The Concessionaire shall state in his Technical Proposal, the types of error and malfunction of the VIDS System that can be diagnosed from the ATMS Software.

5. Camera

5.1 General

- a. The IP camera shall be POE/POE+ powered bullet type with inbuilt IR of 60 meters.
- b. The Camera shall have inbuilt SD card slot and shall be provided with at least 128 GB class 10 SD card.
- c. The shutter speed of the camera shall be 1/4 second to 1/100000 seconds for capturing the motion detection even during low light condition and provide proper image.
- d. The face detection function shall be activated as soon as the motion detection is triggered.
- e. The camera shall detect any object addition, object removal, and line crossing.
- f. Whenever any event is triggered, the camera shall record the event on SD card also.

5.1.1 Lens

2 MP Full HD motorized varifocal lens with minimum 5-45 mm motorized auto-focus function having optical defog feature and auto focus covering suitable range of focal length shall be provided and mounted on the camera. The range of the camera shall be minimum 60 meters. The resolution shall be full HD at 60 FPS.

5.1.2 Night vision capability

Cameras shall have inbuilt IR illuminator of 60 meters for night vision functionality. External IR illuminator shall be acceptable in case of box cameras, however inbuilt IR shall be preferred. The minimum illumination shall be of 0.01 lux for colour image with automatic gain control on in auto/ manual mode. The camera shall be capable of recording black and white video even in 0.001 lux with IR up to a distance of 60 meters.

5.1.3 Image enhancement capability

Camera shall have hue light compensation, back light compensation, and three-dimensional digital noise reduction features. The camera shall support true wide dynamic range of minimum 120 dB.

5.1.4 Camera Housing

The camera shall be housed in a suitable housing to protect them from solar radiation, UV, dust and rain. The field of view of the camera shall not be obstructed by the housing. Picture quality or optical performance shall not be degraded by the housing. The Housing shall have IP-67 or higher rating for Weather-proof, and NEMA 4X-rating or IK10 or higher rating for Vandal-proof.

5.2 VIDS LPU and Cabinet

- l. LPU (Local Processing Unit) shall be a fan-less industrial grade rugged compact CPU housed in a cabinet together with power supply and network equipment.
- m. The cabinet shall be electrically and mechanically isolated and shall have a degree of protection of IP 55 or higher specified in IEC 60529. If necessary, the cabinet may be provided with a ventilation fan for controlling internal temperature, but the protection code requirements shall be met.
- n. A right hinged door shall be provided on the front to realize easy maintenance work.
- o. The turning direction of the handle shall be counter-clockwise.
- p. The power supply unit shall be provided with a circuit breaker.
- q. The anti-lightning and surge protection complying with the IEC 61643-1 shall be provided.
- r. The cabinet shall be finished with the anticorrosive treatment.
- s. The Concessionaire shall state the details of the anticorrosive treatment and painting.
- t. The Cabinet shall have door open alert feature and alarm to be sounded locally as well as the Central Control Centre.
- u. The Cabinet shall have suitable built with appropriate locking arrangements to protection from theft, vandalism etc.
- v. The cabinet shall be of suitable size to accommodate the equipment to be housed in the cabinet and shall be designed to meet the environmental conditions at the site and cooling, heating, ventilation requirement for the equipment, etc.

5.3 Local warning flashing lights and Alarm

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

- a. Pole mounted flashing lights of minimum 300mm diameter with a visibility of at least 500m shall be used for local warning.
- b. There shall be at least five such warning lights each mounted typically at a distance of 100 meters and 200 meters before the incidence monitoring point when seen from the direction of travel. The above distances shall be suitably optimized during detailed engineering. Two warning lights shall be installed in the median and three on the shoulder side.
- c. The lights shall be powered by a local solar PV based power supply withinbuilt Li-ion battery and shall be interconnected with the incident detection system either by cable or by wireless (GSM based).
- d. During periods of poor visibility, as detected by the VIDS or TMC / Sub-centre operator, the lights shall go into a flashing mode until visibility improves to a level for adequate incident detection. The TMC / Sub-centre operator shall have the option to turn on/off the lights remotely.
- e. The above lights shall stop flashing either on the event of the disappearance of the detected incident(s) or on the occurrence of a reset from the TMC / Sub-centre operator.
- f. In case of failure of the VIDS LPU the above lights shall, by default, switch to the flashing mode.

5.4 Solar powered Amber Flasher Light

Apart from the local warning flashing light mentioned above, a set of two standalone Solar powered Amber Flasher Lights (FL) / Solar Blinkers of 300 mm Dia with at least 96 hours power backup shall be provided at each location mentioned in the equipment location list. The FL shall be installed such that it is visible to the merging traffic as well as to the traffic plying on the main carriageway. The set of FL shall be installed at each median opening (also at the location even if the median opening has been closed, as these are the points where two-wheelers, pedestrians etc. frequently use for road crossing and may be potential accident prone areas even after the closure of the median opening), junctions, merging / diverging points near the flyovers, major bridges, railway over bridges, villages, accident prone areas, location identified as frequent animal crossing etc.

The Solar panel and Lithium-ion battery (in lockable and theft proof housing/ enclosure) shall be installed on the top of the FL pole, at a suitable height to prevent theft.

5.5 Motion Detection surveillance camera, hooter alarm with beacon, and all-in-one solar streetlight

- a. A surveillance camera of 2MP at 25 FPS shall be provided at each equipment location along with hooter alarm and beacon. The IP camera shall be POE powered bullet type with inbuilt IR of 50 meters with illumination at 0.005 lux for colour image and black& white at 0.001 lux with IR. The lens shall be of 2.8-12 mm motorised varifocal with true WDR, 3D DNR, BLC, AGC and triple streaming. The Camera shall have inbuilt SD card slot and shall be provided with at least 128 GB class 10 SD card. The shutter speed of the camera shall be 1/3 second to 1/100000 seconds for capturing the motion detection even during low light condition and provide proper image. The housing shall be IP 67 rated with IK10 protection against vandalism. The camera shall support one alarm I/O port for activation of Hooter and beacon.
- b. The function of this camera is to monitor the cabinet and pole surrounding for pilferage and vandalism attempts. The motion detection feature shall raise the alert in the control centre as soon as any movement is detected nearby the cabinet and camera pole to alert the control centre operators regarding any possibility of pilferage and vandalism attempt.
- c. Hooter shall be controlled locally by the camera and shall sound when the motion detection period is greater than 5 seconds. The alert in the TMC/Sub-centre shall be raised by VMS/ATMS software as soon as hooter is activated.
- d. The face detection function shall be activated as soon as the motion detection is triggered.
- e. The camera shall also detect any object addition, object removal, and line crossing.
- f. Whenever any event is triggered, the camera shall record the event on SD card also.
- g. The camera and hooter beacon alarm shall be installed at height of 8 meters to prevent vandalism.
- h. The camera shall be mounted on 1-meter cantilever arm attached to the pole.
- i. All-in-one solar streetlight of 15W 2000 Lumens with inbuilt motion detection sensor and auto on-off and auto dimming function shall be installed at each location at a suitable height.

6. Quality

- a. The system shall operate on a 24x7 basis. The VIDS shall be capable of taking clear images of road and traffic conditions under any brightness conditions during the daytime and night-time.
- b. It shall be the responsibility of the Concessionaire to furnish and install all necessary hardware, software, and database, integrate all system components and deliver a complete operational VID.

7. Power Supply

- a. A solar power supply system consisting of a solar panel, a controller, a UPS and Lithium-ion battery bank shall be provided at each location that operates on solar power. Solar power equipment except solar panel shall be accommodated in the same stainless-steel



cabinet as controller or in a separate stainless-steel cabinet. The solar panel shall have sufficient size to generate the power required. The Concessionaire shall provide the support for solar panel and connection between the panel and the controller, which shall not be exposed. A mechanism shall be provided to adjust the angle of solar panel to the solar panel support and prevent pilferage. The solar panel shall be installed at the minimum height of 8 meters.

- b. The Lithium-ion battery shall provide power for Camera at least for 3 days even if solar power cannot be generated due to the weather condition. The Concessionaire shall present the calculation of power consumption and capacity of solar power supply system to be used for the system. The Concessionaire shall also consider the power requirement of network devices, wireless access points, PoE switch, SPD etc. suitably during the calculation.
 - a. Proper earthing shall be provided at each equipment location.
 - b. Power consumption of all types of VIDS shall be 100VA or less regardless of the type of power supply.

8. Installation

- a. VIDS Camera device shall be installed on the top of individual supporting pole. The supporting structure with enough length must be provided to keep good visibility.
- b. VIDS camera station (local control electronics) shall be installed in VIDS cabinet on the supporting pole for VIDS camera.

Section 06 Vehicle Speed Detection System (VSDS)

1. General

The Concessionaire shall install the ANPR camera-based solution for over speed detection and enforcement, and radar sensor-based speed detection system for speed display on LED panel. The ANPR system should correctly link the vehicle number plate with the vehicle speed.

The ANPR camera shall be mounted permanently to monitor a single lane of a highway. Multiple ANPR cameras shall be placed on an overhead gantry to get the complete picture of traffic flow for each lane including hard & earthen shoulder in the location.

The ANPR system shall be capable of detection both spot over speeding as well as section based over speeding.

The ATMS Software shall be capable of generating e-challan automatically and integrated with the Vahan database, NIC ITMS, and NPCI FASTag mapper for obtaining the vehicle registration and contact details for e-challan and cross-verification of the vehicle class. The Contractor shall be responsible for integration of AMTS software with the Vahan Database, NIC ITMS, and NPCI FASTag Mapper as part of this Contract.

In addition to ANPR based VSDS, radar triggered Vehicle Actuated Speed Display (VASD) shall be installed at each location to cover all the lanes per direction. The purpose of the VASD is to display the speed of the vehicle to the driver and alert about his/her speed and prevent him/her from over-speeding, hence shall act as speed calming device. The location of VASD and ANPR camera based VSDS may be same or vary as per the site requirement.

The Concessionaire shall be required to integrate with AFS (ANPR cum FASTag System) for exchange of ANPR data, as per the requirement raised by NHAI / Independent Engineer for the project/ NH stretch.

The cameras shall be integrated with Road Condition Monitoring module for collection of road condition data and statistics.

2. System Configuration

The Radar Speed Sensor shall be provided for traffic monitoring and give input to the VASD for display of vehicle speed in real-time. The ANPR camera shall be used to capture the vehicle speed and estimate of vehicle length to identify vehicle class, reverse vehicle movement detection, and wrong lane driving (on the bases of the vehicle classification, e.g. Bus/truck driving in the car/overtaking lane, car driving in over taking lane, etc.). both VSDS and VASD systems shall work independent to each other.

The radar shall be capable for monitoring three/four lanes plus the hard & earthen shoulder simultaneously and send the command to each VASD display for displaying the real-time speed of the vehicle in each lane. The speed of the vehicle in hard/earthen shoulder shall be displayed on the adjacent display. Precise tracking and video overlaying in difficult situations like

- Multiple car tailgating Parallel motion,
- High occlusion target scenarios – e.g. small car or bike next to a large truck

The system shall be capable of capturing all type and classes of vehicles, including but not limited to 2-wheelers, three wheelers, tractor, over-sized, non-standard vehicles, etc.

The Concessionaire shall be responsible for Integration of ATMS system and sub-systems with the NHAI Mobile App for the road users as per the requirement raised from time to time by the Electronics/ IT department of NHAI or its authorized agency.

3. Location

VSDS and VASD shall be installed at suitable locations as identified during the survey by the Concessionaire and approved by the Independent Engineer. The VSDS and VASD shall be installed in the section where the over speeding chances are higher, such that at least one set is installed at suitable location between two junctions / flyover/ interchange / entry- exit points and the distance between two locations shall not exceed 10 kms in each direction. The ideal distance between two locations is 5 kms in each direction.

Both the system shall be installed in both the directions (LHS & RHS) of the road at each location.



Minimum of 3 sets shall be installed in each direction on the project stretch for obtaining sufficient data for section-based speeding, ATCC, and TTMS functionalities, such that the shoulder is also covered, additional camera per direction shall be provided, if required to cover the shoulder.

VSDS and VADS systems shall be installed in both the directions (LHS & RHS) of the road at each location on the same gantry.

4. Roadside Equipment

- a. ANPR Camera
- b. LPU
- c. Cabinet
- d. Vehicle Actuated Speed Display integrated with Speed Radar
- e. Speed Radar
- f. Motion Detection surveillance camera, hooter alarm with beacon, and all-in-one solar streetlight
- g. Civil works and gantry structure
- h. Solar and UPS

5. TMC Equipment

Speed Enforcement Application module (part of the ATMS software) and console.

6. System Function

6.1 Radar System

- a) The radar Sensor must have high accuracy and detection range. The operational range should be 90 meters.
- b) The Sensor shall be Capable for the tracking up to 32 vehicles simultaneously.
- c) The accuracy of speed detection shall be more than 98% at a speed range of 0.5 to 200 km/hr.
- d) Inbuilt radar in VASD shall also be acceptable if the accuracy level of more than 98% at a speed range of 0.5 to 200 km/hr can be achieved by the inbuilt radar and display on the VASD in real-time with read range of 100 meters.
- e) The radar shall be calibrated and tested by the third-party for speed detection. Test and calibration certificates shall be submitted by the Concessionaire along with the Technical Proposal and commissioning. The commissioning certificate shall only be issued after authentication of the test reports and calibration certificates.

6.2 ANPR Camera

- a) The ANPR camera shall be installed at site independent of the radar system.
- b) Success rate of number plate recognition, reading and associating with transaction shall not be less than 90% during night-time at a speed of 180 kmph for standard number plates. The vehicle image capturing, and processing zone shall be within 40 meters for higher accuracy.
- c) The night vision should not affect the accuracy.
- d) The camera shall capture the image of each over speeding vehicle for spot speeding and each vehicle for section speeding and send to the control room. In case the ANPR/OCR is unable to read/recognize the number plate, the system shall create an incident and send an alert to the operator. The operator shall be able to zoom the vehicle image to read the registration number plate and manually enter the vehicle number in the system for further processing. The Concessionaire shall be responsible to propose the system capable of processing all over speeding vehicles, irrespective of the accuracy, read rate of the ANPR.
- e) The video recording of each ANPR camera shall be stored for a period of 60 days in H.264, H.265 format and the video clip of over speeding vehicles shall be stored for the entire period of the Contract i.e. for minimum of 5 years. The length of the video clip shall be proposed by the Concessionaire such that the same can be produced to the enforcement agency as and when required as an evidence of speed violation. It shall be solely the

responsibility of the Concessionaire to produce the evidence and provide required support to the Authority and enforcement agency for justifying the speed violation.

- f) The software and cameras shall be calibrated on monthly basis and the certified test report shall be submitted to the Authority and Independent Engineer. In addition to the monthly testing and calibration, the Authority or Enforcement agency may instruct the Concessionaire to test the cameras and software at any time to ascertain the accuracy of the cameras, software and radars.
- g) The ANPR Cameras and VSDS Software shall be calibrated and tested by the third-party for speed detection. Test and calibration certificates shall be submitted by the Concessionaire along with the Technical Proposal and commissioning. The commissioning certificate shall only be issued after authentication of the test reports and calibration certificates.

6.3 Specifications

- a. The system shall perform during day and night as well as in adverse weather conditions.
- b. It shall have built in diagnostic functions to quickly assess the validity of speed calibration.

6.3.1 General

- a. The IP camera shall be POE powered box type with external IR of 100 meters or better.
- b. The Camera shall have inbuilt SD card slot and shall be provided with at least 128 GB class 10 SD card.
- c. The shutter speed of the camera shall be 1 second to 1/100000 seconds for capturing the motion detection even during low light condition and provide proper image.
- d. The Camera shall have Ethernet port, 2 alarm input/2 Alarm output.

6.3.2 Lens

2 MP Full HD manual varifocal lens with minimum 5-50 mm C/CS mount DC drive. The range of the camera shall be up to 100 meters. The resolution shall be full HD at 60 FPS.

6.3.3 Night vision capability

Cameras shall have inbuilt IR illuminator of 100 meters for night vision functionality. External IR illuminator shall be acceptable, however inbuilt IR with housing shall be preferred. The minimum illumination shall be of 0.005 lux for colour image with automatic gain control on in auto/ manual mode. The camera shall be capable of recording black and white video even in 0.001 lux with IR up to a distance of 100 meters.

6.3.4 Image enhancement capability

Camera shall have hue light compensation, back light compensation, hue light compensation, defog, and three-dimensional digital noise reduction features. The camera shall support true wide dynamic range of minimum 120 dB.

6.3.5 Camera Housing

The camera shall be housed in a suitable housing to protect them from solar radiation, UV, dust and rain. The field of view of the camera shall not be obstructed by the housing. Picture quality or optical performance shall not be degraded by the housing. The Housing shall have IP-67/IP-68 rating for Weather-proof with better dust & dirt protection, and NEMA 4X-rating or IK10 or higher rating for Vandal-proof. The housing shall have built-in heater and blower.

6.4 VSDS LPU and Cabinet

- a. LPU (Local Processing Unit) shall be a fanless industrial grade rugged compact CPU housed in a cabinet together with power supply and network equipment.

- b. The cabinet shall be electrically and mechanically isolated and shall have a degree of protection of IP 55 or higher specified in IEC 60529. If necessary, the cabinet may be provided with a ventilation fan for controlling internal temperature, but the protection code requirements shall be met.
- c. A right hinged door shall be provided on the front to realize easy maintenance work.
- d. The turning direction of the handle shall be counter-clockwise.
- e. The power supply unit shall be provided with a circuit breaker.
- f. The anti-lightning and surge protection complying with the IEC 61643-1 shall be provided.
- g. The cabinet shall be finished with the anticorrosive treatment.
- h. The Concessionaire shall state the details of the anticorrosive treatment and painting.
- i. The Cabinet shall have door open alert feature and alarm to be sounded locally as well as the Central Control Centre.
- j. The Cabinet shall have suitable built with appropriate locking arrangements to protection from theft, vandalism etc.
- k. The cabinet shall be of suitable size to accommodate the equipment to be housed in the cabinet and shall be designed to meet the environmental conditions at the site and cooling, heating, ventilation requirement for the equipment, etc.

6.5 Vehicle Actuated Speed Display (VASD)

6.5.1 Function

The speed display shall display the speed of the vehicle in real-time and provide textual or graphical warning to the vehicles exceeding the pre-set speed limit. The speed shall be displayed in green colour if the speed is within the permissible limit for the vehicle class, orange colour if the speed is matching the speed limit, and red if the vehicle is over-speeding. The display shall blink continuously if the speed of vehicle is more than 120% of the permissible speed limit, along with the message “Over-Speed – Slow down” in the first row of the display. One speed display shall be installed for each lane on both the sides of the road.

Time shall be displayed at the top section of the display in HH:MM:SS (24 hour) format at all the times, even if no speed is being displayed on the VASD. The font size shall be suitable and visible from 100 meters distance. The time on all the displays shall be synced with the central server.

6.5.2 Specifications

- a. The system shall perform during day and night as well as in adverse weather conditions.
- b. It shall have built in diagnostic functions to quickly assess the validity of speed calibration.
- c. It shall adjust display intensity automatically to suit the ambient light conditions.
- d. It shall be modular in construction for ease of maintenance.
- e. It shall display numeric speed data as well as graphical (standard IRC road warning sign) (preferably) / textual warning.
- f. Measurement:
 - i. Speed range: 0.5 km/h to 200 km/h
 - ii. Maximum Measuring errors: Up to 100 km/h ± 3 km/h, Above 100 km/h ± 5 km/h
 - iii. Minimum Monitored section length: 100m
- g. It shall have the facility to log vehicle speed of over-speeding vehicles and transfer them to the ATMS control centre.
- h. The speed display shall be formed using individual modules.
- i. Speed display must be constructed using corrosion resistant panel with LED pixels in row: column matrix.

- j. The Display shall show the speed in green colour if the speed is within 80% of the limit for the vehicle class, orange if the speed is exceeding 80% of the speed limit and red (blinking) if speed of the vehicle exceeds the speed limit for the vehicle class.
- k. Scanning/Multiplexing ratio shall be 1/8 or better.
- l. The LED Cluster shall consist of individual LED's rated for out-door use.
- m. The board size shall be minimum 1,000 mm (W) x 2,000 mm (H) $\pm 5\%$
- n. The LED configuration shall be 3 in 1 SMD and the pixel pitch shall be 6mm outdoor or better. Lower pixel pitch shall be considered better. The pixel density shall be more than 2500 pixels per square meters.
- o. The LED board shall have the capacity to display any content, graphics, videos, symbols, text in full matrix, with multiple font size and character height, and multiple languages.
- p. Shall support an industry standard communication interface such as TCP/IP on copper, Wi-Fi, and/or fibre optic to help setting the pre-set speed and retrieve log data.
- q. 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.
- r. It shall optionally be possible to configure the display to send real time violation event record (speed, and time stamp) over the connected network while recording the same
- s. It shall be possible to control the brightness of displays automatically using built-in light sensors.
- t. All PCB's shall be of FR4 material, 1.6mm thick and LED matrix PCB shall be 2.4mm thick. PCBs shall be of quality suitable for use in the environmental conditions as specified.
- u. The equipment shall allow local diagnostics via laptop connected to its communication port.
- v. Display size shall be suitable to display both the speed of the vehicle and warning message simultaneously in two rows.
- w. Brightness intensity shall be 7500 cd per sq.m. with option to adjust the brightness manually as well as auto brightness adjustment feature.
- x. Fault diagnostics shall be provided to include the following as a minimum:
 - i. Radar Failure
 - ii. LED Failure

7. Motion Detection surveillance camera, hooter alarm with beacon, and all-in-one solar streetlight

- a. A surveillance camera of 2MP at 25 FPS shall be provided at each equipment location along with hooter alarm and beacon. The IP camera shall be POE powered bullet type with inbuilt IR of 50 meters with illumination at 0.005 lux for colour image and black& white at 0.001 lux with IR. The lens shall be of 2.8-12 mm motorised varifocal with true WDR, 3D DNR, BLC, AGC and triple streaming. The Camera shall have inbuilt SD card slot and shall be provided with at least 128 GB class 10 SD card. The shutter speed of the camera shall be 1/3 second to 1/100000 seconds for capturing the motion detection even during low light condition and provide proper image. The housing shall be IP 67 rated with IK10 protection against vandalism. The camera shall support one alarm I/O port for activation of Hooter and beacon.
- b. The function of this camera is to monitor the cabinet and pole surrounding for pilferage and vandalism attempts. The motion detection feature shall raise the alert in the control centre as soon as any movement is detected nearby the cabinet and the Gantry to alert the control centre operators regarding any possibility of pilferage and vandalism attempt.
- c. Hooter shall be controlled locally by the camera and shall sound when the motion detection period is greater than 5 seconds. The alert in the TMC/Sub-centre shall be raised by VMS/ATMS software as soon as hooter is activated.
- d. The face detection function shall be activated as soon as the motion detection is triggered.



- e. The camera shall also detect any object addition, object removal, and line crossing.
- f. Whenever any event is triggered, the camera shall record the event on SD card also.
- g. The camera and hooter beacon alarm shall be installed at the gantry to prevent vandalism.
- h. The camera shall be mounted on at a suitable location on the Gantry such that it focuses on the enclosure / cabinet housing the LPU and Li-ion battery bank.
- i. All-in-one solar streetlight of 15W 2000 Lumens with inbuilt motion detection sensor and auto on-off and auto dimming function shall be installed at each location at a suitable height.

8. Power Supply

- a. The power supply shall be connected from communication rack using the POE or Adaptor.
- b. A solar power supply system consisting of a solar panel, a controller, a UPS and Lithium-ion battery bank shall be provided at each location that operates on solar power. Solar power equipment except solar panel shall be accommodated in the same stainless-steel cabinet as controller or in a separate stainless-steel cabinet. The solar panel shall have sufficient size to generate the power required. The Concessionaire shall provide the support for solar panel and connection between the panel and the controller, which shall not be exposed. A mechanism shall be provided to adjust the angle of solar panel to the solar panel support and prevent pilferage.
- c. The Lithium-ion battery shall provide power for at least for 3 days even if solar power cannot be generated due to the weather condition. The Concessionaire shall present the calculation of power consumption and capacity of solar power supply system to be used for the system. The Concessionaire shall also consider the power requirement of network devices, wireless access points, PoE switch, SPD etc. suitably during the calculation.
- d. Proper earthing shall be provided at each equipment location.

9. Installation

The system will be installed on the gantry at specified locations.

10. Acceptance test

Acceptance test shall be conducted for speed system at the factory (before Site Acceptance test), during installation work and upon completion depending on the test item. Test will be classified into two types, functional and performance test, in addition, trial operation shall be conducted after the Acceptance test.

11. Design Principle of VSIDS, TMCS, VIDS, and other Foundations

11.1 Design Strength

The foundation shall be of reinforced concrete with the concrete having the compressive strength of $2,500 \text{ N/cm}^2$ (250 kg/cm^2) after 28 days (cylinder type), or when made with a high rapid strength Portland Cement, it shall acquire the same strength after 7 days.

11.2 Contractor's Detailed Survey and Design

Before commencing the actual work, Contractor shall carry out the field detailed survey/design of the facilities. The detailed drawings including the calculation data based on the survey/design shall be prepared and shall be submitted to NHAI for approval.

11.3 Construction of Foundation

11.3.1 VSIDS, TMCS, VIDS, and other Foundations

- a. Contractor shall comply with the following specifications for preparing and mixing concrete.
- b. All foundations shall be constructed with a ready-mixed or site-mixed, M20 Grade Or if made manually then the concrete when made with a normal Portland Cement, shall

attain a minimum compressive strength of 2,500N/cm² (250kg/cm²) in 28 days (cylinder type) , or when made with a high rapid strength Portland Cement, it shall acquire the same strength in 7 days (Test to be performed on cylindrical type concrete specimen of size 150mm x 300mm).

- c. The slump range for the concrete used in the construction of foundation shall be between 8 and 15cm.
- d. NHAI may order three (3) test pieces (cylinder type) from any batch of the concrete to be taken and properly marked for the laboratory test as required.
- e. The concrete shall be slowly poured around the moulds or forms, up to adequate level evenly and tamped into all parts of the moulds or forms, by using a vibrator until a densely solid mass without cavities is obtained.
- f. The concrete, once mixed, shall be used within 60 minutes. After one hour, any remaining concrete shall be removed and shall not be used.
- g. Cement mortar shall consist of one (1) measure of Portland Cement and two (2) measures of sand.
- h. The concrete shall be covered with saturated sack-cloth or similar materials and shall be sprinkled with water to keep sufficient moisture, adequate times a day for 7 days.

11.3.2 Excavation for Foundation

- a. The Contractor shall take all countermeasures necessary for safety of the public and for protecting and preserving any and all temporary or permanent utilities.
- b. Contractor shall obtain all permissions, right-of-way and/or permits necessary for the execution. The permissions shall include property owners' approvals for necessary work on their properties.
- c. Contractor shall obtain all permissions, right-of-way and/or permits necessary for the execution. The permissions shall include property owners' approvals for necessary work on their properties.
- d. Contractor shall be directly responsible for all damages to existing utilities and shall restore these services immediately at his own expense.

11.3.3 Backfilling

- a. Backfilling shall commence after notifying Independent Engineer.
- b. Upon completion of the backfilling, all remaining soil shall be removed and the road surface, pavement and the area concerned shall be immediately cleaned.
- c. Before backfilling, all foreign objects shall be removed from the excavation.

11.4 Material for Foundation

11.4.1 Cement

- a. All cement used in underground construction shall be Portland Cement and in accordance with BS 12 or equivalent.
- b. The cement shall be stockpiled in such a manner as to afford easy access for inspection. Cement shall be kept dry at all times prior to use in order to prevent deterioration. Open air storage of cement shall not be permitted.
- c. Deteriorated cement, such as cement containing lumps that are too difficult to powder by hand, shall not be used.

11.4.2 Water

- a. All water used for mixing and curing of concrete shall be supplied by the waterworks.
- b. Water from other sources may be used only if authorized by NHAI after tests have shown the quality to be better than that supplied by the waterworks.
- c. Water from any source which has been contaminated with dirt, oil, salt or other foreign substances shall not be used.

11.4.3 Fine Aggregate

- a. The fine aggregate for concrete shall consist of natural river sand or equivalent material.

- b. The fine aggregate shall be uniformly graded and shall meet the grading requirements as follows:

Sieve Designation	Percentage by Weight Passing square mesh sieve
(10.0mm)	100
No.4 (5.0mm)	95 to 100
No.16 (1.2mm)	45 to 80
No.50 (0.3mm)	10 to 30
No.100 (0.15mm)	2 to 10

- c. The fine aggregate shall be stored in such a manner as to prevent mixture with other aggregate prior to the use and also to prevent inclusion of foreign materials.

11.4.4 Coarse Aggregate

- a. The coarse aggregate for concrete shall consist of crushed stones having hard, strong and durable pieces free from adherent coatings such as mud or other foreign materials. The coarse aggregate shall be graded between a maximum size of 25mm and a minimum size corresponding to No.4 sieve size. It must be free from dirt, flouy stone dust, earth or any similar materials.
- b. The coarse aggregate shall be stored in such a manner as to prevent mixture with other aggregate, prior to the use and also to prevent inclusion of foreign materials.

11.4.5 Reinforcing Bar

Reinforcing bars shall be deformed steel bars. The bars shall be free from dirt, oil, paint, grease, thick rust and other defects and shall confirm to the following requirements:

Item	Unit	Specific Value
Tensile Stress at Minimum	N/mm ²	500 (49 kg/mm ²)
Yield Point at Minimum	N/mm ²	300 (30kg/mm ²)
Elongation at Minimum	%	14
Design Stress	N/cm ²	160(1,600kg/mm ²)

12. Acceptance test

Details of the test item, test procedure and criteria to judge test result shall be proposed by the Contractor subject to the approval by the NHAI.

12.1 Function and performance test

In principle, function and performance requirement stated above shall be tested. More specifically, the following tests shall be conducted as minimum:

- 1) Message composition
- 2) Data exchange
- 3) Central control
- 4) Local control
- 5) Colour and brightness
- 6) Response time
- 7) Display off function
- 8) Error detection

12.2 General test

The following tests shall be conducted as minimum:

- 1) Appearance
- 2) Power supply fluctuation



- 3) Instantaneous power interruption
- 4) Insulation resistance
- 5) Dielectric strength
- 6) Temperature variation
- 7) Waterproof test (field equipment)
- 8) Amount of zinc coating (field equipment and support)



Section 07 Adaptive Traffic Signal Control System

1. General

ATSC system shall be deployed at intersection/ crossing / junction locations along the Highway stretch, such as junctions formed under the flyover, VUP, and underpasses. The locations shall be identified during the site survey by the Concessionaire.

ATSC shall be provided at every junction under the VUP and Flyover where signalling system is not available and required by the Traffic Police. In case Traffic signals are available and doesn't require replacement, only RLVD and Automatic pedestrian Detection system shall be deployed.

The quantity provided in the BOQ/indicative list of equipment is tentative and the final quantity shall be derived as per the actual project requirement during the site survey and Detail Design phase and the quantity shall be reduced or increased accordingly.

The primary purpose of these signals will be to provide traffic and transit management services in support of improving congestion and reducing delays at the intersections.

The proposed system shall comply with the functional requirement stipulated in IRC:SP:110:2017.

Training shall be provided to all the concerned stakeholders such as traffic police, NHAI representatives, etc. as per the requirement. The training schedule and procedure shall be finalized in consultant with the Independent Engineer and Traffic Police.

The cameras shall be integrated with Road Condition Monitoring module for collection of road condition data and statistics.

2. ATSC Components

The ATSC to be provided as part of this contract encompass the following components:

1. Traffic Signaling System
2. Red light violation detection system (RLVD)
3. Automatic Pedestrian Detection system (APDS)
4. Traffic Signal System monitoring, control, analytics and management module at TMC integrated with ATMS Software
5. Traffic Signal Controller Cabinets to accommodate traffic signal hardware or red-light enforcement, surveillance cameras, switches, emergency preemption equipment, etc.
6. Vehicular and pedestrian signal heads at every signalized intersection.
7. Traffic Signal Poles – high poles, cantilever poles (mast arms) and gantries
8. Camera based Traffic Detectors
9. Digital Communication System
10. Solar based Power supply with 72-hour backup
11. SPD, Lighting protection, etc.
12. Foundation, conducting, etc.
13. Integration with NMS and FMS
14. Integrate with Smart City ITS Control Rooms/ ICC, as applicable.
15. Automatic generation of e-challan and SMS service, same as in case of violation detection from VSDS and VIDS system.

Dismantling of existing equipment and installation of new ATSC system shall be in the scope of the Concessionaire and no additional cost shall be payable for any dismantling of existing equipment if required at any intersection / location.

3. Operations & Maintenance of ATSC

The Contractor shall perform following tasks during the O&M phase:

- a. Finalize the Maintenance SOP developed as part of the proposal using stakeholders' inputs.
- b. provide comprehensive maintenance of the System as mentioned in the Maintenance SOP including cleaning of the Solar panels regularly.
- c. provide comprehensive maintenance of the System as mentioned in the Maintenance SOP including cleaning of the Solar panels regularly.
- d. monitor & evaluate the efficiency of the adaptive control system on a regular basis and developing strategies for enhanced operation.
- e. monitor the ATSC system performance with respect to the entire stretch and traffic management module targets.

4. System Design

The Concessionaire shall submit the detailed design of following components during the detail design phase for the approval of the Independent Engineer. The design of each component shall be on the bases of the system required for each type of junction / intersection.

- a. Traffic signal design
- b. Traffic signal poles, mast arms and gantries
- c. Traffic signal Heads – vehicular and pedestrian
- d. Traffic Signal Cabinet Assembly
- e. Detection system
- f. TMC Controlled Adaptive Software
- g. Conduits and Junction Boxes

The system shall be designed and installed in accordance with relevant National (Indian) and International technical, safety and environmental standards, specifications and type approvals, including but not limited to current versions of the following documents:

1. Guidelines on Design and Installation of Road Traffic Signals – The Indian Roads Congress, (IRC: 93-1986).
2. Guidelines for Pedestrian Facilities – The Indian Roads Congress, (IRC: 103-2012)

The proposed system shall be fully compatible and seamlessly integrate with the current ATSC and RLVD system being deployed in the concerned smart city or city ITS project or traffic police project, as applicable.

4.1 Design Drawings

The traffic signal design drawings shall specify the location of the following component for every junction:

1. Traffic signal heads
2. Traffic signal cabinet
3. Traffic signal poles
4. Traffic signal conduits and pull boxes
5. Detection system (RLVD, APDS, etc.)
6. Other installed intersection technologies

Following minimum information shall be provided in the traffic signal design drawings:

1. Electrical circuit schedule/table
2. Pole schedule/table
3. Detector assignment schedule/table
4. Phasing Diagram
5. Pole foundation
6. Traffic controller foundation
7. Conduit and pull boxes installation

Traffic signal drawings shall be supplemented with any necessary documents to comply with requirements of the project and prevailing standards.

5. RLVD (Red Light Violation Detection) System

- a. System should be totally digital



- b. The system shall detect and capture vehicle details when: i) It violates the stop line/zebra crossing, ii) It violates the red-light signal
- c. System shall be Non-Intrusive. It shall have the option of working without integration with traffic controllers but Concessionaires should also provide undertaking that their system also works with integration of controllers.
- d. Red light system shall be a completely fair system with all evidence captured before and after the red-light jumping infraction has happened.
- e. Each camera system shall cover road width of 3.5 meter or 7 meter or 10.5 meter and above.
- f. The Camera specifications shall be same as specified in the VIDS section for bullet/box camera and VSDS section for ANPR camera.
- g. Red light system should detect vehicle presence to act as input to control the Traffic Controller.
- h. System can be a composite unit with all components inside the IP66 box OR comprised of camera or other units mounted on poles or gantries with controller and processors at side poles to make sure all lanes of the road are covered.
- i. System should be able to recognize the entire event by which the same can be justified automatically by fetching the number plate of cars in violation.
- j. The system shall have alert generation feature as per the requirement of the Traffic Police, the same shall be finalized after discussion with the concerned enforcement agencies of the state in consultant with the Independent Engineer.
- k. Certification: UL (Underwriters Laboratories), BIS (Bureau of Indian Standards) and RoHS compliant certificate.

6. ATSC and RLVD Module in TMC

- a. The system should provide function to the Operator to manually check the entry in application and edit the numbers which may be wrongly OCR- read, before the numbers are fed to the e-Challan generating sub-system. An audit trail should be maintained to record such editing activities.
- b. No deletion or addition of data without validation, proper password protection. Deleted data if any to be inserted automatically in a separate table.
- c. The system should provide facilities to search for the cases of violations that occurred during any specific span of time and provide a statistical analysis of the number of such incidents occurring during various days of the month.
- d. A customized web-based dashboard to be developed for all types of master data entry and for customized reports with graphical analysis.
- e. System can be integrated with existing e-Challan generating systems as well as with fine generation/imposition for each infraction with multiple images clearly showing color of red-light signal and violation (i.e. color image of context camera), date, time, vehicle registration number, classification of offence etc. Image having water mark of Date & time, Place, Latitude & Longitude to be uploaded.
- f. Integration with RTO database, Vaahan databased, and police control rooms etc. to be integrated by the Concessionaire.
- g. It is desirable that the proposed solution should already be in use with enforcement authorities and is used for generating fines. End user certificates for proper working shall be submitted, if applicable.

Section 08 Power and Other Cables, Power conditioning equipment**1. Power Cable****1.1 Type of Power Cable**

The types of cables shall be as follows:

No.	Item	Specifications
1.	Outdoor Power Cable	Minimum 1.5 square mm - 22 square mm, 3 cores

1.2 Specification of Outdoor Power Cable

Outdoor power cable shall meet the following specifications:

- 1) Bright annealed, 99.97% electrolytic grade
- 2) Copper conductor (solid/stranded),
- 3) Voltage grade 1100 V,
- 4) Single or multi core cable,
- 5) Flame retardant low smoke (FRLS),
- 6) PVC / XLPE insulated,
- 7) With high oxygen and temperature index
- 8) Armored,
- 9) IS 8130, IS 5831, IS 3975, IS 1554 (Part I) / IS 7098 (Part I) or BS 6346/ IEC 60502

2. Power Conditioning Equipment System**2.1.1 General**

- a. This specification lays down the general, functional and technical requirements of the power conditioning equipment.
- b. Power supply rated at 440V, 3 phases will be made available at the Essential Supply Board of the TMC and Sub Centre Building. This supply will be backed up by standby generators to be provided by others; should there be an absence of electrical power.
- c. A power distribution board (PDB) as detailed in the drawing shall be supplied and installed under this Contract. The Concessionaire shall provide power distribution board at other locations where necessary and the cost of such power distribution board shall be considered included in the Contract Price.
- d. The Concessionaire shall supply and install UPS systems indicated below. All equipment except the equipment with solar power supply shall be provided power through this UPS to make sure that the power is continuously available to all equipment during the interruption of commercial power.

2.1.2 System Configuration

The UPS system shall consist of the following components:

- 1) UPS at TMC, Sub Centres and all Road-side equipment
- 2) Power distribution board at TMC centre, sub centres and all Road-side equipment

3. Type of UPS

- a. Rating of UPS Type for TMC and Sub-Centres shall be 10KVA, 15KVA or 20KVA.
- b. The suggested rating of the UPS at each location shall be submitted in the proposed design and BOQ. The Concessionaire shall make his own calculation of the rating based on the power requirement of the equipment he supplies and the sound engineering practice. The Concessionaire shall submit the calculation and the rating to the Independent Engineer for his approval before the supply of the UPS.

3.1 Installation Location

1. All the UPS to be provided shall be online type UPS only with minimum 4 hour back-up for TMC and sub-centres and 72 hours for roadside equipment. The minimum UPS rating for each system and sub-system shall be as shown in the table below:

No.	Position	For ATMS		Remarks
		UPS Rating (minimum)	Tentative Quantity*	
	For Server Rack	10 KVA	2	1 at TMC and 1 at each Sub-centre (4 hours backup each)
2	TMC	20 KVA	2	In Hot Standby configuration (4 hours backup combined)
3	Sub Centre	10 KVA	2	In Hot Standby configuration (4 hours backup combined)
4	Road-Side Equipment	Concessionaire to Propose	1 at each location	With solar panel
				Minimum 72 hours backup

*Actual quantity of UPS as per the project / site requirement, to be finalised by the Authority/ Independent Engineer.

2. The Concessionaire shall be responsible to calculate the UPS rating required for each location in the configuration as mentioned in the table above, based on the load of the equipment being proposed. The load calculation for each location shall be submitted in the Technical Proposal.

4. Cabinet

4.1 Fabrication

Panel or distribution board shall be wall mounted. It shall be fabricated or readymade with 14/16SWG CRCA Sheet, compartmentalized, double door hinged type. Gasket shall be provided to prevent the ingress of dust and vermin conforming to degree of protection IP-54 (panel) and IP-43 (distribution board), IP-65 (outdoor) with suitable space & direction for cable entry. Distribution board shall be cleaned with 7 Tank process, powder coated with primer and epoxy paint as per IS 2174/1962 as amended.

4.2 Switchgears & Meters

All switchgears (MCCB / MCB / fuses/ measuring instruments / meters/ indicating lamps / relays / switches) rating, capacity, make, kA rating, dimension shall be as per the type of DB with quick make & break type operating mechanism suitable for rotary operation with suitable extended operating handles with capacity and position marking on door, flush mounted, with suitable spreaders / links for cable connection as per IS 1248, 2208, 4237, 8623, 10118 (Parts I to IV).

4.3 Wiring

All power wiring within panel and distribution board shall be with suitable size flexible copper wire of 1.1kV grade, C.T. & control wiring with 2.5 square mm and 1.5 square mm, respectively with 1.1kV grade with proper lugging, ferruling, and connection with SS Nut - Bolt with adjustable and fixed washer.

4.4 Indication and Marking

All distribution board and panel shall have suitable main name plate, feeder name plate, danger board plate engraved or anodized aluminium type as per IS 2551. All panels and distribution boards shall have earthing node, point or strip similar to busbar as per IS 3043.

4.5 UPS Specification

The UPS system to be provided under the Contract shall comply with the specifications below.

Description	Specifications
Rated Power	10 KVA/20KVA
Technology	i) True online rack mountable IGBT based UPS with double conversion technology.
	ii) UPS should be capable of paralleling up to 2 units or better .
	iii) UPS should have IGBT based rectifier and inverter.
	iv) Advance battery management feature should be built in for prolonged battery life
	v) The UPS should be compatible for single phase input and single-phase output supply.
Input	i) Voltage range 110 -275 V, Load dependent ,1 Ph,380v AC3 Phase
	ii) 45-55Hz / 54-66Hz (extendable to 40~70HZ when load < 60%)
	iii) Power Factor 0.99 (With PF correction)
	iv) Capacity as per rating
Output	i) Voltage range 220 /230/240 VAC +/- 2%
	ii) Harmonic distortion <3% (Linear Load); <5% (Nonlinear load)
	iii) 45-55Hz / 54-66Hz (extendable to 40~70HZ when load < 60%)
	iv) Power Factor Unity
	v) CREST factor 3:1
Efficiency	95% @ 230V output with typical load (Line mode with battery full charged)
Battery	i) Type - Sealed lead , acid maintenance free (SMF)
	ii) Backup Time - 04 hours in parallel mode
	iii) Transfer Time – Zero
	iv) Audible Noise - <60 db
Display	Multi-language LCD + status LED
Interface slot	USB & Intelligent Slot (SNMP)
Protection Grade	IP 20
Auto shutdown Software	UPS should come with Auto shutdown and monitoring software in CD media
Credentials	i) Manufacturer should be ISO 9001: 2000 certified
	ii) Manufacturer should be ISO 14001 certified
	iii) UPS should meet ROHS standards
Warranty	UPS Should have 05 years Onsite warranty and Batteries should have at least 05 years Onsite warranty
Surge Regulations	IEC 61000-4-5 Level 4
Parallel Cable component	For running UPS in parallel

Description	Specifications
Rated Voltage	2KVA / 3KVA
Technology	True Online Double Conversion Microprocessor based 2 kVA/1.6 kW UPS as per Bureau of Indian Standards
	UPS should have IGBT based rectifier and inverter.
	Advance battery management feature should be built in for prolonged battery life.
	The UPS should be compatible for single phase input and single-phase output supply.
Input	i) Voltage range 110 -300 V, Load dependent
	ii) UPS Input Frequency should be 50Hz with frequency window 40



Description	Specifications
	Hz to 70 Hz.
	iii) Power Factor 0.99 (With P.F correction)
	iv) Capacity as per rating
Output	i) Voltage range 220 /230/240 VAC +/- 2%
	ii) Harmonic distortion <3% (Linear Load), <5% (Nonlinear load)
	iii) UPS output frequency should be 50 Hz +/-1%
	iv) Power Factor 0.8
	v) CREST factor 3:1
Efficiency	UPS should provide online double conversion efficiency >90% ,provide Economy mode efficiency >97.5% and provide Battery mode efficiency >86% and should be certified from Bureau of Indian standard lab
Battery	i) Type - Sealed lead acid maintenance free (SMF)
	ii) Backup Time- 04 hours in standalone mode & @ Full load
	iii) Transfer Time – Zero
	iv) Audible Noise - <51 db
Display	UPS LCD display should provide Input/output/Battery/Load details on single screen.
Interface slot	RS232 & Intelligent Slot (SNMP)
Output socket	UPS should have 3* IEC C13 Output Socket + 1 terminal block
Protection Grade	IP 20
Auto shutdown Software	UPS should come with Auto shutdown and monitoring software in CD media
PCB Coating	UPS should come with conformal coated boards for harsh environment
Surge Regulations	UPS should have inbuilt surge protection as per Criteria B, DM Level 3: 2KV, CM Level 4: 4KV Ref Std : IEC 61000-4-5:2014
Credentials	i) Manufacturer should be ISO 9001: 2000 certified
	ii) Manufacturer should be ISO 14001 certified
Warranty	UPS Should have 05 years Onsite warranty and inbuilt Batteries module /EBM should have at least 05 years Onsite warranty

5. Cable Installation Work

5.1 Cable Pulling

- Sufficient care shall be taken, and measures shall be taken during the loading, transportation and unloading of cable drum so as to avoid shock and damage to the cable.
- Appropriate surplus of cable shall be required at inside of handhole/ manhole.
- Cable shall be connected only inside the handhole/ manhole.
- Cable tag (plastic plate) describing the name of the cable (power cable or earthing cable) and the origin of cable (cable name, type of cable, interchange name & etc.) shall be attached to the cable.
- During the installation of cable, the following constraints shall be observed:
- The maximum tension allowed.
- The minimum curvature radius allowed: When installing cable at the handhole/ manhole, curvature radius shall be more than 6 times of the diameter of the cable being laid at all times. After cable laying work, minimum radius of more than 20 time of the diameter shall be ensured.
- Extension speed of laying:
- Towing cable shall be made smoothly without any excessive tension intermittently at the time of laying, and calibration of appropriate apparatus for setting up allowable tension shall be required.

- j. The extension of cable shall be carried out at a constant speed and it shall apply the suitable back tension for a drum to avoid hunching.
- k. Cable in the point in a handhole/ manhole shall have at least 3 m margin complied with curvature radius at every handhole/ manhole and the point of handhole/ manhole terminal equipment shall have the 3 m margin at both sides of branch.
- l. Winding up of Insulating tape for the connecting point of electric wire shall be required.
- m. Connection between electric wire and terminal equipment shall be connected using terminal lug or a screw.

6. Inspection and Acceptance test

Acceptance test specified shall be performed by the Concessionaire under the supervision of Independent Engineer.

Necessary equipment and materials for the site inspection and the Acceptance tests shall be provided by the Concessionaire at his own expense. Written report including the test results shall be prepared by the Concessionaire and verified by the Independent Engineer.

6.1 Interim Inspection

- a. During interim inspection, at least the following test and inspection items shall be performed:
- b. Visual inspection of cable route, cable location, dimension, accessories, cable terminations and cable joints.

6.2 Acceptance test

During Acceptance test, at least the following test and inspection item shall be performed. Acceptance test item for power cable on-site inspection are as follows:

No.	Item	Contents
1	Visual Check	Cable Installation/Workmanship/ Installation Practice Compliance to Drawings
2	Power Cable Performance Test	insulation resistance test, Inductance Capacitance
3	As-built Drawings	Verification

Details of the test item, test procedure and criteria to judge test results shall be proposed by the Concessionaire subject to the approval of the Engineer.

Section 09 Digital Transmission System

1. Digital transmission system

The field / roadside equipment deployed under the scope of this Contract shall be connected with the central equipment at the Traffic Management Centre and sub-centres and data and voice are exchanged between them. Digital transmission system is required to perform the service of data and voice communication. IP based digital transmission system over optical fibre cable shall be provided for this purpose.

The Concessionaire shall design, supply, install and test a digital transmission system that satisfies the needs of the component systems in terms of speed, bandwidth and reliability.

2. System configuration

Digital transmission system shall consist of local line transmission system and access line transmission system. The former connects between nodes established along the Highway/ Expressway and uses optical fibre cable while the latter connects roadside facility to the node using optical or metallic cable.

It is specifically noted that when the Highway / Expressway is extended, trunk line transmission system will be introduced for long distance data transmission between the Traffic Management Centre and the offices on the highway / expressway. Digital transmission equipment for trunk line transmission system will not be installed under this project. The local line transmission system to be provided shall be compatible with the standard digital transmission system commonly used in trunk line transmission. The optical fibre cable to be installed along the Project shall have minimum 48 cores to accommodate trunk line system.

All transmission cables shall be optical fibre cable having suitable number of cores except the metallic cable to be used to connect roadside emergency telephones to the nearest exchange or line concentrators.

3. System design

The Concessionaire shall undertake the detailed design of the digital transmission system. The design work shall include but not be limited to transmission protocol, network and transmission equipment, type and size of cable, cable splicing, conduit and cable installation work, manhole, hand-hole and pull box at bridge and earth sections.

Digital transmission system shall adopt IP. Suitable media and transmission protocol at Layers 1 and 2 shall be decided and type of digital station equipment shall be selected. In developing the design, various factors such as amount and type of data, transmission distance, quality of service (QoS), reliability, latency, and changeover time to backup route shall be considered. Type of optical fibre cable shall also be considered in the design. Packet based transmission system will be preferred than circuit-based transmission system such as Gigabit Ethernet.

Layer 3 switch will be used at each node to connect local network or device to the local line network. Layer 2 switch will also be used to connect devices to the local network.

In addition to the equipment listed above, the system requires fibre distribution frame and main distribution frame for cable termination, surge arrester or similar surge protection device to protect the equipment from the lightening, and accessories necessary for cable installation. The Concessionaire shall supply and install these devices and accessories.

4. Reliability

Digital transmission system shall have high reliability to ensure continuous operation of the system. Bit error rate for the end to end data communication must be 1×10^{-6} or better.

5. Capacity and quality of service

The digital transmission shall have a sufficient capacity in terms of speed and bandwidth to meet the demands to be decided, based on the estimated amount of data including digitized voice data at each facility such as Traffic Management Centre, Toll Plazas, sub-centres and service area/wayside amenities. Video signal from the TMCS camera shall be transmitted in H.264/H.265 format and the digital transmission system shall provide sufficient capacity for it.

The Concessionaire shall estimate the type, amount and location of data transmission need and design the system, equipment and cables that satisfy the demand.

Quality of service (QoS) capability shall be provided to the digital transmission system to ensure smooth and uninterrupted delivery of data for voice and video image transmission required for VIDS, VSDS, and TMCS camera system.

6. System supervision

The digital transmission system shall be equipped with a supervisory function which continuously monitors the system operation and issues an alarm in case malfunction is found. The supervisory shall have the following functions:

- Management of occurrence and recovery of malfunction
- Registration and modification of system configuration
- Registration and modification of network configuration
- Testing of equipment and circuit
- Logging of equipment operation and cable
- Changeover between primary and backup routes

7. Communication Cable

7.1 General

The type of cable for digital transmission system shall be as per the design and site requirement. The cable having suitable number of cores for optical cable and pairs for metallic cable shall be selected.

Two types of cable, optical fibre cable and metallic cable shall be used for digital transmission system along the Highway/ Expressway. In addition, power cable of suitable size shall be installed to provide power to the roadside equipment, as applicable.

7.2 Specification

Optical fibre cable (OFC) to be installed along the Highway/ expressway (main duct route) shall have a minimum of 24 cores. Branching of optical fibre cable shall be made in such a way that only the cores connected to the facility are taken into the facility and other cores will be bypassed. Splicing of optical fibre cable shall be made with the method that allows re-opening of splicing housing and change of connection. The connection of core shall be made with fusion splicing.

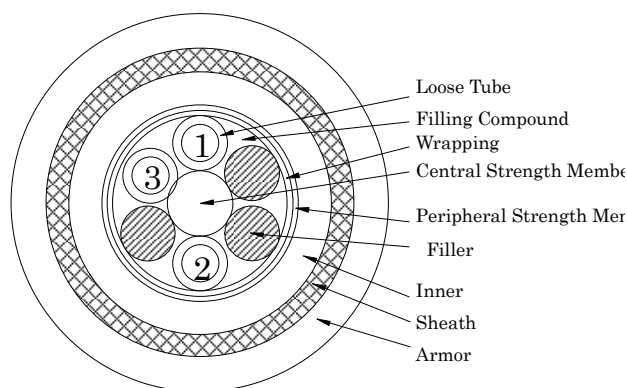
Other materials not specified in this Part shall be based on the Concessionaire's own technical specifications, subject to the approval of Independent Engineer. In this connection, Concessionaire shall submit, together with Technical Proposal, the technical specifications of main and other materials.

7.2.1 OFC Specification

The optical fibre cable to be supplied and installed under the Concessionaire shall be single-mode fibre optic cable having characteristics meet ITU-T G.652B, or equivalent and specification as below.

No.	Item	Specifications
1.	Cable type	OF-SM 24C OF-SM 8C
2.	Number of cores	OF-SM 24C: 24 cores OF-SM 8C: 8 cores
3.	Mode	Single mode
4.	Cladding diameter	125.0 $\mu\text{m} \pm 1.0$
5.	Coated fibre diameter	245 $\mu\text{m} \pm 10$
6.	Core/cladding concentricity error	$\leq 0.8\mu\text{m}$
7.	Coating/cladding concentricity error	$\leq 12\mu\text{m}$

No.	Item	Specifications
8.	Cladding non-circularity	$\leq 1.0 \%$
9.	Mode Field Diameter	$9.3\mu\text{m} \pm 0.5$ at 1310nm
10.	Attenuation (cable)	0.36dB/Km at 1310nm 0.25dB/Km at 1550nm,
11.	Zero-Dispersion Wavelength	1300 to 1322 nm
12.	Zero-Dispersion Slope	≤ 0.092 ps/Sq. Nm .km
13.	Cut-off Wavelength	≤ 1260 nm
14.	Polarization Mode Dispersion Coefficient	≤ 0.2 at 1310nm
15.	Fibre macro bend loss	$\leq 0.05\text{dB}$ at 1550 nm with 75 mm dia, 100 turns
16.	Fibre macro bend loss	$\leq 0.5\text{dB}$ at 1550 nm with 32 mm dia, 1 turn
17.	Coating Strip Force	$1.3 \leq F \leq 8.9$
18.	Minimum Proof Strength	0.70 (100kpsi) Gpa
19.	Strain	1 %



Specifications for Fiber Optic Armoured Cable

7.3 Packing and Delivery

- Packing and delivery of fibre optic cables shall conform to the following:
- Each length of cable shall be coiled on a substantial wooden or steel drum. Standard cable peace length shall be 1000 to 3000 meters.
- After completion of the optical tests, both ends of the cable shall be sealed by a suitable method to prevent the entrance of moisture.
- The starting end of the cable shall be secured on the inside of the drum flange.
- Due care shall be taken during the transportation of the cable drum so as not to cause damage to the cable.

7.4 Metallic Cable

The size of CCP cable shall be 0.65 mm or larger. The number of pairs shall be decided taking the future demand after 10 year into consideration. At least spare capacity of 100 % shall be reserved for future use. The minimum number of pairs shall be 50 pairs for the cable to be installed along the Highway/expressway and 10 pairs for the cable other than the above. In case of metallic cable, all pairs shall be connected to the MDF at each facility.

8. Conduit and Cable Work

8.1 General

- Conduit work includes underground conduit, conduit attached to bridge and culvert, handhole, manhole, cable rack and associated accessories necessary for cable installation.

- b. The Concessionaire shall undertake the detailed design of conduit and cable work including preparation of plain plan of conduit and cable route showing type and length of conduit, number of conduits, type and length of cable, and type of handhole, manhole. The detailed design shall be submitted to the Independent Engineer for his approval.
- c. For the section where electromagnetic induction or electrostatic induction caused by high power transmission line is expected, countermeasures such as use of steel conduit or used of aluminium sheath shall be taken.

8.2 Conduit Works

Scope of work shall cover the following.

- Installation of conduit (HDPE PLB duct $\Phi 40\text{mm} \times 1$),
- Excavation and back filling,
- Construction of cable trench,
- Construction of manhole,
- Temporary reinstatement of road surface,
- Safety measures and warning signs during installation works,
- Power cable duct to be included (as required),
- Site clean-up and disposal of excess materials
- Compaction and backfill.

8.2.1 Installation of Cables

Scope of cable installation work shall cover the following.

- Installation of cable rack (vertical part of inside building) and ODF (Optical Distribution Frame).
- laying of cable into HDPE pipe,
- splicing of optical fibres and jointing of cables,
- splicing of metallic cables and jointing of cables,
- termination of optical fibre cable and metallic cable,
- testing of optical fibre cable and metallic cable,
- preparation of as-built documents,
- site clean-up and disposal of excess materials,
- safety precaution where necessary,
- preparation of as-built documents,
- Acceptance test.

8.3 Cable Works

Conduit works done under this Project shall have satisfied to conduit works acceptance tests before cable are pulling in, specially to cable test piece for conduit (ducts). Conduits shall be rodded by an acceptable method and cleaned before cables are pulled / blown in.

Duct assignment shall be always done carefully to avoid crossing of cables between the duct entrance and cable bearer, and blockage of future access to vacant duct. In general, placing shall start at the bottom row and handhole/ manhole wall side of the duct arrangement.

Splicing shall be carried out as soon as possible after placing of the cables.

The extension of fibre optic cable shall be carried out at a constant speed and suitable back tension shall be applied to the drum to prevent hunching.

While under tension, a minimum bend radius of 20 times the outside cable diameter shall be maintained through the use of pulleys and sheaves where required. After pulling, no bend may have a radius, at rest, of less than 10 times the outside cable diameter.

At the splicing point, slack of minimum 3 meter shall be kept on each side of splicing kit. The slack shall be neatly arranged and the requirement for the minimum radius shall be met.

8.3.1 Type and Size of Conduit

Main materials to be supplied by the Concessionaire for the implementation of the duct installation shall be in accordance with, or better in quality than, the specification stipulated hereinafter.

8.3.2 Application of Conduit

In general, HDPE (high density polyethylene) pipe having nominal inside diameter of 40mm shall be used. Galvanized steel pipe shall be used in the following cases and in accordance with Concessionaire's own specification subject to the approval of Independent Engineer.

Bridge Attachment, b) Culvert Crossing, c) Highway/Expressway road crossing and d) etc.

8.3.3 Warning Tape

"CAUTION: NHAI F.O CABLE BELLOW" caution marks in English and Hindi should be printed in every two meters of the yellow warning tape to be placed in the cable trench (100mm width and 0.15mm thickness).

Cable Tag

Cable tag (plastic plate) describing the name of the cable and the origin of cable (cable name, type of cable, interchange name & etc.) shall be attached to the cable

All other materials not specified in this ToR shall be in conformity with the Contractor's own technical specification, subject to the approval of the Independent Engineer.

8.3.4 Cable Tag

Cable tag (plastic plate) describing the name of the cable and the origin of cable (cable name, type of cable, interchange name & etc.) shall be attached to the cable

All other materials not specified in this Functional and Technical Specifications shall be in conformity with the Concessionaire's own technical specification, subject to the approval of the Independent Engineer.

8.3.5 Depth of Conduit

The covering depth from the top of HDPE pipes and GI pipes to the surface of ground shall be as follows:

Location	Depth
Side-shoulder	165cm
Carriageway	100cm or more
Highway road crossing, Main road crossing and Interchange area	120cm or more

However, in special case, the depth shall be determined in consultation with Independent Engineer, as per the site conditions and soil type.

8.4 Installation and Construction

Conduit installation works shall be performed in accordance with the specification stipulated hereinafter.

Other installation and/or construction works, the detail of which is not specified in this section, shall be based on the industry standard specification and/or the Concessionaire's own Technical Specifications, subject to the approval by Independent Engineer.

NHAI / Independent Engineer shall, at any time when deemed necessary during the construction period, carry out inspection and/or tests on the facility under construction and/or the portions of facilities completed by the Concessionaire.

Upon completion of conduit section, loose materials such as concrete, mud, dirt, sand, etc. shall be cleaned out from new ducts before testing. 6.0 m cable test piece may be used for main duct sections (cable test piece diameter 35mm) with sharp curve under the condition of the prior approval of the Independent Engineer.

The Concessionaire shall apply the Area Log Book in order to facilitate a full supervision on the construction work.

8.5 Handhole and Manhole

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

Type	Number of Ducts	Length (m)	Width (m)	Depth (m)	Cable Bracket
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

Handhole and Manhole shall be equipped with covers, duct plug, ladders, steps, cable bearers, cable brackets, name plates and pulling irons according to detailed drawings.

8.6 Excavation for Handhole, Manhole and/or Conduit

All excavation shall be done in a thorough and workmanlike manner in accordance with the detailed drawings and the Specifications.

The Concessionaire shall obtain all pertinent records from the Electric, Water Supply, and Sewage pipe and other organizations for underground utilities in order to proceed with his work and safeguard the other utilities.

During the execution of the work, if existing underground facilities are damaged, or any part thereof is disturbed, the Concessionaire shall immediately notify of the facts to NHAI and owner of the utility and shall be responsible for the rectification of the damaged utility at its own cost. The Concessionaire shall indemnify the NHAI and its representatives from any loss or damaged caused by the Concessionaire during execution of the works. The Concessionaire shall cart away all excavated materials except that to be used for backfilling.

9. Inspection and Acceptance test

Site inspection specified herein shall be performed throughout installations and constructions of the various type of conduit facilities.

Should any errors in construction, faulty materials or other evidence of unsatisfactory construction and installation are found in the course of test, the Concessionaire shall immediately repair, replace and/or remedy such unsatisfactory items.

The Concessionaire shall perform the conduit facility inspection by himself every time to see if the work meets the requirement before the Acceptance test.

Acceptance test specified shall be performed by the Concessionaire under the supervision of the Independent Engineer. Necessary equipment and materials for the site inspection and the Acceptance tests shall be provided by the Concessionaire at his own expense. Written report including the test results shall be prepared by the Concessionaire and verified by the Independent Engineer.

During interim inspection, at least the following test and inspection items shall be performed:

Visual inspection of location, dimension, accessories and workmanship of handhole/manhole, Number and type of conduit, Cable test piece passage test, Check of new conduit, Backfilling and temporary reinstatement Acceptance test.

During Acceptance test, at least the following test and inspection item shall be performed:

Acceptance test item for handhole, manhole, conduit and optical fibre cable on-site inspection are as follows:

No.	Item	Contents
1	Visual Check	Handhole, Manhole & Conduit Construction/Cable Installation Workmanship/ Installation Practice Compliance to Drawings
2	Optical Line Performance Test	Optical Fibre Attenuation Test (Transmission Loss Measurement by Laser Source & Power meter)/ OTDR (Optical Time Domain Reflectometer) Test (OTDR Measurement both direction and Splice Loss)
3.	As-built Drawings	Verification



Section 10 Facility Monitoring System

1. Function

Facility monitoring system shall be provided to monitor the operation of facilities on the Highway/ Expressway. The system shall monitor the operation of the following component systems:

- 1) Traffic Monitor Camera System (TMCS)
- 2) Video Incident Detection System (VIDS)
- 3) Automatic Traffic Counter and Classifier (ATCC) module
- 4) Travel Time Measurement System (TTMS) module
- 5) Probe Data System
- 6) Central processing System
- 7) Vehicle Speed Detection System (VSDS)
- 8) Adaptive Traffic Signal Control System (ATSC)
- 9) ADAS
- 10) Incident Monitoring System (IMS)
- 11) Digital Transmission System
- 12) Power supply system (at building and field)

The functions of facility monitoring system may not be integrated in a single system. They may be achieved by the operation monitoring function of the component systems. The role of the facility monitoring system is to consolidate the monitoring function undertaken by component system, present the system status in a concise manner to the operator and keep the record of system operation. In case any abnormality or malfunction is detected, the system shall issue an alarm together with the information regarding type and location of the trouble so that remedial action can be taken swiftly.

The Concessionaire shall design, procure, manufacture, install, test and commission the facility monitoring system that meets the concept and functions stated herein.

2. Operating Status

- a. Items to be monitored and its content differ from one system to another system to be monitored. In general, the condition of the system and device such as 'Normal', 'Error' and 'No Reply' shall be classified in detail.
- b. The system shall have a function to test itself without affecting normal operation of the system being monitored by the system.
- c. Each error or malfunctioned status shall be assigned with severity level for each system. Depending on the severity level, different action shall be taken by the system. For minor errors such as abnormal data from vehicle detector for one interval, error is recorded in the log and no alarm will be issued. For severe errors such as interruption of communication circuit, alarm signal shall be automatically displayed on the system supervisory server overwriting the display being shown.

3. Monitoring

The manner of monitoring shall differ depending on the system and device to be monitored. In general, normal operation shall be confirmed periodically by the monitoring system by sending inquiry command. The time interval of inquiry shall be adjustable for each component system and its devices. But alarm signal shall be issued immediately by the component system and their devices comprising it to minimize delay.

4. Recording and logging

The facility monitoring system shall keep record of its operation and status of the various systems and devices in a unified manner in the database. All incident and events shall be recorded. Data retrieval software shall be provided to retrieve and display the operating history of the specified systems and devices. The database thus stored will be used to calculate the reliability indicators



of the system and device including MTBF (mean time between failures) and MTTR (mean time to repair).

Availability calculation shall be reported in a quarter.

The Formula of calculation of availability is shown as follows.

$$\text{Availability} = \{ 1 - [(A)/(B-C)] * 100 \}$$

Where

A= Time for which system is down

B = Total Time

C= Scheduled downtime

5. Monitoring signal interface

- a. The Concessionaire shall provide necessary number of monitoring signal interface units to receive operating condition and alarm signal from the system or device to be monitored. The interface shall be provided with sufficient number of analog, digital and pulse interfaces. It shall be capable of receiving operating condition signals through interface and sending them to the Traffic Management Centre using FTP, SNMP or DATEX-ASN protocol.
- b. The interface shall be provided with an optical hub or switcher and can be connected to optical fibre cable directly.
- c. The interface shall be equipped with a clock and the clock shall be adjusted using network time protocol (NTP) or simple network time protocol (SNTP).
- d. Some of the monitoring signal interface shall be installed outdoor. The device to be used outdoor shall be capable of withstanding the environmental conditions for outdoor equipment.

Annexure-I Indicative list of key Components

(Rough Estimation for 6-lane highway section of 100 kms considering 10 flyovers/Interchange)

The Concessionaire shall conduct the site survey in consultation with the Independent Engineer and shall propose the equipment location during the design phase of the Contract.

- I. TMCS shall be provided at approx. every 1 Km in the median and 1 additional for each flyover / interchange.
- II. VIDS shall be installed at each junction point of the ramps at each interchange such that one camera of the VIDS monitors the ramp and other two cameras monitor the main carriageway.
- III. VSIDS shall be installed at a suitable location on MCW between two interchanges or after every 10 kms, whichever is lesser.

Note: This is Indicative list of key components. The Concessionaire shall provide item-wise rates and quantity for each component proposed as well as any additional item deemed necessary by the him to ensure completeness and compliance with the Scope of work. The Concessionaire shall also provide comprehensive list with unit price of proposed spares for each section as a separate enclosure. All values must be verified before submission, in case of any errors/ incompleteness, Concessionaire shall be responsible, and no additional items/ claims for the payments shall be entertained.

Only one make / model for each component along with Country of Origin, delivery lead time, etc. shall be specified in the BOQ submitted by the Concessionaire for the Approval of the Authority / Independent Engineer.

ATMS - Indicative list of key Components				
	Total Length (KM)	100	Junction	0
	Lanes	6	Interchange / Flyover	10
	Traffic Management Centre (TMC)	1	Sub-Centre	0
	Project vehicles (patrol, ambulance, crane, maintenance vehicle etc.)	20	PIU	1
Sr. No.	ATMS Component	Unit	Qty	Remarks
1	Traffic Management Centre (TMC) (TMC 1 no. per project & Sub-Centre 1 no. per additional 80 kms)			
1.1	Central Processing Server in hot standby configuration (Primary + Secondary) at TMC and 1 nos. at each sub-centre	Nos.	2	
1.2	Video Recording Server with storage (minimum 360 TB) 2 nos. at TMC and 1 nos. at each sub-centre	Nos.	2	
1.3	Backup Video Recording (Only Incidents) Server with 240 TB storage 1 nos. at TMC and 1 nos. at each sub-centre	Nos.	1	
1.4	Facility Monitoring System Controller (1 nos. at TMC and 1 nos. at each sub-centre)	Nos.	1	
1.5	Graphic Display 2x6 (FHD Laser DLP/ 0.9mm Pixel LED) for TMC incl. Controller, Software, Video Switches	Set	1	
1.6	Graphic Display 2x3 (FHD Laser DLP/ 0.9mm Pixel LED) for TMC incl. Controller, Software, Video Switches	Set	0	
1.7	Internet & SMS Server	Nos.	1	
1.8	Command Centre Operator Console with 4 nos. 21 inch	Nos.	4	



ATMS - Indicative list of key Components				
	touchscreen monitors			
1.9	USB joystick to control PTZ cameras	Nos.	5	
1.10	Emergency Telephone (1033) console with 2 nos. 21 inch touchscreen monitors	Nos.	2	
1.11	Facility Monitoring System Console with 2 nos. 21 inch touchscreen monitors	Nos.	1	
1.12	Operations Laser Printer (Colour)	Nos.	1	
1.13	Operations Laser Printer (Black)	Nos.	1	
1.14	Firewall, IDS, IPS, Core Switch, and Network Equipment (Bidder shall attach the breakup of Network equipment with unit price of each item)	LS	1	
1.15	Aadhar enabled Biometric Fingerprint machine	Nos.	2	
1.16	Power Distribution Board (PDB)	LS	1	
1.17	Server Rack	Nos.	2	
1.18	Maintenance Equipment as per ToR and site requirement	LS	1	
1.19	Surge Protection Device (SPD)	LS	5	
1.20	Lighting protection	LS	5	
1.21	Advance Driver Advisory System (ADAS), GPS tracker, industrial grade rugged (Waterproof) dashboard mounted 10" Tablet, Dashcam with video calling feature, body cam, rear & front view varifocal cameras with vandalproof housing (mounted on vehicle), LPU, storage, UPS, live monitoring provision of cameras from TMC & sub-centres, etc. for patrol, ambulance, and maintenance vehicles. (Note: Quantity shall be as per the project requirement)	Set	20	
1.22	Incident Monitoring System (IMS) for PIU office: Workstation (1 nos. at each location), All-in-one color A4 printer, 100"(±2%) 4K UHD LED display (commercial grade), UPS as per site requirement, Networking devices, switches, CCTV camera, DG of suitable rating as per site requirement, Connectivity with TMC & Sub-centres, etc.	Set	1	
1.23	ATMS Software package at TMC for entire expressway stretch	LS	1	
1.24	Uninterruptible Power Supply (UPS) For Server Rack (10KVA Online Double Conversion UPS -IGBT based - Warranty 5 years) (1 at TMC and 1 at each Sub-centre)	Set	1	
	Battery backup -24000 VAH for Each UPS -Warranty 5 years-100AH X 20nos.	Nos.	25	
	Racks Links DC cable	Nos.	1	
1.25	Uninterruptible Power Supply (UPS) For TMC & Sub centre operator consoles (20KVA Online Double Conversion UPS - IGBT based arranged in parallel configuration -Warranty 5 years)	Set	2	
	Battery backup -34560 VAH for Each UPS -Warranty 5 years-100AH X 20nos.	Nos.	40	
	Racks Links DC cable	Nos.	2	
1.26	Power Distribution Board (Essential & Critical Supply)	Set	3	



ATMS - Indicative list of key Components				
1.27	Civil construction of TMC including Operation room, Server Room, UPS room, Incharge cabin, NHAI cabin, Independent Engineer cabin, pantry, toilet, etc. with interior works, complete technical furniture, raised floor, false ceiling, indoor and outdoor lighting, Audio/Mic system, Public Announcement / addressing system, CCTV system including PTZ cameras outside the buildings, Access Control system with smart card and biometrics, MEP works, HVAC system, power backup system including sufficient DG, Firefighting, alarm, extinguishers, etc.	LS	1	
1.28	Any other item(s) considered necessary to comply with the Scope of Works			
2	Traffic Monitoring Camera System Equipment (TMCS) (1 no. at every 1km)			
2.1	PTZ Camera 36x with 500m IR	Nos.	100	
2.2	Cabinet & 12m Pole with 1m arm at 8m	Nos.	100	
2.3	Motion Detection surveillance camera, hooter alarm with beacon, and all-in-one solar street light	Nos.	100	
2.4	Chamber / Manhole and Pole Foundation, PCC, backfilling with sand	Nos.	100	
2.5	Solar System with UPS, Li-on battery & Pole with SPD, and lighting protection	Nos.	100	
2.6	Industrial 5-port managed Gigabit Ethernet switch with 3x10/100/1000Base-T(X) and 2xGigabit combo ports, SFP socket	Nos.	100	
2.7	Any other item(s) considered necessary to comply with the Scope of Works			
3	Video Incident Detection System Equipment (VIDS) (at every junction, merging / demerging / accident prone area / black spot)		40	
3.1	VIDS Camera (4 nos. at each Junction + 3 nos. at each interchange/flyover ramp)	Set	120	
3.2	Warning amber lights with hooters and solar with at least 96 hours backup, pole and foundation (10 nos. at each junction/ location/interchange)	Set	40	
3.3	Local Processing unit (LPU)	Nos.	40	
3.4	Cabinet & 12m Pole with 1m arm at 8m	Nos.	40	
3.5	Motion Detection surveillance camera, hooter alarm with beacon, and all-in-one solar street light	Set	40	
3.6	Chamber / Manhole and Pole Foundation, PCC, backfilling with sand	Set	40	
3.7	Solar System with UPS, Li-on battery & Pole with SPD, and lighting protection	Nos.	40	
3.8	Standalone Solar powered Amber Flasher Light of 500 mm Dia with at least 96 hours backup, Pole & Foundation (2 at each median opening)	Set	0	
3.9	Industrial 8-port managed Gigabit Ethernet switch with 3x10/100/1000Base-T(X) and 2xGigabit combo ports, SFP socket	Nos.	40	
3.10	Any other item(s) considered necessary to comply with the Scope of Works			
4	Vehicle Speed Detection System Equipment (VSDS) (1 nos. each at LHS & RHS at every 10kms / between 2 interchanges)		10	
4.1	ANPR camera with IR flasher for 6 lanes (8 Cameras - one	Nos.	80	



ATMS - Indicative list of key Components				
	each for all lanes in each direction + shoulder)			
4.2	Local Processing Unit (LPU)	Nos.	10	
4.3	Speed Detection Radar (upto 90m range) for 4 lanes (one in each direction for all lanes + shoulder)	Nos.	20	
4.4	Vehicle Actuated Speed Display (VASD) System (one each for all lanes in each direction + shoulder)	Nos.	80	
4.5	Motion Detection surveillance camera, hooter alarm with beacon, and all-in-one solar street light	Set	10	
4.6	Gantry (including manufacturing, galvanizing, pile foundation) (1 no. for LHS and 1 No. for RHS at each location)	Nos.	20	
4.7	Cabinet	Nos.	10	
4.8	Industrial 12-port managed Gigabit Ethernet switch with 3x10/100/1000Base-T(X) and 2xGigabit combo ports, SFP socket	Nos.	10	
4.9	Solar System with UPS, Li-on battery, Pole, cabinet for VSDS, with SPD, and lighting protection	Set	10	
4.10	Any other item(s) considered necessary to comply with the Scope of Works			
5	Digital Transmission System			
5.1	Supply of 24 core single mode armoured OFC Multitube (TEC G-652) (Loop 10-15m every MH/HH) + all accessories	Mtr	105000	
5.2	40 mm PLB HDPE duct as per latest TSEC specifications + all accessories	Mtr	105000	
5.3	Trenching of 1.5 meters, Laying & Backfilling for PLB HDPE duct, cable pulling, chambers lowering, etc.	Mtr	105000	
5.4	1m x 1m x 1.8m (depth) chambers (with concrete cover) with proper reinforcement and minimum M25 grade at every 500m	Nos.	200	
5.5	24 core OFC LIU - Bamboo Type	Nos	200	
5.6	Fiber Patch Cord Single Mode – 2m Length LC to LC	Nos	152	
5.7	SFP - 20 km Transmission range	Nos	5	
5.8	Any other item(s) considered necessary to comply with the Scope of Works			
6	Adaptive Traffic Signal Control System (ATSC)			
6.1	Traffic Signalling System (Discrete LED aspect) for entire junction / interchange	Set	10	
6.2	Vehicle Detector (Non-intrusive)	Set	10	
6.3	Red light violation detection system (RLVD) for entire junction / interchange	Set	10	
6.4	Automatic Pedestrian Detection system (APDS) for entire junction / interchange	Set	10	
6.5	ATSC Controller with cabinet	Set	10	
6.6	Pedestrian signal system (Discrete LED aspect, pole, etc.) for entire junction / interchange	Set	10	
6.7	Traffic Signal Poles – high poles, cantilever poles (mast arms) and gantries with civil works - foundations, manholes, etc.	Set	10	
6.8	Solar System with UPS, Li-on battery, Pole, cabinet, SPD, and lighting protection	Set	10	



ATMS - Indicative list of key Components				
6.9	Cabling, installation, trenching, HDD, ducting, chamber, etc.	LS	10	
6.10	Any other item(s) considered necessary to comply with the Scope of Works			
7	Services			
7.1	Installation, testing & Commissioning	LS	1	
7.2	ATMS System Technical support staff (5 years)	Years	5	
7.3	ATMS Control Room Operations staff (5 years)	Years	5	
7.4	Spares for 5 years	Years	5	

ATMS O&M Staff			
S.No.	Description	Nos.	Remarks
A. Technical Staff			
1	System Maintenance Engineer/ Manager	1	1 at TMC & 1 at each sub-centre
2	System IT Engineer	1	1 at TMC & 1 at each sub-centre
3	System Maintenance Technicians	4	1 for each at TMC & sub-centre in each shift + Relievers
4	Maintenance Vehicle with Driver and helper	1	1 at TMC & 1 at each sub-centre
5	Manhoist vehicle with Driver and helper	1	1 at TMC / Sub-centre
6	Overhead Cost		Including tools
B. Control Room Operations Staff			
1	Traffic Management Manager	1	1 at TMC
2	Traffic Management Engineer	0	1 at each sub-centre
3	Asst Manager - Operations	4	1 for each at TMC & sub-centre in each shift + Relievers
4	Control Room operators	13	3 at TMC & 3 at each sub-centre in each shift + Relievers
5	Support Staff	1	In General Shift at TMC and Sub-centres
6	Office Assistant	4	1 at TMC & 1 at each sub-centre in each shift + relievers
7	Security Guard	4	1 at TMC & 1 at each sub-centre in each shift + relievers
8	Overhead Cost		Incl. office maintenance, recurring charges, DG and electricity bill

PART-II Forms to be submitted by Concessionaire





Form TECH: Format for Submission of Detailed methodology and technical work plan supported with broad system architecture and design in Technical Proposal.

Sub.: Advance Traffic Management System (ATMS) for *(Project Name)* section of National Highway

Ref: Functional and Technical Specifications of above subject.

NOTE:

- i. The Concessionaire shall submit elaborately the following items with Technical proposal and Detail Design for evaluation of the Independent Engineer, while giving information, the Concessionaires are advised to strictly focus and address the topic/sub-topic as asked for, in a structured manner. Any superfluous submission shall be at Concessionaires' risk*
- ii. Concessionaire shall provide comprehensive list of proposed spares for each section.*

Dated: /...../2021

(i) Detailed Methodology:

.....
.....

(ii) Technical Work Plan:

.....
.....

(iii) Broad system architecture and design proposed:

.....
.....

(iv) Equipment Delivery Schedule and Time schedule to complete the entire work under Functional and Technical Specifications, supported with Bar Chart, including the interior and allied works for TMC:

.....
.....

(v) Limitations on part of Concessionaire to address requirements under Functional and Technical Specifications, and SLA:

.....
.....

(vi) Design Concept of Central Processing System

(Design Concept including approach of concept and methodology for Central Processing System.)

.....
.....

Event Generation Method and Event List

(The Event Generation Method and Event list for design of Central Processing System.)

.....
.....

Event Management Method

(The event flow, event priority management method, event associate method, completion of missing data method, tuning of setting, supporting function for event management for Design of Central Processing System.)



.....
.....
Exchange Information Method with linked Different Highway Operator

(The method and technology for exchange information and expandable method for exchange information with linking different operator for design of Central Processing System.)
.....
.....

.....
.....
Layout of Operation Room in Traffic Management Centre and sub-centres

(Layout of Operation room in effective technology and suitable for operation.)
.....
.....

.....
.....
Contents Image of Graphic Display and Dashboard

(Showing Contents Image of important items and Dashboard with feasible technology for effective operation.)
.....
.....

.....
.....
GIS Map layout, process, and features

(Showing GIS Map Image of important items meeting Functional and Technical Specification features with feasible technology for effective operation.)
.....
.....

.....
.....
Operation and Maintenance Service Plan for ATMS

(Method and outline of Operation and Maintenance Service Plan for ATMS, mentioned in the Operation & Maintenance Specification.)
.....
.....

.....
.....
On-line Access during the Operations & Maintenance phase
.....
.....

(vii) Mobilization Schedule
.....
.....

(viii) Safety Plan
.....
.....

(ix) Schedule of Guarantee
.....
.....

(x) Concessionaire's Equipment
.....
.....

(xi) Spare Parts
.....
.....

(xii) Proposed Sub Contractors for Major Items of Plant Design, Supply and Installation Services

The Details of proposed Manpower for implementation and O&M phase shall be submitted in the format provided below (Form SUB and Form MAN)



.....

.....

(xiii) Arrangements by Concessionaire to address O&M Requirements, including complete manpower details proposed during implementation and O&M period.

NOTE: 1) The Manpower proposed here shall be dedicated for this project and shall not be proposed for any other project or assigned any other similar project of NHAI. The resource cannot be change for at least two years. In case of any variation or change in the manpower / person proposed in the Technical Proposal and manpower / person deployed upon successful award of the works, minimum 20% remuneration of the proposed role for the total contract period shall be deducted.

2) The Details of proposed Manpower for implementation and O&M phase shall be submitted in the format provided below (Form PER-1 and Form PER-2)

3) The substitute proposed by the Concessionaire must have more experience than the proposed candidate in all respect (no. of years of relevant experience, no. of similar projects executed, qualification of the replacement candidate, etc.):

.....

.....

(xiv) Comments on Accuracy of information/data expected in RFP with justification:

.....

.....

(xv) Any other aspects the Concessionaire may wish to add:

.....

.....

(xvi) Catalogue, brochure, or other supporting document

(Catalogue, brochure, or other supporting document for each equipment proposing for this project.)

.....

.....

(xvii) Applied standards

(Applied standards for each works and equipment s are clearly identified and those satisfy India standards or international defect standards)

.....

.....

Note: Following documents shall be enclosed along with this form

- (a) In case of any Non-Compliance in the Functional and Technical Specifications, Matrix thereof shall be submitted in the following format:

S. No.	RFP Clause & Page no.	RFP Provision	Non-compliance (details)	Remarks with alternate solution details

- (b) Technical details of each component, clearly mentioning the make, model, country of origin, and end of life of each component/ equipment as per the format given below, brief technical datasheet shall also be enclosed along with the material approval certificate*.

- (c) Please include all items mentioned under the indicative list of key components.

- (d) Quality Certificate and Undertaking for Country of Origin: The Concessionaire shall submit Quality Certificate from each OEM confirming that everything to be supplied by the OEM shall be brand new, free from all encumbrances, defects and faults in material.



Workmanship and manufacturing shall be of highest grade and quality and consistent with the established and generally accepted standards. Materials of the type ordered shall be in full conformity with the specifications, drawings or samples, if any, and shall operate properly. The Concessionaire shall ensure that none of the key component or its sub-component such as PTZ / TMCS Cameras, VIDS system, Vehicle Speed Detection System, Control Centre / Command Centre / TMC equipment including servers, storage, network devices, security devices are procured / sourced from any of the region and / or company barred / banned / blacklisted / restricted by any of the Government Department / Authority / PSU / Ministries / Defense etc. in India. The proposal may be considered as non-compliance / non-responsive in case this requirement is not fully met by the Concessionaire. The Concessionaire shall submit the certificate from each OEM in the format given below, fully complying to this requirement.

***Material Approval Certificate (MAC) – To be filled for every key component and all its sub-component proposed. The technical datasheet of the OEM relevant and specific to the proposed make & model must only be enclosed along with the MAC.**

Signature of Authorized Signatory of Concessionaire

Name

Seal

Date



Project		Service Provider:		Client:	
				National Highways Authority of India	
Location:					
Material Approval Certificate				Discipline (ITS/ARC/QV/MEP/EE)	(to be filled in by NHA)
Document No.	(to be filled in by Service Provider)			Date Close Out	(to be filled in by NHA)
Service Provider				Contract No.	
				Date	
We request the approval to the following for use on the above contract					
Document Title					
Works / Building					
Sub-Location					
Contractor / Sub-Contractor / OEM					
Contract Specifications Clause					
Technical Details (Make, model, country of origin, MTTR, MTBF, OEM warranty, end of life and other tech. details as applicable for each)					
Construction Drawing No. / Reference					
Estimated Date Required On Site					
Enclosures (samples, data, data sheet, test results, technical documentation, etc.)					
Meets / Doesn't Meets Requirement		<input type="checkbox"/> Yes	<input type="checkbox"/> No	In case of non-compliance please submit comparison statement	
We certify that the above submitted item has been reviewed in detail and is correct and in strict conformance with the contract, drawings and specifications except as otherwise stated above.					
Date					
Name				Authorized Representative of Service Provider	
Client		Date received			
Routing:	Project Manager	Architecture	Civil	IT	Electronics
for action					
for info					
<input type="checkbox"/>	Approved	<input type="checkbox"/>	Approved with comments	<input type="checkbox"/>	Rejected
Comments:					
Date Approved/Rejected				Date Authorized	
Name				Name	
Authorized Representative of NHA					

**Form PER - 1: Proposed Personnel**

Sub.: Advance Traffic Management System (ATMS) for *(Project Name)* section of National Highway

Ref: Functional and Technical Specification of above subject.

Dated: /...../2020

[The Concessionaire shall provide the names of suitably qualified personnel to meet the specified requirements stated in Functional and Technical Specifications.]

1.	Title of position*
	Name
2.	Title of position*
	Name
3.	Title of position*
	Name
4.	Title of position*
	Name

*As listed in Functional and Technical Specifications.

Signature of Authorized Signatory of Concessionaire

Name

Seal

Date

**Form PER - 2: Resume of Proposed Personnel****Sub.: Advance Traffic Management System (ATMS) for (Project Name) section of National Highway****Ref: Functional and Technical Specification of above subject.**

Dated: /...../2020

[The Concessionaire shall provide the data on the experience of the personnel indicated in Form PER-1, in the form below.]

Name of Concessionaire

Passport size
recent color
photograph of the
candidate

1. Proposed Position :**2. Name of the Candidate** (in Block letters) :**3. Father's/Husband's Name** :**4. (a) Date of Birth** in Christian era
(in dd/mm/yyyy format) :

(Please furnish proof of age)

(b) Age as on submission date :..... Yrs, ... Months &, Days**5. Permanent Address** :**6. Address for Correspondence** :**7. E-mail address, Phone Numbers** : Email:
Mobile:**8. Details of Educational Qualifications from Matriculation onwards**
(Please furnish proof of qualifications)

Sl. No.	(1)	(2)	(3)	(4)	(5)
Examination passed	Year of passing	Name of College / Institute	University / Board	Main subjects	Percentage of marks obtained

**9. Experience**

Total Experience : Yrs, Months &, Days
 Relevant Experience : Yrs, Months &, Days

10. Details of experience of each employment (in chronological order):

In case of change in posting held within the same employer, please fill in details separately.

1	Name and Address of the organization	Position held	Period of tenure		Responsibilities / Job Profile
			From DD/MM/YYYY	To DD/MM/YYYY	
					1
					2
Technical details of project experience				3	
				4	

2	Name and Address of the organization	Position held	Period of tenure		Responsibilities / Job Profile
			From DD/MM/YYYY	To DD/MM/YYYY	
					1
					2
Detailed description of project experience				3	
				4	

3	Name and Address of the organization	Position held	Period of tenure		Responsibilities / Job Profile
			From DD/MM/YYYY	To DD/MM/YYYY	
					1
					2
Detailed description of project experience				3	
				4	

4	Name and Address of the organization	Position held	Period of tenure		Responsibilities / Job Profile
			From DD/MM/YYYY	To DD/MM/YYYY	
					1
					2
Detailed description of project experience				3	
				4	

Note: In case of more than 4 employments, the relevant details in prescribed format be added.



Certification by Candidate:

- i) I am willing to work on the project and I will be available for entire duration of the project assignment and I will not engage myself in any other assignment during the currency of this assignment on the project
- ii) I, the undersigned, certify that to the best of my knowledge and belief, this CV correctly describes myself, my qualification and experience. In case NHAI discovers anything contrary to above, NHAI would be at liberty to remove the personnel from the present assignment and debar him for an appropriate period to be decided by NHAI.
- iii) I have not left any assignment with the consultants/ agencies/ Concessionaires engaged by NHAI/ contracting firm for any continuing works of NHAI without completing my assignment. I will be available for the entire duration of the current project. If I leave this assignment in the middle of the work, I may be debarred for an appropriate period to be decided by NHAI. I have also no objection if my services are extended by NHAI for this work in future.

Signature of the Candidate

Place:

Date:

Undertaking from Concessionaire

The undersigned on behalf of (name of Concessionaire) certify that Shri.....(name of the proposed personnel and address) to the best of our knowledge has not left his assignment with any other firm engaged by NHAI / contracting firm for the ongoing projects and he is currently not engaged with any other firm engaged by NHAI / contracting firm for the ongoing projects. We understand that if the information about leaving the past assignment with MORT&H/NHAI without completing his assignment is known to NHAI, NHAI would be at liberty to remove the personnel from the present assignment and debar him for an appropriate period to be decided by NHAI.

Signature of Authorized Signatory of Concessionaire

Name

Seal

Date

Note:

Each page of the CV shall be signed in ink by both the staff member and the Authorized Representative of the firm. Photocopies will not be considered.

**Form SUB: Proposed Sub-Contractors for Major Items of Equipment and Installation Services****Sub.: Advance Traffic Management System (ATMS) for *(Project Name)* section of National Highway****Ref: Functional and Technical Specification of above subject.**

Dated: /...../2020

A list of major items of ATMS is provided below.

The following Sub-Contractors and/or manufacturers are proposed for carrying out the item of the facilities indicated. Concessionaires shall propose only one sub-Contractor and / or manufacturer for each item.

Major Items of Equipment and Installation Services	Proposed Sub Contractors/Manufacturers	Nationality	Reference Project*

*Attach proof of relevant experience of minimum two projects.

Signature of Authorized Signatory of Concessionaire

Name

Seal

Date



Form MAN: Manufacturer's Authorization

(to be printed on the Letter head of the Manufacturer)

[The Concessionaire shall require the Manufacturer to fill in this Form in accordance with the instructions indicated. This letter of authorization should be signed by a person with the proper authority to sign documents that are binding on the Manufacturer.]

Sub.: Advance Traffic Management System (ATMS) for (Project Name) section of National Highway

Ref: Functional and Technical Specification of above subject.

To:

WHEREAS

We *[insert complete name of Manufacturer]*, who are official manufacturers of *[insert type of goods manufactured]*, having factories at *[insert full address of Manufacturer's factories]*, do hereby authorize *[insert complete name of Bidder]* to submit a Bid, the purpose of which is to provide the following goods, manufactured by us *[insert name and/or brief description of the goods]*, and to subsequently negotiate and sign the Contract.

We are Indian *[OEM/ Manufacturers / Class-I local supplier]* as per DPIIT Order no. P-45021/2/2017-PP (BE-II) dated 04.06.2020 (revised "Public Procurement (Preference to Make in India) Order 2017").

We have direct presence in India having own service and support offices at *[insert full address of Manufacturer's Service Centres]* to ensure smooth on-site after sales service support.

We hereby extend our full guarantee and warranty in accordance with RFP requirement, Defect Liability, of the Contract, with respect to the goods offered by the above firm.

We, hereby confirm that the above goods shall be covered under comprehensive on-site warranty for a period of 5 years from the date of installation & commissioning at the site and we shall maintain sufficient spares and have sufficient technical resources at our regional service centre to provide next business day service support at the site. In addition to this, we shall provide adequate training to the on-site maintenance staff of the bidder for regular corrective and preventive maintenance.

We, hereby confirm that the on-site warranty and training support stated above shall be extended to the Authority directly or its representative or any other Contractor appointed by the Authority, upon the request from the Authority.

Name: *[insert complete name Authorised Signatory]*

In the capacity of *[insert legal capacity of Authorised Signatory]*

Signature: *[Authorised Signatory]*

Duly authorized to sign the document for and on behalf of: *[insert complete name of Manufacturer]*

Dated on _____ day of _____, 2020 *[insert date of signing]*



Quality Certificate from OEM

(To be enclosed with MAC of each Component / Sub-Component)

Sub.: Advance Traffic Management System (ATMS) for (*Project Name*) section of National Highway

Ref: Functional and Technical Specification of above subject.

We _____ (Name and address of OEM) certify that everything to be supplied by us hereunder shall be brand new, free from all encumbrances, defects and faults in material. Workmanship and manufacturing shall be of highest grade and quality and consistent with the established and generally accepted standards. Materials of the type ordered shall be in full conformity with the specifications, drawings or samples, if any, and shall operate properly. It is also certified that the supplied items / equipment's have not been sourced from OEM backlisted by Government of India or firms of anti-national antecedents.

We, M/s also undertake that in case of any item supplied by us found to be defective, faulty, or used at any stage, it shall be replaced by us at our cost.

Signature of OEM

Name

Seal

Date

Signature of Witness

Name

Seal

Date

Signature of Authorized Signatory of Concessionaire

Name

Seal

Date