JAPAN INTERNATIONAL COOPERATION AGENCY

REPUBLIC OF INDIA

Special Assistance for Project Implementation (SAPI) for Hyderabad ORR Project Phase I

Final Report

May 2009

ALMEC Corporation

NEXCO East Ltd.

Value Planning International, Inc.

TABLE OF CONTENTS

LIST OF TABLES

List of Figures

LIST OF PHOTOS

ABBREVIATIONS

AASHTO	American Association of State Highway and Transportation Officials
ADT	Average Daily Traffic
ADV	Animal-drawn Vehicle
AP	Andhra Pradesh
APRDC	Andhra Pradesh Road Development Corporation
ARIB	Association of Radio Industry and Businesses
ATCC	Automatic Traffic Counters-cum-classifier
AVCC	Automatic Vehicle Counter and Classifier
BOT	Build Operate Transfer
CALM	Continuous Access for Long and Middle
CBD	Central Business District
CCD	Charge-coupled Device
CCTV	Closed-circuit Television
CDA	Cyberbad Development Authority
CEN	European Committee for Standardization
CGM	Chief General Manager
CMU	Corridor Management Unit
CR	Cycle Rickshaw
DD	Detailed Design
DPR	Detailed Project Report
DSRC	Dedicated Short Range Communication
EA	Executing Agency
ECB	Emergency Call Boxes
EOI	Expression of Interest
EPC	Engineering Procurement and Construction
EPTRI	Environmental Protection Training & Research Institute
ETC	Electric Toll Collection
FS	Feasibility Study
GHMC	Greater Hyderabad Municipal Corporation
GHz	Giga Hertz
GNSS/CN	Global Navigation Satellite System / Cellular Network
GOAP	Government of Andhra Pradesh
GPS	Global Positioning System
GSM	Global System for Mobile Communications
HADA	Hyderabad Airport Development Authority
HGCL	Hyderabad Growth Corridor Ltd.
HMA	Hyderabad Metropolitan Area

HMDA	Hyderabad Metropolitan Development Authority
HTMS	Highway Traffic Management Service
HUDA	Hyderabad Urban Development Authority
HUMTC	Hyderabad Unified Metropolitan Transport Committee
IC	Interchange
ICB	International Competitive Bidding
ICT	Information Communication Technology
IEC	International Electrotechnical Commission
IIT	Indian Institute of Technology
INCAP	Infrastructure Corporation of Andhra Pradesh
IRR	Inner Ring Road
ISM	Industrial Scientific Medical
ITS	Intelligent Transport System
ITU	International Telecommunication Union
JBIC	Japan Bank for International Cooperation
JICA	Japan International Cooperation Agency
LCV	Light Cargo Vehicle
MAT	Multi-Axle Truck
MCH	Municipal Corporation of Hyderabad
MRTS	Mass Rapid Transit System
MSRDC	Maharashtra State Road Development Corporation
NH	National Highway
NHAI	National Highways Authority of India
NHDP	National Highway Development Program
O&M	Operation and Maintenance
OBU	On Board Unit
O-D	Origin and Destination
OFC	Optical Fiber Cable
OMT	Operation, Maintenance and Transfer
ORR	Outer Ring Road
PIARC	Permanent International Association of Road Congresses
PMC	Project Management Consultant
PPP	Public Private Partnership
RFID	Radio Frequency Identifier
RFP	Request for Proposal
ROW	Right of Way
RR	Radial Road
RSU	Roadside Unit
SAPI	Special Assistance for Project Implementation
SEZ	Special Economic Zone
SMS	Short Message Service

SPV	Special Purpose Vehicle
TCC	Traffic Control Center
TCO	Traffic Control Office
TCS	Toll Collection System
TMS	Tolling Management Service
TOR	Terms of Reference
VICS	Vehicle Information and Communication Service
VMS	Variable Message Signs
WPC	Wireless Planning and Coordination

MAIN TEXT

CHAPTER 1 INTRODUCTION

1.1 Project Background

To achieve sustainable economic growth, the Government of India has given importance to a balanced national road network development through the construction of new roads, widening and rehabilitation of existing ones, improvement of road operation and management, as well as the promotion of public-private partnership. However, the substantial economic growth which India has experienced has spurred rapid urbanization, bringing about heavy traffic congestion in urban areas where a sharp increase in vehicle population on an inadequate road network has been observed.

Hyderabad, the capital city of Andhra Pradesh State and one of the fast-growing mega cities in India, has a population of 6.4 million as of the 2001 census and is expected to swell to 13.6 million by 2021. Motor vehicle numbers will also significantly increase, i.e. 7% yearly. Under such a situation, congested city roads have become a serious deterrent to investment and economic growth.

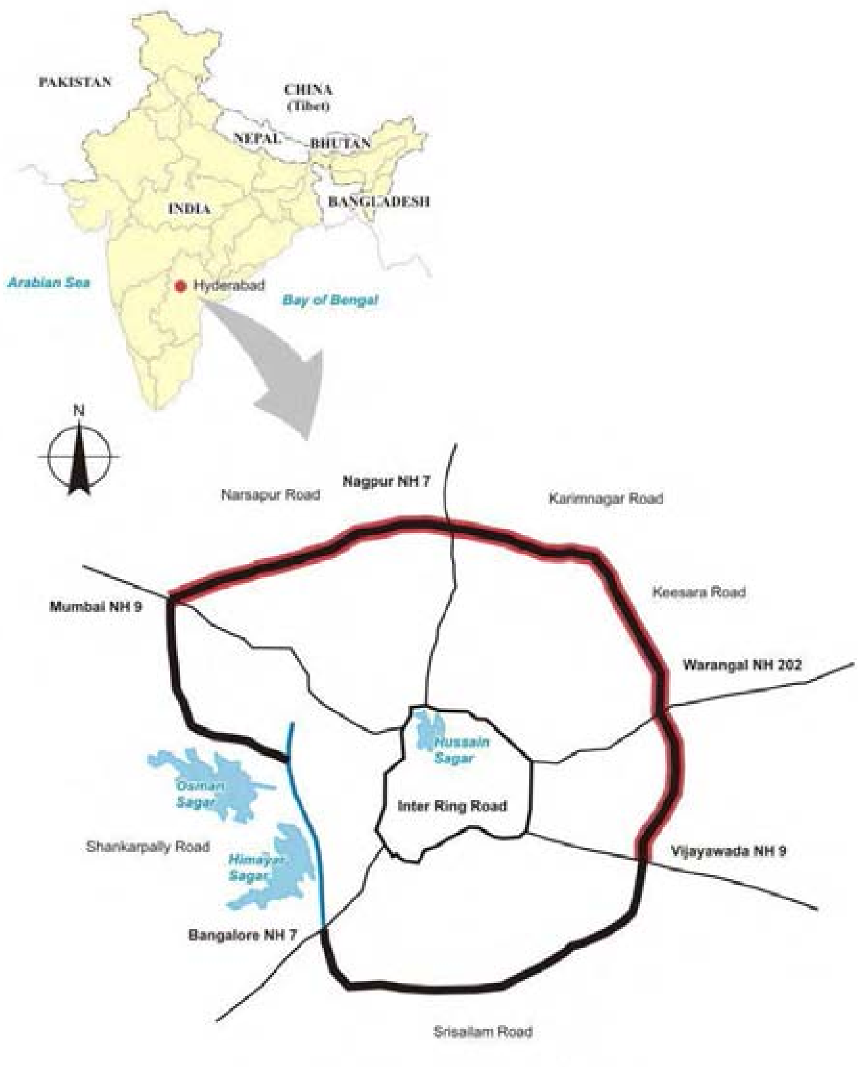
An inland city and a historical melting pot in the Deccan Plateau, Hyderabad has no physical constraints for urban expansion, such as steep terrain and coastlines. Hence, the adoption of circumferential roads connecting newly built ring towns adequately guides spatial planning. In fact, the 1975 Development Plan for the Municipal Corporation of Hyderabad (MCH) decided to form a 30-meter wide loop road called the Inner Ring Road (IRR) in the old city to ease congestion. Meanwhile, the Draft Master Plan for Hyderabad Metropolitan Area or “Hyderabad 2020” has designed another loop road, called the Outer Ring Road (ORR), with an alignment of 158km.

In December 2005, the State Government of Andhra Pradesh established a special purpose vehicle (SPV) for the ORR project, Hyderabad Growth Corridor Ltd. (HGCL) which receives equity from two public organizations under the state government: Infrastructure Corporation of Andhra Pradesh (INCAP, 26%) and Hyderabad Metropolitan Development Authority (HMDA, 74%). The company negotiated with a consortium of domestic banks and obtained a long-term loan of Rs.5 billion by mortgaging the lands held by HMDA to carry out phase I of the ORR project. Regarding Phase II A covering 62.30 km from Narsingi to Patanchru and from Shamshabad to Pedda Amberpet, five concessionaires were selected through international competitive bidding (ICB) under the BOT-annuity model. For Phase II B, two loan agreements were made between the Government of India and JICA in March and November 2008.

The first JICA loan package, amounting to 41.8 billion yen, includes construction work (38.0km of the ORR and its associated roads), consulting services, and HIV/AIDS prevention. The second package, amounting to 42.0 billion yen, encompasses construction work (33.3km of the ORR, its associated roads, and intelligent transport system or ITS to support the entire ORR), consulting services, and HIV-AIDS prevention.

Originally, the ITS subcomponent added to the second package includes the installation of a basic highway traffic management system (HTMS) only to collect, analyze, and provide real-time ORR information. However, it is now envisaged that an integrated ITS, such as electronic toll collection system, will work on the network to enable toll collection.

Figure 1.1 Hyderabad Outer Ring Road Project



Outer Ring Road Alignment

Phase 1	(blue line)	24.38 km	State Government of AP
Phase 2A	(black line)	62.30 km	PPP (BOT Annuity)
Phase 2B	(red line)	71.30 km	JICA Loan
TOTAL		**157.98 km**	

Table 1.1 JICA Loan Components of the Hyderabad ORR Project

Package	Item	Summary of Activities or Conditions
1	Construction Works	■ Construction of ORR main carriageway (8 lanes, 38.0km) ■ Rehabilitation of major radial roads and associated roads across the ORR project section
	Consulting Services	■ Supervision and technical assistance for construction works
	HIV/AIDS Prevention	■ Provision of integrated HIV-AIDS prevention measures (advocacy campaign, educational program, capacity building, counseling, testing, monitoring and evaluation) mainly for civil construction workers
	Project Cost and Loan Amount	■ Project cost: 54,165 million yen ■ Loan amount: 41,853 million yen
	Loan Period and Interest	■ Loan period: 30 years inclusive of a 10-year grace period ■ Interest rate: 1.2% for construction works and 0.01% for consulting services
2	Construction Work	■ Construction of ORR main carriageway (8 lanes, 33.3km) ■ Rehabilitation of major radial roads and associated roads across the ORR project section ■ Installation of ITS on the entire ORR and its access roads
	Consulting Services	■ Supervision and technical assistance for construction works
	HIV/AIDS Prevention	■ Provision of integrated HIV-AIDS prevention measures (advocacy campaign, educational program, capacity building, counseling, testing, monitoring and evaluation) mainly for civil construction workers
	Loan Amount	■ Project cost: 54,046 million yen ■ Loan amount: 42,027 million yen
	Loan Period and Interest	■ Loan period: 30 years inclusive of 10-year grace period ■ Interest rate: 1.2% for construction works and 0.01% for consulting services

Source: JICA

1.2 Study Objectives and Terms of Reference

A. Study Objectives

The study aims at assisting the implementation of the Hyderabad ORR project, focusing on ITS. More specifically, the study’s objectives are three-fold:

(i) To concretize ITS services for efficient and integrated operation and maintenance of the Hyderabad ORR;

(ii) To coordinate concerned organizations and agencies to achieve the above objective, including, but not limited to, interchange design for ETC, real-time information provision to road users, and ITS-related O&M body; and

(iii) To support the effective implementation of the proposed ITS during the Yen-loan Project Phase II, particularly ITS-related bid procedure and documents.

B. Study TOR

In order to achieve the above-mentioned objectives, the study scope was delineated in the TOR made between JICA and the HGCL in July 2008, as follows:

TOR 1: To Conduct Additional Works for ITS Implementation

(1-1) Detailed review of traffic demand forecast
(1-2) Review of HTMS in the existing contracts
(1-3) Assistance provision for necessary adjustment of HTMS for ITS development
(1-4) Comparison of ITSs and recommendation on the best system for the Project
(1-5) Review of existing interchange design and support for necessary modification for ITS development, particularly ETC

TOR 2: To Formulate the ITS Project Implementation Plan

(2-1) Delineation of ITS project scope
(2-2) Preparation of designs and specifications of ITS items
(2-3) Formulation of ITS project implementation schedule
(2-4) Estimation of project costs

TOR 3: To Assist the Executing Agency in Tender Preparation of ITS Items

(3-1) Drafting of bidding documents for ITS equipment procurement and project management consultancy services
(3-2) Provision of advice on ITS bidding procedure

TOR 4: To Recommend ITS Organization

(4-1) Review of ITS-related O&M terms in the existing contracts covering southern and western sections
(4-2) Recommendations on ITS organizational structure with clear responsibilities
(4-3) Recommendations on detailed schedule for ITS organizational setup

1.3 Study Implementation Arrangements and Activities

A. Study Organization

For study implementation, JICA contracted a joint venture comprising three consulting firms, namely ALMEC Corporation, NEXCO East, and Value Planning International Ltd. The joint venture organized a study team composed of seven experts, as follows:

Team Leader/Transport Planner: Kumazawa Ken
ITS Specialist A: Kondo Noboru

ITS Specialist B: Yamanouchi Yasuhide, Prof.
Highway Structure Specialist A: Dachiku Kiyoshi
Highway Structure Specialist B: Nishikatsu Yasuaki
Procurement Specialist: Wakatsuki Eiji
Organization & Management Specialist: Hara Kei

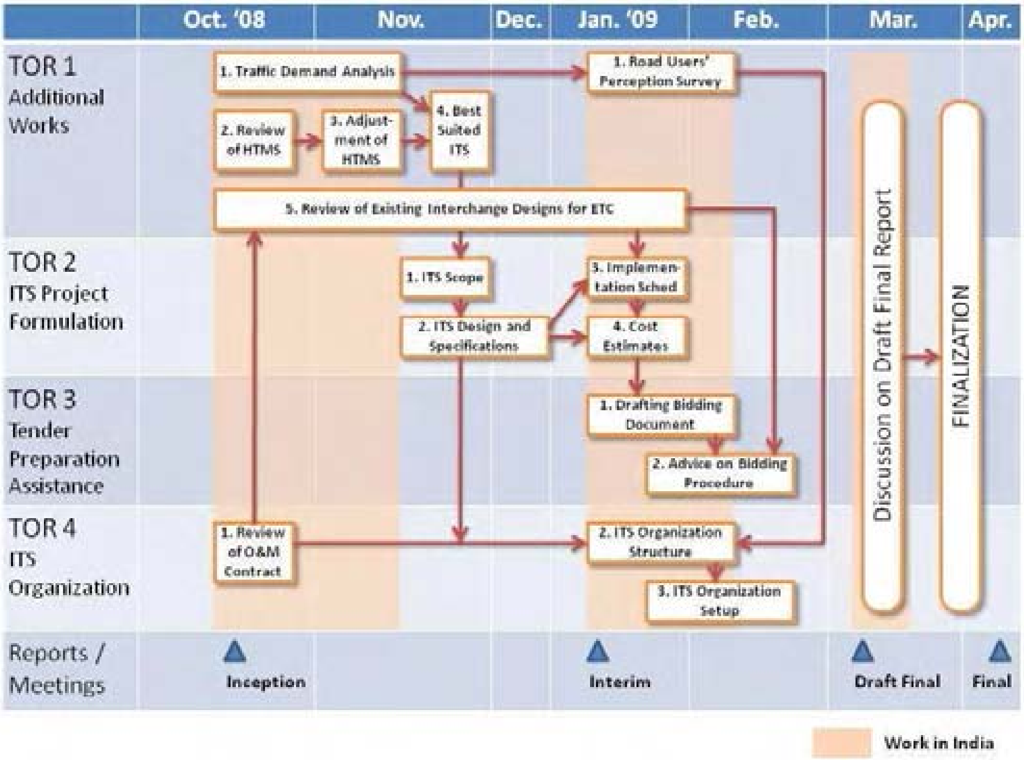
On the Indian side, the HGCL serves as the executing agency (EA), while some government agencies and private companies are considered as the study's stakeholders. These stakeholders include the Government of Andhra Pradesh (GOAP), Hyderabad Metropolitan Development Authority (HMDA), Infrastructure Corporation of Andhra Pradesh (INCAP), the BOT concessionaire, engineering, procurement and construction (EPC) contractors, and the consultants engaged in the project feasibility study and detailed design, etc.

B. Implementation Schedule and Milestones

The study commenced in October 2008 and concluded in May 2009. The overall workflow is illustrated in Figure 1.2. The milestones in the course of the study are indicated as follows:

- Inception Report: It was submitted in October 2008 while scope and organization of the SAPI was confirmed.
- Interim Report: It was submitted in January 2009. Additional works for ITS implementation were reported and ITS development concept was agreed in the Interim Report Meeting.
- Workshop on ITS development for the Hyderabad ORR: It was convened among relevant central government officials in Delhi in 12 January 2009.
- ITS Study Tour in Japan: This was an additional activity from the original study scope in order to familiarize the counterpart personnel with ITS technology and its operation and management. The study tour record is attached as Annex 8.
- Draft Final Report: It was submitted at the end of April, including overall SAPI outputs.
- Study Finalization: It was done in May taking comments from the counterpart agencies into account.

Figure 1.2 Study Workflow



CHAPTER 2 PROJECT APPRECIATION

2.1 Project Scheme and Implementation Status

2.1.1 Project Preparation

A. Conceptualization and Expected Benefits

In order to guide urban development in an orderly manner and mitigate traffic congestion, a hierarchical road network consisting of ring roads and radial roads has been adopted in the Hyderabad Metropolitan Area (HMA). In achieving such a metropolitan structure through the ORR project, the following key benefits are expected:

- Reduce traffic congestion within the city by offering an alternative transport route that connects to the city's periphery. The reduction in congestion within the city will also help in increasing traffic speeds;
- Boost the area being developed and connect the urban settlements in and around the HMA;
- Provide linkages with the radial arterial roads, the MRTS, and the bus systems through intermodal facilities;
- Provide quick access to the new Shamsabad international airport from strategic parts of the city; and
- Connect new urban nodes outside the city, such as the Hi-tech City and other strategic large-scale development areas.

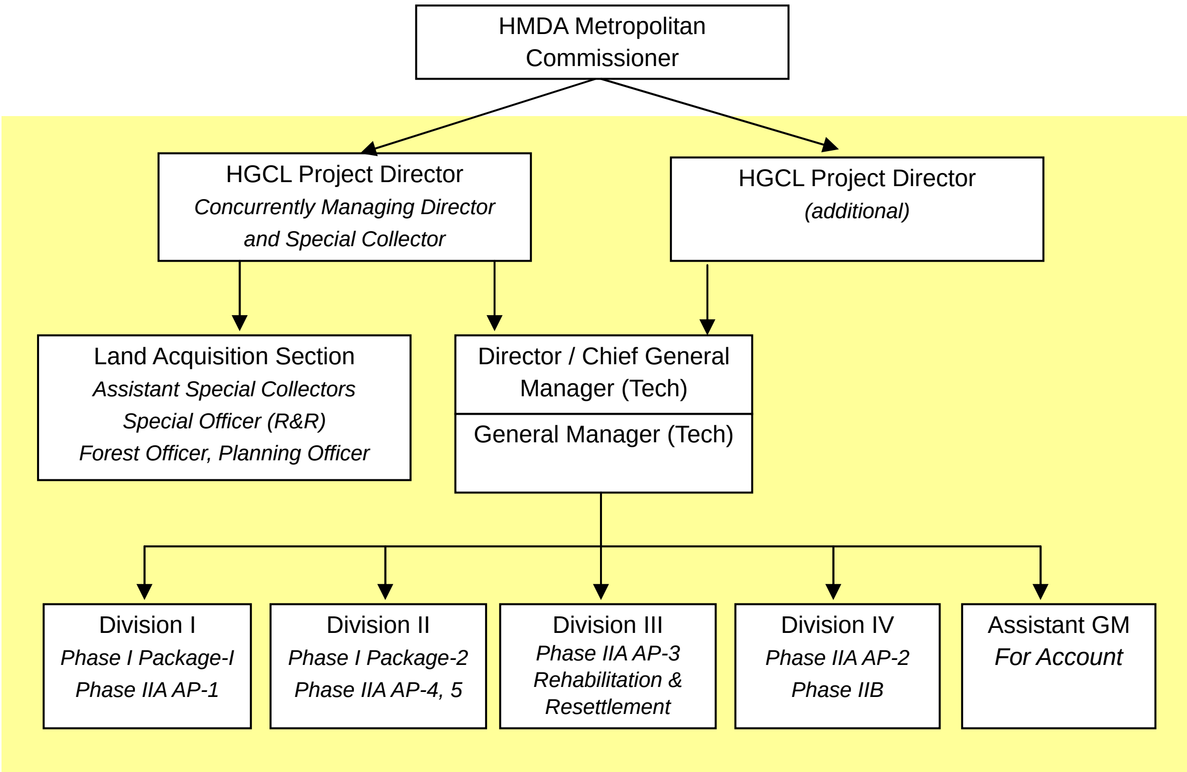
B. Mobilization

The HGCL was established in December 2005 to capitalize the growth potentials of HMA's suburban areas and to effectively implement the ORR project. It is the single point organization for all activities related to the project, such as the finalization of project design, calling for bids, award of contracts, mobilization of finance, etc. The HGCL is manned by around 70 personnel as shown in Figure 2.1.1. Some of its organizational characteristics are as follows:

- The HMDA Metropolitan Commissioner appoints the Project Directors of the HGCL.
- There are two project directors: The first acts as Managing Director and Special Collector for the company. However, the second project director, a position created in 2008, still has to have a clear function.
- There are four technical divisions headed by Deputy General Managers under the Director/Chief General Manager and General Manager. They deal with different

contract packages. No rail division has yet been established.

Figure 2.1.1 HGCL Organizational Structure



Note: Made by SAPI Team after Interview (as of November 2008)

C. Legal Basis for the Construction and Operation of a Toll Road by the HGCL

Legal Precedence in India: India acquired independence from the British on 15 August 1947. It has adopted the system of parliamentary democracy. India now is a union of 28 states and one national capital territory. The union directly administers 6 territories and these are called union territories. Andhra Pradesh is one of the states of the union. India became a republic on 26 January 1950, and its Constitution was promulgated.

During the British rule and prior to the promulgation of the Constitution, there were several laws enacted and administered in India. The Indian Tolls Act 1851 (hereinafter referred to as the "Tolls Act")is one such law which enabled the government to levy and collect tolls upon roads and bridges. It was applicable throughout India. By virtue of the provisions contained in Articles 372 and 372A of the Constitution of India, all the laws enforced in the territories of India immediately before the commencement of the new Constitution stayed in effect until altered, repealed, or amended by a competent legislature or authority. The Tolls Act thus continued to be in force and remains applicable throughout India.

In regard to the distribution of legislative powers as provided in the Constitution, states have the power to legislate on the subject of tolls (Entry 59 of List II of Schedule VII to the Constitution). This power extends to all roads and bridges situated in the respective states excluding national highways over which the Parliament alone has legislative power (Entry 23 of List I of Schedule VII to the Constitution). Thus the State's power of legislation is limited only to state roads and bridges.

Regarding national highways, the Indian Parliament has enacted the National Highways Act (Act No. 48 of 1956) which has been amended a few times, the latest being in 1997. Section 2 of this Act lists down 174 highways in the country as national highways. Section 4 of this Act declares that all national highways are vested in the Union of India, while Section 5 states that the central government is responsible for the development, maintenance, and repair of all the national highways. However, among other powers, the central government is allowed to direct the tasks of development and maintenance of national highways to state governments or an officer or authority of the central government. Section 7 of the Act, along with Section 9 (b), prescribes that the central government can from time to time set the fees (tolls) and the conditions to levy such fees for using the national highways.

Subsequently in 1988 the Indian Parliament enacted the National Highways Authority Act (Act No. 68 of 1988, NHAI Act) and created a separate corporation called the National Highways Authority of India (NHAI). The functions relating to the development and maintenance of many national highways are now exercised by NHAI.

By virtue of the provisions contained in Articles 294 to 296 of the Constitution of India the states have been allowed to assume the properties and assets of the former Governor's Provinces and the erstwhile Indian States. Thus the responsibility for developing and maintaining roads in the country other than national highways, such as state highways and other roads, falls on the state government or the local authorities in the state where the concerned roads are situated. As such the state government or the local authorities, such as municipalities and municipal corporations, have developed and maintained state highways and other roads.

In 1998, the State of Andhra Pradesh enacted the Andhra Pradesh Road Development Corporation Act (along the lines of NHAI Act) and created a corporation called the Andhra Pradesh Road Development Corporation (APRDC). Among other things, this act mandates the APRDC to develop and maintain state highways and other roads vested or entrusted by the state government.

In relation to urban areas, the State of Andhra Pradesh has enacted the Andhra Pradesh Urban Areas (Development) Act, 1975 and created the Hyderabad Urban Development Authority (HUDA) as a separate corporation with the following mandate, among others: preparation of a master plan and the integrated planning and development of Hyderabad's urban areas. Later on, the Hyderabad Metropolitan Development Authority Act was enacted in 2008 (Act No. 8 of 2008) with the view of establishing the Hyderabad Metropolitan Development Authority (HMDA) which would be responsible for planning, coordinating, supervising, promoting, and securing the development of the Hyderabad metropolitan region including the development and maintenance of roads in the metropolitan area other than national highways. The HDMA was created under Section 4 of this Act and subsequently the government abolished HUDA whose assets and liabilities were vested in the HMDA.

To suit their own needs and exigencies, states from time to time amend the Tolls Act. The State Legislature of Andhra Pradesh has also amended the Act. Section 9 of the Tolls Act empowers the state government to set the rules, among other things, on the method of collecting tolls and the manner of distributing the receipts therefrom. So far, however, no such rules have been made in the State of Andhra Pradesh, although the whole policy of levy and collection of tolls on the roads and bridges in the state is under review by the state government and such rules are likely to be made in the near future. Pending the existence of such rules, the state government has issued notifications for levy and collection of tolls under the powers contained in Section 2 of the Tolls Act. Under Section 2, as amended in the State of Andhra Pradesh, the state government may levy tolls in respect to any road or bridge improved or repaired by either the government or at the expense of any person, body, or association of individuals subject to the conditions and limits determine by the state government. The tolls shall be levied only at such rates and for such period as the state government imposes through notification in an official gazette.

In the past the constitutional validity of the Tolls Act had been challenged in the courts. But the courts have upheld the constitutional validity of the Tolls Act in those instances. The Supreme Court, in the case of the State of U.P v. Devi Dayal Singh (AIR 2000 SC 961), however, laid down certain principles regarding levies and the collection of tolls on roads and bridges. Briefly stated, these principles are as follows:

- Toll is a fee and is compensatory in nature.
- For the valid imposition of a toll, there must be a corresponding benefit.
- The public benefit envisaged under Section 2 of the Tolls Act is the construction and repair of any road or bridge at the expense of the state government. For the advantage obtained by the public through the construction of roads and bridges, the state government is entitled to reimburse itself for providing the service.
- Although the Tolls Act empowers the state government to levy rates of tolls as it thinks fit, the compensatory nature of the levy must bear a reasonable relationship to the provision of its benefits. No doubt, tolls collected are part of public revenue and may be absorbed in the general revenue of the State; nevertheless, by definition, a toll cannot be used otherwise or in augmenting the State’s revenue.

In the above decision, the Supreme Court was dealing with a case wherein the toll bridge was constructed by the state government itself; however, its principles would equally apply even in the case of public-private partnership (PPP) projects.

Toll Roads in Andhra Pradesh: The practice of collecting toll on state and municipal roads and bridges has been in vogue in the State of Andhra Pradesh. According to a report published in the newspaper "Hindu" some time ago, the present government abolished toll collection in 16 state highways but was contemplating the reintroduction of toll collection on three highways following their upgrading to 4-lane highways.[1] Because information and data on toll collection in the State have not been readily accessible, data collection will continue and these will be provided in the next report.

Regarding national highways in the State, available information shows that at least eight projects have been executed by the NHAI through BOT schemes which are based on toll collection. Several such projects are underway and are scheduled to be completed by 2009. Levies and toll collection covered by these projects are governed by the rules under the National Highways Act and the rates thereof are fixed and notified from time to time in accordance with the said rules.

HGCL's Legal Status: The Andhra Pradesh Urban Areas Development Act (Act No.1 of 1975) was enacted for the planned development of urban areas within the State. This Act mandated the state government to create the Urban Development Authority. Such authorities are vested as corporate bodies with power to contract, acquire, hold, and dispose of both movable and immovable properties. Section 5 of the Act specifically empowers such authorities to acquire, hold, manage, plan, develop and mortgage, or otherwise dispose of land and other properties in order to promote and secure the development of the urban areas. HUDA was such authority constituted under this Act. Subsequently, in 2008 the State enacted the Hyderabad Metropolitan Development Authority Act and created the Hyderabad Metropolitan Development Authority (HMDA) which was tasked to develop the Hyderabad metropolitan area. Consequently, this paved the way for the abolition of HUDA by the state government and the transfer of all its properties, rights, and obligations to the HMDA.

Over the course of these developments, the state government likewise recognized the need to provide for the rapid development of infrastructure as well as attract private sector participation through the enactment of the Andhra Pradesh Infrastructure Development Enabling Act (Act No.36 of 2001) which provides for the constitution of an authority as a corporate body with power to acquire, hold, and dispose of properties and other incidental things thereto. This resulted in the establishment of the Infrastructure Corporation of Andhra Pradesh Limited (INCAP) under the Companies Act of 1956 as a wholly owned company of the Government of Andhra Pradesh. Under its charter, INCAP is authorized, among other things, to promote special-purpose vehicle companies to develop infrastructure.

The HGCL has been promoted by INCAP and the erstwhile HUDA as a special-purpose vehicle to implement the government's proposal to develop the outer ring road (ORR)

[1] A report published in the news paper "Hindu" in 2008.

along with the satellite townships (in short, the HGC Project) in and around Hyderabad. The HGCL is a corporate body having a common seal and perpetual succession. It has powers to acquire, hold and dispose of properties, borrow loans, and mortgage its properties. INCAP and HUDA signed a memorandum of understanding to provide for the shareholding of their rights and obligations in implementing the HGC Project.

Table 2.1.1 NHAI Regulations on Toll Fees

Type of Vehicle	Base Capping Rate, 1997 (Rs. Per Km)	Indexed Rate, 2007 (Rs. Per Km)
Car/Jeep/Van/Light Motor Vehicle	0.40	0.65
Light Commercial Vehicle/Light Goods Vehicle/Mini Bus	0.70	1.05
Truck/Bus	1.40	2.20
Heavy Construction Machinery /Earth Moving Equipment/Multi Axle Vehicles (3 to 6 axles)	3.00	3.45
Oversized Vehicle (7 or more axles)	-	4.20

Note: NHAI

2.1.2 Project Scheme

The ORR has an 8-lane divided carriageway with full access control in addition to service roads on both sides and a railway. The overall right of way is 150m wide at most of its total aligned 158km. Figure 2.1.2 illustrates the typical cross-section of the ORR.

In terms of construction and financing, the entire ORR stretch is divided into three phases:

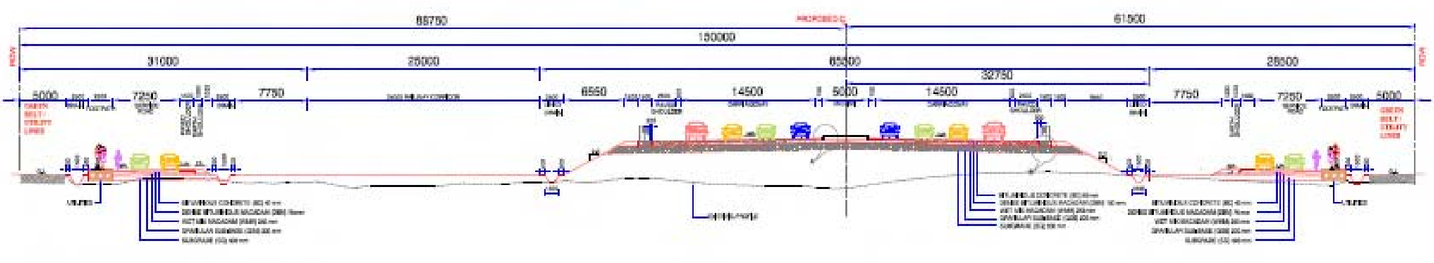
- Phase I – The section from Gachibowli to Shamshabad (24.4km) is being financed by loans from a consortium of banks;
- Phase II-A – The sections from Narsingi to Patancheru and from Shamshabad to Pedda Amberpet (62.3km in total) will be carried out under a BOT scheme wherein, the concessionaire will provide the initial financing required to construct the road, while the HDMA/HGCL will pay the concessionaire in 25 annuity payments over a specific period of time in addition to 20% of the project cost upfront as grant to the concessionaire;
- Phase II-B – The section from Patancheru to Padda Amberpet via Kandlakoya, Shamirpet, and Gha will tap ODA funding from JICA. The Japanese yen loan has a low and fixed interest rate (i.e. 1.2%) with a long-term repayment period (i.e. 30 years) inclusive of a 10-year grace period.

The road component of the ORR project is partially under construction or is in the pipeline. On the other hand, no specific timeline has been set for its railway component. As of April 2009, road infrastructure development is scheduled as follows:

- Phase I, between Hi-Tech Park and Shamshabad Airport, is considered to have the heaviest traffic demand and thus has the earliest constructed section which should have been partially operational by December 2008 and fully operational in either January or February 2010.
- Phase II-A will be completed in either May or June 2010, according to the BOT concession agreements, while Phase II-B will be completed by the end of 2011.

Simultaneously, to completely capture the benefits from the ORR project, 33 radial roads are proposed for development to connect the ORR with the inner ring road (IRR). Out of the 33 radial roads, 26 are existing roads which will be improved, while seven will be developed.

Figure 2.1.2 Typical Cross-section of the Hyderabad ORR



Source: HGCL

2.1.3 Construction Status

Phase I Section: The HGCL has arranged two (2) contract packages both of which should have finished by the end of 2008. Only a provisional opening, by way of a four-lane carriageway is possible during the contract period.

However, the HGCL has released information on an amendment to the construction schedule: completion was moved to 2010 at an early time. It has been observed that the hilly and rocky terrain hampers the road construction, particularly the service roads in the Contract Package I section. Work progress as of end -September was 20.4%, which means that it lags behind the Contract Package II section which has already gained 38.1% completion for the same period. Further delays may continue until the service roads are completed.

Phase II-A Section: The HGCL has arranged five (5) contract packages under a model of BOT with annuity. The concession agreements were concluded in August 2007.

Because terrain conditions along the Phase II-A sections are rather flat compared with the Phase I sections, construction has been easier. The HGCL has given information that the Phase II-A sections will become operational by the mid of 2010. It has been noted that the most critical part of the road construction schedule has been the acquisition of rights of way.

Table 2.1.2 Summary of Phase I Contract Packages

	Contract Package I	Contract Package II
Section and Length	From Gachibowli to APPA, 11.00km	From APPA to Shamshabad, 13.38km
Awarded Contractor	Corporation Transstroy, OJSC, Moscow, Russia	Continental Engineering Corporation, Taiwan
Contract Price	Rs. 2,197.4 million	Rs. 2,950.9 million
Date of Commencement	4-7-2006	12-7-2006
Contract Period	30 months	30 months
Current Status	Partial operation with four-lane connectivity starting on 14/11/2008.	Partial operation with four-lane connectivity starting on 14/11/2008.
Hindrances	Partial ROW preparation (3.85km long) for service roads due to local residents' relocation	No hindrance except one residential lot in Shamshabad.

Note: Information collected by SAPI Study Team, as of November 2008

Table 2.1.3 Summary of Phase II-A Contract Packages

	AP-1	AP-2	AP-3	AP-4	AP-5
Section and Length	From Narsingi to Kollur, 12.00km	From Kollur to Patancheru, 11.70km	From Pedda Amberpet to Bongulur, 13.00km	From Bongulur to Tukkuguda, 13.00km	From Tukkuguda to Shamshabad, 12.63km
BOT Concessionaire	Hyderabad Ring Road Project Pvt. Ltd.	Cyberabad Expressways Pvt. Ltd.	East Hyderabad Expressway Ltd.	Hyderabad Expressways Pvt. Ltd.	Ramky Hyderabad Ring Road Ltd.
EPC Contractors	Induni & CIE (Switzerland), Era Constructions	Maytas Infra Ltd., Gayatri Projects Ltd.	Infrastructure Leasing & Financial Services Transportation Networks Ltd., KMC Constructions Ltd.,	Maytas Infra Ltd., Gayatri Projects Ltd.	Ramky Infrastructure Ltd., Elsamex (Spain)
Project Cost (Rs. Million)	3,003.6	4,035.5	3,882.5	3,593.1	3,325.1
Date of Commencement	12-12-2007	20-12-2007	10-12-2007	20-12-2007	27-11-2007
Handed-over ROW	11.00km or 91.7%	10.80km or 92.3%	9.26km or 71.2%	8.45km or 65.0%	11.33km or 89.7%
Hindrances	Golkonda Education Society, Court Case for 1km	Court Case for the lands at Patancheru	Local resistance for 3.74km in total, Indian Oil Filling Station	Local resistance for 4.65km	Local resistance for 1.30km

Note: Information collected by SAPI Study Team, as of November 2008

Phase II-B Section: This section comes with a loan assistance from JICA. The following is a summary of the development transaction between Japan and India:

- In August 2006, the feasibility study on the Hyderabad ORR was completed by the HGCL;
- In March 2007, the Government of India requested the Government of Japan to provide a Japanese yen loan to the ORR project;
- In December 2007, the Japan Bank for International Cooperation (JBIC) dispatched the project appraisal mission;
- In March 2008, the first loan package was agreed between the Government of India and JBIC; and
- In November 2008, the second loan package was agreed between the Government of India and JICA.

Project management consultants to be hired within the loan will serve only for the duration of the construction supervision and management period and not cover detailed design (DD). The HGCL explains that the Detailed Project Report (DPR) consultant (Aarvee Associates and BCEOM) it hired has already done the FS and DD.

Table 2.1.4 Implementation Schedule of the Japanese Loan for the ORR Project

	Phase I	**Phase II**
Land Acquisition and Resettlement		
Completion	August, 2008	February, 2009
ORR Construction Works		
Tendering for Construction	August, 2008	February, 2009
Commencement of Construction	September, 2008	March, 2009
Completion of Construction	February, 2011	August, 2011
Commercial Operation	March, 2011	September, 2011
Consulting Services for ORR Construction		
Selection of Consultant	July, 2008	January, 2009
Commencement of Consulting Services	August, 2008	February, 2009
Completion of Consulting Services	February, 2011	August, 2011
Improvement of ORR Related Radial Roads		
Tendering for Construction	June, 2008	October, 2008
Commencement of Construction	June, 2008	November, 2008
Completion of Construction	December, 2009	June, 2010

Source: Various Project Documents compiled by SAPI Team

2.1.4 Relevant Issues

For the effective actualization of the growth corridor concept of the Hyderabad ORR, the SAPI Team has identified the issues that came out of the project appreciation discussed above. In general, these issues are land acquisition, urban growth management, and project cost recovery.

Land Acquisition: According to the HGCL, they have acquired 4,556 acres for the ORR project, while a further 741 acres will be acquired. Compensation is done by either cash or land substitution. It was noted that farmers took more prolonged negotiation and persuasion than other land owners. Lands at the fringes of urbanizing, or urbanized areas, such as Tukkuguda were hardly acquired. (Refer to Table 2.1.5)

Urban Growth Management: Many industrial estates, research parks, and satellite towns are under construction or are being planned for construction along the ORR corridor. However, there is no available integrated land-use transport plan. Although rail infrastructure is a potent tool for defining urban structures in mega cities and it is included in the ORR concept, there is no plan to develop a 25-meter ROW in the ORR for rail development.

Project Cost Recovery: The HGCL and HMDA shoulder a huge debt for the ORR project. They have to repay the Phase I loan to the bank consortium, pay the 25-year annuity to the BOT concessionaires, and the 30-year loan to JICA through the central government. Their main resource will be the collected toll charges. But it should be noted that the toll concept is new to the ORR project. For example, the DPR for Phase II-B in 2006 did not consider toll collection in interchange drawings, and thus no financial analysis was made. Efficient toll collection is critical to ensure project sustainability.

Table 2.1.5 Status of Land Acquisition

Phase	Location	No. of Acres	Present Status
Phase I	From Gachibowli to Shamshabad	434	Completed
Phase II-A	From Narsingi to Patancheru	971	944 acres acquired
	From Shamshabad to Amberpet	1,530	1,378 acres acquired
Phase II-B	From Amberpet to Patancheru	2,362	1,800 acres acquired
Total	158km	5,297	4,556 acres acquired

Source: HGCL, as of the end-September 2008

2.2 Hyderabad ORR under Metropolitan Development

2.2.1 Metropolitan Profile

A. Metropolitan Administration

The HMDA was launched in August 2008 as a metropolitan administrative body. The Andhra Pradesh government issued orders for the constitution of the HMDA and its replacement of HUDA which was created in 1975. At the same time, the HMDA merged two local development authorities, i.e. Cyberbad Development Authority (CDA) and Hyderabad Airport Development Authority (HADA).

The HMDA's jurisdiction covers 54 *mandals* in five neighboring districts that include Hyderabad, Medak, Ranga Reddy, Mahaboobnagar, and Nalgonda. They will be provided with round-the-clock water supply on a priority basis in the next 4-5 years. The jurisdiction area comprises 6,852 square km which is 3.7 times larger than that of the former HUDA (1,865 km^2). The HMDA will also ensure uniform development of the surrounding municipalities that lag behind in terms of infrastructure. The HMDA has the following four functions:

(a) Planning – to prepare and revise the master plan and zonal development plans;

(b) Regulation and control - to regulate and control development through statutory plans and other measures;

(c) Development - to undertake various developmental projects in the developmental area; and

(d) Coordination - to coordinate with other public agencies concerned with the provision of urban infrastructure, services, and amenities.

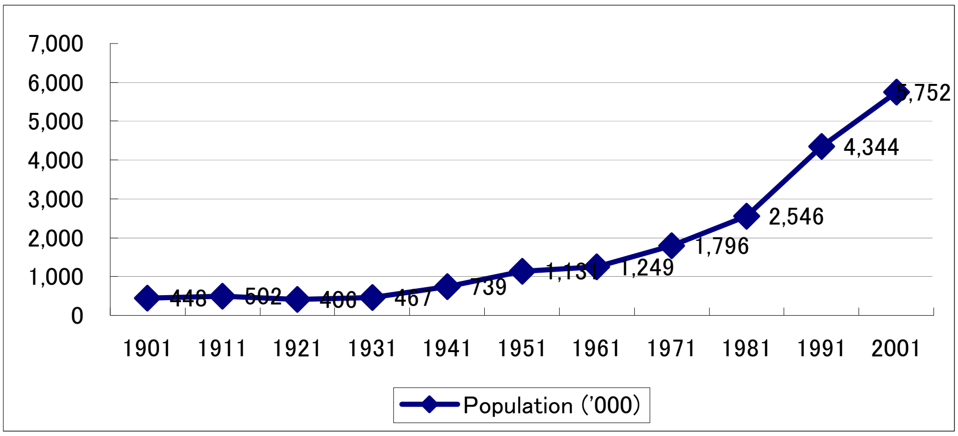
A city administration unit provides citizens with various urban and social services. In the study area, Hyderabad has a long history of city administration since 1869. The city has experienced several organizational changes and jurisdictional expansions. From April 2007 onwards it became Greater Hyderabad Municipal Corporation (GHMC) following its merger with 12 municipalities. The city is divided into five zones (including north, south, central, east, and west) and 17 circles to provide better services as the city has grown from 175 square km to 650 square km.

The mandate of the GHMC includes the charging of property taxes; regulation of on-street advertisements; issuance of birth/death certificates, trade licenses, and building permits; provision of sanitation, parks and playgrounds, parking, and other services.

B. Demography and Urbanization

Urban population data are available even prior to the formation of HUDA in 1975. Data show a continuous growth from 406 thousand in 1921 to 5,752 thousand in 2001. The Metropolis Association states that a city of at least a million people living in its urban agglomeration is regarded as a metropolis. In this sense, Hyderabad gained its metropolitan status way back in 1951 when its urban population was over 1.1 million. A sharp urban growth trend reaching 2.3 times was observed between 1981 and 2001. It should be noted that the 2001 urban population figure in HUDA was smaller than that of HUDA (6.4 million) because the urban area was smaller than HUDA's jurisdiction in the same year.

Figure 2.2.1 Population Growth in Hyderabad's Urban Areas, 1901–2001

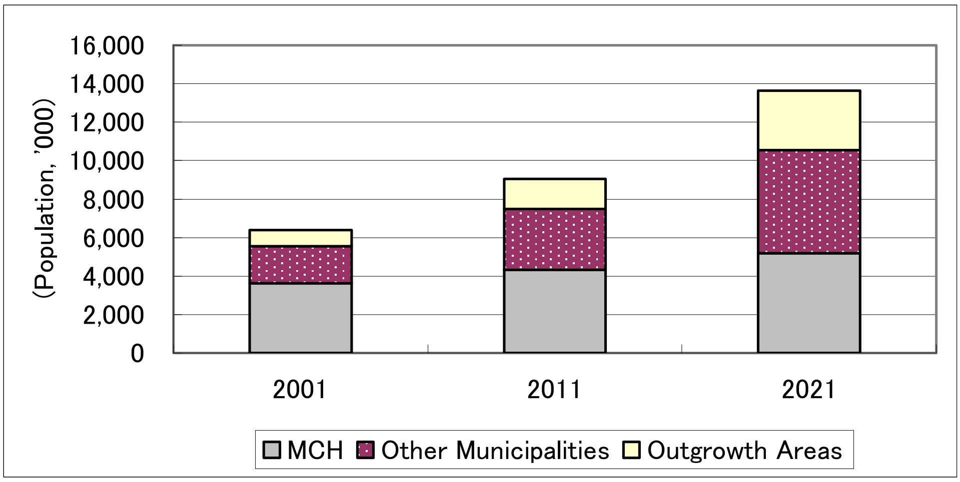


Source: Hyderabad 2020, HUDA 2003

The Draft Master Plan for Hyderabad Metropolitan Area: "Hyderabad 2020" has a population projection for HUDA, i.e. 9.1 million by 2011 and 13.6 million by 2021. The population in HUDA increased from 2,993 thousand in 1981 to 6,383 thousand in 2001 at an annual growth rate of 3.85%. An almost similar rate (3.87%) is expected until 2021. During the projection period, MCH population share will decline from 58.8% in 2001 to 38.8% by 2021 due to urban expansion.

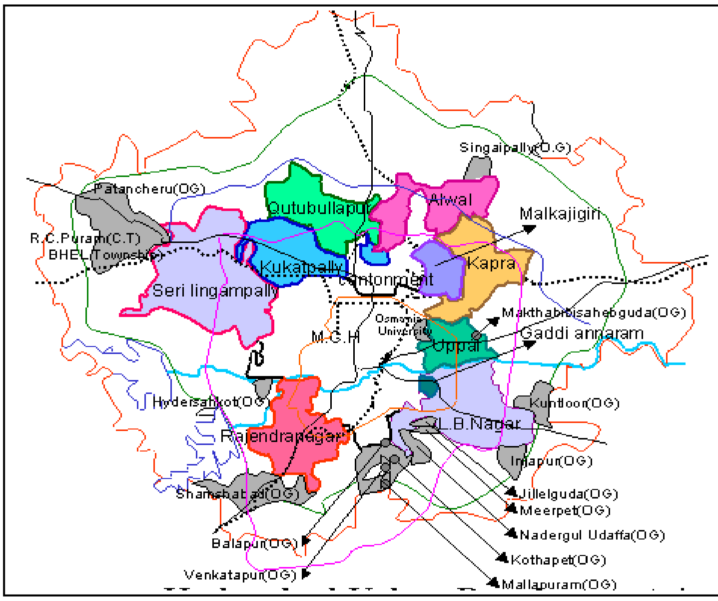
However, MCH population itself will increase at a steady pace from 3,633 thousand in 2001 (210 persons/ha) to 5,174 thousand by 2021 (300 persons/ha). Other metropolitan cities have experienced that motorization in association with transport infrastructure development does not encourage dense downtown development at a population density of over 200 per hectare. This implies that further suburban development would happen at a faster pace than that anticipated in "Hyderabad 2020."

Figure 2.2.2 HUDA's Population Projection by Area, 2001—2021



Sources: Hyderabad 2020 and HUDA 2003

Figure 2.2.3 HUDA's Population Projection for Hyderabad's Urban Areas, 2001—2021



	CORRECTED	
HYDERABAD URBAN AGGLOMERATION 200		
Component	**Population 2001**	**Area in sq.km**
MCH	3632586	172.6
Secunderabad cantt	207258	40.17
Osmania university	11207	2.85
Kukatpalle M	**291202**	**43.12**
Lbnagar M	**267592**	**64.61**
Malkajgiri M	**192810**	**16.75**
Qutbullabur M	**229322**	**52.02**
Kapra M	**159176**	**43.81**
Rajendranagar M	**143377**	**50.87**
Uppalkalan M	**117875**	**21.97**
Serilingampally M	**153255**	**96.99**
Alwal M	**109386**	**26.32**
Gaddiannaram M	**53622**	**2.12**
Balapur OG	6585	13.54
Kothapet OG	11381	2.31
Venkatapur OG	3790	0.32
Mallapur OG	986	2.7
Hydershakot OG	655	1.21
Kuntloor OG	3879	10.65
Injapur OG	1730	4.26
Nadargul(partly) OG	1719	30.06
Jilalguda OG	11257	2.5
Meerpet CT	12940	4.04
Shahajadi begam OG	0	0.09
Shamshabad OG	18737	24.76
Makta bibi sahebguda	872	0.16
Singaipally OG	1190	1.82
Ramchandrapuram CT	52248	19.28
Rcpuram BHEL townsh	40332	11.21
Patancheruvu	14811	15.06

Sources: Hyderabad 2020 and HUDA 2003

C. Vehicle Ownership

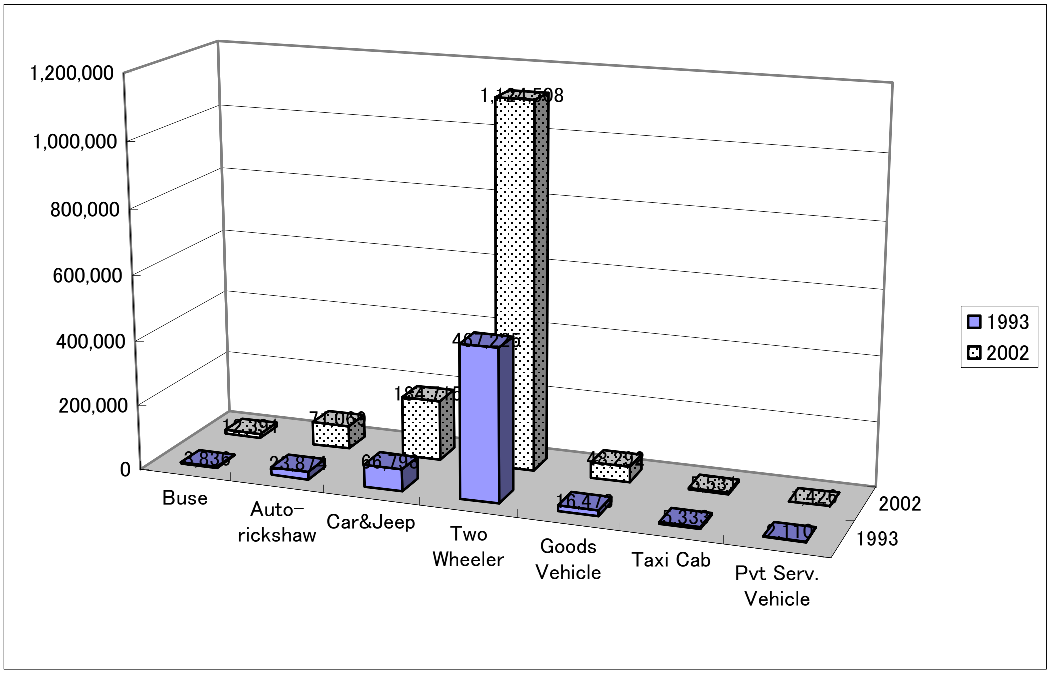
Motorization in Hyderabad is high. The number of registered vehicles jumped from 0.6 million in 1993 to 1.4 million in 2002, or a 10.6% increase annually. It has a much faster pace than population growth, which is pegged at 3.8%. During the same period, all kinds of private vehicles registered sharp increases. Although public transport fleet, buses, and auto-rickshaws substantially increased, taxi cabs have maintained a constant fleet size.

Due to such dynamic motorization, the number of vehicles per 1,000 residents substantially increased from 116 vehicles in 1993 to 218 vehicles in 2002. Compared with advanced Asian cities such as Tokyo and Seoul, vehicle ownership in Hyderabad has already reached the 200 and 300 vehicles per 1,000 resident ownership range. However, Hyderabad differs from these cities in vehicle composition; two wheelers are dominant in Hyderabad with a 78% share, while four wheelers are dominant in Tokyo and Seoul with two wheelers taking minor shares in these cities.

Two-wheeler patronage may shift to public transport usage with the provision of attractive public transport services and the imposition of stricter policies to two wheelers such as a local ban on riding two wheelers within CBDs, as China did in the late 1990s. On the other hand, a shift from two wheelers to private cars may happen only when considerable income increases occur among motorists.

Since the main carriageway of the ORR does not allow two or three wheelers, only 252,355 vehicles or 17% of all the Hyderabad registered vehicles in 2002 will be able to use it.

Figure 2.2.4 Registered Vehicles in Hyderabad, 1993 and 2002



Sources: Hyderabad 2020 and HUDA 2003

Figure 2.2.5 Trends in Vehicle Ownership in Selected Cities

Note: Number of vehicles per 1,000 residents
Source: Sustainable Transport in East Asian Megacities (STREAM), 2007 except Hyderabad

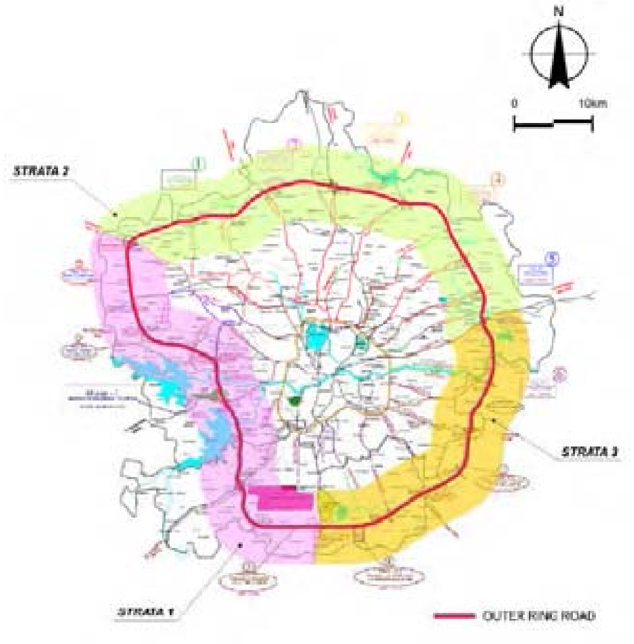
2.2.2 Urban and Industry Development Trend

A. Recent Corridor-wide Development Trend

In order to analyze recent corridor-wide development trend along the Hyderabad ORR, socio-economic survey was conducted. In the survey, the ORR corridor is defined within 5 km from both the sides of ORR. There are 207 settlements located within the ORR corridor. It is divided into three strata across the following major ORR interchanges:

- Strata 1 consisting of 88 settlements and crossing Mankhal, Shamshabad, APPA and Muttangi interchanges;
- Strata 2 consisting of 77 settlements and crossing Dundigal, Medchal, Shameerpet and Cherial interchanges;
- Strata 3 consisting of 42 settlements and crossing Ghatkesar, Ambarpet and Mangalpalli interchanges

Figure 2.2.6 Strata Setting for ORR Corridor Analysis



The ORR Corridor has a population of 1.5 million in 2007. The population has grown by 3 times since 1981. Among three strata, Strata 2 is the fastest growing area.

Table 2.2.1. Population Growth of the ORR Corridor between 1980 and 2007

	1981	1991	2001	2007
Strata 1	158,821	228,499	297,277	403,604
Strata 2	209,025	277,665	564,137	760,480
Strata 3	157,855	203,978	245,522	342,040
Total	525,701	710,142	1,106,936	1,506,124

Source: Population Census (1981, 1991, 2001)
Local Statistical Offices (2007)

The ORR Corridor has newly received 703 establishments between 1996 and 2007. 613 of which were established during the second half of the period (2002-2007). Among three strata, Strata 1 is the most popular area for new comers. In Strata 1, major new establishments are pharmacy, electrical & electronics allied, and mechanics & engineering allied.

Table 2.2.2 New Establishments Located in the ORR Corridor between 1996 and 2007

	1996-2001	2002-2007	Total
Strata 1	61	479	540
Strata 2	25	99	124
Strata 3	4	35	39
Total	90	613	703

Source: Local Statistical Offices (2007)

B. Non-residential Investment Opportunities

The socio-economic survey shows that there are 34 special economic zones (SEZ) surrounded by the Hyderabad ORR, 18 SEZ assisted by the public sector and 16 SEZ developed by the private sector. 25 of all 34 SEZ intend to attract IT and IT enabled services. Although recent non-residential investment has been concentrated at Strata 1, new areas for guided investment as a SEZ form are scattered along the whole stretch of the ORR. (Refer to Table 2.2.3 and Figure 2.2.7)

In addition to SEZ, local statistical officers during the socio-economic survey informed local development trend. They are summarized as follows:

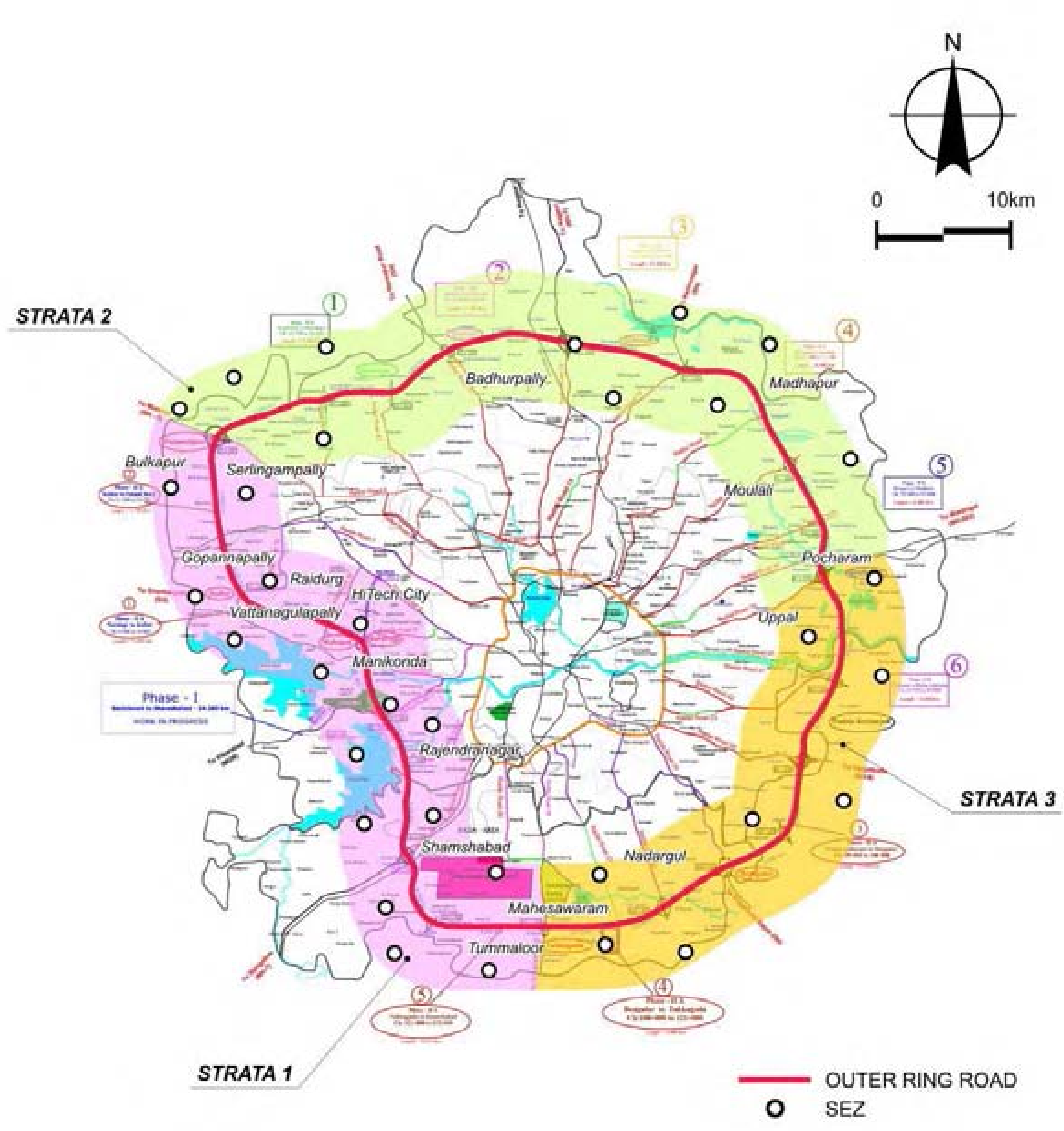
- Kandukur: The state government intends to allocate 250 acres to George Techno University.
- Medchel: Around 150 factories have been accumulated. Major business categories are refrigerator and cold storage, apparel industries.
- Ibrahimpatnam: One factory for medical care is under construction.
- Serilingampally: Some large-scale residential development projects have been underway since 2003.
- Patancheru: The area has already been developed for industrial use.
- Shankarpally and Moinabad: The area is prohibited from development in order to maintain water reserve to be supplied to Hyderabad.
- Rajendra Nagar: The area is largely occupied by several institutes such as Acharya N.G. Ranga Agricultural University, National Institute of Rural Development, etc. Recently only residential development has been observed.
- Shamshabad: Township development has been observed in recent years near the international airport.
- RC Puram: The area is fully developed by residential and industrial estates.

Table 2.2.3 SEZ Surrounded by the Hyderabad ORR

Notified	Name of the Developer	Type of SEZ	Extent in Hectares	Location
Govt./Govt. Assisted SEZs	APIIC Ltd.	IT/ITS	20.53	Serlingampally
	Hyderabad Gems SEZ Ltd.	Gems & Jewelers	80.93	Maheshwaram
	Satyam Computers Services Ltd.	IT/ITES	12	Hi-tech city
	K.Reheja IT Park Pvt. Ltd.	IT/ITES	16.29	Madhapur
	Fab city SPV (India)	Semi conductor facility	120.06	Maheshwaram
	Lanco Hills Technologies Park Pvt. Ltd.	IT/ITES	11.77	Rajendra nagar
	INDU Techzone Pvt. Ltd.	IT/ITES	60.7	Maheshwram
	IMAAR Hills Town Ship Pvt. Ltd.	IT/ITES	10.33	Manikonda
	Brahmani Infra tech Pvt. Ltd.	IT/ITES	60.7	Saroornagar
	Top notch Infrastructure Ltd.	IT/ITES	11.735	IDA, Uppal
	Divya NSL Infrastructures Ltd.	IT/ITES	15.175	Raidurg
	Stargaze Properties Pvt. Ltd.	IT/ITES	68.96	Maheshwaram
	HUDA	ITES	47.6	Serlingampally
	J.T.Holdings Pvt. Ltd.	IT/ITES	28.33	Maheshwaram
	APIIC Ltd.	Hardware	111	Maheswaram
	Wipro Ltd.	IT/ITES	40.46	Vattanagulapally
	APIIC	Building	110	Tummaloor
	APIIC	Aerospace	220	Nadargul
Private Developers SEZs	AP Techno Project Pvt. Ltd.	IT/ITES	10	Serlingampally
	Satyam Computer Services Ltd.	IT/ITES	10.5	Bahadurpally
	CNC Ltd.	IT/ITES	20.59	
	Sanghi SEZ Pvt. Ltd.	IT/ITES	202.4	
	Maytas Properties	IT/ITES	15.92	Gopannapally
	DLF Commercial Developer Ltd.	IT/ITES	101	
	SERENE	IT/ITES	68.96	Pocharam
	Rahega Group	IT/ITES	67	Pocharam
	Lahari Infrastructure	Multi Services	100	Bulkapur
	Parsvanth Developers Pvt. Ltd.	Bio Technologies	10.11	Tattanaram
	Gen Pack India	IT/ITES	20.23	
	Navayuga Legala Estates Pvt. Ltd.	IT/ITES	10.22	Serlingampally
	GMR Hyderabad International Airport Ltd.	Airport based Multi Products	101.2	Shamshabad
	GMR Hyderabad International Airport Ltd.	Aviation Sector	100	Shamshabad
	Uni tech realty construction Pvt. Ltd.	IT/ITES	10	Moulali
	Ananth Techologoies Ltd.	IT/ITES	202.35	Saroornagar

Source: Local Statistical Offices and others

Figure 2.2.7 Location of SEZ



2.2.3 Scrutinizing ORR Traffic Demand

The ORR project provides strategic functions in metropolitan development, i.e. alleviating traffic congestion in the Hyderabad CBD by diverting traffic from the radial roads to the Hyderabad ORR and generating developmental traffic from newly built industrial estates, research parks, and satellite towns under a polycentric urban structure. Due to these functions, traffic demand exercise for the ORR project should support such metropolitan development scenarios. However, this exercise faces some difficulties such as the following:

- There is no existing traffic since the ORR is mainly a new alignment;
- Diverted traffic can be expected from the radial roads across Hyderabad ORR, particularly vehicles which do not need to pass through the congested CBD. However, their trip patterns in terms of origin and destination (O-D) are not clear;
- No developmental traffic has been gauged from plausible land-use transformation along the ORR corridor; and
- No analysis has been made for drivers' willingness to pay although the Hyderabad ORR will charge toll fees.

The ORR traffic demand has been reviewed from two angles: existing traffic characteristics on radial roads across the Hyderabad ORR and the comparative review of two previous demand forecasts, i.e. by the DPR consultant and by IIT Chennai. It should be noted that they are regarded as interim analyses for the primary objective, which is to scrutinize the ORR traffic demand.

A. Traffic Characteristics on Radial Roads

The Hyderabad ORR is designed to provide a network of dense connectivity with national highways, state highways, and other minor roads. In the HMDA road network development plan, there are 33 radial roads between the IRR and the ORR. All radial roads exist while some are being improved, e.g. widened. For instance, seven radial roads are being improved under the JICA loan project. These radial roads are listed in Table 2.2.4.

Table 2.2.4 List of Radial Roads

Radial Road No.	Starting Point	Ending Point	Length to ORR (m)	Existing Carriageway	Road Improvement	2006 Traffic Survey
RR-1	Aramghar Jn	Samshabad	6,629	4-lane		Leg-1
RR-2	ANG Rangga Agrt. University	Himayat Sagar	6,600	2-lane	JICA Loan	
RR-3	Rethibowli junction	AP Police Academy	10,700	2/4/6-lane	JICA Loan	Leg-2
RR-4	Cantonment Y jn. At Langar	Gandipet T junction	9,935	2/4/6-lane	JICA Loan	Leg-3
RR-5	Shaikpet	Kokopet	7,756	1/2/Missing link		
RR-6	Nanal Nagar Junction	HCU Depot	15,465	4/6 lane		
RR-7	Panjagutta (Hi Tech City)	Edulanagulapally	6,500	2 lane	JICA Loan	
RR-8	Moosapet	BHEL Jn	11,500	2/4 lane		
RR-9	Panjagutta	Muttangi (NH-9 P-H)	28,920	4/6 lane		Leg-4
RR-10	Paradize Junction	Godrej Y Junction	9,194	2/4 lane		
RR-11	Balanagar	Saragudem	16,212	2/4 lane	JICA Loan	Leg-5
RR-12	Tarbund	Kandla kooi (NH-7)	16,436	4 lane		Leg-6
RR-13	Cantonment Jn.(Secunderabad)	Old Awal	11,600	2/4 lane		
RR-14	Patni Junction	Thummukunta	19,746	2/4 lane		Leg-7
RR-15	Mettuguda	Yadgiripally Junction	22,308	2/4 lane		
RR-16	Tarnaka	Near to Cherial X Road	18,109	2/4 lane		Leg-8
RR-17	Habsiguda	Charlapally	18,500	2/4 lane		
RR-18	Survey of India	Mazneerguda Rly Station	14,673	Single lane		
RR-19	Uppal Junction	Anojiguda (NH-202)	13,863	4 lane		Leg-9
RR-20	Nagole Bridge	Singaram	14,146	Katcha Road		
RR-21	Nagole Bridge	Gourelly	13,996	Katcha Road		
RR-22	Nagol Junction	Gourelly X Road	13,977	1/2 lane		
RR-23	Mansoorabad	Thattiannavaram X	4,800	Single lane		
RR-24	LB Nagar	Tohas (NH-9 H-V)	12,009	4 lane		Leg-10
RR 25	Biramalguda	Manneguda	13,557	2/4 lane	JICA Loan	Leg-11
RR-26	KanchanBagh	Nadargul	14,000	2/4 lane		
RR-27	Midhani Junction	Near to Pungulur	18,300	1/2/katcha road		
RR-28	Chandrayanagutta	Srinagar	15,666	2/4 lane	JICA Loan	Leg-12
RR-29	Laxmiguda X Roads	Mamidipally	10,115	Single/Missing link		
RR-30	HCU Depot	Near to Vattinagulapally	8,140	2/4 lane		
RR-31	Taranagar	Davaraguda	7,866	Single/Missing link		
RR-32	Nizampet X Road	Near to Kazipalle	9,663	Single/2 lane		
RR-33	Extension Financial Distric	Road to Kokpet	1,200	New		

Although 33 radial legs are available across the Hyderabad ORR, 12 have significant value from the traffic demand viewpoint. These include five national highways and five state highways. The DPR consultant conducted traffic count surveys at 12 points on the selected radial roads near the Hyderabad ORR. (Refer to Figure 2.2.8)

The traffic count survey was conducted by adopting a 24-hour traffic count for seven days in February 2006. All vehicular traffic was counted and divided into fast-moving and slow-moving vehicle types (or non-motorized vehicles). Further classification is done as follows:

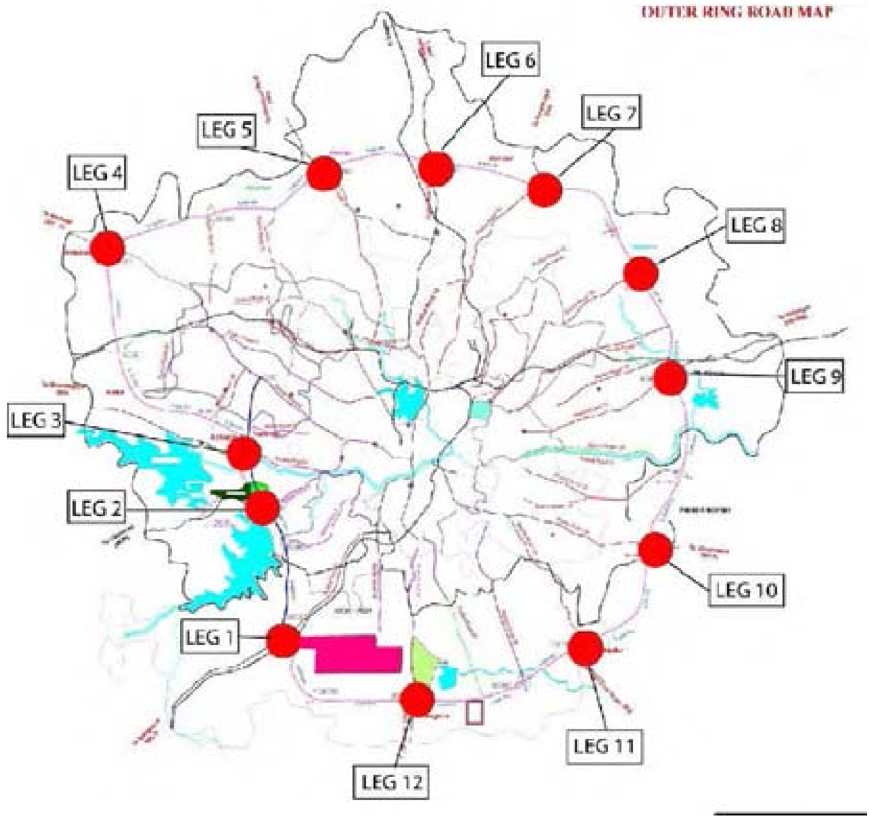
Fast-moving Vehicles:

- Two Wheeler
- Three Wheeler
- Car (new, old)
- Bus
- Minibus
- 2-axle and 3-axle Truck
- Multiaxle Truck and Tractor
- Light Cargo Vehicle (LCV)

Slow-moving Vehicles:

- Cycle
- Cycle Rickshaw (CR)
- Animal-drawn Vehicle (ADV)

Figure 2.2.8 2006 Traffic Survey Points



The traffic survey results are summarized in Table 2.2.5. Some of the observed characteristics are listed below.

- The aggregated average daily traffic (ADT) volume is 182,645 vehicles. The heaviest ADT which amounted to 24,564 was counted at Leg-1 or NH7 through Shamshabad. This road forms part of Hyderabad-Bangalore corridor and serves the Rajiv Gandhi International Airport. The smallest ADT of 7,914 was surveyed at Leg-9;
- Five national highways accounted for 102,154 vehicles or 56% of the surveyed traffic. Similarly, five state highways accommodated 63,399 vehicles, sharing 35% of the surveyed traffic.
- Cars were not the most popular vehicle type on all the surveyed points. Nine survey points recorded two wheelers as the largest type in terms of vehicle number, while 2-axle and 3-axle trucks were the biggest vehicles in the rest of three survey points located on NH7 and NH9.
- Slow-moving vehicles took a marginal share in the surveyed traffic, e.g. 3.7% at Leg-3 even though it held the highest share of slow-moving vehicles among the surveyed points.
- Each survey point had a different peak traffic hour, ranging from 9:00-10:00 to 18:00-19:00. Daytime traffic is larger than nighttime traffic. From the survey results, however, no specific peak hour was found. Peak hour rates (peak hour traffic / all day traffic) showed rather flat time fluctuations. Five survey points indicated peak hour rates between 7% and 8%. (Refer to Table 2.2.6)
- It was also difficult to point out a metropolitan peak day. Even Sunday was recorded as the peak day at Leg-9. Friday registered as the peak day in four out of the 12 survey points. Variations from the ADT at every survey point were observed to be at acceptable levels, ranging from 8% to 30%. (Refer to Table 2.2.6)

Table 2.2.5 Average Daily Traffic by Survey Point

LEG		Fast Moving Vehicles								Slow Moving Vehicles			
		2W	3W	Cars	Bus	Mini Buses	2AT,3AT	MAT	LCV	Cycle	CR	ADV	TOTAL
Leg-1	in number	5.408	2.018	5.832	2.245	136	6.670	673	1.528	35	10	10	**24.564**
	in PCU	2.704	2.018	5.832	6.735	204	20.010	3.027	2.291	18	20	78	**42.937**
Leg-2	in number	7.955	974	4.374	1.158	220	1.301	1.301	821	208	5	1	**18.317**
	in PCU	3.977	974	4.374	3.475	330	3.902	5.853	1.231	104	9	10	**24.240**
Leg-3	in number	3.468	1.534	2.015	332	77	872	108	432	305	18	16	**9.178**
	in PCU	1.734	1.534	2.015	997	116	2.615	485	648	153	35	131	**10.464**
Leg-4	in number	4.381	2.909	3.902	1.347	181	4.568	347	1.655	395	11	5	**19.701**
	in PCU	2.191	2.909	3.902	4.040	272	13.704	1.562	2.482	198	22	38	**31.320**
Leg-5	in number	4.464	1.231	1.951	637	229	2.032	349	1.223	135	24	15	**12.289**
	in PCU	2.232	1.231	1.951	1.911	344	6.096	1.571	1.834	67	47	122	**17.405**
Leg-6	in number	4.516	1.275	4.077	883	142	2.295	380	1.283	544	10	4	**15.408**
	in PCU	2.258	1.275	4.077	2.650	213	6.885	1.708	1.925	272	19	29	**21.311**
Leg-7	in number	4.453	547	3.420	1.038	104	1.645	177	1.009	273	5	12	**12.683**
	in PCU	2.227	547	3.420	3.114	156	4.934	798	1.514	137	9	94	**16.950**
Leg-8	in number	3.714	874	909	229	18	1.562	90	379	121	11	7	**7.914**
	in PCU	1.857	874	909	687	27	4.685	406	569	61	21	59	**10.154**
Leg-9	in number	7.361	1.650	4.966	1.177	133	3.019	341	1.404	203	11	12	**20.278**
	in PCU	3.680	1.650	4.966	3.532	200	9.058	1.533	2.107	102	23	95	**26.945**
Leg-10	in number	3.798	779	5.272	2.805	301	7.058	395	1.759	34	2	1	**22.203**
	in PCU	1.899	779	5.272	8.414	452	21.174	1.777	2.638	17	3	8	**42.433**
Leg-11	in number	4.267	539	2.101	1.033	104	1.384	108	854	201	5	2	**10.599**
	in PCU	2.133	539	2.101	3.100	156	4.153	487	1.281	101	10	17	**14.078**
Leg-12	in number	3.751	827	2.241	595	50	1.042	304	476	181	20	25	**9.511**
	in PCU	1.875	827	2.241	1.786	75	3.125	1.367	714	90	40	200	**12.341**

Source: DPR Technical Report for Hyderabad ORR, 2006

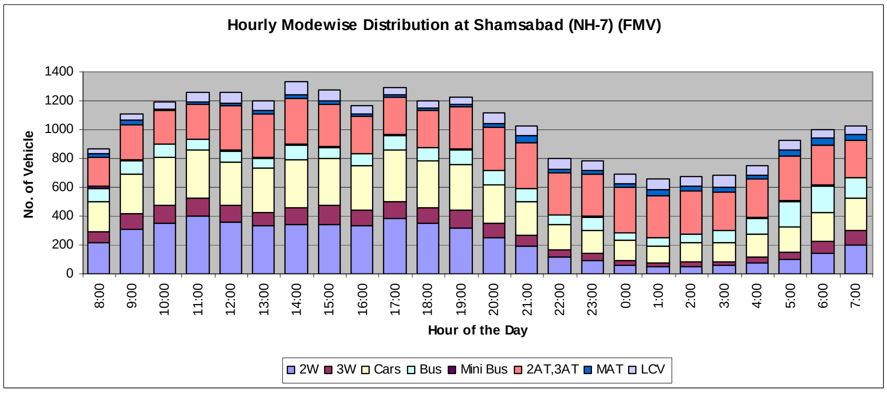
Table 2.2.6 Peak Hours and Peak Days by Survey Point

LEG	Peak Hour			Peak Day		
	Hour	No. of Vehicles	Peak Hour Rate	Day	No. of Vehicles	Variation from ADT
Leg-1	14:00-15:00	1,331	5.4%	Tuesday	28,170	+14.7%
Leg-2	10:00-11:00	1,374	7.5%	Saturday	20,735	+13.2%
Leg-3	09:00-10:00	835	9.4%	Friday	11,987	+30.6%
Leg-4	11:00-12:00	1,352	7.0%	Wednesday	21,228	+7.8%
Leg-5	17:00-18:00	825	6.8%	Monday	13,288	+8.1%
Leg-6	17:00-18:00	1,164	7.8%	Friday	17,989	+16.8%
Leg-7	12:00-13:00	825	6.7%	Friday	13,781	+8.7%
Leg-8	10:00-11:00	556	7.2%	Wednesday	8,365	+5.7%
Leg-9	18:00-19:00	1,331	6.6%	Sunday	22,176	+9.4%
Leg-10	11:00-12:00	1,216	5.5%	Wednesday	25,091	+13.0%
Leg-11	09:00-10:00	799	7.7%	Friday	11,909	+12.4%
Leg-12	13:00-14:00	705	7.6%	Thursday	11,244	+18.2%

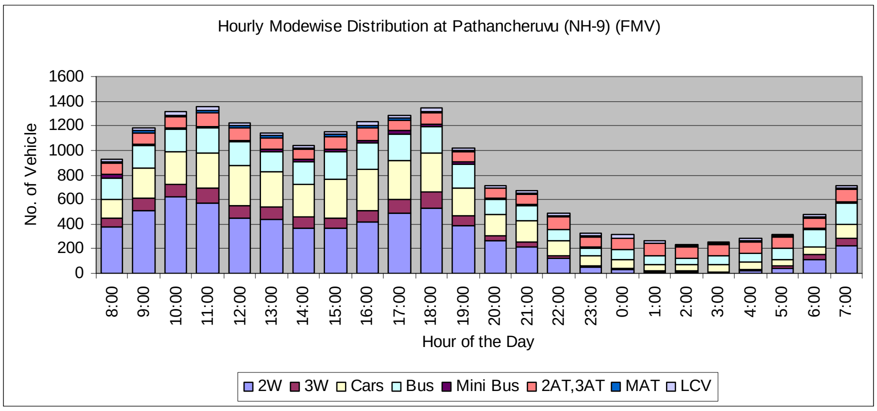
Source: DPR Technical Report for Hyderabad ORR, 2006

Figure 2.2.9 Hourly Traffic Variations on National Highways by Vehicle Type, 2006

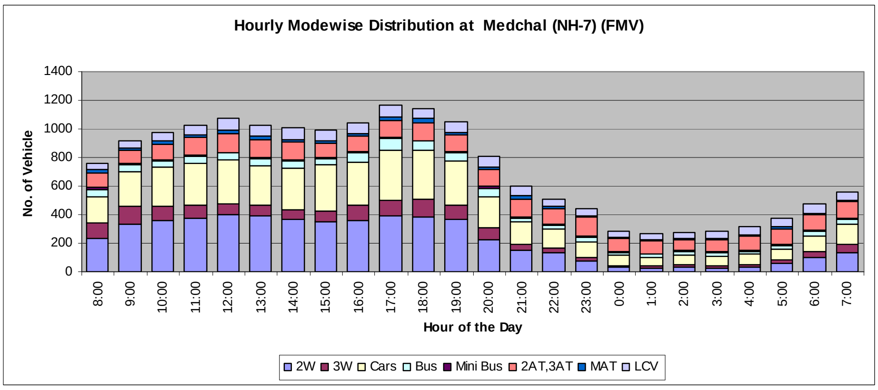
(Leg-1, NH7 South)



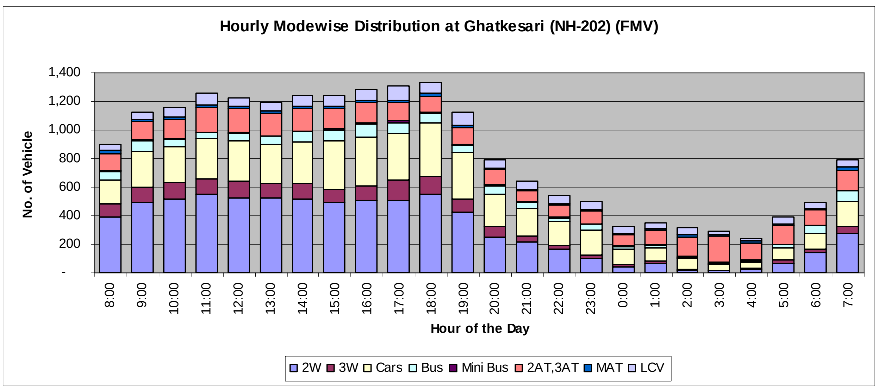
(Leg-4, NH9 West)



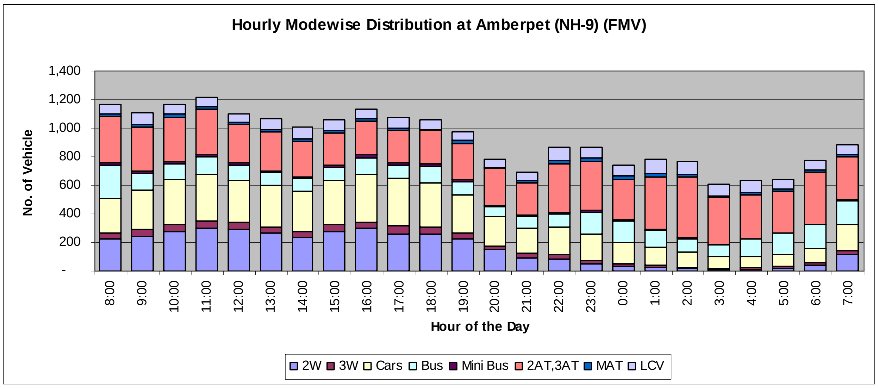
(Leg-6, NH7 North)



(Leg-9, NH202)



(Leg-10, NH9 East)



Source: DPR Technical Report for Hyderabad ORR, 2006

B. Comparative Review of the ORR Demand Forecasts

There are two available documents showing the ORR's traffic forecasts: One was done by the DPR consultant for the ORR project and the other was done by IIT Chennai. Forecasts done by the two experts were made under different purposes, base data, and methodology, although they served the same client, HUDA. The SAPI Study reviewed these documents and the summary of the review are as follows:

- <u>DPR Consultant (Aarvee Associates and BCEOM)</u>: The DPR for the ORR Japanese Yen Loan Package was compiled in 2006. Demand forecast was done for infrastructure design and economic analysis. Initially, the toll road concept was not incorporated into its projections. Later on, the DPR consultant assumed a 20% reduction in traffic volumes due to the tolls. They conducted a variety of traffic surveys mostly in 2006. However, demand forecast methods were not sufficiently described. Traffic demand projection explained through growth in the number of registered vehicles at the metropolitan level was not appropriate for projecting individual road links. The demand projection did not consider infrastructure capacity constraints. As a result, there were unrealistic forecasts, or overestimations.

- <u>IIT Chennai</u>: The report titled "Evaluating Financing Alternatives for Phase IIB of Hyderabad ORR Project" was submitted to HUDA in March 2008. Based on the title, demand forecast was undertaken for financial analysis. The reason for carrying out the work only recently was due to the failure of past studies to adequately consider complete network effects and the uniqueness of the ORR, i.e. it has no existing alignment with conventional traffic patterns. They used traffic database from the 2003 EPIRI study and applied the orthodox 4-step traffic forecast method. The work results are understandable with explainable procedures.

Demand forecast results from the above-mentioned two documents are compared in Figure 2.2.10 and Table 2.2.7. The DPR consultant estimated larger traffic volumes along all the ORR sections. Large gaps can be found even in the near future, i.e. by 2011, ranging from 24.5% to 86%.

Figure 2.2.10 Comparison of ORR Demand Forecast Results

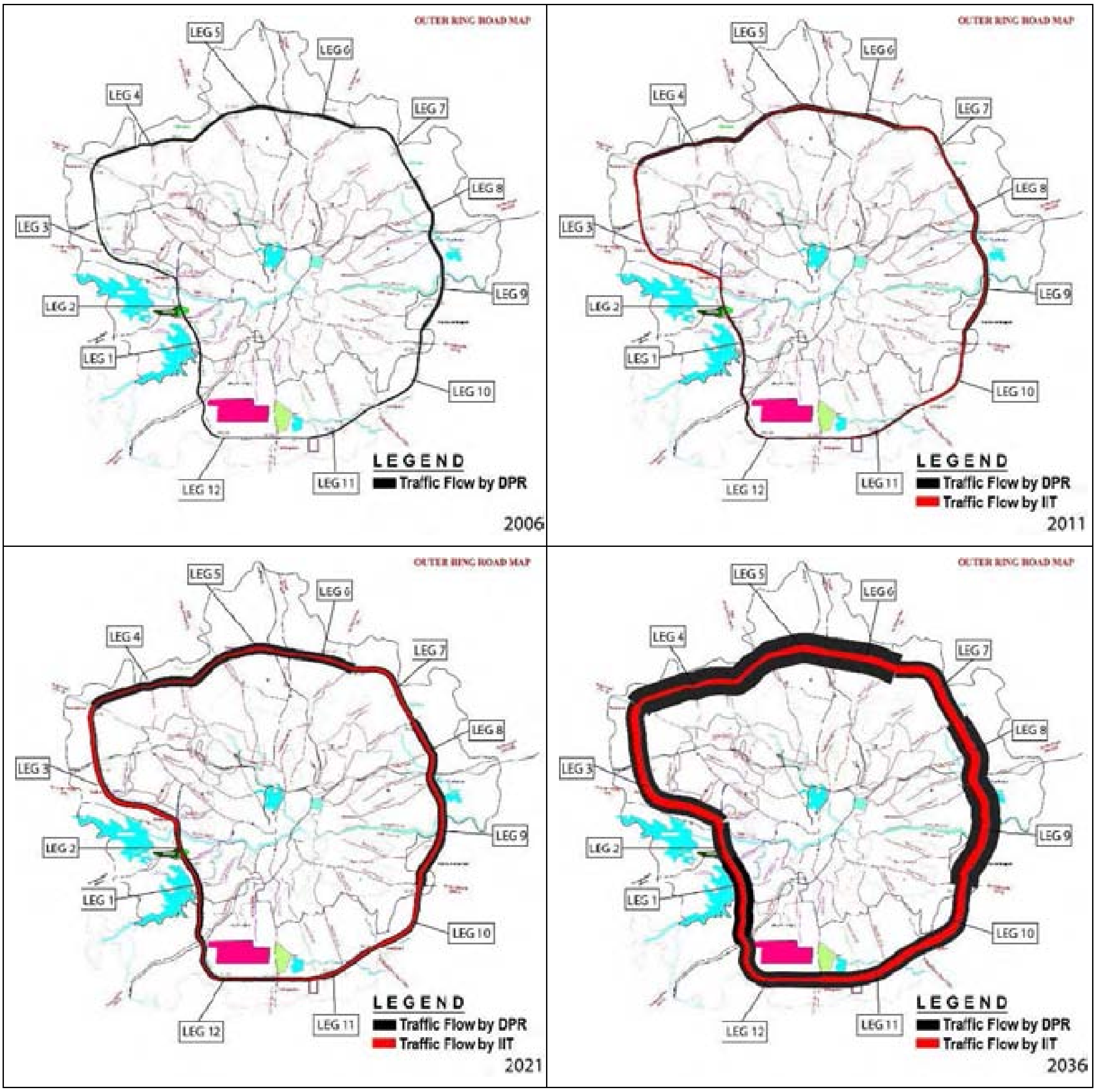


Table 2.2.7 Comparison of Daily Traffic Demand

			2006	2011			2021			2031		
ORR Section	**From**	**To**	DPR Consultant	DPR Consultant	IIT Chennai	Gap (%)	DPR Consultant	IIT Chennai	Gap (%)	DPR Consultant	IIT Chennai	Gap (%)
1	Shamshabad	APPA	34,931	49,271	13,839	71.9	96,126	34,906	63.7	172,687	82,909	52.0
2	APPA	Gandiet	35,450	49,959	16,991	66.0	97,636	30,491	68.8	175,936	78,168	55.6
3	Gandipet	Patancheru	34,672	49,053	37,037	24.5	96,126	60,200	37.4	173,103	103,820	40.0
4	Patancheru	Narsapur Road	52,136	73,043	10,220	86.0	140,201	23,026	83.6	248,553	54,245	78.2
5	Narsapur Road	Medchal	57,655	80,801	20,903	74.1	154,619	37,509	75.7	272,957	78,598	71.2
6	Medchal	Shameerpet	58,305	80,936	20,477	74.7	153,619	40,927	73.4	271,819	95,939	64.7
7	Shameerpet	Keesara	38,276	52,340	24,808	52.6	96,491	51,244	46.9	166,864	106,666	36.1
8	Keesara	Gahtkesari	58,761	79,977	26,299	67.1	146,443	55,362	62.2	252,380	118,085	53.2
9	Gahtkesari	Amberpet	64,463	87,702	29,348	66.5	160,945	58,170	63.9	278,330	113,260	59.3
10	Amberpet	Nagarjunasagar	37,924	51,184	36,792	28.1	93,747	54,842	41.5	163,264	98,540	39.6
11	Nagarjunasagar	Srisailam Road	32,589	44,342	13,408	69.8	82,371	41,029	50.2	144,719	90,327	37.6
12	Srisailam Road	Shamshabad	31,861	43,366	8,081	81.4	80,721	24,253	70.0	142,137	61,234	56.9

Note 1: Gap (%) = 1 - (IIT Projection/DPR Projection)
Note 2: Shaded road sections to be financed by JICA
Source: DPR on ORR Phase II-B, Evaluating Financing Alternatives for Phase II-B of Hyderabad ORR Project by IIT Chennai

Both the two documents did not analyze daily ORR capacities. However, it is necessary to examine allowable traffic demand on the ORR's main carriageway. Daily road capacity can be determined by two factors: hourly road capacity and peak hour traffic rate. The two factors are analyzed particularly for the Hyderabad ORR using the 1985 Highway Capacity Manual, as follows:

- Hourly Road Capacity: The ORR main carriageway has eight lanes with a design speed of 120 km/h. If the ORR would function as an interstate freeway, the maximum lane capacity of 2,000 pcu/hour could be allowed. But the ORR is designed to have 22 interchanges along the 158km alignment for converging and diverging traffic or an average section distance of 7km between interchanges. It should be regarded as an urban trunk road without traffic signal interruptions. Thus, a lane capacity of 1,500 pcu/hour is appropriate.

- Peak Traffic Rate: According to the 2006 traffic survey, the major radial roads crossing the ORR have the most frequent range of peak traffic rate at 7―8%. Presently, motorcycles and trucks are dominant in the surveyed traffic. In the future, however, car traffic is expected to increase. The main purpose of car drivers is commuting. Provided that urban traffic increases sharply compared with inter-city traffic, traffic time fluctuations must be presumed to be larger with a higher peak traffic rate following the rhythms of urban life. In this regard, the Highway Capacity Manual introduces various samples of urban circumferential roads, e.g. 11.5% as the highest peak hour rate and 7―8% as the lowest level among 1,000 samples. To avoid large redundancies in infrastructure capacities, a peak hour rate of 10% is appropriate in the ORR case.

With the assumptions of the two factors, it can be said that the ORR's main carriageway has 120,000 pcu in daily capacity.

ORR Main Carriageway Capacity = (Hourly Capacity x No. of Lanes) / Peak Hour Rate
(1,500 x 8) / 0.10 = 120,000

Taking the above into consideration, the DPR for the ORR project projected excessive traffic demand. By 2021, it predicted that six of the 12 sections would carry larger traffic volumes than the capacity of 120,000 pcu/day, requiring 10- or 12-lane carriageways like the M25 Motorway in London (refer to Table 2.2.8). By 2031, the DPR projection showed a figure beyond 270 thousand pcu/day. It is quite difficult to look for such enormous road traffic on other roads in the world[3].

On the other hand, IIT Chennai's projection is rather moderate in light of the ORR's

[3] According to PIARC or the World Road Association, the largest road traffic was recorded at 257,000 vehicles a day on the A4 Motorway in the Paris suburb in 2002.

infrastructure capacity. By 2021, it predicted that traffic demand on the five sections would exceed 50,000 pcu/day, requiring a 6-lane carriageway to avoid congestion. Traffic demand on seven sections by 2031 was projected to be within the range suitable for an 8-lane carriageway, i.e. 90,000–120,000 pcu/day. No further larger traffic is projected in other sections.

The review of the two forecasts aims to enable the SAPI Study to design the ITS for the Hyderabad ORR. Generally, ITS planning works are undertaken to meet demand 10 years ahead. However, the review shows that it would be difficult for the SAPI Study to consider the DPR forecast as a precondition, since by doing so, many tollbooths must be designed to allow such huge traffic even though the main carriageway may not be able to accommodate them. In conclusion, the SAPI Study adopts the traffic demand forecast by IIT Chennai for ITS planning.

Table 2.2.8 ORR Experience in London

Road Development	The M25 motorway is a 188-km ring road which encircles Greater London. It is one of the busiest stretches of the British motorway network, and one of the largest and crowded outer ring roads in the world. M25 was first proposed in 1969 and completed in 1986. This strategic alignment gives access to four airports and one seaport. Originally, the M25 had a 6-lane configuration. To meet increasing traffic, the section between JT6 and JT12 became 8 lanes, the section of JT12 to JT14 10 lanes, and the section of JT14 to JT15 12 lanes. JT14 is the access gate to Heathrow Airport which handled 67 million passengers in 2005.
Road Traffic	The Department of Transport count data show that the busiest single motorway link in Britain in 2005 was between junctions 13 and 14 on the western side of the M25 near Heathrow Airport, which carried a maximum of 177 thousand vehicles a day. Overall, the western side of the M25 is also the busiest section of the motorway, with an estimated average daily flow of 140 thousand vehicles. In 2003, the M25 Motorway recorded the largest traffic of 196 thousand vehicles a day near Heathrow Airport. It was a significant year for the Greater London transport administration because road traffic congestion choked various economic activities and thereafter all remedial measures were put in force including road pricing within the London CBD.
M25 Alignment	
	

2.2.4 Road Users' Survey

The SAPI Study conducted road user's survey in January 2009 to understand road users' perception on the Hyderabad ORR. The survey report is attached to the report as Annex 1 while major findings are summarized as follows:

- The road traffic counting survey was conducted at the 5 ORR interchanges across the national highways of NH7, NH9 and NH202. Compared with the 2006 traffic survey where the results are summarized in the previous section, daily 4-wheeler traffic volumes at the same survey points differ moderately ranging from – 18.7% to 14.4%.

- The respondents by car and truck gave positive perception on the future usage of the ORR, showing over 84% on the average. Among vehicle types, truck drivers showed higher expectation on the ORR usage than car drivers. (Refer to Table 2.2.9)

- On the other hand, their O-D patterns show that most of trips concentrate on the city center as departure or destination points. Therefore likely diversion traffic from the national highways to the ORR due to shorter travel distance, ranging from almost 0% to 15%, may not be large as expected in the previous traffic demand reports related to the ORR project. Higher likely diversion rates such as 15.4% at the NH7 North interchange imply inconvenient road network and longer traffic demand at present. (Refer to Figure 2.2.11, Table 2.2.10)

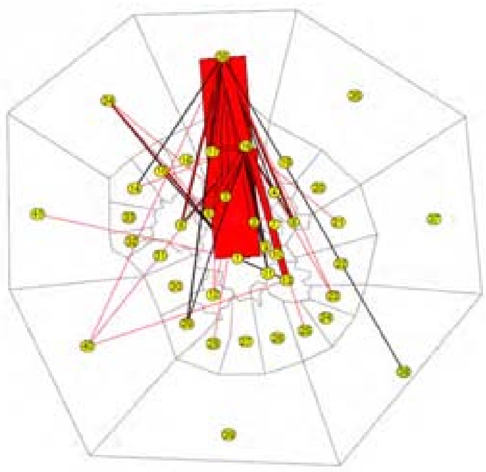
- The respondents are willing to pay to the ORR operator by Rs 20 and above. The thickest payment range by car users is Rs 30 while truck users Rs 40. Very large vehicles over 3-axle are willing to pay above Rs 60. Those toll payments could allow them to drive by 30-50km provided that the 2007 NHAI toll tariff (refer to Table 2.1.1) would be applied. It is thus considered that toll road business is acceptable in Hyderabad at a financially sustainable level. (Refer to Table 2.2.11)

Table 2.2.9 ORR Usage Perception

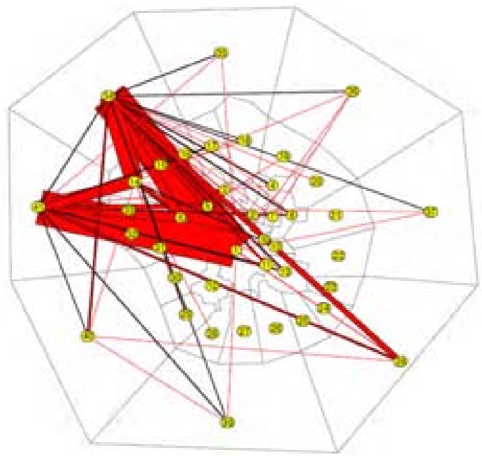
Vehicle Type/Willingness to Drive	Willing to Drive through ORR-YES	Willing to Drive through ORR-NO	Total
Car/Jeep/Van/Taxi	924 (71.6%)	367 (28.4%)	1,291
Mini-Bus	90 (95.7%)	4 (4.3%)	94
LCV	645 (84.2%)	121 (15.8%)	766
2-Axle Trucks	2,116 (83.8%)	409 (16.2%)	2,525
3-Axle Trucks	2,270 (90.4%)	242 (9.6%)	2,512
Multi Axle Trucks	320 (89.6%)	37 (10.4%)	357
Total	6,365 (84.4%)	1,180 (15.6%)	7,545

Source: Interview Survey by JICA SAPI 2009

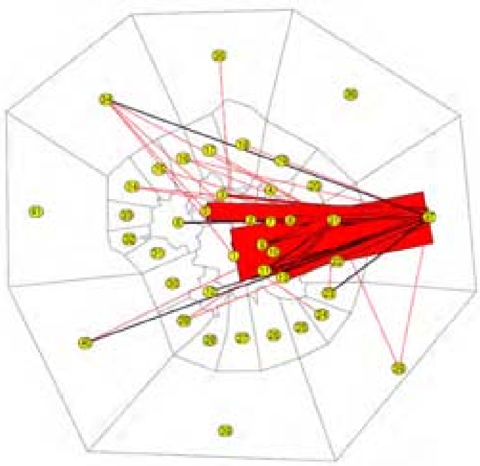
Figure 2.2.11 O-D Trip Patters



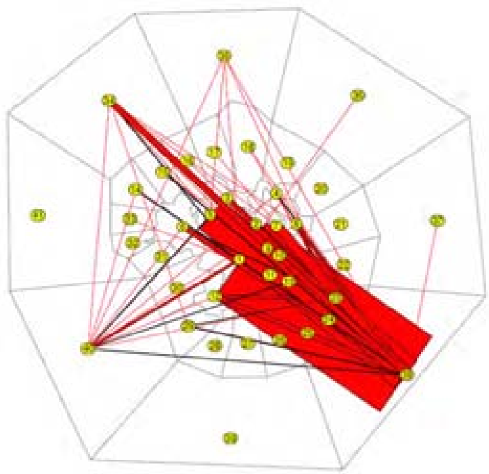
(NH 7, North)



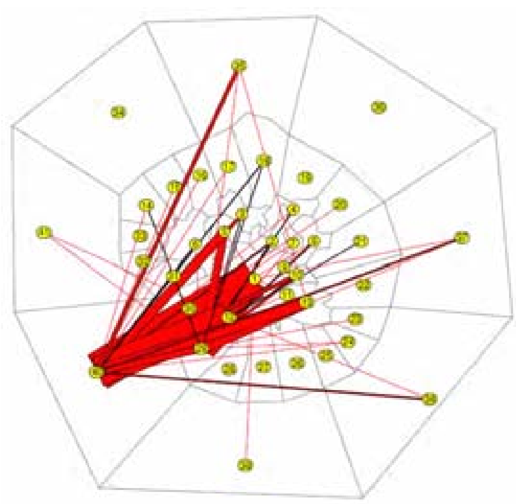
(NH9 West)



(NH 202)



(NH9 East)



(NH7 South)

Table 2.2.10 Likely Diversion Traffic from National Highways to ORR

		NH9 West	NH7 North	NH202	NH9 East	NH7 South
Daily Traffic (vehicle)*		11,934	11,236	12,370	16,031	14,103
Likely Diversion Traffic (vehicle)**		636	1,735	895	101	193
Total Diversion Rate (%)		5.3	15.4	7.2	0.6	1.4
Vehicle Type	Car/Jeep	4.8	19.4	7.1	0.3	0.5
	Bus	1.8	0.7	5.8	0.0	1.4
	2-axle Truck	5.0	13.6	7.9	0.2	1.3
	3-axle Truck	8.9	17.6	8.2	0.8	2.0

Source: Interview Survey by JICA SAPI 2009

Note: * Exclusive of 2-wheelers and 3-wheelers

** Likely conversion traffic assumes to select shorter routes between the existing national highways and alternate ORR routes.

Table 2.2.11 Willingness-To-Pay for ORR Usage

Vehicle Type/Toll Amount	Willingness to Pay for Using ORR							Total
	Rs. 10	Rs. 20	Rs. 30	Rs. 40	Rs. 50	Rs. 60	Above Rs. 60	
Car/Jeep/Van/Taxi	1	75	310	213	53	68	105	825
%	0.12%	9.09%	37.58%	25.82%	6.42%	8.24%	12.73%	100.00%
Mini-Bus	0	4	10	25	13	10	11	73
%	0.00%	5.48%	13.70%	34.25%	17.81%	13.70%	15.07%	100.00%
LCV	2	25	162	158	44	90	91	572
%	0.35%	4.37%	28.32%	27.62%	7.69%	15.73%	15.91%	100.00%
2-Axle Trucks	8	116	420	589	209	277	364	1,983
%	0.40%	5.85%	21.18%	29.70%	10.54%	13.97%	18.36%	100.00%
3-Axle Trucks	1	57	337	518	162	336	592	2,003
%	0.05%	2.85%	16.82%	25.86%	8.09%	16.77%	29.56%	100.00%
Multi Axle Trucks	0	12	40	43	37	70	100	302
%	0.00%	3.97%	13.25%	14.24%	12.25%	23.18%	33.11%	100.00%

Source: Interview Survey by JICA SAPI 2009

Note: The most popular tariff zone is shaded.

2.3 Review of the Hyderabad ORR Civil Works

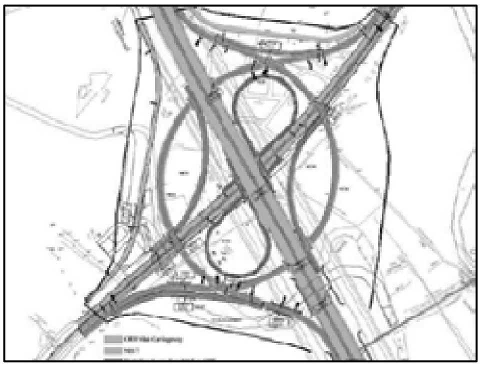
2.3.1 Analysis of the Interchange Design for Toll Collection

A. Necessity of Reviewing Interchange Designs

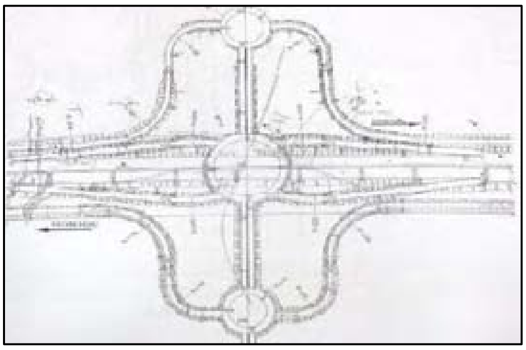
It is not certain when, in the course of project preparation, planning, and design, the toll concept was included in the ORR project. The DPR for Phase II-B was submitted to JICA in August 2006, but it did not include a financial analysis. At that time, revenue (toll collection) and cost analysis was not necessary to justify the project.

In the DPR, two interchange designs were applied: a cloverleaf type for major interchanges and a combination of rotaries and diamonds for minor interchanges. In some developed countries including Japan, either of these types is rarely used in urban toll roads. The basic reason being that both designs require large tracts of land, necessitating various toll gates. Judging from the original drawings, it is difficult to understand that the toll collection concept was introduced from the start of project preparation.

Figure 2.3.1 Original Interchange Designs in the DPR



(Cloverleaf Type)



(A Combination of Rotary and Diamond)

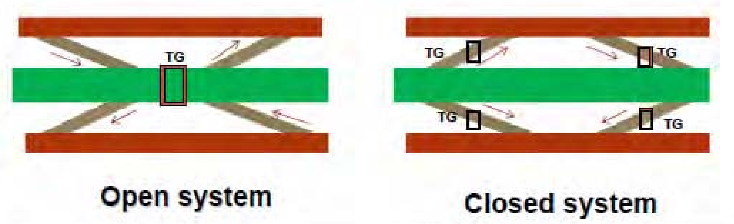
The discussions between HGCL and JICA in November 2007 and June 2008 evinced evident discrepancy between the project cost recovery scheme through toll collection and the physical plan, particularly the interchange designs which allowed a complicated and ipso facto inconvenient toll collection scheme.

As a result, the SAPI Team, in the TOR concerning interchange design, was given the task to conduct a "review of existing interchange designs including the southern and western parts of the ORR (five locations in total) and support necessary modifications for the D/D (development of outline design, revision of work process, etc.) suitable for a toll collection system with an ITS."

B. Toll Collection System

Toll road operations have a basic principle: fewer toll plazas mean easier operation. Thus in designing interchanges for toll expressways, it is very important to minimize the number of toll plazas. This can be achieved by choosing an open system for toll collection, where toll plazas are located on the main carriageway. However, this system has some serious drawbacks such as using only fixed toll rates, the suspension of traffic at intervals due to toll plazas which means that they are unsuitable for long-distance toll roads and toll road networking. It is proper for the HGCL to have chosen a closed system for the ORR since the ORR is a long-distance urban road with potential for additional toll road networks in the future. It could also mean the installation of toll plazas at the ramps of the interchanges.

Figure 2.3.2 Toll Collection Systems



	Toll rates	Network	Cost	Operation
Open	Fixed	Single	Low	Simple
Closed	Km-based	Network	High	Complex

Source: JICA SAPI Study

C. Design Concepts for Large Interchanges

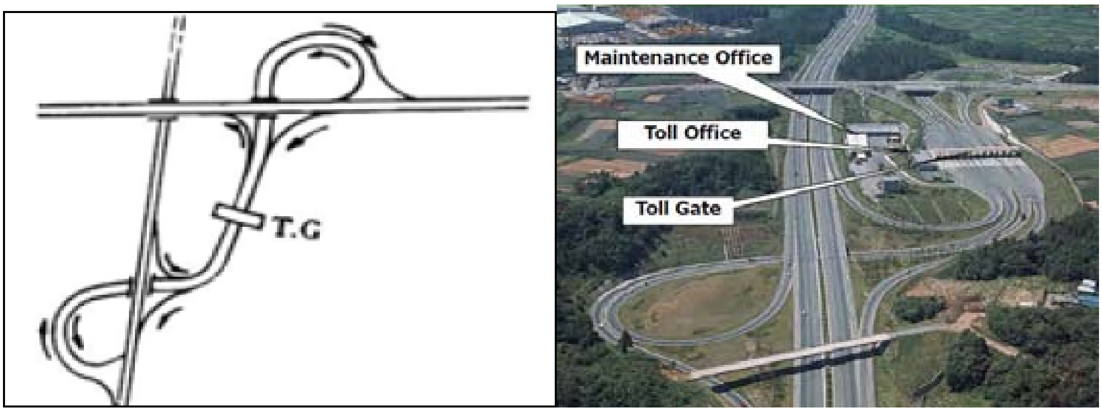
Cloverleaf-type interchanges adopted by the DPR for connection with national highways is good for connecting two toll expressways where toll collection is not a high priority. These are called "system interchanges." However, they are not suitable for the connection of a toll way with an ordinary road where toll collection is necessary.

Interchanges formed by trumpet-type and Y-type systems are more suitable for integrated toll collection schemes rather than the cloverleaf type. There are several shapes even within the trumpet-type and Y-type systems, as shown in Table 2.3.1.

Taking available ROW for interchanges and the national highways across the ORR into account, the SAPI Study recommends that the original "Cloverleaf type" interchanges be modified into a "Double trumpet type". Such modifications can allow the development of one integrated toll plaza. This will greatly benefit both the road operator and users through:

(i) efficient operation and maintenance; (ii) higher security; (iii) quick response to various kinds of troubles and emergencies; and (iv) allows lesser numbers of toll booths.

Figure 2.3.3 Example of Double Trumpet Type Interchanges



D. Design Concepts for Minor Interchanges

The original minor interchange design was made through a combination of rotaries and diamond-type ramps. Both the design elements are reviewed below.

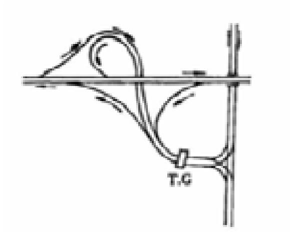
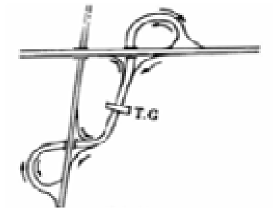
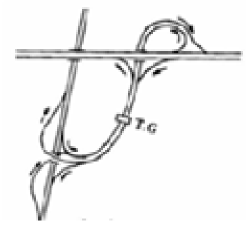
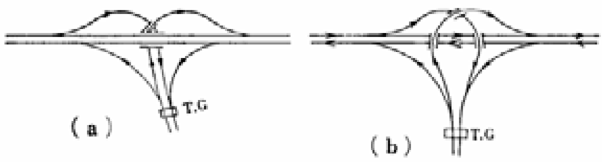
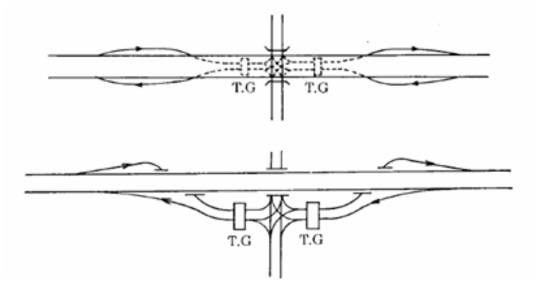
There is a long history of discussions on the merits and demerits between rotary (roundabout) and cross intersection for traffic management and channeling. In summary, the rotary is superior to the cross intersection when traffic is very low and the system has more than four legs. The rotary is an obstacle against fast-moving traffic, and thus accidents are likely to be less serious. As to its demerits, it has some critical flaws such as insufficient design capacity to ensure smooth traffic and difficulty in allowing pedestrian crossing.

Because of these disadvantages, highway engineers in Japan and other countries like the USA seldom recommend the use of rotary intersections in new interchange projects. The SAPI Study proposes the conversion of the rotary type into a cross intersection system where channeling can be easily conducted when due traffic volume is observed.

On the other hand, the diamond type is common in minor interchanges due to its simple feature which does not require detours and enables the minimizing of land acquisitions. In addition, construction cost is very low since this type has no crossing structures. But in cases where service is provided in both directions, the construction of toll gates is required in two different places which means increases in maintenance costs.

In conclusion, the SAPI Study recommends that minor interchanges be developed in the form of a simple diamond type with signalized intersections.

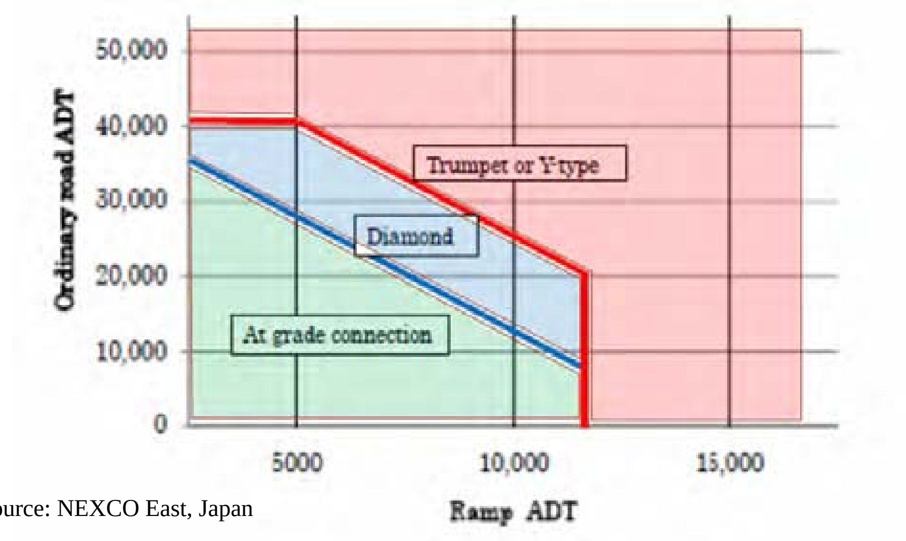
Table 2.3.1 Various Interchanges with Toll Gates

Single Trumpet: A trumpet on a main corridor and at-grade intersection with connecting highway. 	*Double Trumpets*: One trumpet on a main corridor and the other on the connecting highway. 	Trumpet on a main corridor and Y type on the connecting highway. 
Standard Y type: This is used in cases where it is difficult to use the trumpet type due to topographical restrictions. Large construction space and budget are required because crossing with main lanes occur at two points.		
At-grade Y-type: This is a variation of the Y type and is used in cases where traffic is light and no waiting time occurs in crossing an intersection. Because this type has one intersection with the main lanes, the cost for land and construction is less than the standard Y type.		
Diamond type: Due to its simple feature, the diamond type does not require any detours and enables minimized land acquisition. In addition, the upper part needs low construction cost since this type has no crossing structures. But in cases where service is provided in both directions, toll gates are required in two places.		

E. Classification of Large and Minor Interchanges

It is important to construct an optimal interchange in terms of traffic handling capacity and construction costs. In this sense, NEXCO East, the largest toll operator in Japan, has a rich experience in setting adequate planning standards. As shown in Figure 2.3.4, appropriate interchange design can be determined by two traffic factors: ADT on ordinary roads and ADT on rampways. When both kinds of traffic are anticipated as low, at-grade connection type and diamond type is economical and practically acceptable. Adversely, the trumpet-type system is the most typical interchange to cope with heavy traffic systems.

Figure 2.3.4 Selection of Interchange Types with Traffic Demand



Source: NEXCO East, Japan

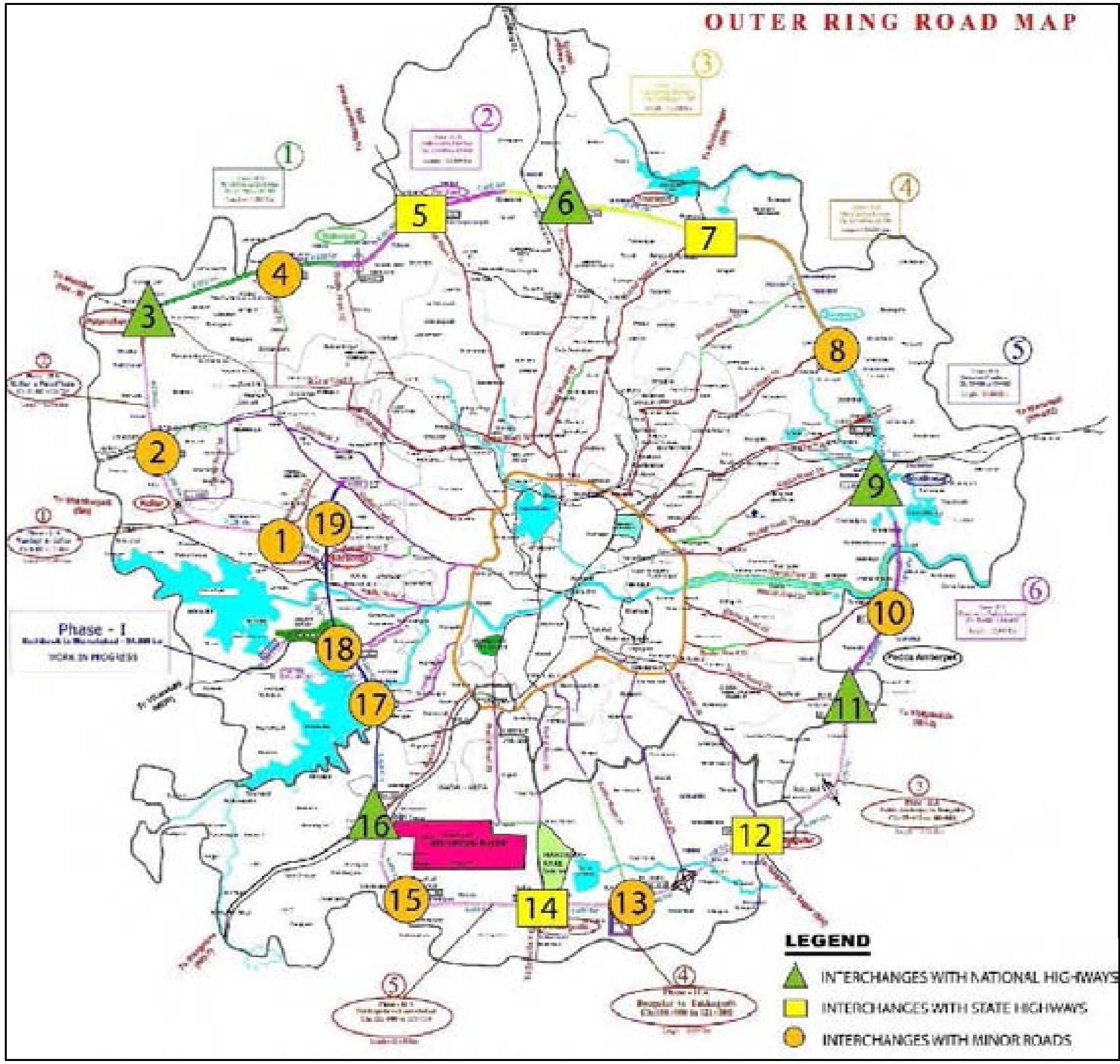
F. Classification of ORR Interchanges

The ORR project will construct 18 interchanges with ordinary roads on a 158km stretch and one (1) toll barrier on the main carriageway near the Hi-tech Park. In the course of the SAPI Study, the HGCL has determined the types of interchanges, taking account of the hierarchy of connecting roads such as national and state highways and minor roads. It is remarkable that the trumpet type will be constructed at the interchanges connecting with the national and state highways as long as an ROW can be secured.

Table 2.3.2 Types of Interchange

	On / Off Ramp	Entry / Exit Road	Number
ORR	One toll barrier on main carriageway at Hi-tech City		1
National Highway	Trumpet type	Trumpet type	5
State Highway	Trumpet type	Trumpet type / At-grade intersection	5
Minor Road	Diamond type	At-grade intersection	8
Total			19

Figure 2.3.5 ORR Interchanges



No	IC	STA(km) of IC	Distance between institutions	Remarks
0	Narsingi	0.000	2.020	Junction
1	Kokapet	2.020	11.880	MR
2	Idulnagalapalli	13.900	8.592	MR
3	Patancheru	22.492	8.508	**NH-9**
4	Sultanpur	31.000	11.700	MR
5	Saragudem (Narsapur Rd JCT)	42.700	9.480	SH
6	Medchal	52.180	9.050	**NH-7**
7	Shamirpet	61.230	11.740	SH
8	Keesara	72.970	8.885	MR
9	Ghatkesar	81.855	7.895	**NH-202**
10	Taramatipet	89.750	6.900	MR
11	Amberpet (To Vijayawada)	96.650	12.320	**NH-9**
12	Bongulur	108.970	7.060	SH
13	Raviryal	116.030	5.470	MR
14	Tukkuguda	121.500	8.240	SH
15	Pedda Golconda	129.740	3.354	MR
16	Shamshabad	133.094		**NH-7**
17	Rajandranagar (Separated IC)	144.285 & 142.630		MR
18	APPA	147.650		MR
19	Nanakramguda TollBarrier	154.370		MR

NH = Interchanges with National Highways
SH = Interchanges with State Highways
MR = Interchanges with Minor Roads

2.3.2 Interchange Design Particulars

A. General

The American Association of State Highway and Transportation Officials (AASHTO) has been widely referred to for design and standards in many countries including India. India likewise uses the “Manual of Specifications and Standards for Six-Lane and Four-lane National Highways through Public Private Partnerships” prepared in 2008. The two documents helped guide the task of the SAPI Study in reviewing original interchange designs.

Generally, interchange design is influenced by the following planning elements:

a. Road classification;
b. Traffic volume;
c. Design speed;
d. Adjacent land use;
e. Environmental considerations;
f. Economic considerations;
g. Topography; and
h. Relationship to other features of the highway system.

Among these factors, the ORR design speed was set at 120 km/h at the maximum. Design speed is regarded as the maximum speed for safe driving, and it affects various geometric elements such as horizontal and vertical alignments, sight distance, super elevation, carriageway widths, shoulder widths, etc.

Table 2.3.3 Design Speed by Road Class

Class	Design Speed (km/h) 20 40 60 80 100 120
ORR	
National Highway	
State Highway	
Minor Road	

B. Standard Design Elements

A complete interchange design consists of the main carriageway, on/off ramps, service roads, connecting roads, and toll plazas. Some design elements can be standardized.

<u>ORR Road Designs</u>: The ORR cross-section where the on/off ramps run parallel is depicted in Figure 2.3.6. On/off ramps are illustrated separately in Figure 2.3.7. The provision of high speed service compatible with safe driving and space for speed acceleration and

deceleration is inevitable in the connection between the main carriageway and entry/exit ramps, as shown in Figure 2.3.8.

Figure 2.3.6 ORR Cross-section with Ramps

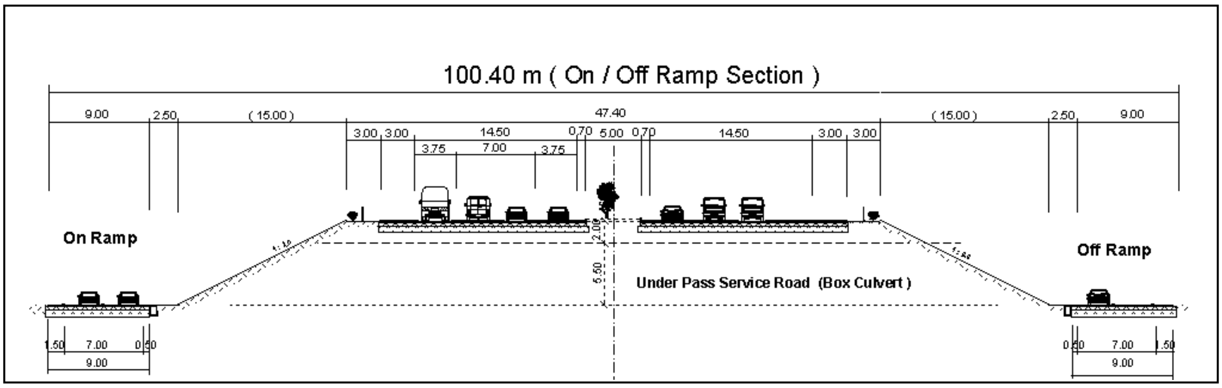


Figure 2.3.7 On/off Ramp Cross-section

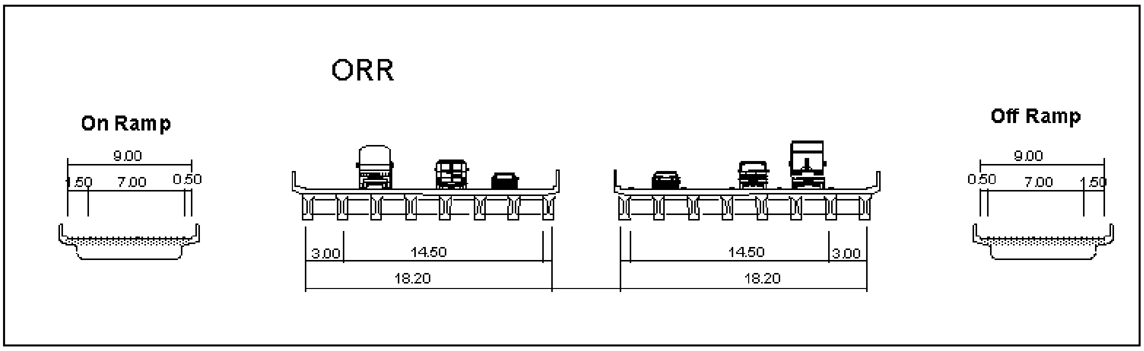
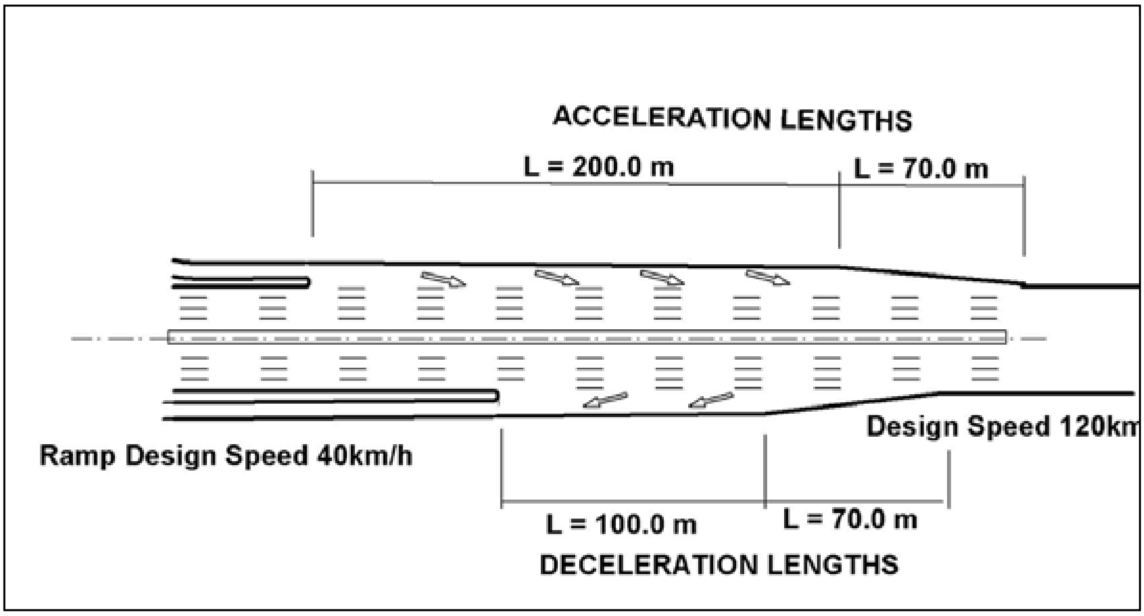


Figure 2.3.8 Acceleration / Deceleration Length



Toll Plaza Concept: The following four design principles are adopted for designing a toll plaza and they are incorporated in Figure 2.3.9.

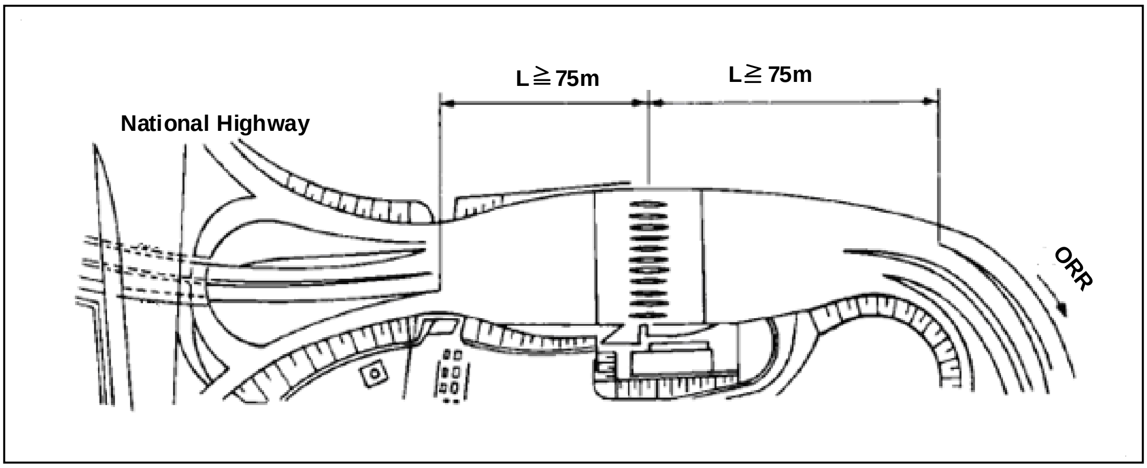
(i) The horizontal curve for the toll plaza should be secured within at least a 200m radius, although it should be as large an area as possible;

(ii) The gradient shall be less than 2%;

(iii) Rigid pavement should be constructed for 60m in length in the central section of a toll plaza; and

(iv) The toll plaza area should be secured over 75m from the centerline.

Figure 2.3.9 Toll Plaza Design Image



Toll Gates: The necessary quantities of toll booths depend on the peak-hour traffic demand. After the calculation based on the year 2021 traffic projection, it was found that two types of toll gates are required: 12 lanes for a large trumpet-type interchange, handling over 2,000 vehicles per hour, and seven lanes for a medium trumpet-type interchange, handling below 2,000 vehicles per hour. A minor diamond-type interchange requires eight lanes because of two separated toll plazas per interchange. Other important assumptions are as follows:

(i) Three payment methods are introduced: the ETC, smart card, and manual. The usage share in the year 2021 is 20% for the ETC, 40% for the Smart Card and the remaining 40% for the manual.

(ii) Booth handling capacity is set at 800 vehicles/hr for the ETC, 450/hr for the smart card, 450/hr for the manual entry and 190/hr for the manual exit;

(iii) A multi-axle lane with a 5.5m width is provided at every entry/exit for large trucks and emergency use;

(iv) A 12-lane large trumpet-type toll plaza is divided into two ETC lanes, eight smart card/manual lanes (three for the entry and five for the exit) and two multi-axle lanes with a maximum capacity of 4,550 vehicles per hour exclusive of multi-axle lanes in the calculation;

(v) A seven-lane medium trumpet-type toll plaza is divided into two ETC lanes, three smart card/manual lanes (one for the entry and two for the exit) and two multi-axle lanes with a maximum capacity of 2,690 vehicles per hour exclusive of multi-axle lanes in the calculation;

(vi) No ETC booth in a diamond-type interchange. An ETC user takes her smart card from the on-board unit and shows it at a toll booth operator; and

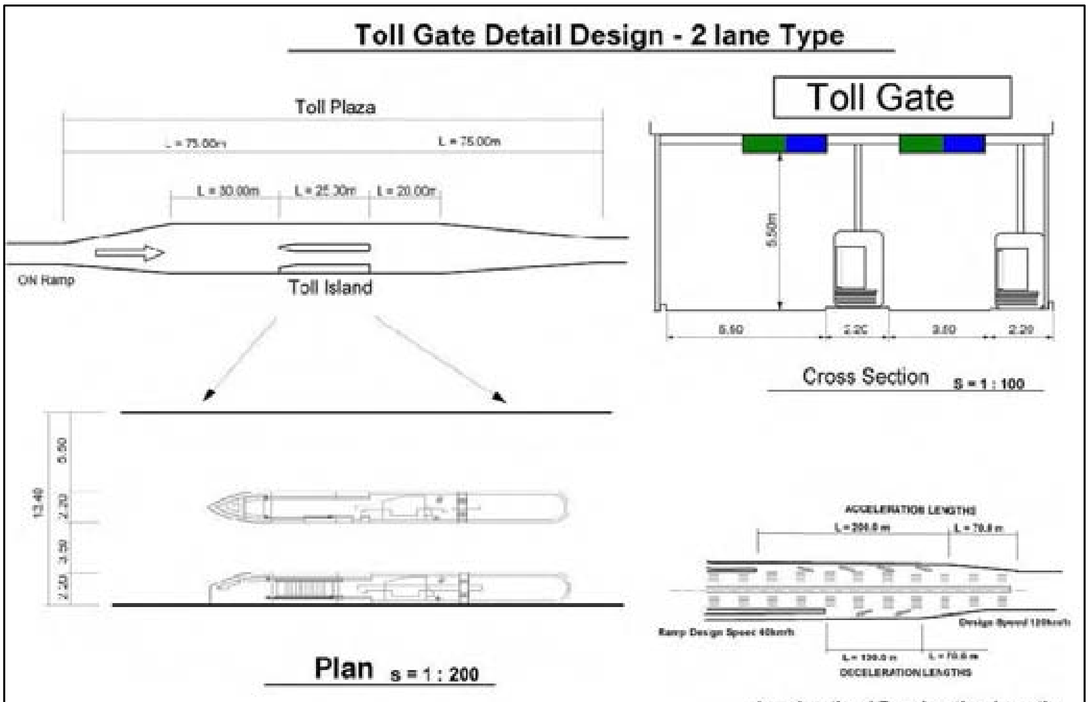
(vii) The average queue for waiting vehicles during peak hour is less than three vehicles.

Table 2.3.4 Number of Toll Booths

	ETC	Smart/Manual (3.5m wide)	Smart/Manual (Multi-axle)	Total
Trumpet (large)	2 lanes	8 lanes	2 lanes	12 lanes
Trumpet (medium)	2 lanes	3 lanes	2 lanes	7 lanes
Diamond (minor)	N.A.	4 lanes	4 lanes	8 lanes

Toll Plaza Design by Interchange Type: As the combined results, three toll plazas are designed by interchange types: minor diamond-type interchange, medium trumpet-type interchange, and large trumpet-type interchange.

Figure 2.3.10 Toll Plaza for Minor Diamond-type Interchanges



Note: Only the entry toll plaza is illustrated.

Figure 2.3.11 Toll Plaza for Medium Trumpet-type Interchanges

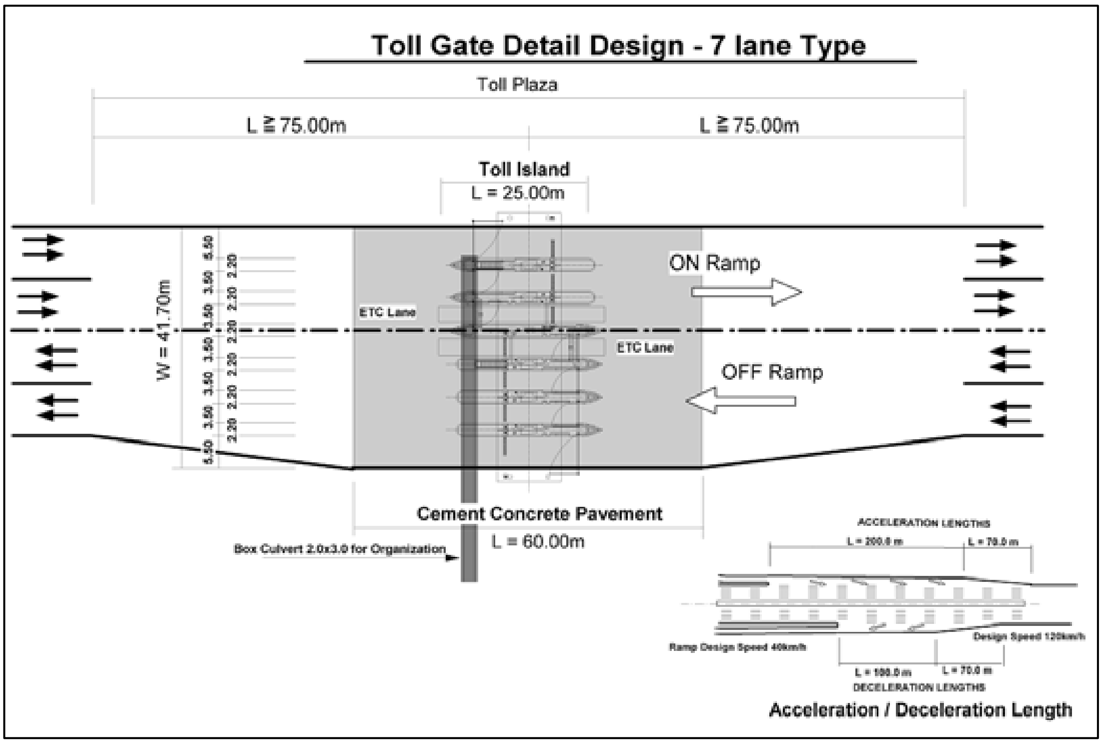
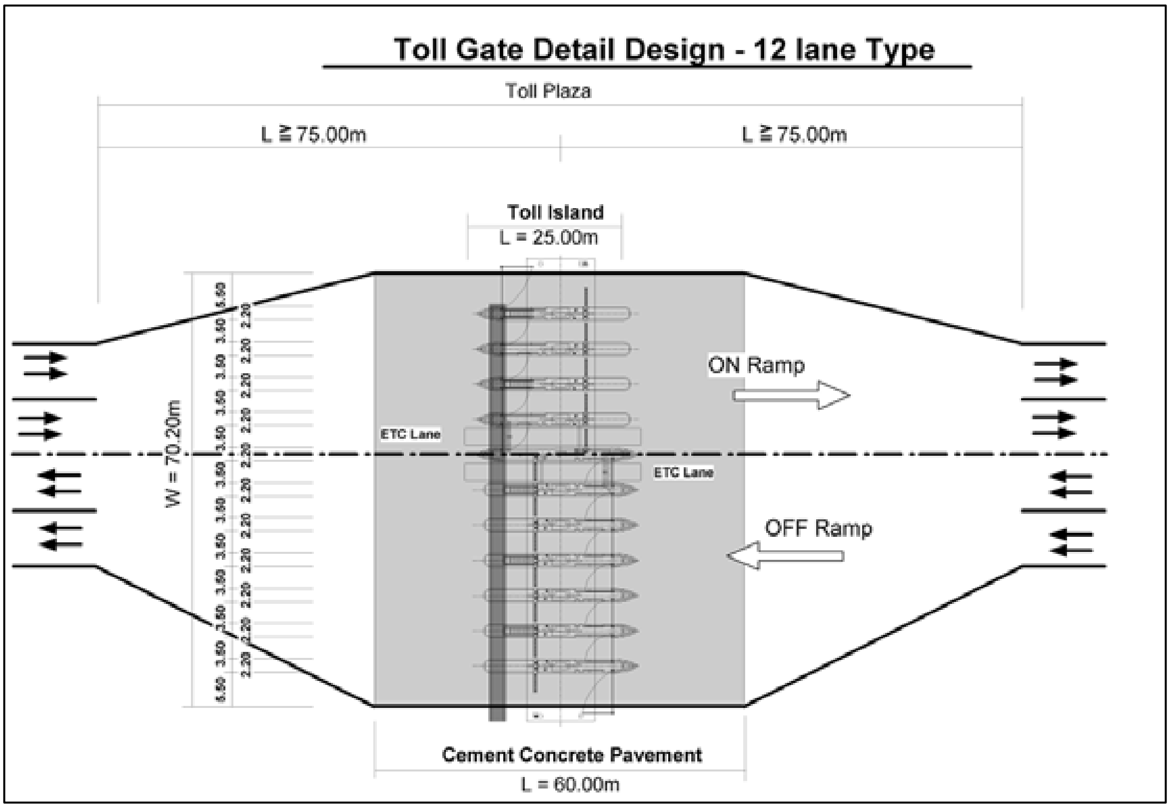


Figure 2.3.12 Toll Plaza for Large Trumpet-type Interchanges



2.3.3 Revised Designs for Selected Interchanges

This section shows some interchange design revisions as proposed in the previous section. As the TOR indicates, five interchanges which connect with the national highways are subject to these design revisions. In addition, two more interchange designs were reviewed. One is located in Tukkuguda, in connection with a state highway, taking account of its construction difficulty due to the limited availability of land. The other draws a standard-type design for minor interchanges.

For this task, the SAPI Team visited the sites several times, interviewed the EPC contractors and consultants, checked the available ROW on the maps, and carefully examined other influencing factors of the interchange construction, such as existing land use, topography, rivers and drains, high-tension electricity wires, etc.

A. NH7 North Interchange

<u>Horizontal Alignment:</u> The available land delineated by the ORR alignment and the project boundary is mostly underdeveloped. However, urbanization is becoming apparent at the adjacent area from the city center. Design conditions for horizontal alignment are set as follows:

a) The original cloverleaf-type design is changed to a double trumpet-type interchange with one integrated large toll plaza (12 lanes in total);

b) At-grade intersection was not adopted for access/egress between NH7, or the Bangalore Corridor, and the toll plaza to ensure smooth traffic flow;

c) The interchange structure is designed within acquired land boundaries; and,

d) The minimum radius requirement is 65m in accordance with the ramp design to allow a 40km/h driving.

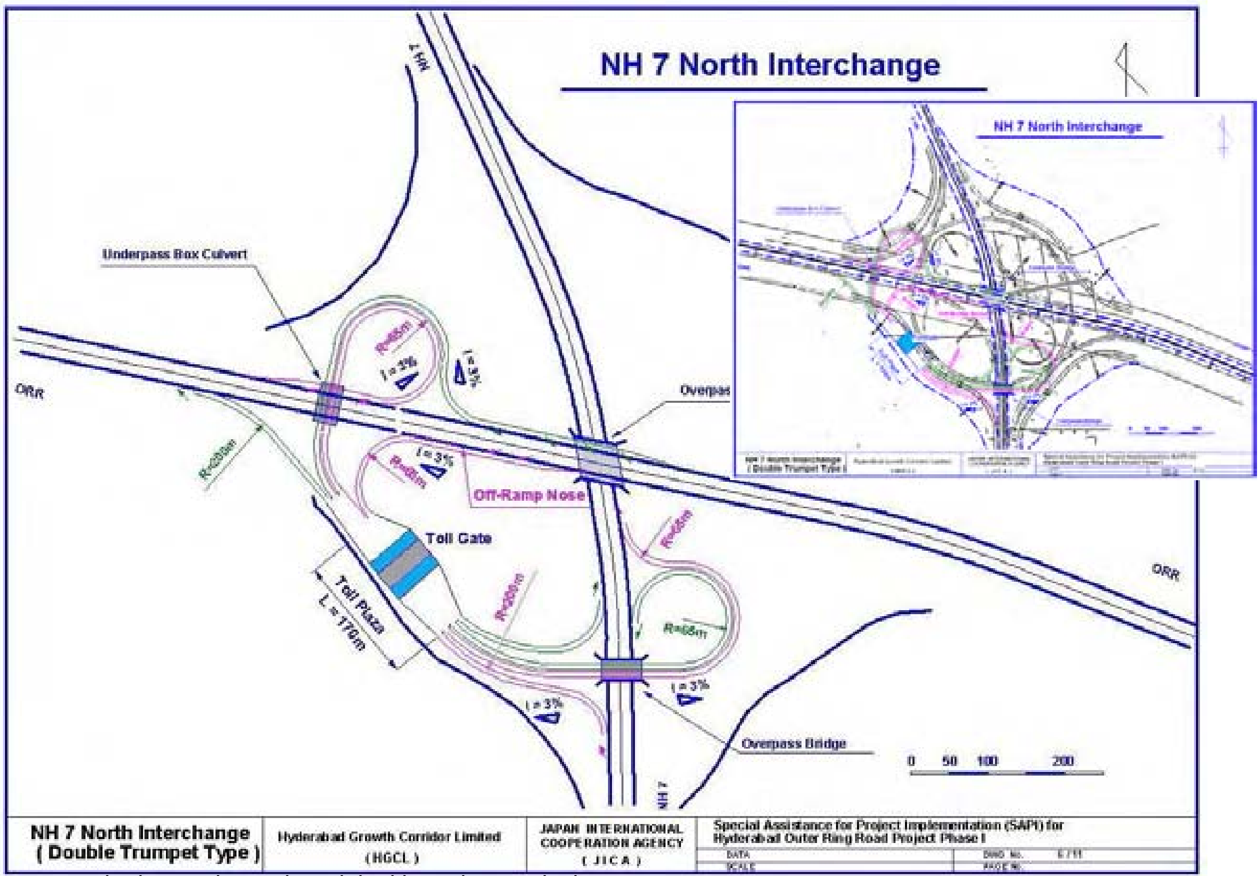
<u>Vertical Alignment:</u> Design conditions for the vertical alignment are set as follows:

a) Ramp longitudinal slope is less than 3.0 %; and

b) The planned heights of the ORR and the overpass bridge were proposed to start from the existing road level and an additional 7.5m (construction clearance of 5.5m + roof construction thickness and ORR pavement thickness of 2.0m).

Compared with the original cloverleaf design, the revised design requires a much smaller space since available land based on the original design is divided into four triangular lots by two trunk roads. The revised design fully uses the southwest lot and partially the southeast and northwest lots while not using the northeast lot at all. (Refer to Figure 2.3.13)

Figure 2.3.13 Proposed Design for the NH7 North Interchange



Note: The insert shows the original interchange design.

B. NH7 South Interchange

The existing lands within the ORR alignment and the interchange border line are mostly underdeveloped. Land development works are ongoing in accordance with the original interchange design. The NH7 leg is the busiest radial road in Hyderabad, i.e. ADT was 24,564 vehicles in 2006. Near the interchange site, the Rajiv Gandhi International Airport started its operation in March 2008.

Since the Phase I section started its operation temporarily in 4-lane carriageway in December 2008, HGCL decided to remain the original cloverleaf-type interchange design. Under such situations, the SAPI Team’s suggestion is limited to the allocation of four (4) toll plazas in the interchange.

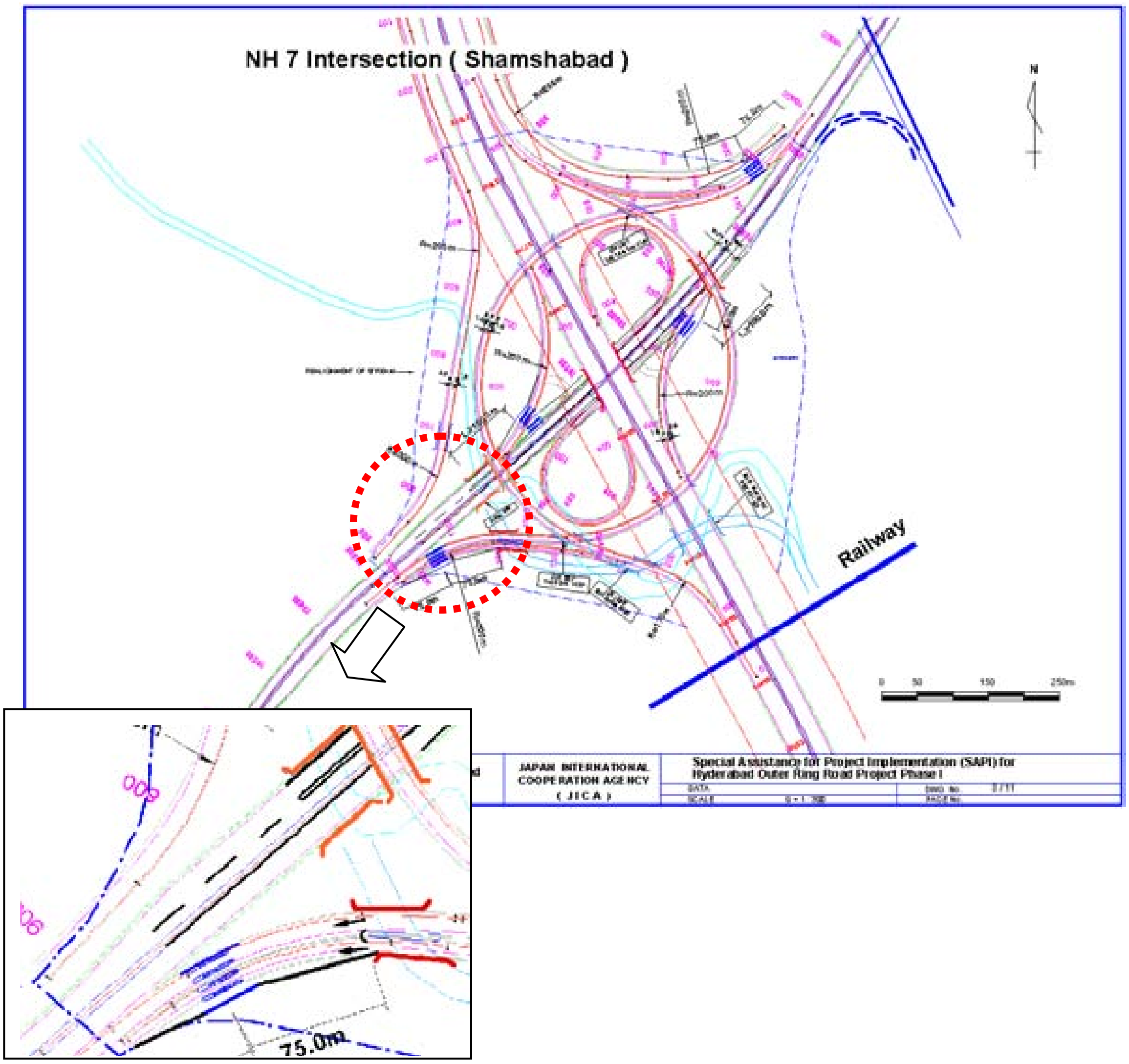
a) The interchange toward the new international airport is located very near the ORR alignment. Smooth and safe traffic movement must be secured particularly on the NH7 carriageway which will serve various kinds of traffic, such as inter-city and urban traffic on the NH7, airport traffic, and ORR traffic through the interchanges;

b) Toll plazas are planned on the original ramp alignment and not on bridges. 100m or longer space is secured from the conversion/diversion points of NH7.

c) The ramp's longitudinal slope is moderately designed particularly at toll plaza sections.

Four (4) toll plazas are physically separated but they should be operated in an integral manner. A special attention should be paid to safety and security in tolling management service.

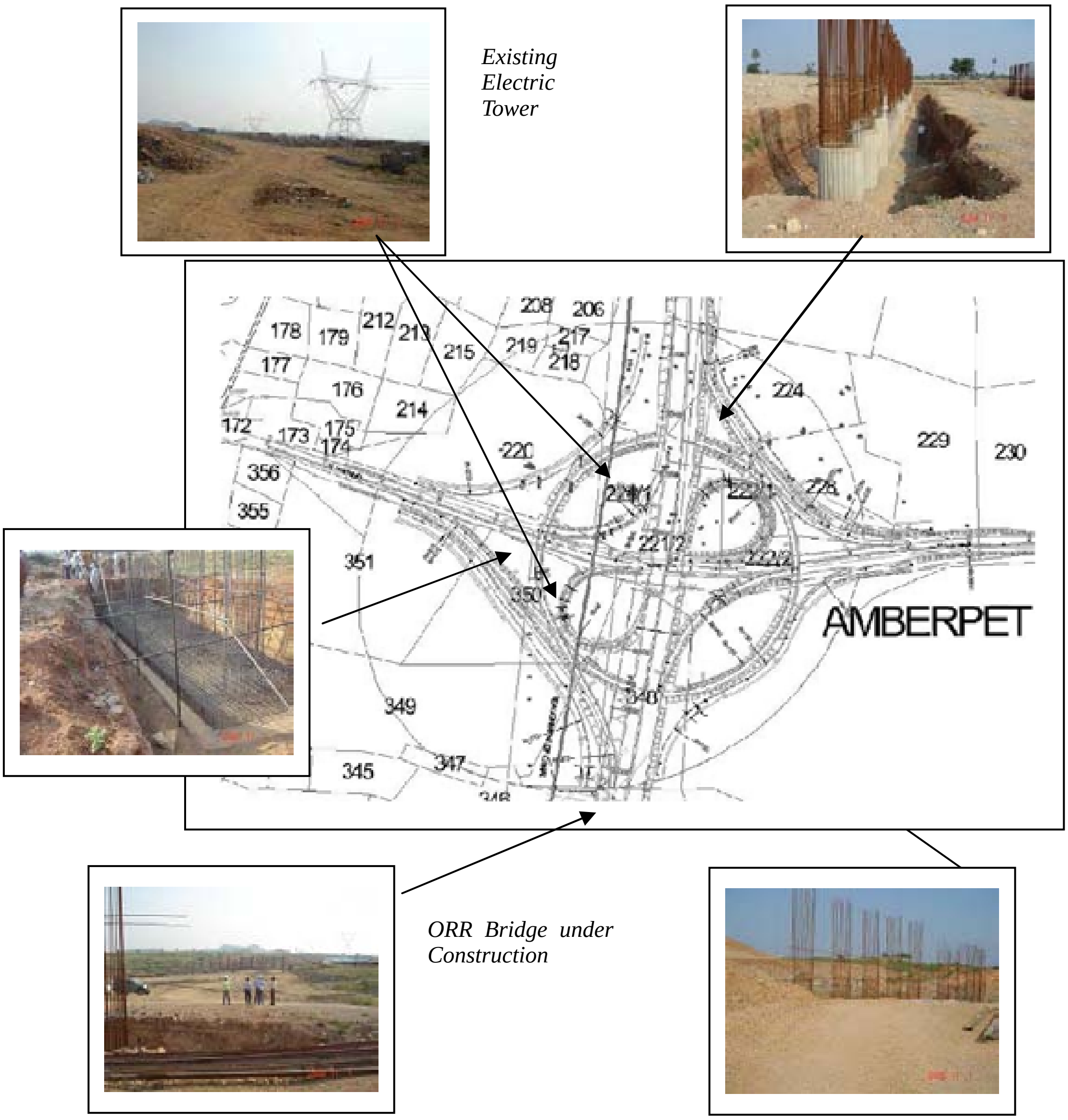
Figure 2.3.14 Design for the NH7 South Interchange



C. NH 9 East Interchange

The NH9 leg is the second busiest radial road next to NH7's south leg. Its 2006 traffic amounted to ADT 22,203 vehicles. In accordance with the original design, the NH9 East Interchange is under construction as gleaned from several site pictures as of November 2008, as shown in Figure 2.3.15. High-tension electricity towers and cables at the site are regarded as obstacles.

Figure 2.3.15 Original Design of the NH9 East Interchange with Construction Site Photos



Horizontal Alignment: Design conditions for the horizontal alignment are as follows:

a) Some structures have been constructed. Due consideration is necessary to utilize the built structures;

b) A double trumpet-type interchange does not require all the land indicated as necessary in its original design. In constructing the interchange, the northern side will be done more easily than the southern side which needs a lot of soil piling work to construct a leveled structure;

c) At-grade intersection is not adopted for access/egress between the NH9 and the toll plaza to ensure smooth traffic flow; and,

d) The minimum radius requirement is 65m in accordance with the ramp design to allow a 40km/h driving speed.

Vertical Alignment: Design conditions for the vertical alignment are as follows:

a) The ramp's longitudinal slope is less than 3.0 %; and,

b) The planned heights of the ORR and overpass bridge are proposed to start from the existing road level plus an additional 7.5m (construction clearance of 5.5m + roof construction thickness and ORR pavement thickness of 2.0m).

Three design alternatives have been prepared to elaborate both development possibilities and the inherent constraints. These are the following:

- Design A: Uses the side more suitable to construction which is the northern side, while utilizing the northern box culvert currently under construction. As a result, it will be difficult to acquire sufficient length to construct a toll plaza which has a designed length of 150m;
- Design B: Uses the costly construction side which is the southern side while utilizing the northern box culvert currently under construction. This allows the design of a lengthy and sloping toll plaza (300m); and
- Design C: Uses the northern side without utilizing the northern box culvert currently under construction. This answers the need to develop an adequate toll plaza (280m) at the northern side.

The study recommends Design C since it is advantageous in terms of construction cost and allows the safe and smooth interchange operation including toll plaza. However, with this design some initial construction works will regrettably not be used.

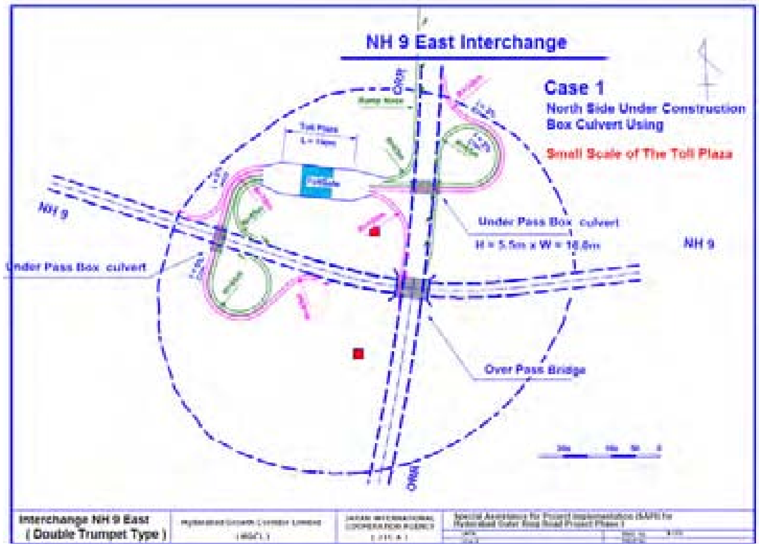
Table 2.3.5 Evaluation of Three Alternative Designs

Item for Evaluation	Design A	Design B	Design C	Remark
Utilization of invested facilities	△	△	X	A, B) Only one box culvert to be utilized.
Toll Plaza Design	△	△	○	A) Barely satisfies the minimum standard. B) To be built on a slope.
Space sharing with the existing electric tower	○	○	○	
Compensation for site clearance	○	○	○	
Traffic management	△	○	○	A) Toll plaza space is not sufficient enough.
Natural environment	○	○	○	
Construction Cost	○	X	△	B) Costly earth works to be required. C) All new facilities to be built.

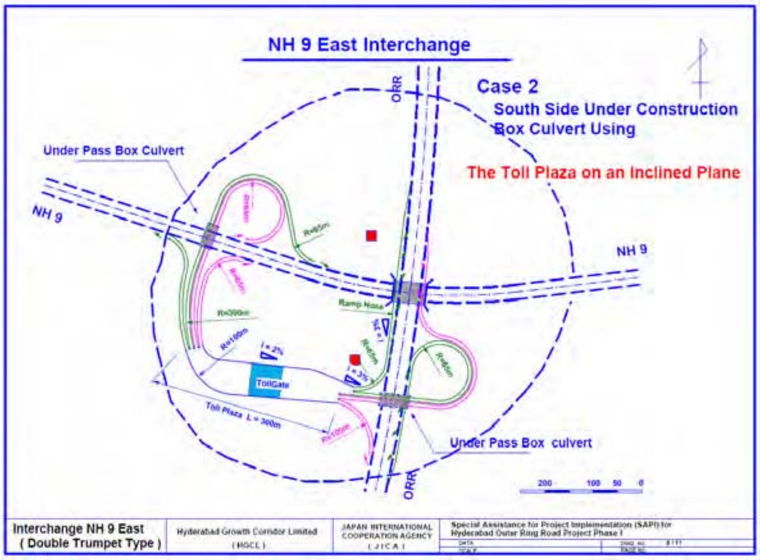
Note: ○: Good, △: Fair, and ×: Bad

Figure 2.3.16 NH9 East Interchange Design Alternatives

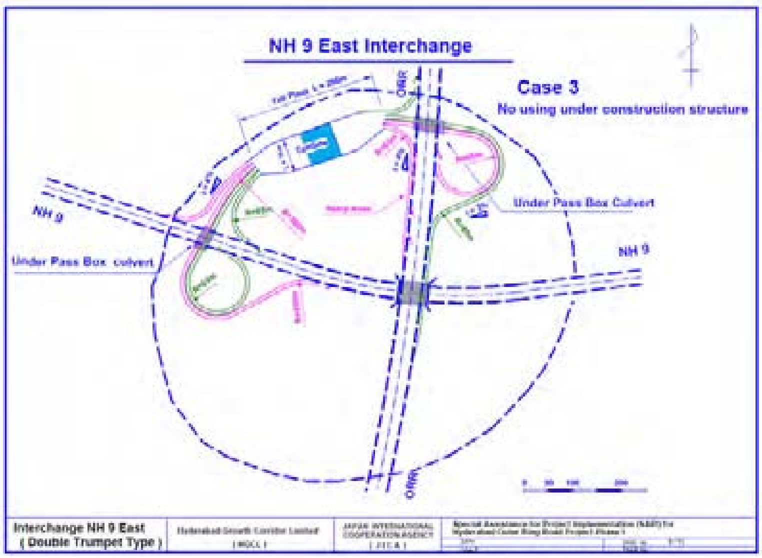
Design A



Design B



Design C



D. NH 9 West Interchange

Horizontal Alignment: The site has two planning issues: One factory insists on continuing its business operation without relocation, and a small river flows across the NH9. Since a double trumpet-type interchange requires smaller land than the original cloverleaf type , the following are the design conditions for the horizontal alignment:

a) Avoid the existing factory and the small river as much as possible;

b) The at-grade intersection should not adopted for access/egress between NH9 and the toll plaza to ensure smooth traffic flow; and

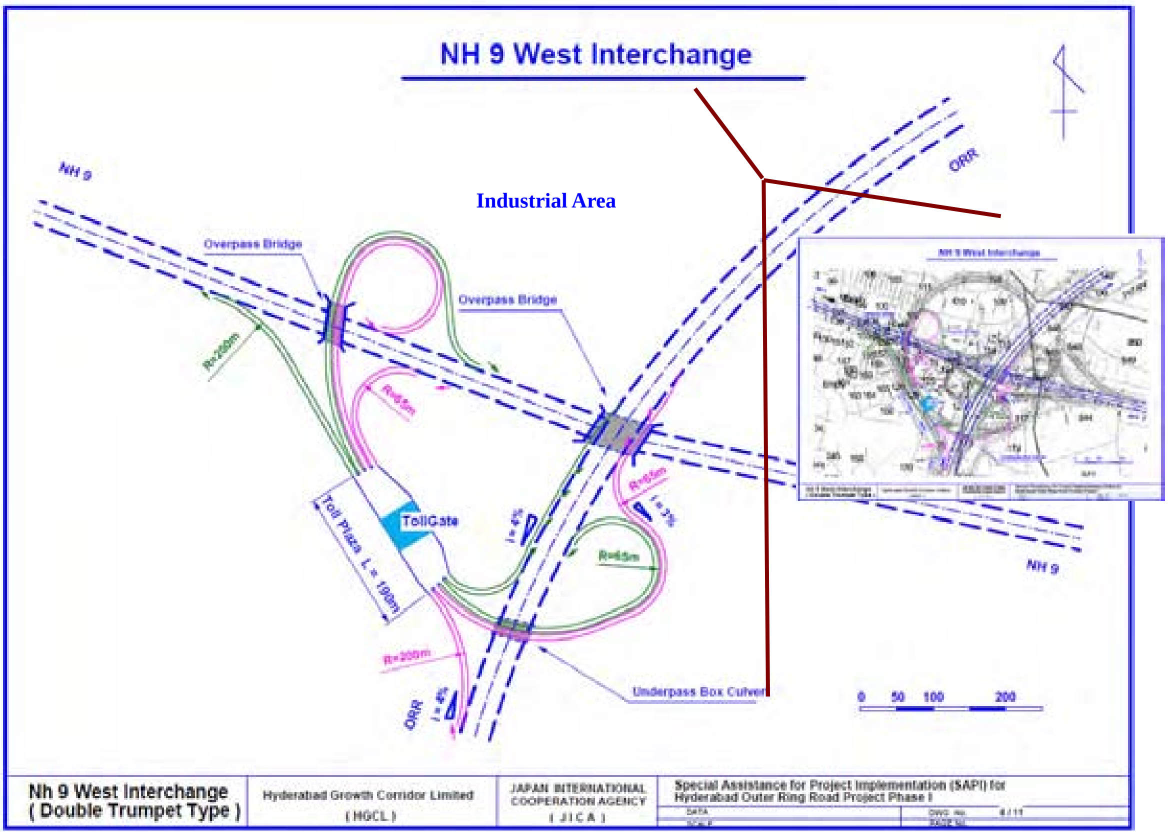
c) The minimum radius requirement is 65m in accordance with the ramp design to allow a 40km/h driving speed.

Vertical Alignment: Design conditions for the vertical alignment are as follows:

a) The ramp's longitudinal slope is less than 4.0 %; and

b) The planned heights of the ORR and overpass bridge are proposed to start from the existing road level plus an additional 7.5m (construction clearance of 5.5m + roof construction thickness and ORR pavement thickness of 2.0m).

Figure 2.3.17 Proposed Design for the NH9 West Interchange



E. NH 202 Interchange

Horizontal Alignment: The site is flat and underdeveloped. A radio tower stands as an obstacle. Design conditions for horizontal alignment are as follows:

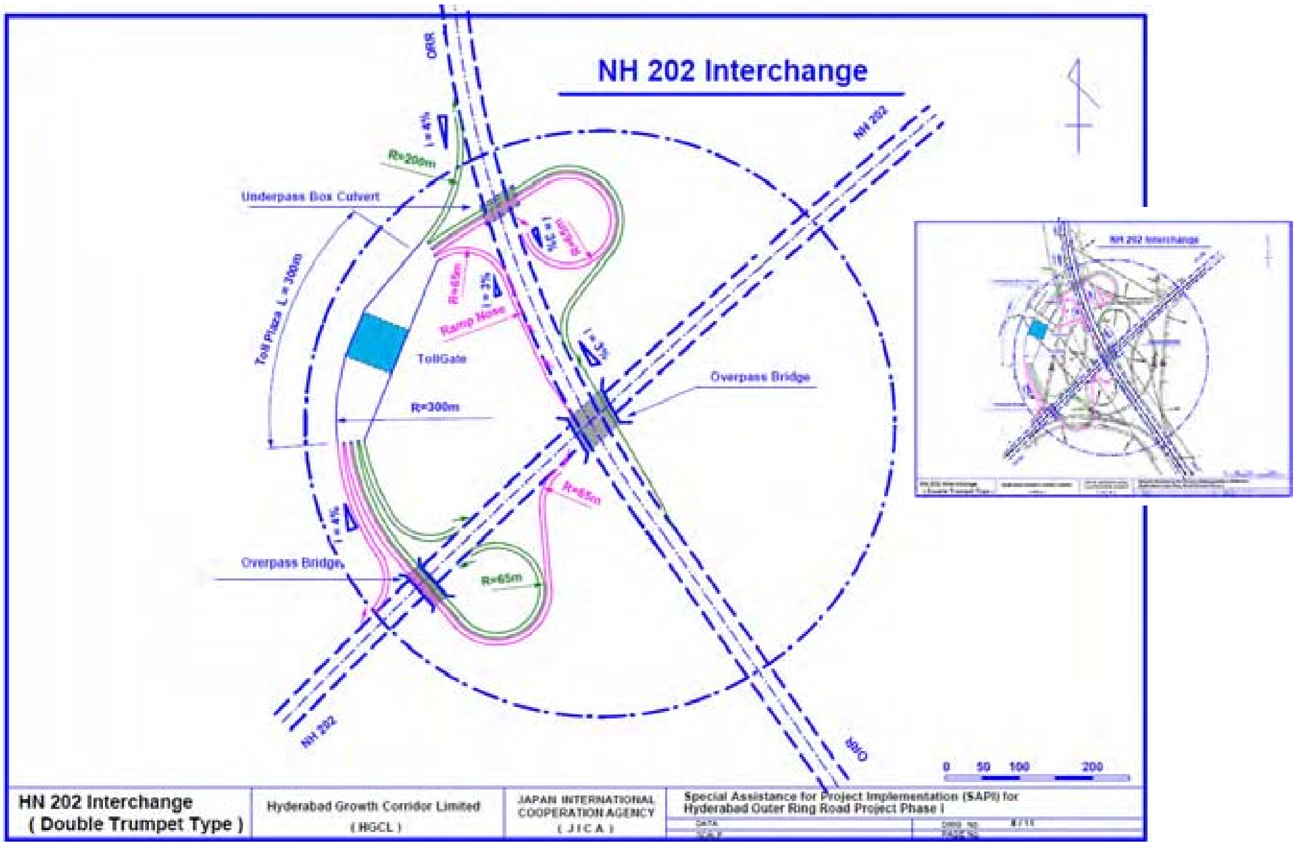
a) The horizontal alignment is designed to avoid the radio tower;

b) At-grade intersection is not adopted for access/egress between NH202 and the toll plaza to ensure smooth traffic flow; and

c) The minimum radius requirement is 65m in accordance with the ramp design to allow a 40km/h driving speed.

Vertical Alignment: The same design conditions as those applied in other national highways that connect to interchanges were adopted.

Figure 2.3.18 Proposed Design for the NH202 Interchange Design



Note: The insert shows the original interchange design..

F. RR28 Interchange

Among the five interchanges connecting with state highways, this is considered the most difficult one due to limited land and space. According to the HGCL, the northern side from the ORR ROW is mostly urbanized while some land parcels are difficult to acquire even at the southern side. It should also be noted that the RR28, a radial state highway, is to be improved within the JICA loan project.

Within the available lands, a typical double trumpet-type interchange cannot be designed. One design was made with some shape modifications. Although this design may not face land acquisition problems, it has the following operational issues:

a) One integrated toll plaza can not be developed;

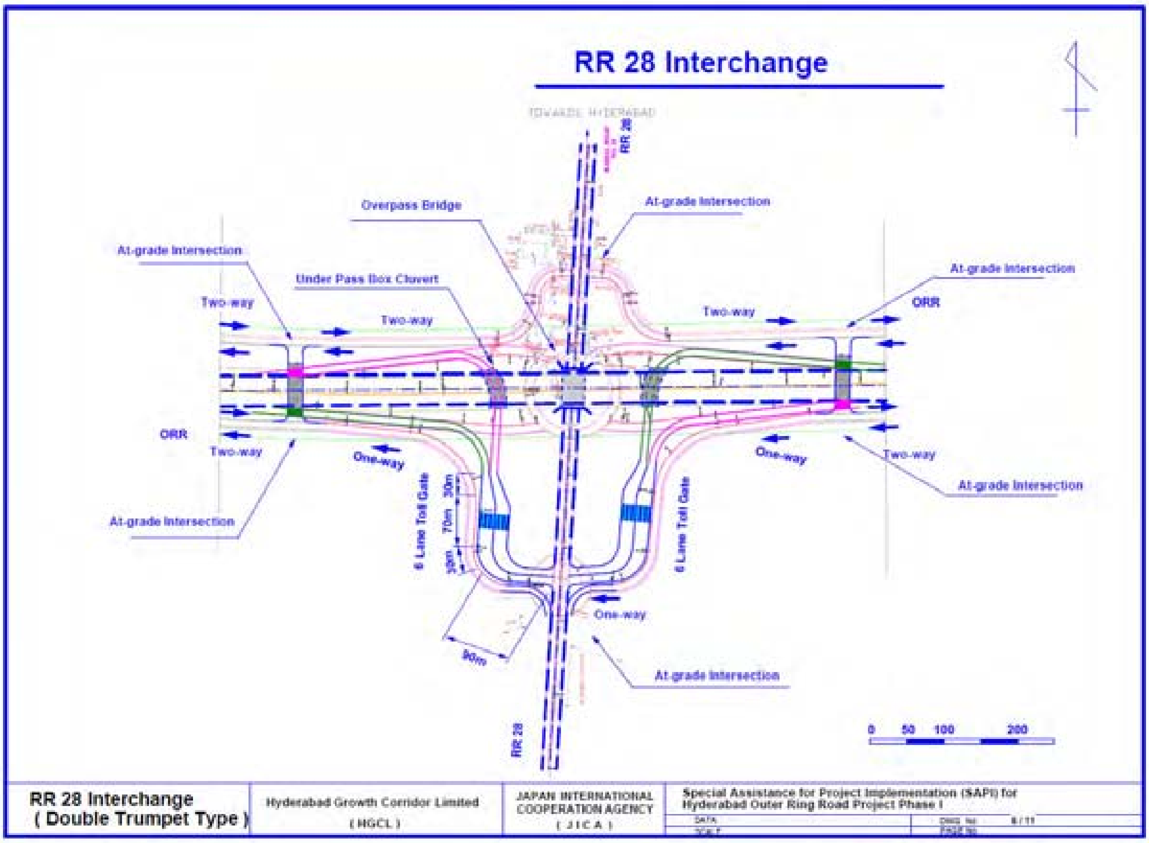
b) Both toll plazas have insufficient space in terms of width and length;

c) One large intersection is necessary where all traffic on the state highway, the ORR, the entry/exit ramps, and service roads must meet; and,

d) The sections of the four service roads between the state highway and the box culverts on both sides must serve one-way traffic.

Therefore, this design is not recommendable if necessary lands have to be acquired.

Figure 2.3.19 RR28 Interchange Design



G. Minor Road Interchanges

There are 11 interchanges on minor roads where the diamond type can be applied. Some design conditions differ from the trumpet-type interchange in the following aspects:

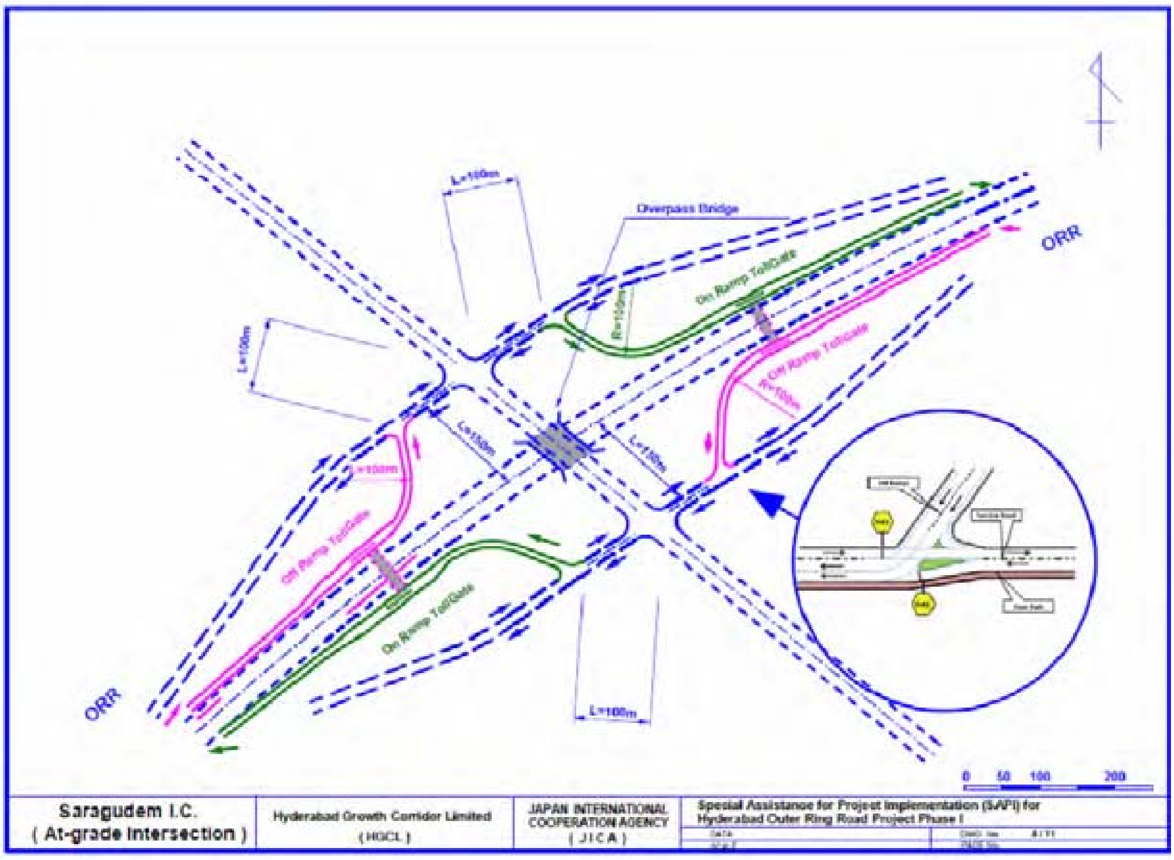
a) Two at-grade intersections are to be developed to cope with the traffic on minor roads and the ORR service roads;

b) The distance between at-grade intersection and the ORR on/off ramps is over 100m on both sides; and,

c) For an integrated toll plaza operation, the on-ramp and off-ramp toll gates should be connected by one underpass box culvert to be used as a passageway exclusively for ORR staff.

One minor interchange has been designed for Sultanpur (Sta. 42.7km), and it appears that the revised design reduces the land that needs to be acquired as indicated in the original design, which proposes to construct three spacious rotaries along the minor roads.

Figure 2.3.20 Interchange Design for Minor Roads



2.3.4 Indicative Construction Cost Variation

The SAPI Team has modified four (4) ORR interchanges in connection with national highways in order to enjoy efficient and secured toll collection services. At the same time, those modification works bring about one positive side effect or reduction in construction cost. This is because the double trumpet design requires smaller space and shorter ramp way in comparison with the original cloverleaf design.

The construction cost variation has been analyzed indicatively based on ramp length and bridge structure. As results, design modification can contribute to construction cost reduction by 30% to 52%. The largest cost reduction of 52% is anticipated at the NH9-West interchange at Patancheru since the modified compact design does not need to bridge over a river. At the safe side, it may be said that construction cost reduction by 1/3 likely happens when a cloverleaf-type interchange is modified to a trumpet-type one.

It is also noted that a trumpet-type interchange requires about half of the land which accommodates a cloverleaf-type interchange.

Table 2.3.6 Construction Cost Variation at Selected Interchanges

		Ramp Length (m)	Difference	Bridge Area (m2)	Difference	Cost Variation
NH7-North (Medchal)	Original	6,830		7,530		
	Double Trumpet	2,955	-3,875	6,100	-1,430	-35%
NH7-South (Shamshabad)	Original	6,088		7,135		
	Double Trumpet					---
NH202 (Ghatkesar)	Original	6,770		6,420		
	Double Trumpet	2,821	-3,949	6,030	-390	-30%
NH9-East (Amberpet)	Original	6,635		7,876		
	Double Trumpet	2,600	-4,035	6,070	-1,806	-38%
NH9-West (Patancheru)	Original	7,900		16,499		
	Double Trumpet	2,943	-4,957	8,552	-7,947	-52%

CHAPTER 3 ITS DEVELOPMENT PLAN

3.1 Comparative Analysis among ITS Services in Japan and Other Countries

Intelligent transport system (ITS) is a concept with many technological innovations, enabling safer, faster and more enjoyable driving and thus ITS development greatly benefits all transport stakeholders including users, operators and administrations.

ITS has been evolving continuously and the system development progress varies among cities and countries. Taking the project nature, e.g., toll expressway, and the locality into account, the section highlights three ITS related intermediary tools between the car driver and the external traffic environment: the electronic toll collection (ETC) system, the car navigation system and the vehicle information and communication system (VICS).

This section reviews and discusses three aspects: Japan's experience, categorization of the ETC systems practiced in the world and future system integration opportunities.

3.1.1 Japan's Experiences on ITS Development

A. Car Navigation System

A car navigation system is a satellite navigation system designed for use in automobiles. It typically uses a GPS navigation device to acquire position data to locate the user on a road in the unit's map database. In Japan, the first car navigation system was produced in 1981. In 1990, the units loaded with digital road maps appeared in the market. Initially, only one CD-ROM was loaded. Thereafter the number of available CD-ROMs increased although a driver needed to change them manually. In 1997, those CD-ROMs were replaced with DVD-ROMs. In 2001, the HDD navigation system with a huge capacity was put on the market.

In addition to basic location service, various services have been provided for assisting safe driving such as "detection service of zigzag driving" and "notification service of curves ahead". Today, car navigation units come with many functions other than just car navigation. As of 2005, 4.2 million car navigation units were shipped in the market with an accumulated unit number of 22.3 million. Over 80% of elderly users commented that the car navigation system made driving more relaxing.

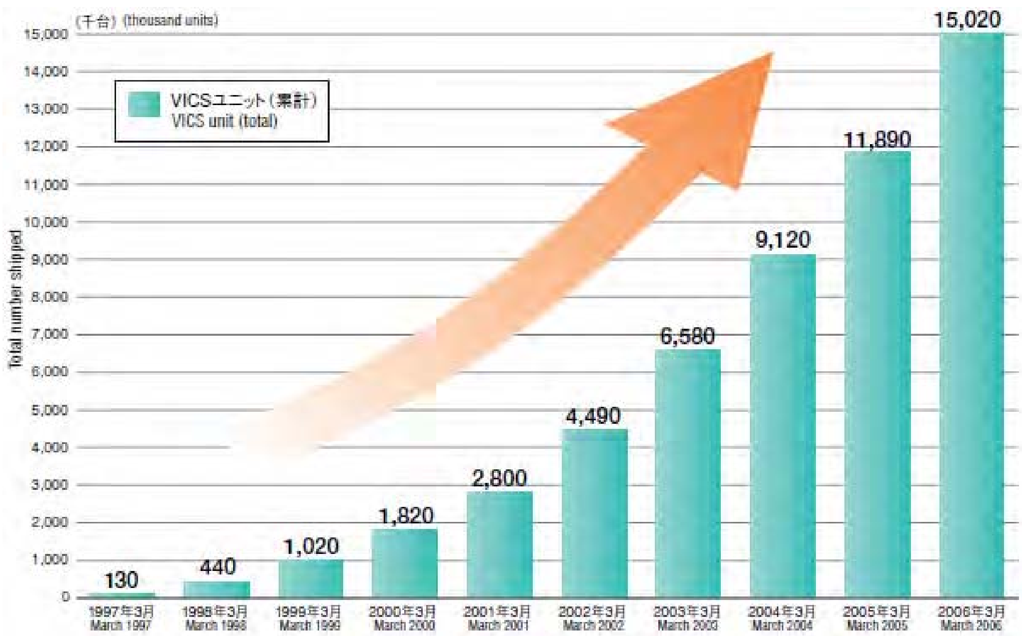
B. Vehicle Information and Communication System (VICS)

VICS is a digital data communication system which promptly provides the latest road traffic information to drivers via the car navigation system. The world's first VICS service started in Japan in 1996. VICS, using 5.8 GHz DSRC, can transmit various and large-volume information quickly. The services are provided in an adequate manner such as network image, still image by roadside camera and warnings by voice, making drivers understand easily.

In 2005, 3.1 million VICS units were shipped out in the domestic market while the accumulated unit number reached 15 million. Today, car navigation units with initially built-in VICS units account for over 70% in the market.

Figure 3.1.1 Trend in Shipment of Car Navigation Units, 1997-2005

Figure 3.1.2 Trend in Accumulated Units of VICS, 1997-2005



Source: ITS Japan Handbook 2006-2007

C. Electronic Toll Collection (ETC) System

Non-stop toll collection is a branch of Highway Traffic Management System, aims to eliminate congestions and delays of the flow in toll roads. Non-stop toll collection was firstly introduced in Norwegian city Bergen, in 1986, operated together with traditional tollbooths. Norwegian city Trondheim introduced the world's first completely unaided full-speed electronic tolling. In 1995, Portugal became the first country to apply a single, universal system to all tolls in the country, the Via Verde (green lane), whose payment system can also be used for parking lots and gas stations. Today, non-stop toll collection systems have been introduced in various ways worldwide. Japanese ETC (Electronic Toll Collection) users increased to 19 million. It is reported that the effect of the introduction of the ETC was quite apparent to solve the congestion around the toll gates. Japanese ETC system is standardized in nation-wide. The operators were four public organizations (Japan Highway Public Corporation or *Nihon Doro Kodan*, Metropolitan Expressway Public Corporation or *Shuto Kosokudoro Kodan*, Hanshin Expressway Public Corporation or *Hanshin Kosokudoro Kodan*, and Honshu-Shikoku Bridge Authority or *Honshu Shikoku Renrakukyo Kodan*), all of which were privatized in 2005.

Table 3.1.1 Trend in ETC Users, 1997-2005

	No. of ETC Users (vehicles/day)	ETC Users (%)
April, 2002	110,000	2.0
April, 2003	360,000	5.6
April, 2004	1,240,000	17.1
April, 2005	2,820,000	37.9
April, 2006	4,380,000	58.7
April, 2007	5,090,000	66.8
April, 2008	5,530,000	73.1

Source: MLIT of Japan

3.1.2 Categorization of Non-stop Toll Collection Systems

A non-stop toll collection system or ETC consists of four major components, namely: (i) automated vehicle identification, (ii) vehicle classification, (iii) transaction processing, and (iv) violation enforcement. When the first ETC systems were introduced in early 1990's, they adopted microwave devices which operated at 915MHz or 2.45GHz. Both frequencies belong to ISM (Industrial Scientific Medical) bands.[1] International bodies were working on standardization for ETC. The U.S. adopted 915MHz band, while CEN (European Committee for Standardization) chose 5.8GHz because the European GSM cellar phone is operating at the 900MHz band and interference would be expected. ARIB (Association of Radio Industry and Businesses) adopted 5.8GHz in Japan too but not being interoperable with the European standard. Recently the FCC also proposed the allocation of a 75 MHz wide band between 5.85 and 5.925GHz reserved for the use of ITS DSRC devices in the United States. ETC systems based on other technologies include DSRC-Infrared technology and GNSS/CN (Global Navigation Satellite System / Cellular Network). The present combinations of the above mentioned four components are categorized as the follow six types of ETC.

[1] The industrial, scientific and medical (ISM) radio bands were reserved internationally for the use of industrial, scientific and medical purposes other than communications. These bands are typically given over to uses intended for unlicensed operation. Typical ISM devices are the home microwave oven operating at 2.45 GHz, WiFi wireless PC LAN, Mayfare type contactless IC card, toy radio control, and etc.. The ISM bands defined by the ITU-R are:

Frequency range [Hz]	Center frequency [Hz]	Availability
6.765–6.795 MHz	6.780 MHz	Subject to local acceptance
13.553–13.567 MHz	13.560 MHz	
26.957–27.283 MHz	27.120 MHz	
40.66–40.70 MHz	40.68 MHz	
433.05–434.79 MHz	433.92 MHz	Region 1 only
902–928 MHz	915 MHz	Region 2 only
2.400–2.500 GHz	2.450 GHz	
5.725–5.875 GHz	5.800 GHz	
24–24.25 GHz	24.125 GHz	
61–61.5 GHz	61.25 GHz	Subject to local acceptance
122–123 GHz	122.5 GHz	Subject to local acceptance
244–246 GHz	245 GHz	Subject to local acceptance

It is reported that 5.15 - 5.35 GHz and 5.725 - 5.875 GHz were de-licensed in India following the US/Canada policy. http://www.dot.gov.in/finstatus/PERFORMANCE_BUDGET_2005-06.pdf

Type 1- OBU-based identification system: Certain kind of vehicle identification is necessary for the non-stop toll collection. Type 1: OBU-based identification system allocates unique IDs by the operator in the car side equipments and identifies them by road side equipments. Air interfaces are either radio frequency (operate at frequencies between 3kHz and 1GHz), microwave (frequencies between 1 and 300GHz.), or infrared (between microwaves and visible light, approximate spectrum at 850±50nm.) DSRC (Dedicated Short Range Communication) is the standardization category for the air interface at ITU, CEN, and other international bodies.

Photo 3.1.1 TELEPASS Gate

Type 1 is widely used by countries in Asia, Europe, and America. Asian examples are ETC in Japan and Taiwan, HiPass in South Korea and Pakistan (active DSRC). European examples are TELEPASS in Italy, Telepeage in France, and AutoPASS in Norway. North American examples are E-ZPass in the US and Canada (passive DSRC).

This type is simple and basic in concept. The reduction of the toll fee miss-collection is relatively easy. This type enables the operator gradual introduction from manual tolling to non-stop toll collection system. The combination of the different tall collection systems is possible. On the other hand, the cost of the on-board equipment tends to hinder the initial spread of users. Promotion policies for the ETC users, such as discount rate, leasing of the OBU, and the reduction of the equipment's price are useful.

Type 2 - wireless tag and CCD camera: As a technology for perceiving the use of the road without decelerating at all, this technology specifies the vehicle by receiving the signal from wireless tag and taking a picture of the lisence plate with CCD camera. The image is used as pursuit information for an illegal user. The U.S. and Canadian examples of this type are Sunpass in Florida and 407 ETR in Toronto.

Photo 3.1.2 407ETR Cameras

In 2005, Chilean city Santiago implemented the world's first 100% full speed electronic tolling at several concessioned urban freeways using wireless tag and CCD camera. The United Arab Emirates implemented in 2007 a similar road toll collection in Dubai. This type is useful for the congestion pricing or urban toll schemes which are implemented to control traffics in downtown area. Examples are; Bergen (1986), Oslo (1990), Trondheim (1991), Toronto (1997), Singapore

(1998), Melbourne (2000), Tel Aviv(2000), Rome (2001), London(2003), Stockholm(2007) and in Valletta, the capital city of Malta(2007).

Photo 3.1.3 DART Tag

Photo 3.1.4 Free Frow tag in South America

Photo 3.1.5 Telepeage Gate and Tag

Photo 3.1.6 Permid Tag

Photo 3.1.7 Sunpass Cameras and Tag

This type enables operations without gate bars. The wireless tag requires a minimum telecommunication facility and the cost of tag can be suppressed to low. On the other hand, this system presupposes a well established registration system of car licensing and number plate. Additional mechanism is necessary for the illegal user who conceals the number plate. The toll collection is not necessarily easy for this kind of illegal users.

Type 3 - wireless tag and GPS: Switzerland introduced wireless tag and GPS-based non-stop toll collection systems for heavy cargo vehicles in 2001. This system determines the location of the vehicle using GPS and sends toll information to the roadside equipment through GSM, allowing toll charges based on the mileage on the toll road. GPS based system is complicated and expensive while effective for the charging of the mile-based toll fee.

Type 4 - CCD camera only: This type is used in London for traffic congestion control since 2003. The number plate of vehicles is specified by using CCTV . The fee charge is a prepayment system.

Photo 3.1.8 CCTV Cameras

Photo 3.1.9 GPS Terminal

Type 5 – Satellite based: This type is used for heavy cargo vehicle in German Autobahn. Satellite based system relies the vehicle's positioning entirely on GPS and calculates moving distance. It necessitates no road side equipments. The user registers and receives a leased GPS terminal. European Union turned its course to this advanced satellite based tolling systems in 2004 as an integrated telematics platform under Directive2004/52/EC. One of the objectives is the utilization of European Global Positioning Satellite, i.e., Galileo system. The experimental projects have been introduced for the accomplishment of interoperable European Electronic Tolling Service. CESARE IV (Common Electronic Fee Collection System for an ASECAP Road Tolling European Service) project is now undertaken which will enable coverage of different national ETC toll collections through accounting network. The national systems in Spain, Italy, France, etc. are conceived to use microwave DSRC in this project.

Type 6 - Smart Card: This type uses pre-paid contactless IC card to open toll gate. It is in-between of manual and non-stop toll collection. Malaysian Smart "Tag Touch'Go" consists of this system. The prepaid IC card is also used for small payments such as parking.

Photo 3.1.10 Touch'n Go Card

The following table summarizes the types of ETC systems by country. Some of the details are introduced in Annex 1.

Table 3.1.2 Trend in ETC Users, 1997-2005

Type	Country	System Name
Type 1- OBU based Identification	Italy	TELEPASS
	France	Telepeage
	Spain	Telepeage
	Portugal	Via Verde
	Ireland	eToll
	United Kingdom	Dart-Tag, M6 Toll tag, Severn TAG
	Norway	AutoPASS
	Canada	E-Z Pass
	Mexico	IAVE
	United States	E-Z Pass, TxTAG, K-Tag, MnPass,
	Brazil	Via Facil
	Japan	ARIB ETC/ Global ETC
	South Korea	hi-pass plus
	Taiwan	ETC
	China(Hong Kong)	Autotoll
	Malaysia	Smart TAG Touch'n Go
	Philippines	E-Pass Tag
	Singapore	Electronic Road Pricing
	Thailand	ASCOM
	Australia	e-TAG
Type 2 - Wireless Tag & CCD	Canada	407 ETR
	United States	SunPass, Fastrak
	Colombia	Free Flow
	Chile	Free Flow
Type 3 - Wireless Tag & Satellite GPS	Switzerland	HVF
Type 4 - CCD Camera Only	United Kingdom	London congestion charge
	Sweden	Stockholm congestion tax
Type 5 - Satellite Based	Austria	go-maut
	Germany	LKW-MAUT
Type 6 - Smart Card	United States	Good To Go!
	Malaysia	Touch'n Go

The SAPI has concluded that the combination of Type 1 and Type 6 be introduced in Hyderabad ORR adding to the manual gates.

3.1.3 Future System Upgrading in line with International Standardization

CALM DSRC

One of the main international standardization activities for the automobile ETC is CALM (Continuous Access for Long and Middle) range technologies in accordance with the ISO TC 204 WG 16.

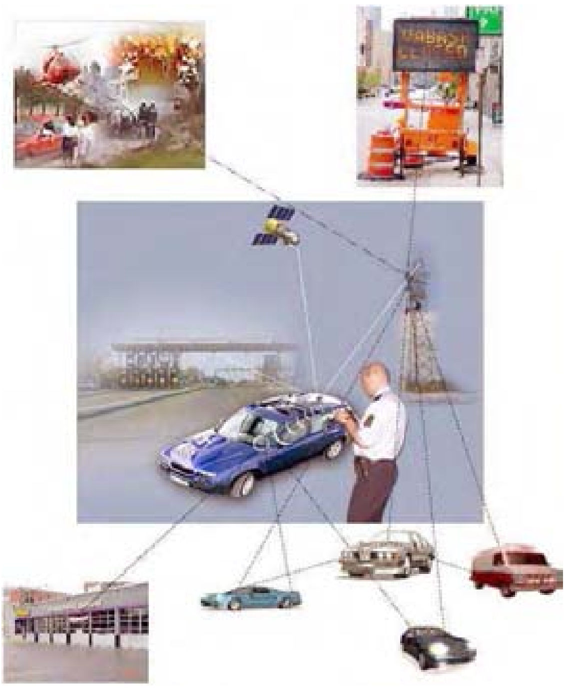
The scope of CALM is to provide a standardized set of air interface protocols and parameters for medium and long range, high speed ITS communication using one or more of several media, with multipoint and networking protocols within each media, and upper layer protocols to enable transfer between media. This service includes the following communication modes;

(1) **Vehicle-Infrastructure**: Multipoint communication parameters are automatically negotiated, and subsequent communication may be initiated by either roadside or vehicle

(2) **Infrastructure-Infrastructure**: The communication system may also be used to link fixed points where traditional cabling is undesirable.

(3) **Vehicle-Vehicle**: A low latency peer-peer network with the capability to carry safety related data such as collision avoidance, and other vehicle-vehicle services such as ad-hoc networks linking multiple vehicles

Figure 3.1.3 Scope of CALM



ISO TC204 Working Group 16/
http://www.isotc204wg16.org/home

The organizational structure of ISO TC 204 WG 16 and network models is as Figure 3.4.1 and Figure 3.4.2. It is notable that the model is quite Internet protocol oriented.
SAPI Team's opinion is that Hyderabad has a greater opportunity of the development of automobile related ICT (Information Communication Technology) industries and their domestic productions in both hardware and software's point of view because this city is well known in holding one of the leading industrial districts in this area.

Figure 3.1.4 ISO TC204 WG16 Architecture

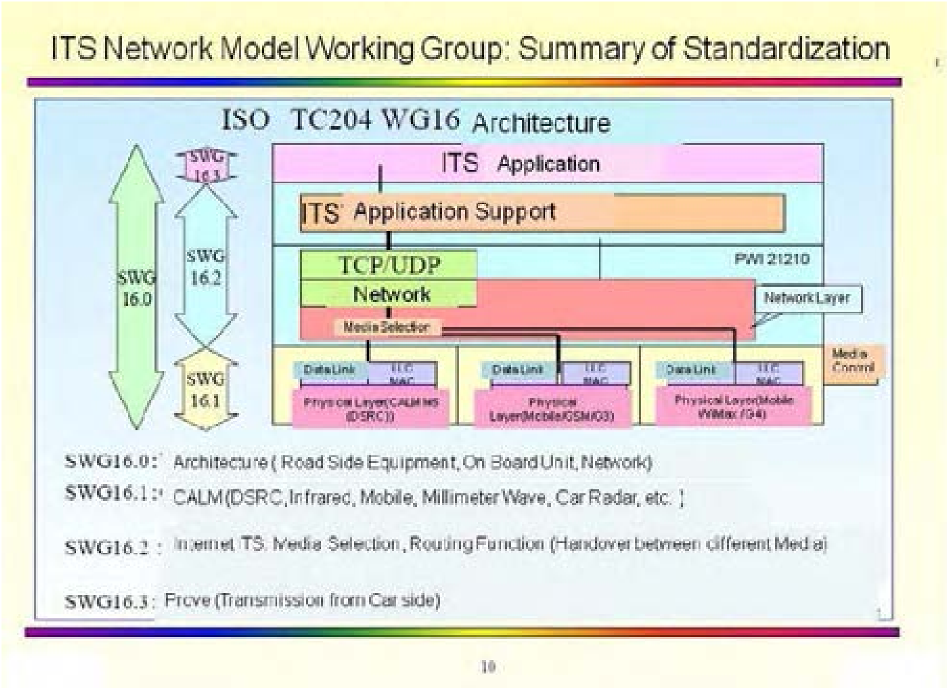
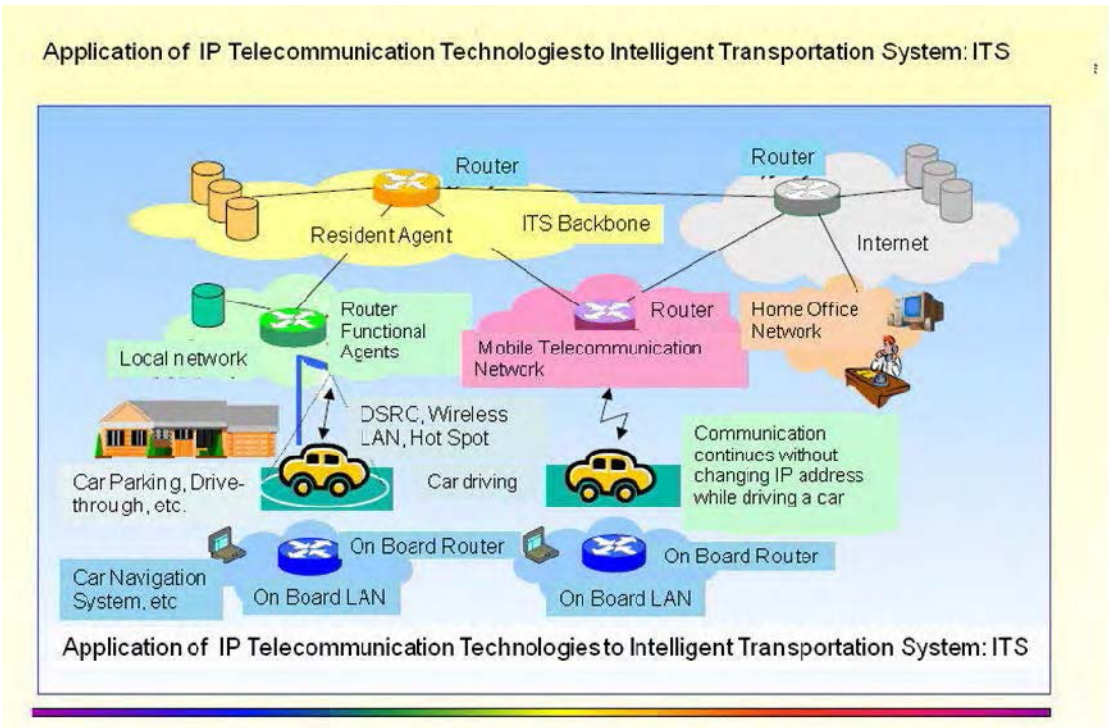


Figure 3.1.5 Application of Internet Technologies to ITS



Examples of the Next Generation Road Services by Road-Vehicle Communication

Car navigation services, VICS (Vehicle Information and Communication Service), and ETC are provided by different on board devices. It is quite possible that those units will be integrated into a single car information communication equipment. This system, which provides next-generation transportation services, will consists of roadside units, ITS on-board-units, satellite, and road-vehicle communication.

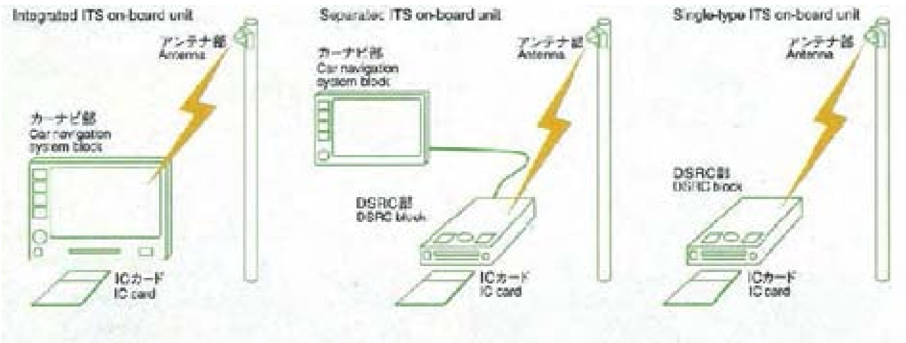


Figure 3.1.6 Future ITS Configurations

One integrated system at the vehicle side enables the following next-generation road services:

- VICS provide surrounding information for motor tourists. This system uses 5.8GHz DSRC (refer to Figure 3.1.7).
- Information for assisting safety driving, about accident-prone road sections, traffic restrictions, the end of queue of vehicles, etc. will be provided in real time for traveling vehicles (refer to Figure 3.1.8).
- Beneficial local information such as traffic conditions, parking, emergency callings will be provided for vehicle users (refer to Figure 3.1.9).
- Cashless payment using credit card system will be available not only at toll gates but also parking lots, drive-through for first food restaurants, etc. Only ETC toll gates, so-called Smart IC, require smaller space than ordinary toll gates without collection staff (refer to Figure 3.1.10).

Figure 3.1.7 Vehicle Information and Communication Service

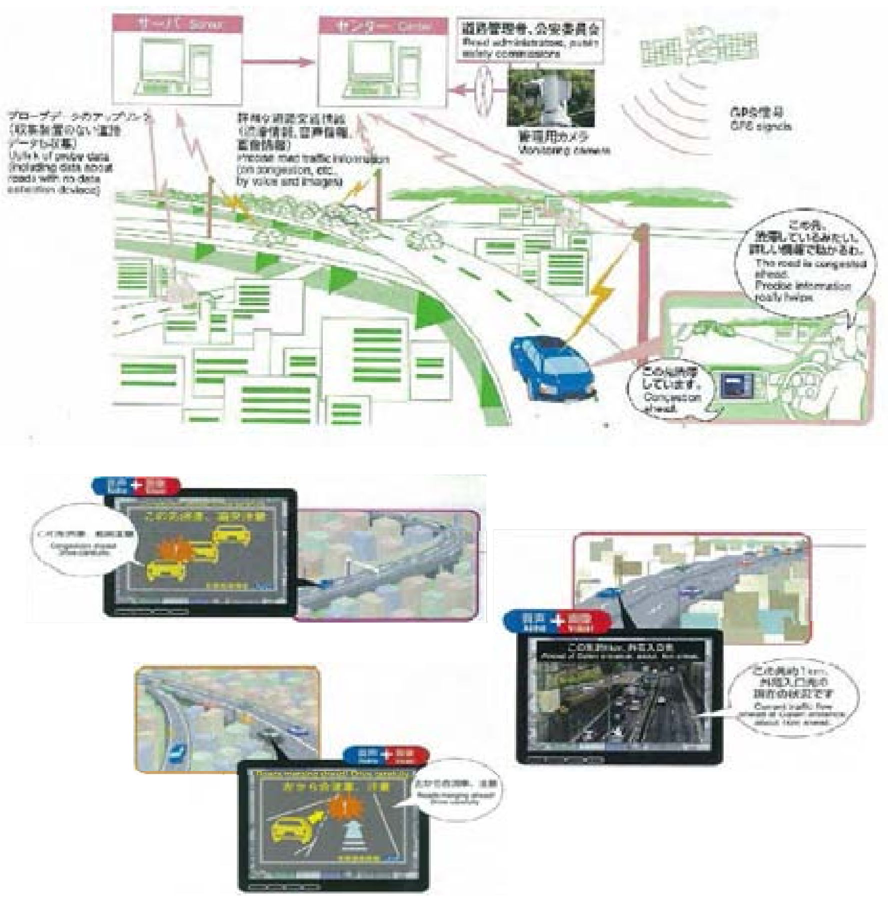


Figure 3.1.8 Information for Assisting Safety Driving

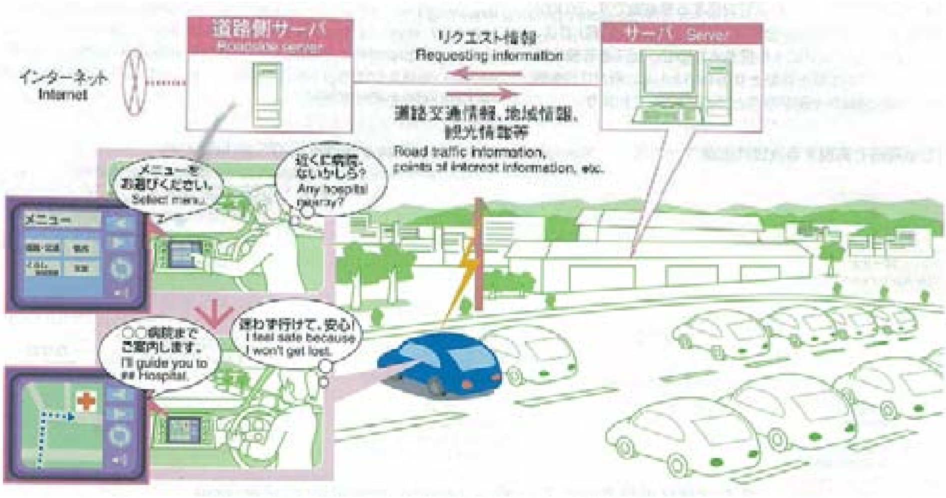


Figure 3.1.9 Information for Local Traffic Conditions

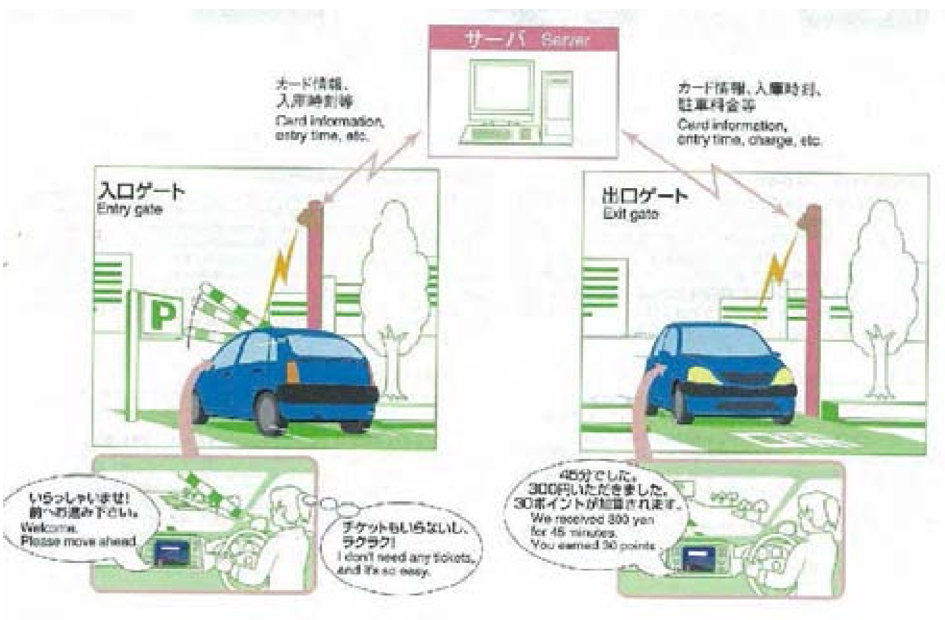


Figure 3.1.10 Smart IC and Cashless Payment

3.2 Identification of Best ITS for the Hyderabad ORR

3.2.1 Development Strategy

The previous section investigates a variety of advanced transport services by means of ITS tools where international standardization takes a leading role. In Hyderabad, any ITS application is far from a fully-fledged level. In order to develop the best ITS for the Hyderabad ORR from no practice situation, the SAPI Study recommends two development strategies in both management and technology aspects.

Management Strategy – Integrated Operation and Management

From a viewpoint of construction scheme, the Hyderabad ORR is divided into three schemes: government financing scheme of Phase I, BOT-annuity scheme of Phase II-A and Yen loan scheme of Phase II-B. Different schemes are also applied to road operation and maintenance after construction. For Phase I and II-B, EPC contractors are responsible for O&M for 2 years immediately after the construction is completed. On the other hand, Phase II-A requests BOT concessionaires to undertake road O&M for 7.5 years and possibly extend this O&M contract one more time or in total the engagement of 15 years contract.

Even though ordinary road O&M could be done by the above schemes, O&M for ITS should be integrated under one implementing body. There are mainly two reasons.

(i) Real-time road infrastructure and traffic information should be shared under one traffic control center (TCC) for service efficiency. For real-time and sizeable information transmission, optical cable fiber is desirable to be installed along the ORR. Again, one integrated O&M body is required.

(ii) Integrated toll collection in ring road configuration is advantageous when setting a uniform tariff structure with some discounting services compared with piecemeal tolling management.

In this connection, the SAPI Interim Report suggested that one ITS O&M body be responsible for even HTMS or basic services of road ITS although once it was contracted out to each BOT concessionaires. HGCL has agreed with this point. Therefore HTMS is reviewed in the next section on the assumption that one integrated O&M body works.

Technology Strategy – Basic and Upper-System Compatible

There are rich opportunities to provide various advanced ITS services in Hyderabad while local needs are quite uncertain because of almost no ITS service have not been experienced among local motorists. The SAPI Study suggests that ITS services in Hyderabad be developed from basic to advanced ones gradually. Compliance to international standardization is a key to ensure this service upgrading way. In other words, economic solution covering basic services only is not recommendable to avoid duplicated investment in the future.

3.2.2 Review of HTMS on Hyderabad ORR

The current BOT contracts between HGCL and five concessionaires include the Highway Traffic Management System (HTMS) to be deployed by the BOT concessionaires. HTMS is composed of six (6) elements:

(1) Emergency Communication System

(2) Mobile Communication System

(3) Variable Message Sign System

(4) Meteorological Data System

(5) Automatic Traffic Counter-cum-classifier System

(6) Power Supply System

This section reviewed each HTMS element in light of an integrated ORR operation and management and forms the basic services of an advanced ITS on the ORR.

(1) Emergency Communication System

This is regarded as a basic system which should be required on any kind of toll way to detect incidents as they occur. The HTMS specifies the installation of emergency call boxes (ECBs) at 2km intervals on either side in both directions. ECBs should be connected to the control center through an optical fiber cable with suitable interfacing. Considering its interfacing capability between drivers and the Traffic Control Center (TCC), the ECBs are an efficient equipment that gather information from drivers themselves regarding any incidents.

The SAPI Team selected all the location for ECBs on the ORR by weight and basement features, avoiding bridges and culverts in order to prevent the redesigning of these structures. Consequently, the maximum interval of ECBs was decided to be widened by 10%, i.e. from 2km to 2.2km. The total number of ECBs reached 178. Serial numbers will be given to ECBs at inside and outside carriageways separately for easy identification by the TCC.

Photo 3.2.1 ECB

In addition, each emergency telephone will be able to:

- Transfer calls to the appropriate organizations (e.g., motorway police, fire stations, ambulance and repair services, etc.): and

- Record calls on voice recorders.

(2) Mobile Communication System

The original HTMS recommends the mobile communication system for speedy communication among ambulances, cranes, and patrolling vehicles. The Wireless Planning and Coordination (WPC) permitted the HGCL to use a single frequency for this purpose with one line exclusively for its use.

A mobile communication system with mobile radio base for ambulance, cranes, and patrolling systems is a costly investment, since it involves the installation of many directional antennas and transmitters in order to cover the whole ORR. Also, emitting strong non-directional radio waves from one location, such as the Traffic Control Center, may violate India’s radio law.

To reduce costs and increase convenience, the use of standard mobile phones instead of radio-based mobiles could be best suited for the system. Not only do they not require additional construction work, they also allow the same communication possibilities. However, agreements with mobile telecommunications providers shall be necessary to provide open lines for road operators in case of emergency such as natural disasters.

(3) Variable Message Sign System

Variable message signs (i.e. sign boards) are some of the most significant information-providing facilities that guide and provide warning to road users. Messages, which should be provided by the TCC and shown on the sign boards, should be short and clear so as not to confuse road users.

Sign boards for VMSs should be installed at the entrance toll gates of six major interchanges connecting national highways (NH-7, NH-9, and NH-202) and on the main corridor from Hi-tech City to Narsingi. In addition, national highways that connect to the ORR should have sign boards installed around 500m before the interchange entrances on both sides to inform drivers the current traffic situation on the ORR .

Main corridors should have sign boards showing the current traffic situation on the road sections ahead. These sign boards should be placed before the inner and outer diverging points of the five interchanges which connect to national highways.

Sign boards should be able to show about 90 different messages using basic words to describe both incident and location. In addition to the text, the inclusion of graphics preceding the text is also recommended to pictorially inform the drivers about the incidences on the ORR.

Figure 3.2.1 VMS Deployment Image

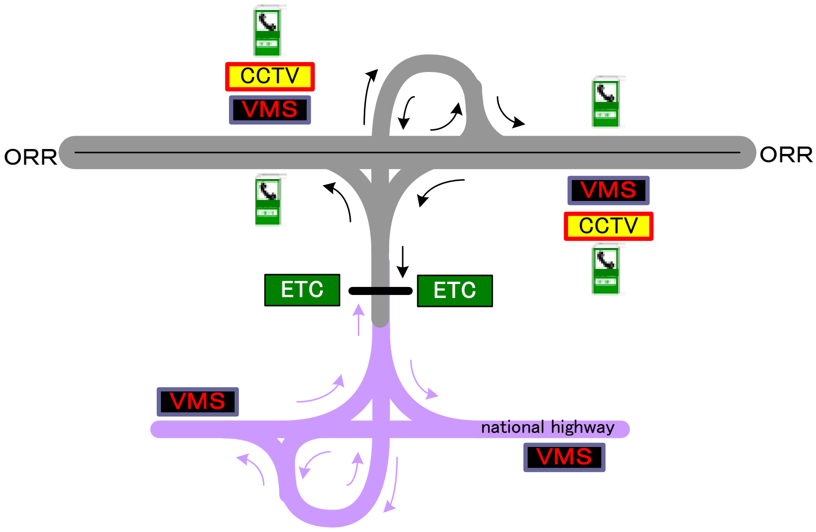


Photo 3.2.2 VMS Operation Image

VMS on the main corridor

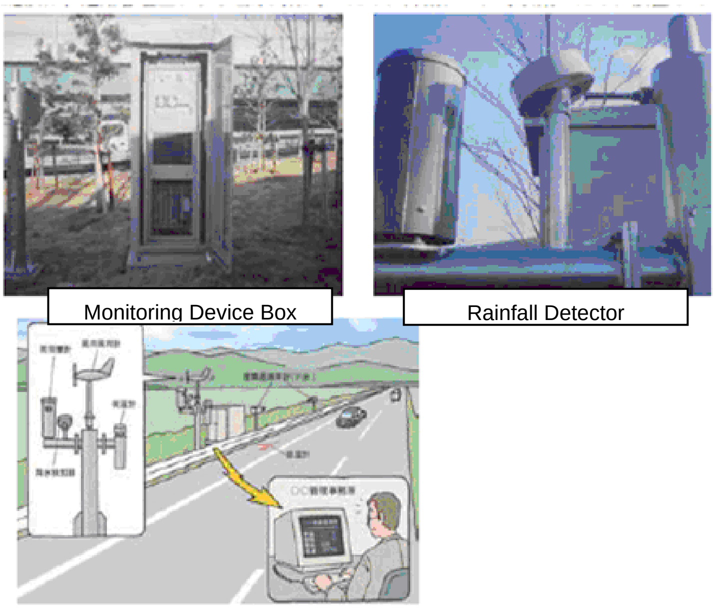
VMS on the access road

(4) Meteorological Data System

This facility is an observation instrument to gather data needed for road management, and include temperature, wind direction and speed, humidity and visibility. Crucial information is that on visibility and wind speed since they directly affect highway safety.

Since there has been no record of either fog or strong winds for the last five years in Hyderabad, the SAPI Team does not recommend the installation of a meteorological data system. Traffic Control Center staff determine visibility levels through displays from the CCTV cameras.

Figure 3.2.3 Meteorological Monitoring Image



(5) Automatic Traffic Counter-cum-classifier System

Automatic traffic counters-cum-classifiers (ATCCs) are able to determine traffic volume, speeds, and vehicle types. Although there are several traffic counter systems, the HTMS recommends the combination of piezoelectric sensors and inductive loops to collect accurate information from the six lanes.

ATCC systems should be installed between interchanges. Although the HTMS prescribes the adoption of this system on six lanes only, the SAPI Team recommends that it be done on every lane since it provides important data on traffic volume, travel speeds per vehicle type, heavy truck ratios, etc. It also gives information that can be used to check toll revenue. To ascertain traffic congestion points, this system should be installed at potentially dense bottlenecks.

Photo 3.2.3 ATCC

(6) Power Supply System

Because a traffic control system operates 24 hours a day, an uninterrupted power supply system should be required for all vital equipment. A power supply system should be installed in every interchange to provide power to various equipment including the ITS, lighting for interchanges, and electricity for administration buildings, in case of power failures.

The HTMS requires the necessity for a power substation and supply rooms to cater to the power requirements of the whole interchange. The substation should have stand-by generators to automatically provide electricity in case of power failures. HGCL plans to install a 25-kw substation to ensure uninterrupted power 24 hours a day.

3.2.3 Additions to HTMS for the Hyderabad ORR's ITS

In addition to the revised HTMS, the following subcomponents are proposed in the development of an overall ITS for the Hyderabad ORR:

(1) Traffic Control Center (TCC)

(2) CCTV

(3) Internet Service/SMS Center

(4) Toll Gate System

(1) Traffic Control Center (TCC)

The TCC is the hub that controls and manages all the ITS services and orchestrates patrol and rescue operations. The TCC collects and analyzes various ORR operations, as well as information and data from the ECBs, CCTVs, ATCCs, and the meteorological data system. The TCC should analyze the collected information and data as quickly as possible and provide accurate information to road users through VMSs, internet, and SMS, and coordinate necessary actions with the traffic police, fire brigade, and other public organizations during accidents and emergencies.

Photo 3.2.4 TCC Image

Taking the 158km alignment into account, the main and sub TCCs should be deployed correspondingly, with the main TCC at the Saragudem IC for the northern part and the sub TCC at the Bongulur IC in the southern part. The Sarangudem IC is an appropriate place because this IC is one of the busiest ICs and under the Phase-ⅡB, therefore construction has not been started yet. The Bongulur IC, located at the opposite side of Saragudem, is chosen due to the safety and security reasons as a standby for controlling the long stretch.

(2) CCTV Camera System

CCTVs are required for monitoring traffic flow through TV monitors. This system enables the TCC to see current road situations and to control the camera remotely by zooming and rotating them. However, surveillance through CCTVs requires a certain

Photo 3.2.5 CCTV

intensity of luminance. Therefore, IC areas are optimum locations for installing CCTVs since all interchanges are planned to have lighting.

Installation points should be both sides of the interchanges and the Kokapet junction in order to monitor merging and diverging sections. In addition, HGCL should consider installing CCTVs at both blackspots and frequent congestion points in the future.

(3) Internet Service/SMS Center

Using the Internet as a tool for providing road information to road users is practical and convenient. When traffic or the ORR is closed due to some incidents, road users can be apprised of the current situation on the interchanges through the Internet and can then plan on alternative routes.

The TCC should also be equipped with an automatic SMS reply facility to enable road users to send SMS inquiries and receive automatic replies about road conditions on the ORR. This would be in addition to the information made available to road users via the Internet.

Photo 3.2.6 Images of Internet Service and SMS

Source: Istanbul TCC (www.tkm.ibb.gov.tr)

(4) Toll Gate System

It is appropriate that three modes of toll collection system would be installed. The first is an electric toll collection system (ETC), which enable the cars to pass with gate-bar lifting. SAPI Team recommends installing this system at the ICs which connect national highways and state highways. The second is touch & go using pre-paid contactless IC-card. The third mode is manual (by collectors). Every toll gate should possess three modes.

A vehicle using ETC lane must be equipped with an OBU (onboard unit) where an ETC card is installed at the OBU slot. The appropriate standards of the ETC card are contactless, ISO/IEC14443 Type A or Type B RFID (Radio Frequency IDentifier). The ETC card is usable for touch & go too for OBU non-using drivers by scanning the cards over the RFID reader at the toll gate. While paper ticket based operation is possible, the manual toll collection service could also consider to use IC-card, i.e. the collector hand over IC-card at the entering booth and accept it at exiting, while calculating thorough the read data by the booth operator who will receive fee accordingly.

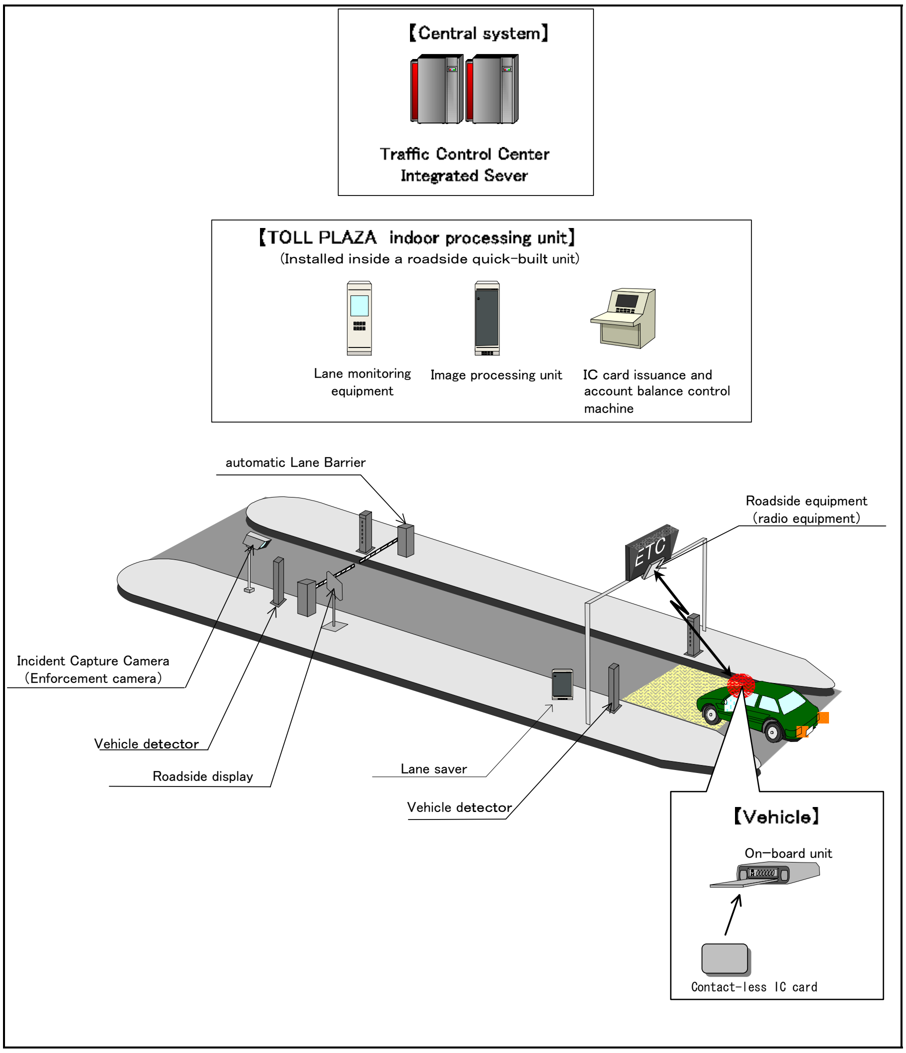


Figure 3.2.4 Concept of ETC Gate

3.3 ETC Design with Basic Specifications

3.3.1 Development Target

To ensure smooth and safe traffic services, the Hyderabad ORR should have a closed toll collection system wherein no toll gate barriers exist on the main carriageway. It is also advantageous to set a distance-based toll tariff. The ETC is a core management technology that increases development benefits accruing from a closed toll collection system.

In Japan, the increase in ETC users has alleviated traffic congestion and reduced CO^2

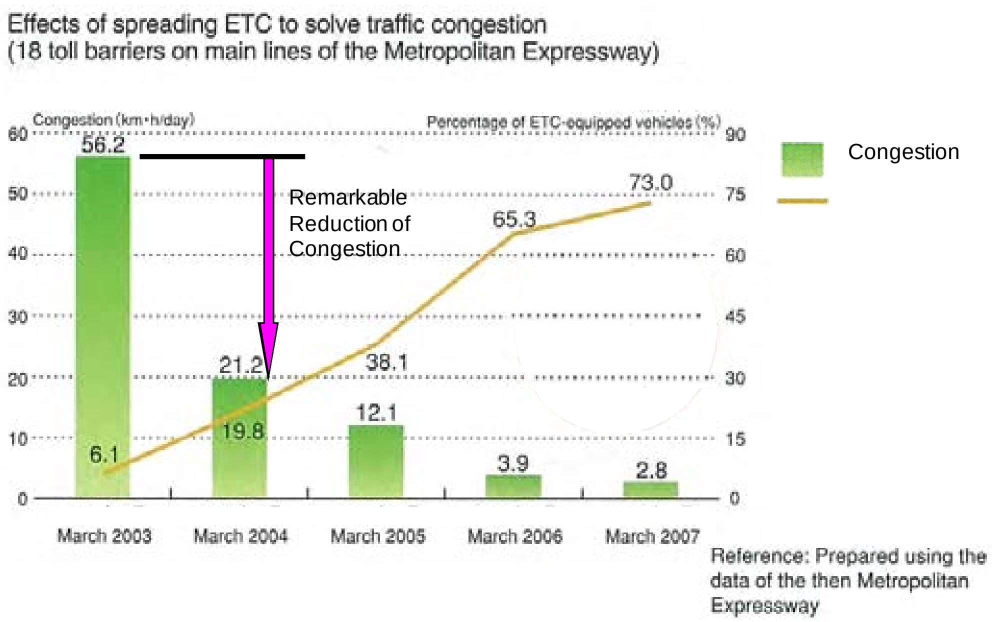
emission in the toll plazas. Japan's experience shows that the rate of OBU-equipped vehicles significantly affects traffic congestion in toll plazas, i.e. serious congestion if only 6.1% of vehicles have OBUs, substantial congestion alleviation if 19.8%, and almost no congestion if 65.3%.

So far, India has limited ETC experience and ETC utilization is still far from being a full-fledged practice. Since the rates of OBU-equipped vehicles in Noida and Gurgaon, both located at the suburbs of Delhi, are low, traffic congestion in these areas has not eased.

By reviewing Japan's experience and India's situation, the following is the suggested ETC development target:

*ETC utilization rate among Hyderabad ORR vehicles should be set at **20%** for the target year of 2021 to alleviate traffic congestion and thereafter enjoy the greater benefits resulting of from efficient traffic flow*

Figure 3.3.1 Impacts of Using ETC System on Traffic Congestion



Source: ITS Japan Handbook 2006-2007

Note: All toll gates data of Metropolitan Expressway Co. Ltd. (18 routes)

Table 3.3.1 Percent of Vehicles Using Toll Payment Methods

	Manual	Touch & Go (Smart Card)	ETC (OBU-equipped Vehicle)
Noida	75%	21%	4%
Gurgaon	60%	40%	
Mumbai – Pune	80%	20%	N.A.
Hyderabad ORR in 2021	40%	40%	20%
NEXCO Japan in 2007	25%	N.A.	75%

Source: Data compiled by SAPI Team

3.3.2 ETC Function Requirements

Desirable ETC system should satisfy multi-dimensional requirements. Those requirements include; (a) system's performance, (b) system's economy, and (c) system's expandability.

(a) System Performance

All toll plazas are single-lane operations with automatic gates. Vehicles stop for toll payment which is accepted by an operator at the booth. At all interchanges, manual and Touch & Go systems are operationally combined in a booth, while the ETC has a separate lane for maximum traffic flows.

ETC enables electronic toll payment/collection and passage of motorists through the toll booth faster and with higher accuracy, security, and lower rates of transaction error. It also discourages fraudulent utilization and protects customers (i.e. automatic vehicle classification and barrier, enforcement camera). In its initial stage and in order to maintain safe driving and accurate operation, an hourly capacity of 800 vehicles on the ETC lane at the minimum must be secured.

Judging from the history of local weather conditions, motorists in the Hyderabad ORR are in no danger of facing fogs, except for the usual heavy rains and strong winds. Therefore, ETC services can be provided with high accuracy. The booth for Manual and Touch & Go is operated combined manner while that of ETC is separated in order to acquire maximum traffic flows.

(b) System Economy

In order to develop an advanced toll collection system in an economical manner, the following should be duly considered:

- Technology transfer from existing products with internationally acceptable standards will avoid research and development costs. Microwave DSRC is the most commonly adopted air interface considering the present ETC systems in countries world-wide, therefore the SAPI team recommends this standard for Hyderabad ORR.

- Technical assistance and transfer of experiences from countries where large scale ETC and HTMC had been introduced in country-wide are desirable for the start up of operation. The SAPI team considers the dialogue between HMDA and Japanese appropriate authority of the international cooperation should be started.
- Expensive ETC gates should not be installed at minor interchanges at the initial stage. For OBU-equipped vehicles, its prepaid IC card can be interoperable with Touch & Go toll collection. According to other countries' experiences, financial and institutional supports to promote the ETC usage are helpful for the initial expansion of the ETC users. These promotions include discount rate for ETC users, initial leasing of OBU by using special funds.
- To make the system simple and economical, OBUs and IC cards should not have vehicle classification features. Vehicle classification is determined by the roadside system at each toll booth, and;
- Promotional campaigns for ETC usage will be done through measures such as wholesale OBU procurement by HGCL to reduce OBU unit cost, free OBU rental or ETC discount services after reaching a certain mileage or an OBU depreciation period.

(c) System Expansion and Upgradability

Hyderabad ORR should develop a reliable and economically feasible ETC system. Considering the future expansion of the national highway in country-wide in India standardization of HTMS and ETC system is desirable in near future. The core technologies should be adoptable for the future modifications. System expandability and upgrading is expected in the following transactions, among others:

- Faster non-stop toll collection service, say, 1,200 vehicles per hour;
- Multi-lane free-flow system. The SAPI team notes the microwave DSRC's adoptability in this issue comparing to the infrared DARC;
- IC card payments for public transportation services and parking charges; and
- Receiving real-time road and traffic information via OBU with display;
- Integrated services of HTMS.

3.3.3 ETC Technology

Considering the six types of ETC (cf. 3.1.2 of this chapter) the SAPI team concluded that the Type 1- OBU based identification should be optional for Hyderabad ORR. Air interface are broadly classified into three: (i) infrared radiation with active OBU, (ii) DSRC with passive OBU and (iii) DSRC with active OBU. Those are compared each other in Table 3.3.2.

Table 3.3.2 Comparison of ETC Technologies

	Infrared DSRC	Microwave DSRC Passive	Microwave DSRC Active
System Performance and future upgrading	• It is relatively weak in certain weather conditions, such as heavy rain and fog. • It can use for free flow toll system but one antenna cannot be available for multi lanes. • Integrated use with Touch & Go is possible if the IC card is usable also for the OBU. • IC card should contain the purse data. • As there are no legal restrictions, personal data cannot be secured.	• Integrated operations with Touch & Go smart card is not possible because IC card contains ID numbers only and fee transactions are conducted by network and server side. • It cannot use for free flow since the range is too short. • High security since its frequency is protected by law.	• It has not been used in India. • Integrated use with Touch & Go is possible if the IC card is usable also for the OBU. IC card should contain the purse data. • It can use for free flow system up to 3 lanes by one antenna. • High security since its frequency is protected by law.
Adopted Areas	Malaysia, India (Noida)	European Countries, India (Gurgaon)	Japan, USA, Korea, China
Manufacturers	Efkon (Austria)	Many, including Kapsh	Many
Production of the equipments in India and other factors	Possible, but infrared components must be provided from a specific manufacturer.	Possible. OBU is most inexpensive and handy because it requires no electric sources.	Possible. Future expandability for Intelligent Transportation System could be promising. Price of the OBU is a bit more expensive than that of infrared.

Note: Compared by SAPI Team

Infrared radiation is electromagnetic radiation whose wavelength is longer than that of a visible light but shorter than that of a microwave. It is practically adopted in many technologies such as night vision, heating, medical care, and communications. The infrared system is affected by weather conditions, such as rain and fog, and by dusty air and dirt on vehicle windows. Obtaining sufficient accuracy in data transmission under such situations is an operational issue.

On the other hand, the DSRC can provide accurate data transmission. Although the 5.8 GHz type is an internationally recognized band, other bands are also used for ETC in the U.S.A. and other countries.

In the case of the passive-type OBU, roadside units (RSUs) emit radio waves to, and receive the reflected waves from, an OBU. The active-type OBU has an independent power supply from the OBU-equipped vehicle. It transmits the required data, such as the attributes of vehicles, to the RSU when receiving radio wave signals from the RSU.

As a result, the SAPI Team recommends the use of the 5.8 GHz DSRC with active OBUs in the Hyderabad ORR project. Moreover, the IC card conforms to the ISO/IEC14443 Type A or Type B. The air interface of the OBU conforms to the wireless DSRC which complies with the ITU-RM. 1453.

3.3.4 ETC Data Flow

In the proposed system, the OBUs and IC cards do not employ vehicle classification features. Vehicle classification is determined by the roadside system in each toll booth. IC cards contain the issuing number and the accounting balance. A central computer system restores the issuing number, interchanges the vehicles that entered and exited, as well as the toll fee paid together with other appropriate information like time and date. These data, in addition to those from the manual and Touch & Go operation, can be utilized for traffic control and management operation in real time.

Figure 3.3.2 shows the basic ETC data flow. Figure 3.3.3 shows the basic data flow in a toll plaza.

3.3.5 Handling process at tollgates of ORR

All tollgates should enable to handle both manual and ETC systems. Some of tollgates of specific ICs, which connect national or state highways, will enable to handle non-stop system. As handling speed of non-stop system is much faster than other systems, adoption of non-stop system is prioritized to the ICs with large traffic volume since it is vital to avoid traffic congestion of toll plazas. Furthermore, reduction of congestion enables to minimize any environmental impact caused by vehicles.

There are two kinds of handling processes depicted by ETC (refer to Figure 3.3.4) and by manual and smart card (refer to Figure 3.3.5).

Figure 3.3.2 Data Flow of Overall ETC System

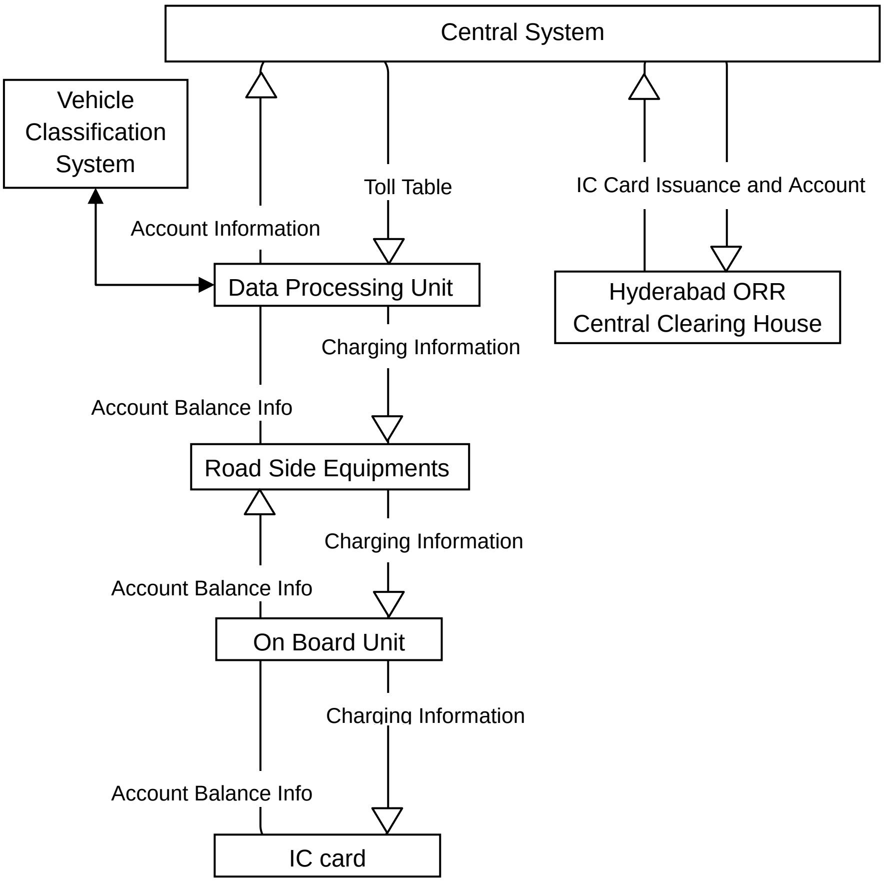
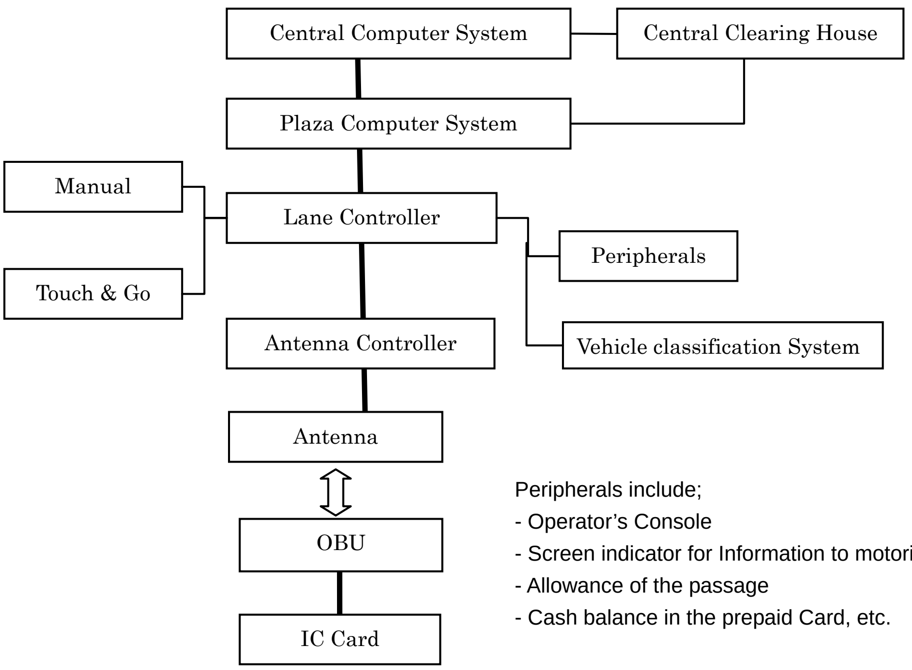


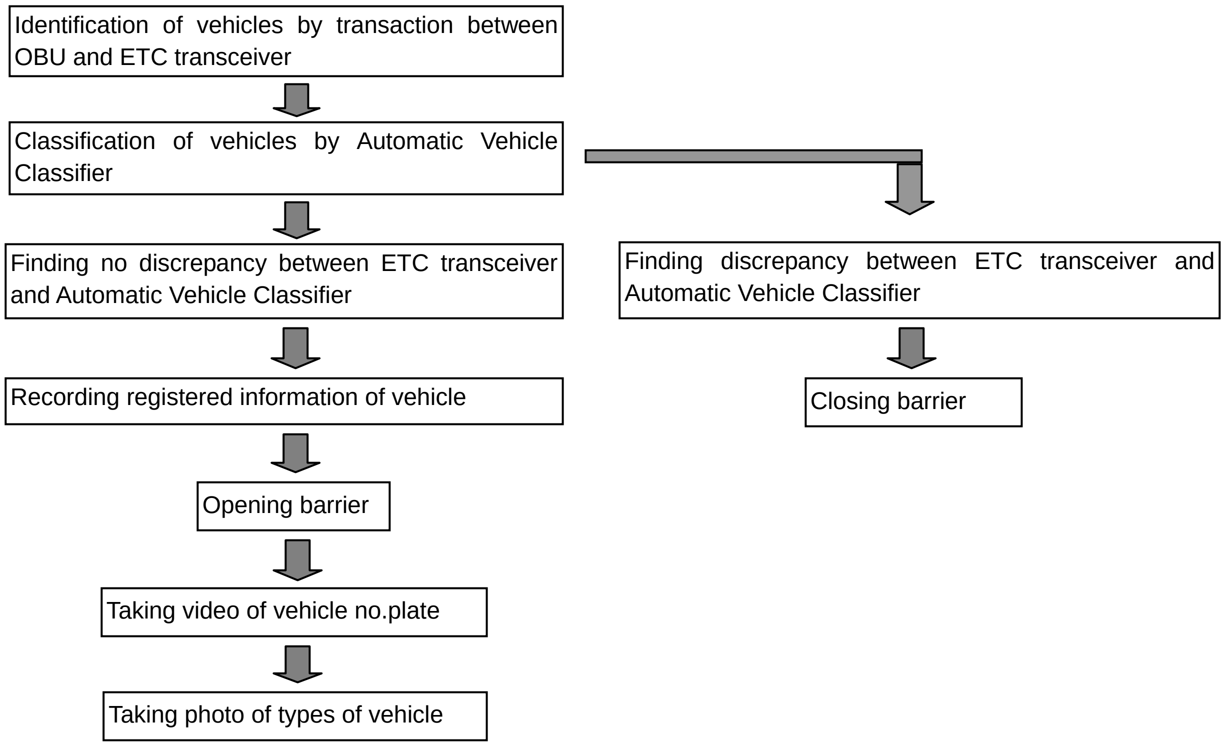
Figure 3.3.3 Data Flow at Toll Plaza



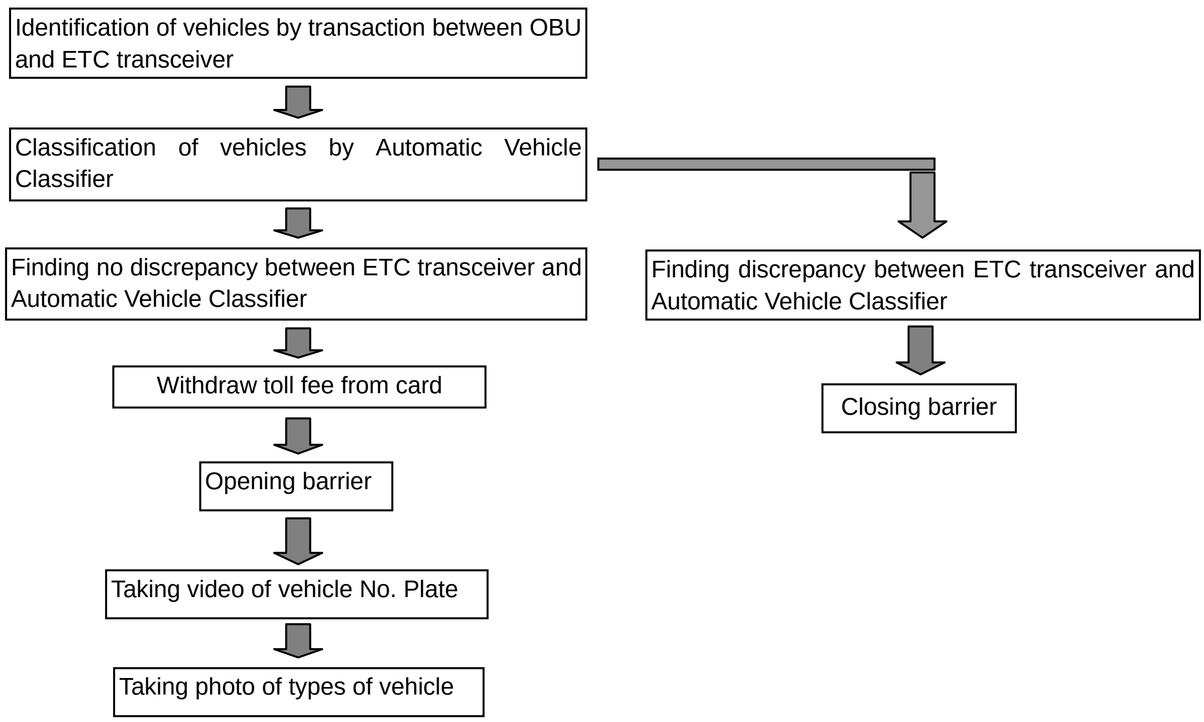
Peripherals include;
- Operator's Console
- Screen indicator for Information to motorist
- Allowance of the passage
- Cash balance in the prepaid Card, etc.

Figure 3.3.4 Handling Process of Non-stop Tollgate System

i. Entry



ii Exit



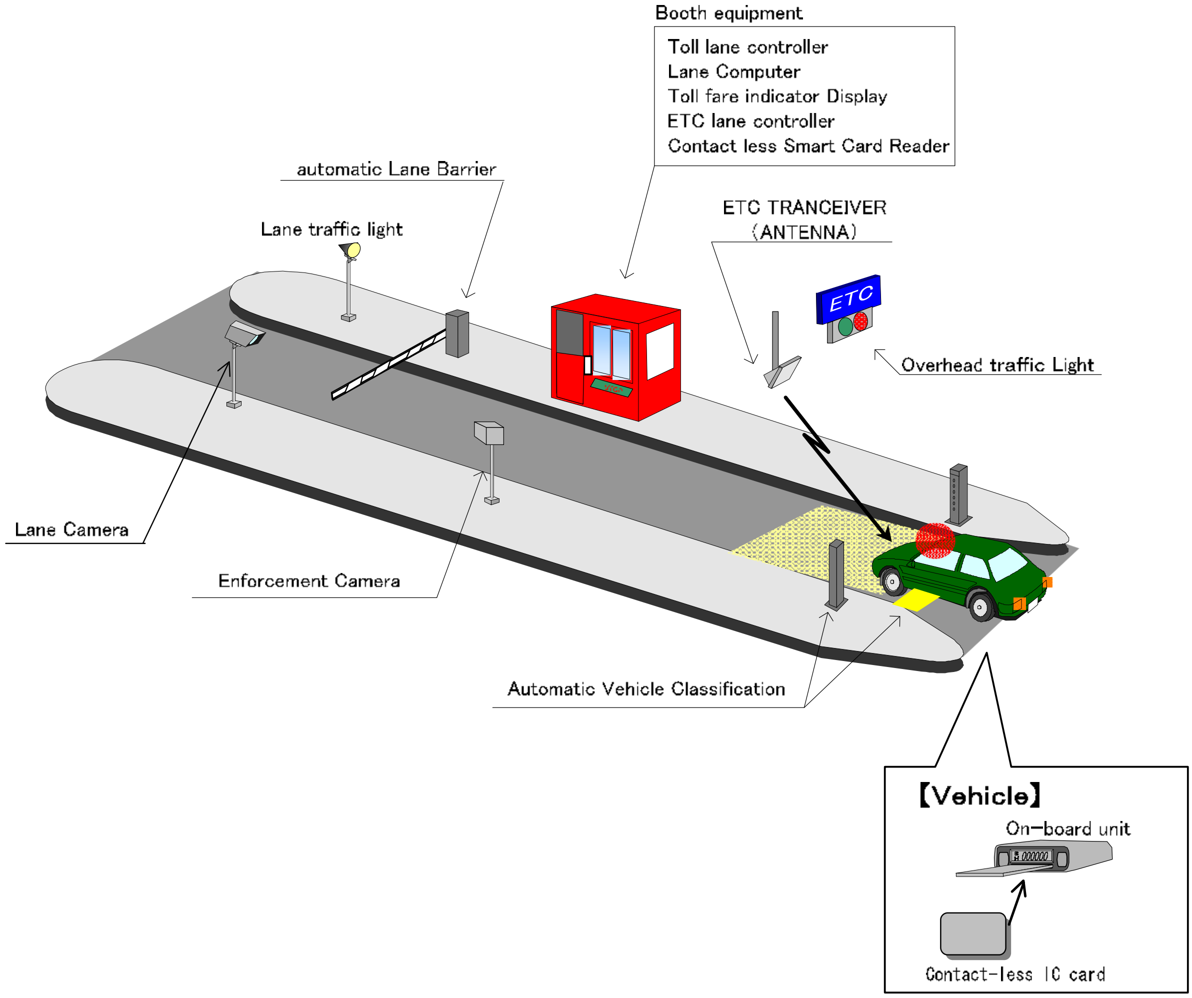


Figure 3.3.5 Handling Process of Manual and Smart Card Tollgate System

i. Entry of Manual System

Classification of vehicle by operator
⇩
Operator input classification of vehicle
⇩
Passing transit card to driver
⇩
Barrier open
⇩
Taking video of vehicle No. Plate
⇩
Taking photo of types of vehicle

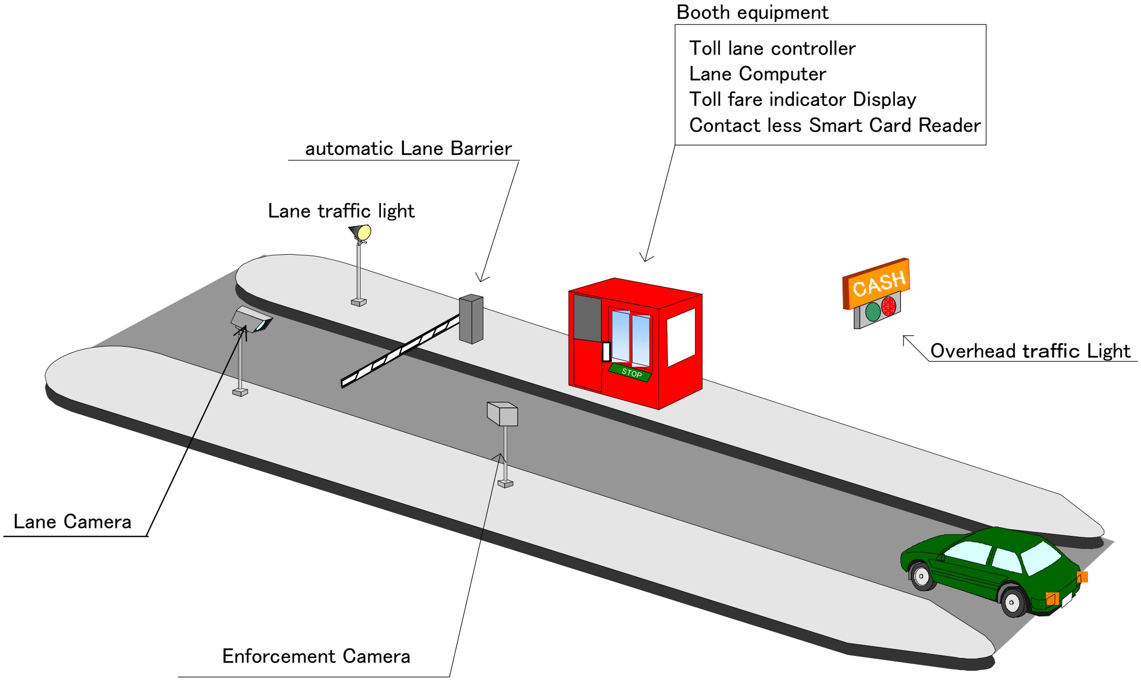
ii. Exit of Manual System

Classification of vehicle by operator
⇩
Operator input classification of vehicle
⇩
Passing transit card and toll fee to operator
⇩
Barrier open
⇩
Classification of vehicle by Automatic Vehicle Classifier
⇩
Taking video of vehicle No. Plate
⇩
Taking photo of types of vehicle

iii. Entry of Smart Card System

Classification of vehicle by operator
↓
Operator input classification of vehicle
↓
Put smart card on card reader
↓
Finding no discrepancy between smart card and operator's recognition
↓
Barrier open
↓
Taking video of vehicle No. Plate
↓
Taking photo of types of vehicle

Finding no discrepancy between smart card and operator's recognition → Finding discrepancy between smart card and operator's recognition
↓
Barrier close



iv. Exit of Smart Card System

Classification of vehicle by operator

↓

Operator input classification of vehicle

↓

Put smart card on card reader

↓

Finding no discrepancy between smart card and operator's recognition

↓

Barrier open

↓

Classification of vehicle by Automatic Vehicle Classifier

↓

Taking video of vehicle No. Plate

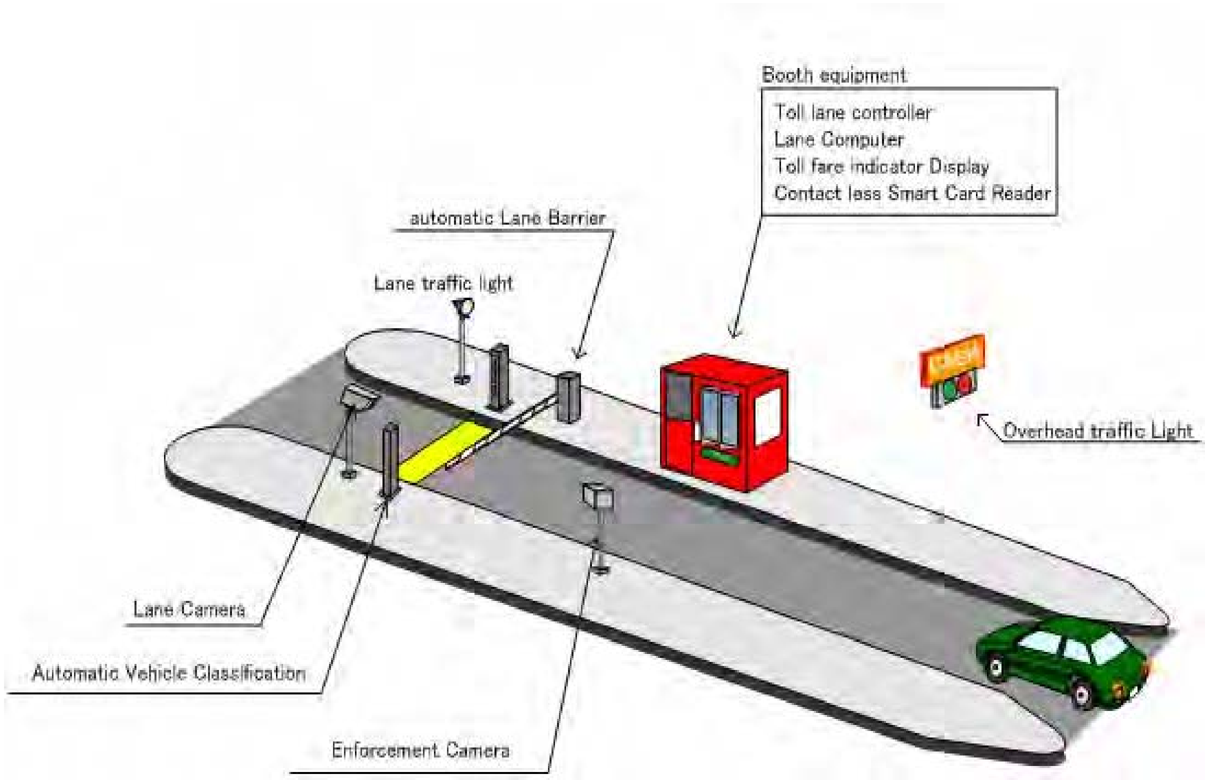
↓

Taking photo of types of vehicle

(Put smart card on card reader →) Finding discrepancy between smart card and operator's recognition

↓

Barrier close



3.4 Proposed ITS Configuration

3.4.1 ITS Network

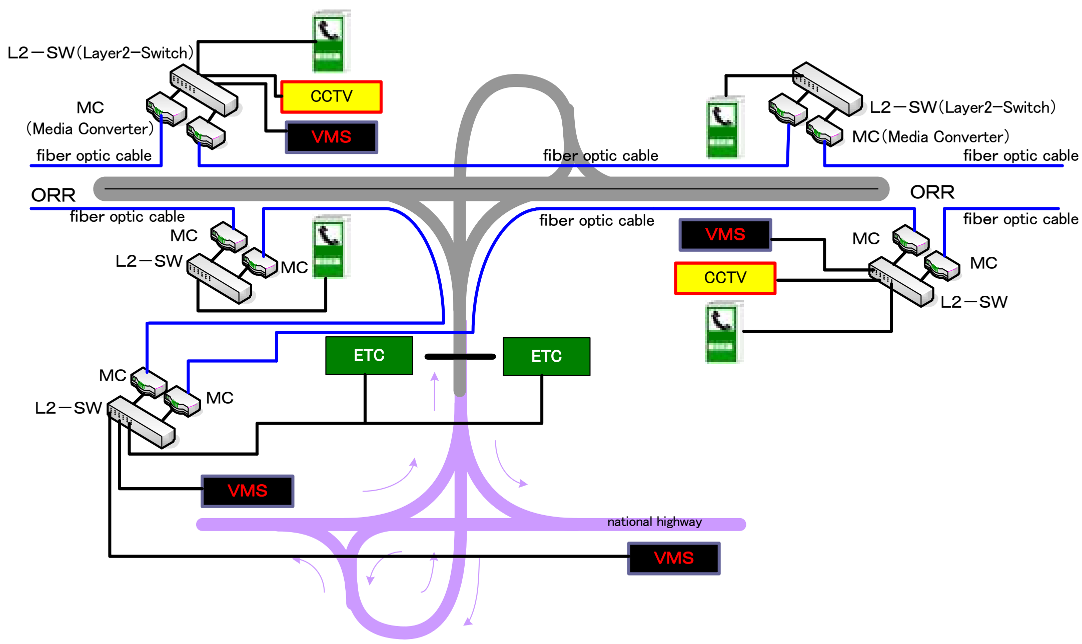
The SAPI team recommends adoption of IP (Internet Protocol) as a telecommunication tool from TCC to all road terminals of the ORR. TCP/IP should be adopted as communication protocol since they spread on the world internet widely.

In order to achieve convenient access network for TCC, fiber optic cable is suitable for long-distance transmission since it enable to transmit around 1,000 times more than copper cable. As ORR will require many more CCTV with increasing of traffic in future, tremendous amount of data need to send to TCC immediately through fiber optic cable.

To avoid unexpected network suspension and improve system reliability, risk mitigation measures such as installation of cables both inner and outer of the ORR and dividing system are useful.

Terminals at the interchanges and on both sides of the main corridor accommodate as layer2-switches. Installation of layer2-switches and other facilities on the main corridor nearby each ECB can minimize cost.

Figure 3.4.1 Accommodation of the road terminal



3.4.2 Overall System Configuration

The overall ITS proposed for the Hyderabad ORR is illustrated in Figure 3.4.2. The detailed ITS network is designed in Figure 3.4.3 wherein the TCC manages all ITS equipment to be installed along the corridor, such as ETC, ECBs, VMSs, CCTVs, and others.

Emergency Communication System

The quantity of ECBs summed up 164 units according to 2km spaces deployment. The cost of ECBs composed of followings.

- Fiber Electric Interface
- Housing
- Solar panel, Voltage regulator and battery charger
- Civil work to supply and install plinth
- Complete clean earth facility for equipments of ECBs
- Installation of ECB systems

Variable Message Sign System

The quantity of VMS summed up 22 units. The cost of VMS composed of followings.

- Full matrix outdoor single color VMS board :3lines×20 characters, 35cm character height, single amber LED color.
- VMS control module
- Gantry with access ladder, cat walk, guard rail, etc
- Foundation, ducting, etc as per drawings and specifications
- Controller Cabinet with foundation plinth
- Complete earthing facility for VMS equipment
- Lighting and Surge protection for VMS
- VMS Power Supply Module ……

Meteorological Data System

MDS should install only one at TCC. The cost of MDS composed followings.

- Multi Sensor
- Visibility Sensor
- Mast Holding Assembly 4 Mtrs Height
- Solar Panel 15watt
- Rechargeble battery (12V 120Ah)
- Battery Charger
- Data Logger
- Display Unit 40cm×30cm
- Cable cost
- Enclosure
- Installation

Automatic traffic counters-cum-classifier system

The quantity of ATCC summed up 38 units. The cost of ATCC composed of followings

- ATCC with installation cost

Traffic Control Center

The cost of TCC composed of followings.

- VMS server
- IP video receiver c/w rack chassis and CCTV receiver card
- Stand-alone network recorder 1 TB
- TCC workstation
- ECB workstation
- Interfacing equipments with fiber converter rack and IP telephony converter.
- MET workstation
- TCC integrated server

Optical Fiber Cable

The quantity of Optical fiber cable summed up 352.2km. The cost of Optical fiber cable composed of followings

- 12core SM armored fiber cable along with installation works

Preliminaries and Provisions

- Storage of equipments for office
- Insurance, workmen's compensation
- Storage of equipments for site
- Travel & subsistence costs for prototype tests at place of manufacture
- Complete test units for pre-installation testing by HGCL 24-hour burn-in process on stand alone and integrated for 1 month
- Training for operation and maintenance for toll lane controller, lane equipments, plaza equipments, networking equipments, vehicle classification stations, POS system, head quarter electronic toll correction system, POS ETCs, head quarter manual cash collection system, real time monitoring system, module at HGCL office and staff control system
- 10 sets of users and maintenance manuals for each toll plaza
- Routine and curative maintenance for 2 years

CCTV

The quantity of CCTV summed up 41 units. The cost of CCTV composed of followings

- Video Cameras PTZ with gantry, pole, motorized housing, fiber converter and power supply module
- Clean earth facilities
- Installation

Manual and Touch & Go system

The quantity of manual and touch & go system summed up 157 units. The cost of it composed of followings

- Lane control system with microprocessor, 80GB hard disc, internal and external cabling, 15 SVGA TFT monitor and lighting protection system.
- User fare display with traffic light system & siren
- Overhead LED light system

- Intercom slave inside the toll booth
- Emergency foot switch
- Receipt printer – thermal
- Incident capture camera system
- Automatic lane barrier
- Manual lane barrier
- Lane smart card reader
- Automatic vehicle classification of AVC system with the optical barrier sensors and the optical height detection sensors
- Biometric security rock
- Classification repeater sign
- Fog light system

ETC system

The quantity of ETC system summed up 24 units. The cost of ETC system composed of followings

- Lane control system with microprocessor, 80GB hard disc, internal and external cabling, 15 SVGA TFT monitor and lighting protection system.
- User fare display with traffic light system & siren
- Overhead LED light system
- Incident capture camera system
- Automatic lane barrier
- Manual lane barrier
- ETC lane reader system with gantry and necessary accessories
- Automatic vehicle classification of AVC system with the optical barrier sensors and the optical height detection sensors
- Fog light system

Plaza Machinery

The quantity of plaza machinery summed up 20 units. The cost of plaza machinery composed of followings

- Toll plaza server
- Audit workstation
- Lane status display unit 17 TFT
- Tour of duty workstation 17 TFT
- POS workstation 17 TFT
- POS smart card reader
- POS receipt printer
- Audit printer – Laser jet
- Tour of duty printer – Laser jet
- TMS server
- Master intercom
- Slave intercom inside plaza

- Slave intercom for main entrance, main gate and staff gate
- To supply, deliver and install network equipment
- Uninterruptible power supply (UPS) with 30 minutes back up
- Stabilizer and transformer 25 KVA servo controlled
- Power distribution board

Software

The quantity of software summed up 34 units. The cost of software composed of followings:

- Windows 2003 server 20 Lic
- Windows XP embedded 181 units
- ORACLE 10G 20 units
- Antivirus and firewall 20 units
- Booth client Lic 181 units
- Plaza computer system 20 units
- Tour of duty software 20 units
- Lane status display system 20 units
- Audit & reporting module 20 units
- Point of sale functionality 20 units

Cable

The quantity of cabling summed up 181 units. The cost of cabling composed of followings

- Control cables from LCS to peripherals
- Communication cable for intercommunication between remote station unit and master station unit

CCTV for plaza

CCTVs for plaza are composed of the following:

- Dome camera inside the booth (157)
- Dome camera for plaza (20)
- Plaza surveillance camera (80)
- 16 channel DVR system inclusive of PC for recording with 250GB HDD (24)
- Cabling for CCTV (157)

Preliminaries and provisions

- Storage of equipments for office
- Insurance, workmen's compensation
- Storage of equipments for site
- Travel & subsistence costs for prototype tests at place of manufacture
- Complete test units for pre-installation testing by HGCL 24-hour burn-in process on stand alone and integrated for 1 month
- Training for operation and maintenance for toll lane controller, lane equipments, plaza equipments, networking equipments, vehicle classification stations, POS system, head

quarter electronic toll correction system, POS ETCs, head quarter manual cash collection system, real time monitoring system, module at HGCL office and staff control system

- 10 sets of users and maintenance manuals for each toll plaza
- Routine and curative maintenance for 2 years

Figure 3.4.2 Overall ITS Development Plan for the Hyderabad ORR

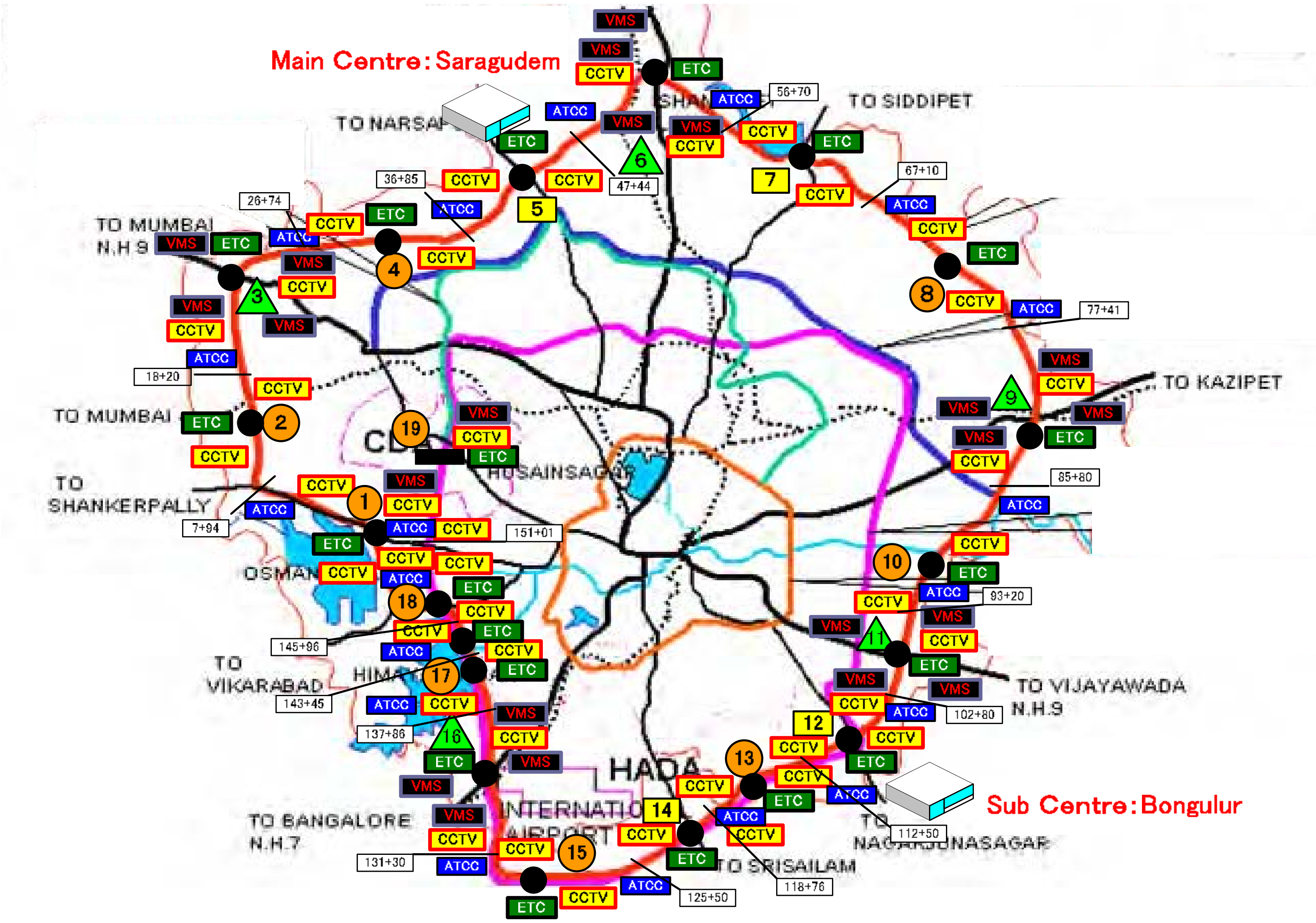


Figure 3.4.3 Detailed ITS Network Configuration (1/3)

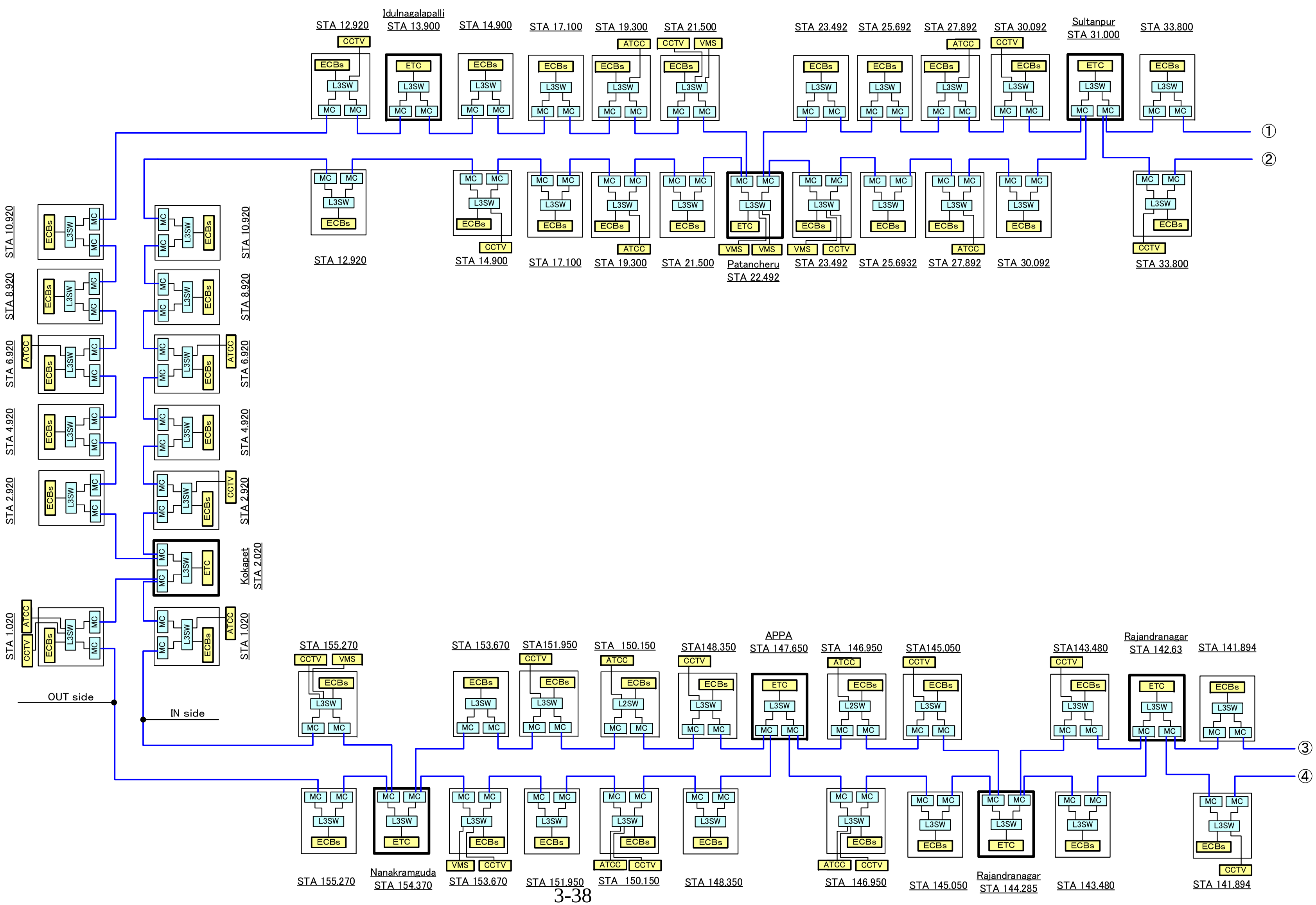


Figure 3.4.3 Detailed ITS Network Configuration (2/3)

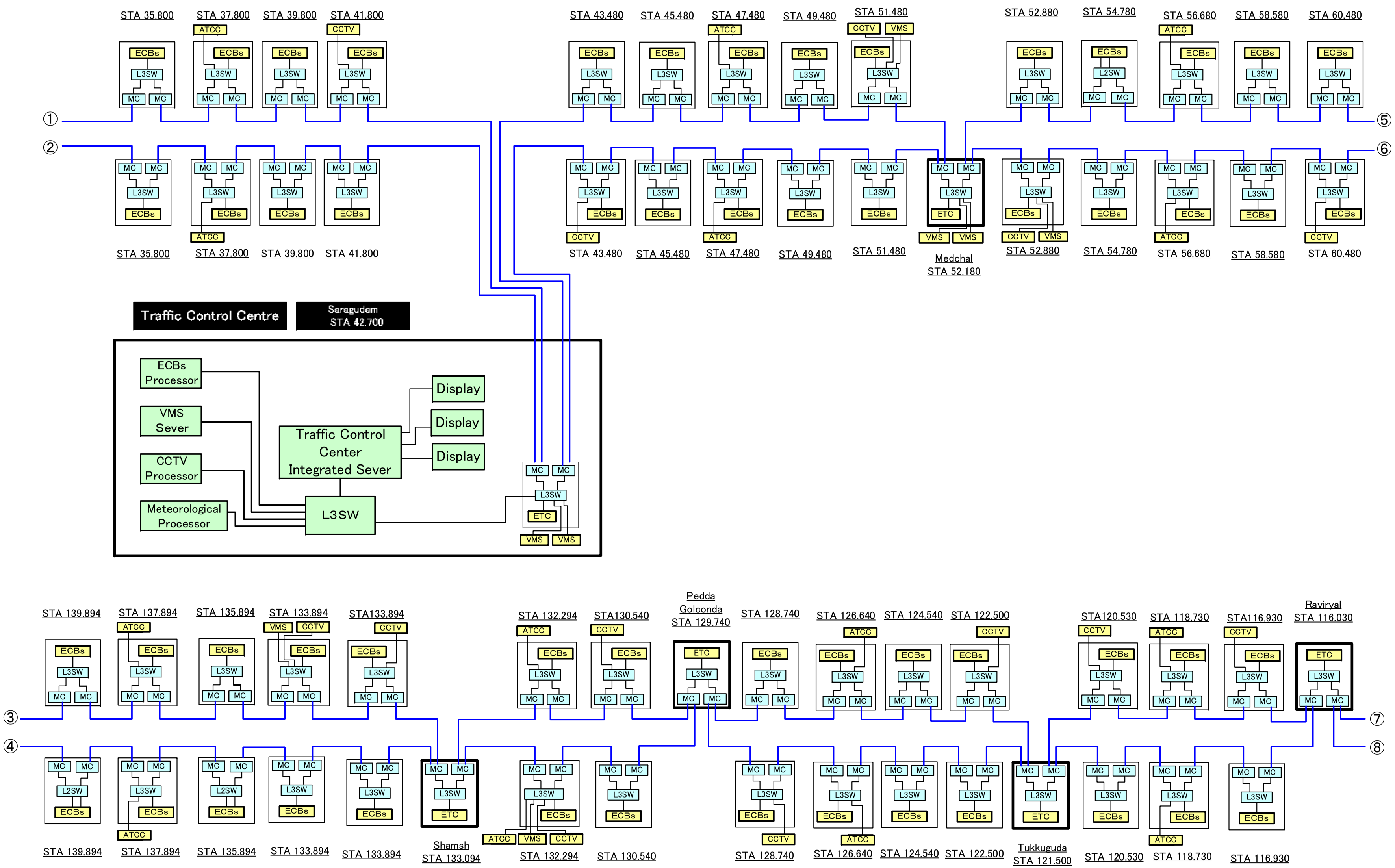
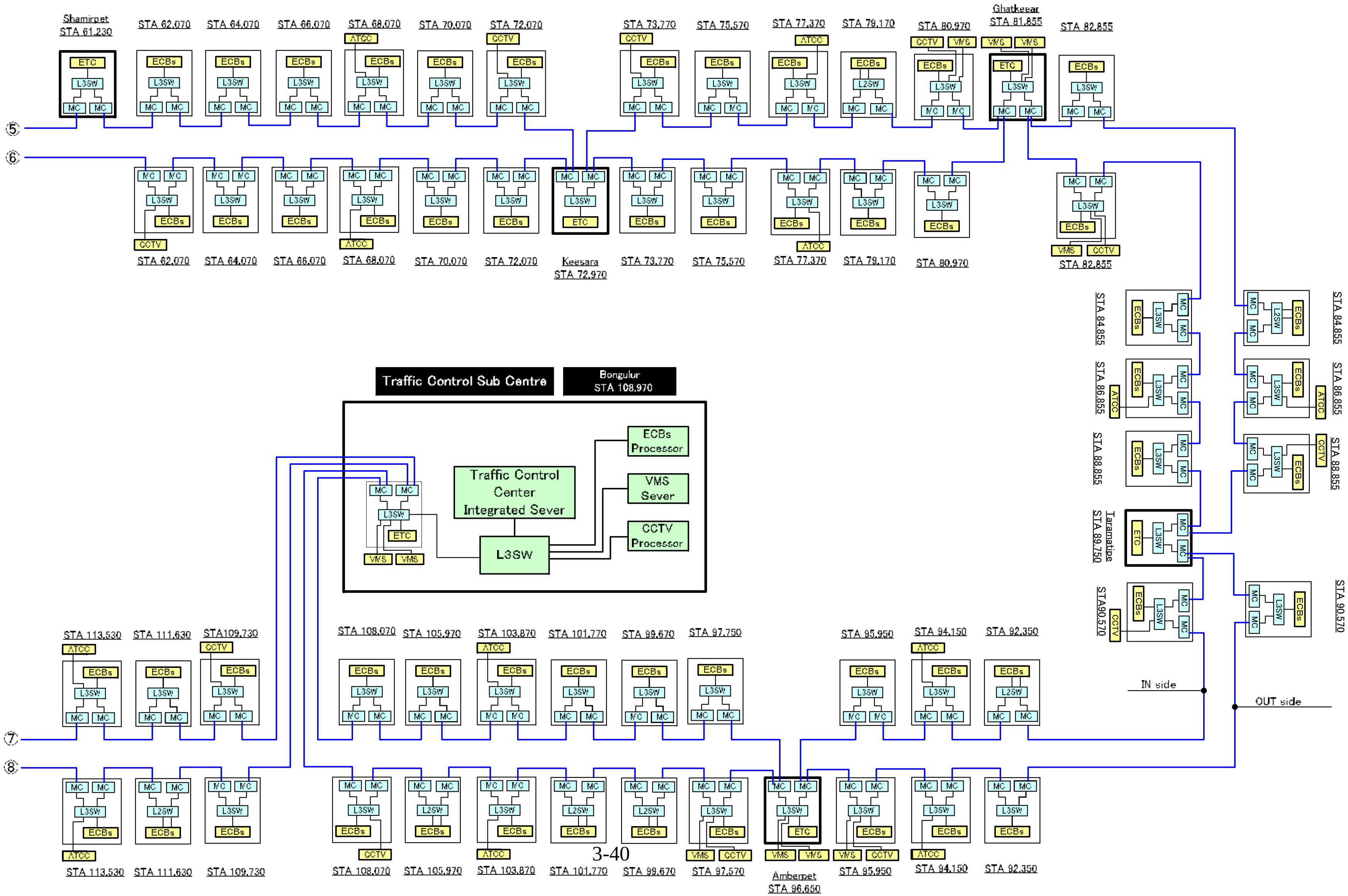


Figure 3.4.3 Detailed ITS Network Configuration (3/3)



3.4.3 Cost Estimates

The total project cost is preliminarily estimated at 4,211 million Japanese Yen excluding project management consultation fees. The aggregated cost has the following subcomponents: (Refer to Table 3.4.1)

HTMS: The original HTMS scope, including emergency communication, VMS, meteorological data and ATCC and excluding power supply, is calculated at 927 million Japanese Yen. Mainly, traffic control center and fiber optic cable are added to the original HMTS plan, which cost 848 million Japanese Yen. The total amount is calculated at 2,253 million Japanese Yen, inclusive of preliminaries and provisions.

CCTVs: These will be installed along the main corridor and at the toll plazas. CCTVs along the main corridor will cost 138 million Japanese Yen.

Toll Collection System: It consists of toll booth equipment for manual, Touch & Go, and ETC systems, their operating software, and the CCTVs. It does not include building structures such as toll gates and toll plaza offices. The total amount is estimated at 1,735 million Japanese Yen inclusive of preliminaries and provisions.

Others: Other networking and power supply related equipment amount to 86 million Japanese Yen.

In addition to the ITS equipment procurement and installation mentioned above, project management consultancy services are important. The fee is estimated at 152 million Japanese Yen. The breakdown is indicated in Table 4.2.3.

Table 3.4.1 Cost Estimates

	Amount (INR)	Amount (Yen)
HTMS		
Emergency Communication System	82,000,000	172,200,000
Variable Message Sign Boards	242,000,000	508,200,000
Meteorological Data System	3,400,000	7,140,000
Automatic Traffic Counter Classifier	114,000,000	239,400,000
Traffic Control Center	43,800,000	91,980,000
Fiber Optic Cable & Installation Cost	360,000,000	756,000,000
Preliminaries & Provisions	227,600,000	477,960,000
Sub-total	1,072,800,000	2,252,880,000
CCTV System	65,600,000	137,760,000
Toll Collection System		
Cash + T&G Lanes	201,195,500	422,510,550
ETC Lanes	76,260,000	160,146,000
PLAZA LEVEL	137,220,000	288,162,000
SOFTWARES	124,072,000	260,551,200
CABLING WORKS	8,145,000	17,104,500
CCTV	51,720,000	108,612,000
Preliminaries & Provisions	227,600,000	477,960,000
Sub-total	826,212,500	1,735,046,250
Network & Power		
Fiber Convertor Box	90,500	190,050
Media Convertor	4,344,000	9,122,400
Layer 3 Switch	5,068,000	10,642,800
Generator(40KVA)	11,250,000	23,625,000
Uninterruptable Power Supply (UPS)	20,000,000	42,000,000
Sub-total	40,752,500	85,580,250
Grand Total	2,005,365,000	4,211,266,500
Project Management Consultant Service		151,937,000

Note: Exchange rates: Rs 1.0 = JPY 2.1

Chapter 4 ITS Bidding and Procurement

4.1. ITS Bidding Scheme

To execute the project smoothly, a broad knowledge of various kinds of ITS equipment are required for both consultants and contractors because their task does not only cover design and supervision but also the examination of the quality of equipment and connectivity. The contractor has to cooperate with various suppliers for the design, importing, and installation of equipment. Contractors should be divided into two: one for advanced HTMS equipment and another for tolling management service (TMS) equipment. This is due to the following reasons:

a) The advanced HTMS, mainly consisting of emergency telephone system, variable message signs, traffic counter classifiers, weather monitoring, etc., are largely hardware and electronics material having less software integration. The major software component is only in the Traffic Control Center (TCC) where the subsystems are integrated to enable data access from all the subsystems. The ITS facilities are connected by a fiber optic network throughout the ORR;

b) The TMS on the other hand has a lot of software subcomponents which are crucial for payment collection and statistics. The TMS will work mainly on the LAN and in integrating with the TCC through the fiber optic network;

c) There are very few companies who can supply both the advanced HTMS and TMS solutions with satisfactory track records; and

d) Since the work involved in the two equipment procurement and installation contracts is huge and in order to implement the project on schedule, it would be advantageous to divide the overall work into two contracts.

For a smooth construction phase, it is thus suggested to HGCL that the three contracts be made through international competitive bidding (ICB).

4.2. Draft ITS Bidding Documents

The bidding documents for both the advanced HTMS and TMS can share the same contents, as follows:

- Section I Notice Inviting Tender
- Section II Instructions to Bidders
- Section III General Conditions of the Contract
- Section IV Special Conditions of the Contract
- Section V Scope of Work
- Section VI Technical Specifications

- Section VII Bill of Material and Formats for Submission of Proposals
- Section VIII HGCL Approved Bank Guarantee Formats

The SAPI Study drafted sections V and VI for both the contracts. The following annexes show them, as follows:

- Annex 3 Scope of Work for the Advanced HTMS Equipment
- Annex 4 Technical Specifications for the Advanced HTMS Equipment
- Annex 5 Scope of Work for the TMS Equipment
- Annex 6 Technical Specifications for the TMS Equipment

4.3. Draft Documents for PMC

Under the Phase-2 Yen Loan Agreement, a project management consultant (PMC), which will be responsible for project supervision and technical assistance on the preparation of an ITS operation and management manual, will be hired. This section aims at assisting PMC contract to be done by HGCL.

4.3.1. Contents of the Request for Proposal

For PMC employment, a set of documents are needed for the Request for Proposal (RFP). The RFP usually contains the following:

- Section 1. Letter of Invitation
- Section 2. Information to Consultants
- Section 3. Form of Contract
- Section 4. Terms of Reference
- Section 5. Forms of Technical Proposal
- Section 6. Forms of Financial Proposal
- Section 7. List of Eligible Source of Countries of Japan ODA Loans

The HGCL has an experience in procuring PMC services under the Phase-1 Yen Loan Agreement. Most RFP documents are almost the same except for Section 4, since the Phase-1 Yen Loan employs only a supervision consultant for civil works. However, Section 4 of this RFP under the Phase-2 must indicate ITS-related consultancy services.

In general, the Terms of Reference (TOR) clearly indicates: (1) project background, (2) tasks, (3) scope and services, (4) expected outputs, (5) duties and qualifications of the consultant, and (6) responsibilities and rights of the client. The next pages show specific PMC service characteristics and conditions in a typical TOR format.

4.3.2. Draft TOR

(1) Introduction

1.1 In order to provide orbital linkage to decongest traffic on the existing arterials and to guide an orderly urban growth management, the Government of Andhra Pradesh is constructing the Hyderabad Outer Ring Road (ORR) through an SPV, the Hyderabad Growth Corridor Limited (HGCL), which receives financing through various sources. The details of the various ORR sections are presented in the table below.

Table 4.3.1 Hyderabad ORR Project

No.	ORR Section	From Ch :	To Ch :	Length in KM	Type of Contract	Phase	Status	Expected Completion Date
1	Gachibowli to Shamshabad	0.00	24.38	24.38	Construction and 2-year Maintenance	I	Partly Completed and the balance work is in progress	Dec. 2009
2	Narsingi to Patan Cheruvu	0.00	23.8	23.8	BOT Annuity	II A	Work is in progress	June 2010
3	Shamshabad to Pedda Amberpet	133.63	95.00	38.63	BOT Annuity	II A	Work is in progress	June 2010
4	Patan Cheruvu to Pedda Amberpet via Kandlayoya	23.7	95.00	71.30	Construction and 2-year Maintenance under a JICA loan	II B	Proposed to be tendered in Feb. 2009	Dec. 2011
	Total			158.01				

Note) As of February 2009

1.2 The ORR, designed to operate as an access-controlled expressway, needs to provide efficient traffic information and management services including toll collection. Toward this end, the HGCL decided to introduce an integrated intelligent transport system (ITS) to the ORR. It is now in the process of finalizing the tenders through an international competitive bidding to implement ITS works on the entire ORR. ITS works will be supervised by the winning bidder on behalf of the HGCL (the Employer).

(2) ITS Works

2.1 The ORR's ITS development plan encompasses the following:

a) Installation of optic fiber cable along both the sides of the main ORR carriageway for a total length of 352.2km;

b) Installation of an emergency communication system in the form of emergency call boxes (ECBs) on both sides of the ORR at an interval of 2.2 km (maximum) or a total number of 178 ECBs. All the ECBs with individual identification numbers will be connected to the TCC and sub-TCCs through an optic fiber cable (which will be laid out on both sides of the entire length of the ORR). The ECBs gather information regarding incidents or accidents from the drivers, record the communication on voice recorders, and transfers calls to the appropriate organizations;

c) Installation of variable message signs (VMSs) at toll gate entrances on six major interchanges connecting national highways and on the main corridor from Gacchibowli to Narasingi. The most significant information will be provided from the TCC to the road users through VMSs which will have a total number of 22;

d) Installation of automatic traffic counter cum classifiers (ATCC) across the full width of the ORR carriageway, i.e. on main carriageways between every interchange. The information will be transferred to the TCC through an optic fiber cable. The total number of ATCCs will be 38;

e) Construction of a 25kw power substation, including power supply rooms, near the TCC and sub-TCCs to provide uninterrupted power supply. To provide instant power in cases of power failures, power supply systems will also be installed at all the 19 interchanges to provide power to various equipment, including the ITS along the ORR and ETC installations at toll plazas as well as electricity for staff and administrative buildings. The scope does not include the lighting at the interchanges;

f) Construction of one Traffic Control Center (TCC) near Saragudem and one sub-TCC near Bongulur, both located along state highways. A TCC is designed to collect information from CCTVs, ECBs, ATCCs, etc., and disseminate the collected information to road users through the internet, SMS, VMS, etc. Patrol and rescue forces are also deployed at both locations. One meteorological monitoring system is attached to a TCC. A sub-TCC functions as back-up unit in terms of information services;

g) Installation of a CCTV camera system as per specifications in all the 19 interchanges including the three sides of the the Narsingi junction so as to monitor real-time traffic flow visually at both the TCC and sub-TCC. The total number of CCTV installations is 41.

h) Installation of toll gate systems which include toll collection through three (3) modes: manual method, touch-and-go method using smart cards, and nonstop toll collection system. As per specifications, an electronic toll collection (ETC) system will be installed only at the toll gates of all interchanges on national highways, state highways, and at portions of the ORR from Gacchibowli and Narsingi. In addition to these is the installation, per design, of toll plaza machinery in all 19 toll plazas. The total number of ETC toll gates is 181 which includes the 60 non-stop toll gates.

(3) Scope and Services

3.1 The duration of the PMC contract is 15 months, and the PMC has three (3) tasks, to wit:

- Task 1 - Supervision of ITS equipment installation;
- Task 2 - Preparation of ITS operation and management manual; and
- Task 3 - Provision of ITS training programs.

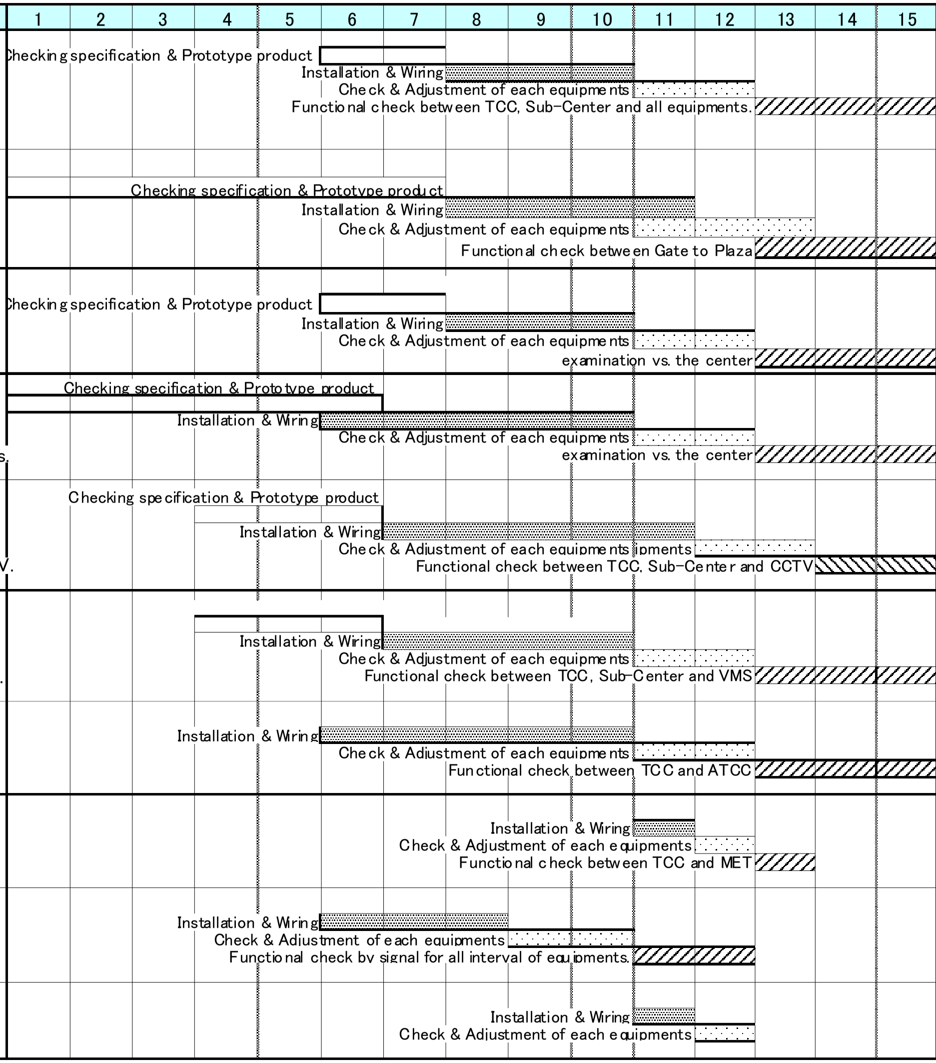
3.2 Task 1: The broad scope of work of supervision consultancy includes checking specifications and prototype products, installations and wiring, checking and adjustment of each equipment, and the functional checking between the TCC, sub-TCC, and all other ITS equipment. Due to the long length (158km) of the project corridor and the various interrelated construction sites along its alignment, the PMC must conduct proper coordination among various agencies not only for the ITS equipment installation schedules but also for civil works contracts. (Refer to Figure 4.2.1)

3.3 Task 2: A set of ITS operation and management manuals will be produced to manage the proposed Hyderabad ORR ITS after the ITS equipment contractors and the PMC have served their contracts. The manuals will be divided into two: (i) information collection, analysis and provision services, and (ii) toll collection related services. For efficient operation and management, the manuals will be designed in a user-friendly manner. The users' major working areas are at the TCC and sub-TCC, and other field sites. The manuals must be compact and portable.

3.4 Task 3: The PMC will provide training programs to personnel in charge of ITS operation, management bodies based on ITS operation, and management manuals through the cooperation with ITS equipment contractors.

Figure 4.3.1 Schedule of ITS Equipment Installation

Schedule	Remark
TCC、Sub-center ・Checking specification & Prototype product ・Installation&Wiring ・Check & Adjustment of each equipments ・Functional check between TCC, Sub-Center & all equipments.	
Toll Gate (Manual,SmartCard,ETC) ・Checking specification & Prototype product ・Installation&Wiring ・Check & Adjustment of each equipments ・Functional check between Gate to Plaza	・Installation work should overlap 1 month into construction of toll gate for visualy well-finished. ・Requiring 2 parties for supervising all Toll Gates & each Toll Gate takes 1
Toll Plaza ・Checking specification & Prototype product ・Installation&Wiring ・Check & Adjustment of each equipments ・Functional check between Gate, Plaza and TCC.	
ECBs ・Checking specification & Prototype product ・Installation&Wiring ・Check & Adjustment of each equipments ・Functional check between TCC, Sub-Center & ECBs,	・Requiring 5 parties for supervising all ECBs for installation & Wiring.
CCTV ・Checking specification & Prototype product ・Installation&Wiring ・Check & Adjustment of each equipments ・Functional check between TCC, Sub-Center & CCTV.	・Requiring 2 parties for supervising all CCTV for installation & Wiring.
VMS ・Installation&Wiring ・Check & Adjustment of each equipments ・Functional check between TCC, Sub-Center & VMS.	
ATCC ・Installation&Wiring ・Check & Adjustment of each equipments ・Functional check between TCC and ATCC.	・Requiring 2 parties for supervising all ATCC for installation & Wiring.
MET ・Installation&Wiring ・Check & Adjustment of each equipments ・Functional check between TCC and MET.	
Network& Optical fiber cable ・Installation&Wiring ・Check & Adjustment of each equipments ・Functional check by signal for all interval of equipments	・Requiring 2 parties for supervising all OFC for installation & Wiring.
GENERATOR ・Installation&Wiring ・Check & Adjustment of each equipments	



(4) **Deliverables**

4.1 The PMC will prepare and submit the following reports to the employer in both hard and soft copies (Table 4.2.2) and in the format prepared by the PMC, as approved by the employer.

4.2 Monthly Progress Reports: The PMC will, not later than the 10th of each month, prepare a brief progress report summarizing the work accomplished by the supervisory team for the preceding month. The report will outline the problems encountered (e.g., administrative, technical or financial) and submit recommendations on how to overcome them. The report should record the Contractors monthly certificates of all claims for cost or time extensions, and the actions required of government and other agencies to allow unconstrained work implementation.

4.3 Quarterly Progress Reports: The PMC will prepare a comprehensive report summarizing all activities under the services at the end of each quarter, and also at other times when warranted by either the PMC or the Employer due to delays in construction work or due to technical or contractual difficulties. Such reports shall summarize the following elements: (i) activities of the PMC, (ii) progress of the Contracts, (iii) all contract variations and change orders, and (iv) status of Contractor's claims, if any; etc.

4.4 Task Completion Reports: The PMC will prepare Task Completion Reports upon completion of each of the three (3) major tasks. Each report will have different contents from the same perspective: problems encountered, solutions undertaken, and recommendations for future projects of similar nature to be undertaken by the employer. Each report will contain the following tasks:

- Task 1 Report will include the summary of construction/installation methods, the type of supervision performed, and final ITS specifications and drawings;
- Task 2 Report: will include the ITS operation and management manuals; and
- Task 3 Report will include the ITS training materials and records.

4.5 Final Completion Report: The PMC will prepare a comprehensive Final Completion Report for each of the major work components after the work reaches a stage of substantial completion during the period of services. The report must be submitted immediately after the completion of the work by the contractor and before the takeover of such stretches by the employer.

Table 4.3.2 Report Requirements

Report	No. of Copies
1) Monthly Progress Report	5
2) Quarterly Progress Reports	5
3) Task Completion Reports	10
4) Final Completion Report with CD	10

(5) **The PMC**

5.1 The PMC will be composed of a team of key experts and includes subprofessional staff and field support personnel. There will be five (5) key experts, consisting of international and domestic consultants, while its subprofessional staff and field support staff will all be Indian nationals.

5.2 The PMC key experts are the Team Leader, Senior ETC Expert, Senior ITS Expert, ETC Expert, and ITS Expert. Their duties, qualifications, and experience are specified as follows:

Team Leader (international, 15 months)

The Team Leader will reside at the project site on a full-time basis throughout the period of the construction supervision services. He will be in charge of overall project supervision of the ETC and ITS in all stretches. His duties will also involve overall supervision of other experts. He will guide, monitor, supervise, and control all activities related to the supervision of all stretches. In addition, he will edit the ITS operation and management manuals and organize training programs. He will interact with the employer and the chief general manager (Tech) of the HGCL.

The Team Leader’s specific qualifications are as follows:

a) A minimum of bachelor’s degree in civil/electronics engineering;

b) Work experience of over 10 years in highway engineering;

c) Over five (5) years experience in developing countries especially in India, preferably for supervision and construction of highway development;

d) Work experience on at least two (2) ITS and ETC or similar projects; and

e) Excellent project management capabilities proven through TL experiences, English capabilities, and experiences in projects funded by JICA or JBIC.

Senior ETC Expert (international, 6 months)

Key responsibilities will include guiding the ETC Expert in proper construction methodologies and giving advice to ensure the smooth operation of the toll collection system (including ETC). The ETC expert will be responsible for all adjustment works on the toll collection equipment,work out an operation and management manual for toll collection services and its training program, and consult with the employer and/or the contractor when any specific problems on the toll collection system arises.

The Senior ETC Expert’s specific qualifications are as follows:

a) A minimum of bachelor’s degree in electronics engineering;

b) Work experience of over 10 years in highway engineering including international work experiences in developing countries; and

c) Work experience on at least two (2) ITS and ETC or similar projects particularly in ETC design and technical specifications, as well as the supervision of the supply and installation of the ETC.

Senior ITS Expert (international, 6 months)

Key responsibilities will be to guide the ITS Expert in proper construction methodologies and to ensure the smooth operation of the ITS system. S/He will be responsible for all the adjustment works for the ITS equipment and work out the operation and management manual for ORR information collection, analysis, and provision services and its training program. S/He will consult with the employer and/or the contractor when any specific problem pertaining to the ITS (including TCC and other information devises) arises.

The Senior ITS Expert’s specific qualifications are as follows:

a) A minimum of bachelor’s degree in electronics engineering;

b) Work experience of over 10 years in highway engineering including international work experience in developing countries; and

c) Work experience on at least two (2) ITS and ETC or similar projects particularly in ITS design and technical specifications, and supervision of the supply and installation of ITS.

ETC Expert (domestic, 15 months)

S/He will be responsible for supervising the installation of all toll collection equipment (including ETC) at the ORR interchanges through day-to-day coordination with civil contractors to avoid unnecessary delays; be in charge until the final setting of toll collection services.

The ETC Expert’s specific qualifications are as follows:

a) Bachelor’s degree in electronics engineering;

b) Work experience of over 10 years in highway engineering; and.

c) Work experience in construction management or supervision in the field of toll collection, preferably smart card and nonstop ETC.

ITS Expert (domestic, 15 months)

S/He will be responsible for supervising the installation of all ITS equipment (except ETC) at the TCC/sub-TCC along the ORR stretch through day-to-day coordination with civil contractors to avoid unnecessary delays. S/He must be in charge until the final setting of ITS services.

The ITS Experts, specific qualifications are as follows:

a) Bachelor's degree in electronics engineering;

b) Work experience of over 10 years in highway engineering; and

c) Work experience on construction management or supervision in the field of ITS preferably equipment for highway traffic management and information services.

5.3 The PMC subprofessional staff include: Two (2) ETC Quality Surveyors, one (1) TCC Quality Surveyor, five (5) HTMS Quality Surveyors covering ECB, VMS, CCTV and ATCC, and one (1) Optical Fiber Cable (OFC) Quality Surveyor. Their role will be to assist the key expert at a project office by way of checking relevant contracts and drawings, checking contractors' performance and issuing interim certificates of the supplied equipment. They are required to hold a graduate degree in electronics or in computer engineering with a minimum experience of five (5) years in similar work.

5.4 The PMC support staff will work at the construction sites mainly to monitor and check the day to day quality control and quantity measurements of the works being carried out under the contract, and to keep all measurement records as per instructions from the subprofessional staff. The support staff will consist of: ETC Technical Surveyors, TCC Technical Surveyors, HTMS Technical Surveyors, and OFC Technical Surveyors. An adequate number of support staff will be allocated.

(6) **The Employer**

6.1 To administer the PMC contract, the HGCL will be the Employer. The Managing Director will oversee the overall contract. He will be duly supported by the Chief General Manager (Tech) of the HGCL and other supporting staff including finance and accounts personnel at the main office.

6.2 The Chief General Manager (Tech) of the HGCL, assisted by a team of technical officers of different cadres at separate project locations and an accounts officer (AO), will be responsible for project management/administration. The CGM will have authority to give directions to the PMC in all matters related to contract management/administration. Both the CGM and PMC will interact with each other on a regular basis and make prompt decisions on technical and contractual matters.

4.3.3. Schedule and Costs

The PMC contract will be done in 15 months at the end of the Hyderabad ORR construction period. Thus, the contract period ranges from October 2010 to December 2011 provided that the ORR will be fully opened by the end of December 2011. If the civil works are delayed, the commencement of this ITS PMC contract must be delayed accordingly.

For budgeting purpose, the PMC services are estimated at 151.9 million Japanese Yen based on the breakdown shown in Table 4.2.3.

Table 4.3.3 Cost Breakdown for the PMC Services

	Unit	Quantity	Foreign Portion (Yen)		Local Portion (Rs)		Combined Total
			Rate	Amount ('000)	Rate	Amount ('000)	Amount (Yen, '000)
A Remuneration							
1 International Consultants	M/M	27	2,250,000	60,750			
2 Domestic Consultants	M/M	30			320,000	9,600	
3 Sub Professional Staff	M/M	107			130,000	13,910	
4 Supporting Staff	M/M	187			53,000	9,911	
Subtotal of A				60,750		33,421	130,934
B Direct Costs							
1 International Airfare	No. of Round Trips	9	300,000	2,700			
2 Accommodation Allowance for International Consultants	Month	27	150,000	4,050			
3 Vehicle Rental (6 Vehicles)	Vehicle-Month	90			40,000	3,600	
4 International Communications	Month	15	50,000	750			
5 Domestic Communications	Month	15			50,000	750	
6 Computers and Peripherais	PC-Office	12			40,000	480	
7 Report Production	lump-sum				200,000	200	
8 Training Course (Venue, Material, Food & Drink)	lump-sum				500,000	500	
9 Other Office Administration (Secretary, Copy Machine)	Month	15			60,000	900	
Subtotal of B				7,500		6,430	21,003
TOTAL				68,250		39,851	151,937

Rs 1.0 = JP 2.1

4.4. Advice on ITS Bidding and Procurement Procedure

4.4.1. Advice on Selecting Qualified Bidders

It is advised that the following eligible/pre-qualified criteria and proposal evaluation criteria be used in selecting a qualified bidder:

(1) **Advanced HTMS Bidders**

1) Eligibility/Pre-qualification Criteria

Bidders that meet all of the following pre-qualification criteria need apply only:

a) The bidder shall have a proven track record as an intelligent traffic system supplier especially on variable message signs, emergency telephone systems, supply and installation of the control center, and shall have been in the traffic management system business for a period of at least 9 years from 1999 onwards;

b) The bidder must have an average annual turnover of Indian Rs. 2000 million (or equivalent in the bid currency) per year in the last three financial years (for currencies other than Indian rupees, the applicable conversion [selling] rate of Reserve Bank of India on the last date of bid submission shall apply). Documentary proof in the form of a certificate from the statutory auditor of the bidder's company strictly as per the format specified in Section VII, duly signed and stamped by the statutory auditor, should be submitted as proof for the above. Any declaration or letter from the Bidder in any other format will not be accepted;

c) The bidder shall have successfully implemented at least 1 (one) project of similar nature and complexity in ITS implementation as per the specs mentioned in the particular technical specification of this tender especially along central control room supply and integration within the last nine (9) years. The system shall have been in operation for a period of not less than three years;

d) Scope of work of the qualifying project shall include turnkey responsibility covering project management, design, engineering, supply, installation, testing, commissioning and integration of the entire intelligent traffic system with the traffic control center;

e) Bidder should have completed projects involving modern Intelligent Traffic system comprising at least the following:

- 25 variable message sign boards;
- 200 emergency road side telephones connected with fiber;
- 50 automatic traffic counter cum classifier systems;
- 50 CCTV PTZ cameras for site surveillance, and;
- Dedicated fiber optic network for at least 180km integrated supporting both data and video for transmission;

Integrated with the central control room and the systems must have been in operation for no less than three (3) years as on the date of the opening of the techno-commercial bids. The reference projects shall be supported by letters from the user agency(s) concerned.

f) A successful completion certificate mentioning the Purchase Order reference number, as well as the start and end dates of the work duly signed by the client organization's project in-charge or any equivalent officer or authorized signatory should be submitted along with the technical bid.

g) Copies of work orders/contracts from the client stating the project title, project value and the brief scope of work of the project shall be submitted along with the bid.

h) The Bidder shall have proven facilities for engineering, manufacture, assembly, integration and testing of the sub-systems of intelligent traffic system in India. The details of such facilities shall be submitted along with the technical proposal.

i) The Bidder shall be an ISO 9000 certified company.

j) Consortium or joint venture allowed (maximum of 4 partners)

2) Technical Proposal Evaluation Criteria

There are six (6) criteria for technical proposal evaluation. Only bids over 750 points shall be qualified technically.

Table 4.4.1 Evaluation Criteria with Score Allocation

	Evaluation Criteria	Max. Mark
1	Past experience of firm in executing similar ITS	500
2	Past experience of firm in maintaining similar ITS	200
3	Establishment in India for manufacturing, testing and support	100
4	System architecture and Methodology	75
5	Operation & Maintenance planning	75
6	ISO Certification	50
	Total Maximum Mark	1,000

<u>Past Experiences of Firms in Executing Similar ITS</u>

This criterion is further divided into five (5) kinds of ITS project experience as follows:

a) Variable Message Sign

i.	25 variable message sign boards installed for 3 years	50 (points)
ii.	35 variable message sign boards installed for 3 years	75
iii.	45 variable message sign boards installed for 3 years	100

b) Emergency Telephone System with fiber backbone

i.	200 roadside ECB units installed for 3 years	50 (points)
ii.	225 roadside ECB units installed for 3 years	75
iii.	250 roadside ECB units installed for 3 years	100

c) Automatic Vehicle Counter cum classifier

i. 50 dedicated independent AVCC installed for 3 years 50 (points)

ii. 60 dedicated independent AVCC installed for 3 years 75

iii. 70 dedicated independent AVCC installed for 3 years 100

d) CCTV Road Surveillance System

i. 50 CCTV PTZ cameras integrated with control center via fiber network installed for 3 years. 50 (points)

ii. 60 CCTV PTZ cameras integrated with control center via fiber network installed for 3 years. 75

iii. 70 CCTV PTZ cameras integrated with control center via fiber network installed for 3 years. 100

e) Fiber Optic Network System

i. 180km dedicated fiber optic network implementation varying voice and data installed for 3 years. 50 (points)

ii. 200km dedicated fiber optic network implementation varying voice and data installed for 3 years. 50

iii. 220km dedicated fiber optic network implementation varying voice and data installed for 3 years. 50

<u>Past Experience of Firm in Maintaining Similar ITS:</u>

i. Projects with all subcomponents for 5 years on an annual management contract basis 200 (points)

ii. Projects with all subcomponents for 3 years on an annual management contract basis 150

iii. Projects with all subcomponents for 2 years on an annual management contract basis 100

<u>Establishment in India for manufacturing, testing and support:</u>

i. Establishment and registration proof in India 50 (points)

ii. Demonstration with purchase orders at least worth 10 million Indian rupees 50

(2) TMS Bidders

1) Eligibility/Pre-qualification Criteria

Bidders that meet all of the following pre-qualification criteria need apply only:

a) The Bidder has a proven track record as a tolling system supplier and has been in the business of tolling system for a period of at least nine (9) years from the year 1999 onwards.

b) The Bidder has an average annual turnover of Indian Rs. 1000 million (or equivalent in the bid currency) per year in the last three financial years (for currencies other than Indian rupees, the applicable conversion [selling] rate of

Reserve Bank of India on the last date of bid submission shall apply). Documentary proof in the form of a certificate from the statutory auditor of the bidder's company strictly as per the format specified in Section VII duly signed and stamped by the statutory auditor should be submitted as proof of the above. Any declaration or letter from the Bidder in any other format will not be accepted.

c) The Bidder shall have successfully implemented at least 1(one) project of similar nature and complexity in ETC implementation as per the ETC specs mentioned in the particular technical specification of this tender within the last nine (9) years. The system shall have been in operation for a period not less than three years.

d) Scope of work of the qualifying project shall include turnkey responsibility covering project management, design, engineering, supply, installation, testing, commissioning and integration of the entire tolling system with the traffic control center.

e) The Bidder should have completed projects involving modern tolling system comprising at least 25 lanes of ETC payment, 50 lanes of Smart card payment & 200 lanes of manual payment lanes in one or more countries in the past nine years, and the systems must have been in operation for no less than one (1) year as on the date of opening of Techno-commercial bids. The reference Toll Lanes must be part of the toll plazas of at least eight (8) lanes each located on national highways/expressways/freeways. It is preferable that the Bidder has the experience of installation of tolling system on project(s) similar to ring road/expressway with multiple entries and exits or a closed toll road system. This fact shall be supported by letters from the user agency(s) concerned.

These reference projects shall have the following subsystems as a minimum part of the bidder's scope:

- Toll lane equipment consisting at least of lane controller, OHLS and user fare display units.
- Automatic vehicle counter and classifier (AVCC) with electronic toll audit and incident capture.
- Contactless smart card/credit card/ETC payment system (any or all) integrated into the toll collection system.
- Automatic boom barrier.
- Integration of above with main traffic control center software.

f) Successful completion certificate mentioning the purchase order reference number and the start and end dates of the work duly signed by the client organization's project in-charge or any equivalent officer or authorized signatory should be submitted along with the technical bid.

g) Copies of work orders/contracts from the client stating the project title, project value and the brief scope of work of the project shall be submitted along with the bid.

h) The Bidder shall have proven facilities for engineering, manufacture, assembly, integration and testing of the sub-systems of tolling system in India. The details of such facilities shall be submitted along with the technical proposal.

i) The Bidder shall be an ISO 9000 certified company.

j) Consortium or joint venture allowed (maximum of 4 partners)

2) Technical Proposal Evaluation Criteria

There are seven (7) criteria for technical proposal evaluation. Only bids over 750 points shall be qualified technically.

Table 4.4.2 Evaluation Criteria with Score Allocation

	Evaluation Criteria	Max. Mark
1	Past experience of firm in executing similar ETC	300
2	Past experience of firm in supply of toll lanes	200
3	Past experience of firm in maintaining similar ETC	200
4	Establishment in India for manufacturing, testing and support	100
5	System architecture and Methodology	75
6	Operation & Maintenance planning	75
7	ISO Certification	50
	Total Maximum Mark	1,000

<u>Past Experience of Firm in Executing Similar ETC System(s)</u>

i. ETC system with at least 150 lanes installed for 7 years 300 (points)

ii. ETC system with at least 100 lanes installed for 5 years 200

iii. ETC system with at least 50 lanes installed for 3 years 100

<u>Past Experience of the Firm in Supply of Toll lanes</u>

i. Projects with more than 200 manual lanes in last 5 years 200 (points)

ii. Projects with >101 & <200 manual lanes in last 5 years 150

iii. Projects with >20 & < 100 manual lanes in last 5 years 100

<u>Past experience of Firm in Maintaining Similar Systems</u>

i. Projects with more than 200 lanes in last 5 years 200 (points)

ii. Projects with >101 & <200 lanes in last 5 years 150

iii. Projects with >20 & <100 lanes in last 5 years 100

<u>Establishment in India for Manufacturing, Testing and Support</u>

i. Establishment and registration proof in India 50 (points)

ii. Demonstration with purchase orders at least worth 10 million India rupees 50

4.4.2. Advice on Selecting Qualified PMC

The PMC contract has 15 months' duration between October 2010 and December 2011. PMC procurement procedures will be done between April and September 2010, including the following:

1) Short-listed Firms and Bidding Procedures

International competitive bidding (ICB) is required in the selection of the ITS contractor and PMC since some aspects of the ORR ITS project has not been practiced in India and many of the equipment to be procured in the project are foreign made.

Under JICA bidding categories, an ITS contractor of "not less than 3,000 million yen" must go through all bidding procedures including pre-qualification. The PMC for the ITS should be employed through a short-list procedure in order to hire capable and experienced consultant.

Table 4.4.3 JICA Procurement Principles

	Less than 500 million yen	Not less than 500 million yen	Not less than 3,000 million yen
Pre-qualification Documents	No	No	Required
Pre-qualification evaluation results	No	No	Required
Bid documents	No	Required	Required
Bid evaluation results	No	Required	Required
Contract	Required (In case of ICB)	Required	Required

A short-list will be made based on the submission of an Expression of Interest (EOI) to the HGCL. Even if a pre-qualification procedure is not required, it is suggested that firm experiences in ITS projects, particularly similar to advanced HTMS and tolling management services in the ORR project, be attached to the EOI as relevant service records of a firm.

When the number of EOIs exceeds over eight (8) firms, short-listed firms up to eight (8) shall be selected after proper consideration of a firm's experience in ITS development and its country/continental distribution such as Asia, Europe, and the Americas. The decision on short-listed firms must be reported to JICA for approval for the next step, i.e., sending Request for Proposals (RFPs) to the short-listed firms.

2) Technical Proposal Evaluation Criteria

Technical proposals will be evaluated using a set of criteria with suggested weights, including firm's experiences, methodologies, work plans, and staffing. The minimum technical score required is over 75 points.

Table 4.4.4 Evaluation Criteria with Score Allocation

	Evaluation Criteria	Max Marks
1	Firm's experience	20
1-1	Experience of ITS projects	(10)
1-2	Experience in India and other South Asian countries	(10)
2	Methodology and Work Plan	30
2-1	Approach, Methodology, Comments on TOR	(20)
2-2	Work Plan, Staffing Plan	(10)
3	Personnel	50
3-1	Team Leader	(20)
3-2	Other 4 Consultants	(20)
3-3	Sub Professional Staff	(10)
	Total Maximum Marks	100

CHAPTER 5 ASSISTANCE FOR ITS ORGANIZATIONAL SETUP

Expressway & highway transport services will improve efficiency and safety through the application of commercial and best practice principles, and at the same time need to maintain high technical and quality standards by preventing it from physical damages, vehicle overloading etc. and ensure adequate operation & maintenance through effective highway traffic controls. As a result road users will secure savings of traveling time and improvement of safety, and then macro economic benefits from avoided injury and damages in traffic accidents. ITS operation will contribute to road user's needs mentioned above and achieve efficiency of operation and maintenance in utilizing advanced and integrated technology.

The Hyderabad ORR under the PPP encouragement program will provide an integrated transport system that is safe, efficient, affordable, accessible to all with environmental sustainability, and minimum basic infrastructure needs to rural population, in particular in Phase II B under ODA loan. A special attention should be given to the balanced regional transport services in ORR with an angle of poverty alleviation, although ORR is a toll highway. The relationship with local communities will become more important as the stakeholder in providing transport and its related services. In addition, local communities and people therein will have a great concern to their safety, especially those who live around and along ORR.

ITS organization/institution shall have responsibilities of customer oriented services to operate, manage and maintain a safe and effective transportation system with security and convenience for transporting goods, services and the people by utilizing optimal and advanced technology. At the same time it shall have sound and transparent management system with a special attention to increasing needs of commitment on necessary operation and maintenance by utilizing the resources with high ethical, technical and quality standards, and it should also promote commercialization and outsourcing of the operation and maintenance as reasonably possible as it justifies. A special consideration will be made to local community and people who live in the surrounding and along with ORR to provide them with employment and business opportunity.

5.1 Necessary Coordination for Integrated ITS Operation and Management

Government of Andhra Pradesh (Infrastructure and Investment Department) issued the order (G.O.Rt. No. 36) on March 2, 2007, and based on the order HUDA took up implementation of Hyderabad ORR project for Phase IIA on BOT (Annuity) basis which is admitted as an important urban initiative to decongest the city and a largest single project of the state which is outside the National Highway Development Program (NHDP). The order also accorded sanction to adopt Toll for ORR of phase IIA in order to maintain high standards of the access controlled expressway corridor and also to make ORR financially viable for HUDA to meet all the maintenance requirements in keeping it according to set global standards. Phase IIA is under implementation on BOT (Annuity) basis, while a part of Phase I (4-lane only) was completed in December 2008 on usual contract basis. ORR adopted different legal and contract procedures between Phase I and IIA, and legal review of the existing contracts is necessary to identify the responsibility of ITS operation and management in the contracts. It should be judged from legal consideration on which organization is authorized to be responsible for ITS operation, management and maintenance which includes tolls collection.

Japanese ODA loan has been applied to Phase IIB of ORR, and practical and optimal ITS operation and maintenance system including organization is to be proposed taking into account integrated ITS operation and management with Phase I and IIA. In case of Japan, a flexible and diverse toll system is adopted together with ETC at every interchange to make possible toll calculations at toll plaza based on driving distance and time period discounts, while system for collecting and providing traffic information is adopted through information boards (VMS), highway radio, VICS, and information provision at service & parking areas, and over internet. HTMS is an integral part of ITS operation, management and maintenance which needs high quality of technology and human resources well trained.

On the other hand Central Government of India is encouraging to introduce efficient operation and maintenance system, and based on the government policy the NHAI is undertaking operation and maintenance of existing completed highways through operation, maintenance and transfer (OMT) basis. This Central Government policy on OMT basis is followed at some of the stage states as well (such as Maharashtra).

5.1.1 Review of the Existing Contracts for Hyderabad ORR Operation and Management

In reviewing legal background of Hyderabad ORR development, operation and maintenance, it is observed that HUDA was constituted as a legal entity under the Andhra Pradesh Urban Areas (Development) Act (1975) and authorized to take all actions in relation to development and maintenance of infrastructure, which includes roads in Hyderabad Metropolitan Region. HUDA was thereafter abolished by the Andhra Pradesh State Government in 2008, and all the properties, rights and obligations of HUDA were vested in its successor Hyderabad Metropolitan Development Authority (HMDA) which was constituted as a Metropolitan Authority (legal entity) under the Hyderabad Metropolitan Development Authority Act 2008. On the other hand, HGCL was established as a special purpose vehicle in December 2005 under the Companies Act (1956) to implement ORR Project by equity participation of HUDA (now HMDA) of 74% shareholding and INCAP (26% shareholding) whose objective, among other things, is to promote PPP scheme through special purpose vehicles (companies) for infrastructure development.

Regarding legal basis of tolls collection on roads and bridges, Andhra Pradesh State Government is empowered to collect tolls under the provisions of Indian Tolls Act (1951) and the Constitution of India. The Tolls Act has been amended, and Section 9 of the Act empowers Andhra Pradesh State Government to make rules providing for the method of tolls collection and other related matters. It is legally understood that HMDA is authorized to collect tolls in ORR from its mission of development and maintenance of infrastructure in Hyderabad metropolitan area, and, in particular, to recoup the margin money in the cost of construction, maintenance of the ORR, payment of annuities to the Concessionaires and repayment of the loans borrowed by the Government and its agencies on that behalf ORR Project. It is confirmed by the state order mentioned above in 5.1, too. However it is legally required for Andhra Pradesh State Government to empower HMDA with necessary legal and regulatory framework for implementing ITS including Toll Collection on the entire ORR Project by issuing appropriate notifications, directives and/or orders in such regard.

Phase I of ORR is partly completed under the existing contracts with respective contractor in which each contractor is responsible for maintaining proper road condition according to contract provisions during the defect liability period of two years after the completion. Regarding phase IIA of ORR on the basis of state government order (No. 36) mentioned above in 5.1, HUDA (now HMDA) concluded the concession agreement with respective concessionaire for a period of 15 years including construction period of 30 months, however HMDA reserves the special rights to the following:

(1) Toll collection on ORR including the project stretch in the concession agreement;

(2) Real Estate Development within the right of way of ORR including way side amenities

(3) Commercial development within the right of way of ORR

(4) Any other right which may accrue to HMDA through the development and execution of the project from time to time

It is not clear whether HGCL is authorized to be responsible for operation and maintenance including tolls collection on behalf of HMDA, although HUDA (now HDMA) transferred mandate relating to implementation of ORR to HGCL on the basis of the Memorandum of Understanding dated October 30, 2006. Under these observations SAPI team confirmed with HGCL representatives in the meeting on January 23 that HMDA is responsible for operation, management and maintenance including tolls collection and ITS-related services, and it was agreed with SAPI team to propose ITS organizational/institutional set-up under HMDA. It is recommended that under such situations the Corridor Management Division of HMDA should be responsible for ITS operation, management and maintenance for all phases of ORR by adopting such procurement procedures including NHAI’s guidance on the OMT Concessions on PPP basis.

5.1.2 Identified Coordination Issues and Key Indications reflecting the Models of Central and State Governments

JICA (former JBIC) and HGCL agreed the importance of coordination among BOT concessionaires in Phase IIA and EPC contractors to secure the HTMS-ITS consistency on maximizing the ORR project benefits, and it will include amendment and/or modification of the existing BOT concessionaire contracts EPC Contract. HGCL may need to review the existing contracts with the BOT concessionaires for the amendment/modification of the ITS-related operation, management and maintenance on Article XVIII, Schedule-C, Schedule-D and Schedule-L in the respective concessionaire contract and also if necessary carry out amendment / modification in any other clauses of the Concession Agreement and EPC Contract in accordance with the outcome of the SAPI study, and inform JICA New Delhi office of such amendment/modification for their information after the negotiation with respective concessionaire. In addition, HMDA needs to closely coordinate with relevant agencies including police department and other relevant departments under the strong initiative of Hyderabad Unified Metropolitan Transport Committee (HUMTC) towards successful operation and management of proposed ITS-related entity which will be described in 5.2 below.

As far as ITS-related operation and management is concerned, HGCL representatives confirmed that a new division should be established for monitoring and supervision purpose within HMDA and not a part of HGCL. It may be noted that for the Phase I of ORR there is 2 year defect liability period and the same may be applicable for Phase IIB for JICA funded Projects as well.

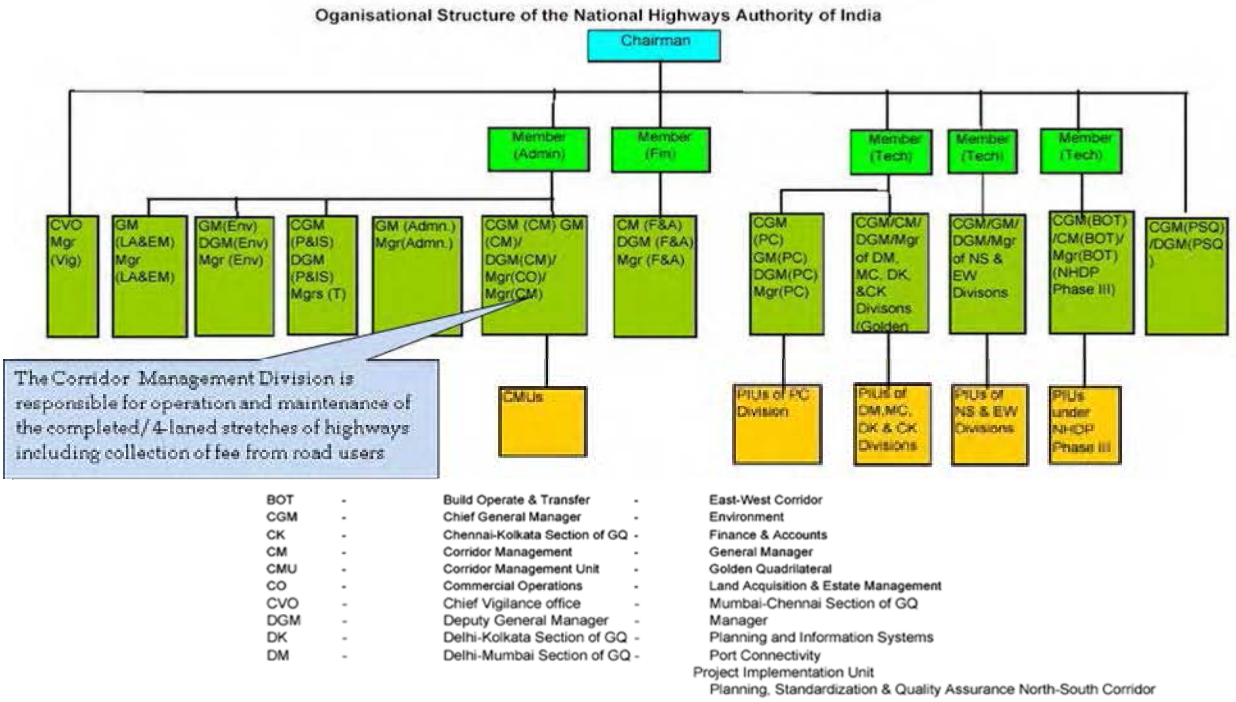
As explained in 5.1.1 above, the Central Government encourages efficient operation, management and maintenance including ITS and tolls collection through NHAI under the OMT Concession on PPP basis, and some states are following this guidance. It is recommended that for Phase I and Phase IIB a study is initiated at the earliest to understand and assess the OMT Concession Model, its advantages and disadvantages for implementation on ORR and some of the states in India having such operation, management and maintenance of roads and highways on OMT Concession basis.

Operation, Management and Transfer (OMT) Concession

NHAI has been implementing NHDP under which the shift from construction to “corridor management” is observed in the process of highway management for externally funded projects and NHAI funded projects. Corridor management includes works connected with the highway management such as; operation and maintenance, levy of fee, construction of toll plaza, enforcement of traffic safety, access control, encroachment, traffic control management, commercial exploitation, roadside amenities and advertisements, land and asset management etc. Under the corridor management and PPP encouragement program NHAI adopted operation and maintenance scheme through Operation, Maintenance and Transfer (OMT) concessions for operation and maintenance of existing and nearly completing (4 lane) highways, and the concessionaire will have responsibility for operation and maintenance for the concession period of 4 or 9 years during which the concessionaire will collect and retain highway user fees (tolls) from the classified vehicle users as per the revised Tolling Policy issued by Government of India in December 2008. NHAI seeks participation from the private sector participants in the bidding process for the selection of OMT Concession Contract with the Bidding criteria being either seeking of the O & M Grant from NHAI or share revenue with NHAI. OMT bids will be invited among pre-qualified bidders who submit the bid documents in response to Request for Proposal which will be prepared by the Financial Consultant appointed by NHAI in consultation with Planning Commission of India, and concession contract will be prepared based on a Model Concession Agreement finalsied and approved by Planning Commission of India.

Regarding the administrative framework, the operation and maintenance contracts are administrated and monitored by the Independent Consultant who is appointed by NHAI with the consent of the concessionaire in accordance with the provisions of the concession contract, and the concessionaire is liable to pay damages to NHAI, when the concessionaire fails to achieve the contract conditions which include termination of contract. NHAI is supervising the performance of the concessionaire with assistance of independent consultant, and the NHAI's Member (Administration) is administratively responsible who is supported by Chief General Manager (Corridor Management), General Manager, Deputy General Manager and Manager of Finance and Accounts for Corridor Management.

Figure 5.1.1 NHAI Organization Structure



Case Study of Mumbai-Pune Expressway

India's first 6 lane access control "Mumbai-Pune Expressway" (95 kms) was made fully operational in April 2002 with 5 interchanges under the stewardship of the Maharashtra State Road Development Corporation (MSRDC) which was established by the Government of Maharashtra through a resolution issued in July 1996, and incorporated as a limited company in August 1996 under the Indian Companies Act (1956). The Central Government gave MSRDC the right to collect toll, strengthen, widen, operate and maintain Mumbai-Pune Section (111 kms) of NH-4 for 30 years, as NH-4 which is running parallel to the Expressway is eating into the toll collection. Operation and maintenance was entrusted by MSRDC to M/S IRB Infrastructure Developers Limited for the period of 15 years from August 2004 to August 2019, and the scope of work includes value addition work, comprehensive operation and maintenance till end of concession period and tolls collection on both Mumbai-Pune Expressway and Mumbai-Pune Section of NH-4 after the completion of expansion of lanes. The operation and maintenance contract between MSRDC and M/S IRB infrastructure Developers Limited is similar to NHAI model of OMT basis.

For proper coordination among different government departments, the Government of Maharashtra constituted a high powered Steering Committee which role is to assist MSRDC in obtaining the requisite clearance, deciding upon various provisions of tender documents & relevant issues, recommending standard issues. The steering Committee also proposed to appoint Project Management Consultant for MSRDC for preparing and ensuring consistency in design standards, cost estimates, tender documents and for supervising the construction works. MSRDC established a separate Toll Monitoring Unit in April 2002 to monitor the toll collection work which includes tender floating for toll collection and fixing agencies, monitoring the toll receipt, actions against the defaulters etc. MSRDC also established a Commercial Unit in January 2003 to encourage and monitor various commercial activities which include commercial exploitation of various assets of MSRDC for revenue generation purpose; food malls and petrol pumps on lease basis, parking schemes on contract basis, beautification scheme of spaces on BOT basis, advertisement in and outside Mumbai, land development along the Expressway etc.

Key observations from the Model of NHAI and MSRDC

The Central Government is encouraging OMT scheme through NHAI model, and seems to aim at efficiency, safety and transparency with emphasis on upgrading management and maintenance which are based on professionalism and innovation to meet road user's needs, while government' role will be focused on strategic policy and planning rather than implementation. This is quoted as a PPP encouragement program to promote private sector's participation under BOT Concession & OMT Concession other than regular contract scheme.

Case study of Mumbai-Pune Expressway shows that the Government of Maharashtra adopted similar scheme of OMT through MSRDC which is a lean organization by using Project Management Consultants, adopting modern procurement system and standards, and setting up a high powered Steering Committee to coordinate cross departmental issues. It is noticeable that the Toll Monitoring Unit and Commercial Unit established under MSRDC to efficiently make MSRDC vitalize on financial and asset management system. In addition, special attention should be drawn to MSRDC's concerns of long-term capacity building with knowledge and know-how accumulation in the organization.

A new division to be established under HMDA for ITS-related operation, management and maintenance should be a lean institution with efficiency, transparency and capacity to utilize modern technology and system. In case where a Tolling Unit is established under HMDA, for example HMDA will become a big institution with the new office which manages at least 19 toll plazas in the interchanges and require at least about 1,500 staff under 24-hours/3 shifting working system which number will be calculated as follows: each toll plaza will need about 70 staff headed by toll manager who is supported by his deputy and maintenance engineers with two divisions for toll collection (chief, shift supervisors, toll collectors & assistant toll collectors) and security (security supervisor and guards), although most of them will be employed on Contract Employment basis. The creation of such a big institution won't be supported by the society, and such business and employment opportunity should be provided to private sector. On the other hand, HMDA should closely coordinate with Government of Andhra Pradesh to obtain the requisite clearance of new issues on traffic control and toll collections on the City Roads which have not been experienced in the state.

5.2 ITS Operation and Management Body

Based on the consideration of a new division in HMDA to be set-up as mentioned in 5.1 above, Hyderabad Outer Ring Road Traffic Control Office (TCO) is proposed to be set-up under HMDA, while day-to-day operations, management and maintenance relating to the ITS-related execution will be outsourced through private sector participation under OMT Concession Contract. TCO shall be responsible for supervision and monitoring of operation, management and maintenance of ITS-related execution which is implemented by private concessionaire with assistance of Project Management Consultant for ITS on the whole ORR who will be hired under JICA-funded Phase IIB of ORR by the time when necessary services and assistance are required as indicated in 5.2.3 below. The Project Management Consultant will provide TCO with necessary Technical Assistance which also includes preparation for monitoring and supervision manuals of ITS-relating operation, management and maintenance, necessary training programme for the staff in TCO and relevant authorities to develop their skills in variously related areas.

TCO set-up should be tied up with the timing of toll collection when it begins, and it will be preferable for HMDA to begin with toll collection based on the partial completion of ORR in order to enable HMDA to mobilize cash flows for repayment of the loans including JICA taken for constructing ORR and for meeting other establishment expenses. It will be also preferable for HMDA to take into account employment creation for rural people who were in particular affected by ORR project in outsourcing tolling and commercializing business opportunities which do not need professionals. HMDC will play an important role to liaise to bring awareness amongst the local communities living near and along ORR, and also in making local community understand the role of ORR towards rural development and poverty alleviation in participating in ORR project.

5.2.1 Mission and Tasks to be Fulfilled

The integral mission of TCO under HMDA is to develop and ensure a safe and effective transport system through standardized controls and management procedures along the entire ORR under PPP encouragement program by applying modern technology on operation and management. Based on the mission on ITS-related tasks mentioned above, TCO's role is divided into 2 functions; the one is for HTMS and another is for Tolling Management System (TMS). Main tasks and objectives of HTMS are to secure a safe, smooth and uninterrupted flow of traffic during normal operating conditions and to minimize disruption to traffic in the event of accidents or other incidents affecting the safety and use of ORR by providing a rapid and effective response according to the liaison procedures of emergency services with police department and other relevant agencies.

On the other hand main tasks and objectives of TMS are to charge, collect and retain tolls in accordance with tolling management procedures, and to manage ETC, ETC accounts and ETC equipment including maintenance. As far as ITS-related tasks as a whole are concerned, TCO shall handle HTMS and TMS through private sector's operation, management and maintenance on concession basis. Taking into consideration the character of HTMS and TMS, a special attention should be given to the legal and regulatory basis on respective establishment of TCO and contracting with the private concessionaire, and also the revenue management on tolling through an escrow account opened by concessionaire and TCO.

Based on the consideration mentioned above, TCO's tasks for HTMS and TMS will be:

(1) Tasks for HTMS

- Monitoring and supervision of traffic conditions through private concessionaire in accordance with contract provisions
- Monitoring and control of HTMS installed on ORR through private concessionaire in accordance with contract provisions
- Liaising with the concessionaire and relevant agencies in case of accidents, dangerous defect & objects detection etc. which disturb the traffic on ORR through Emergency Communication System and Highway Patrolling Service
- Preparing, managing and updating all necessary plans, manuals and procedures related to HTMS and
- Preparing and updating all necessary plans, manuals and procedures related to Safety and also managing Safety of the Users of ORR
- Preparing and updating all necessary plans, manuals and procedures related to Disaster Management and also effectively handling the Disaster Management on ORR

(2) Tasks for TMS

- Monitoring and supervision of toll collections and revenues
- Monitoring and supervision of ETC subscription & its use
- Monitoring and supervision of toll revenue validation after reconciliation on data from 3 sources ; amount declared by toll collectors, amount calculated by toll system and amount counted at bank or third party
- Inspection of each toll plaza preventing from fraud
- Improvement and/or modification of toll collection management systems & procedures
- Monitoring the Maintenance requirements and up gradation requirements and audit systems for ETC Systems established by the Private Sector Concessionaires through out the Concession Period

5.2.2 Organization Design with Personnel Requirements

TCO will be headed by Member – Traffic Control who is supported by minimum of 4

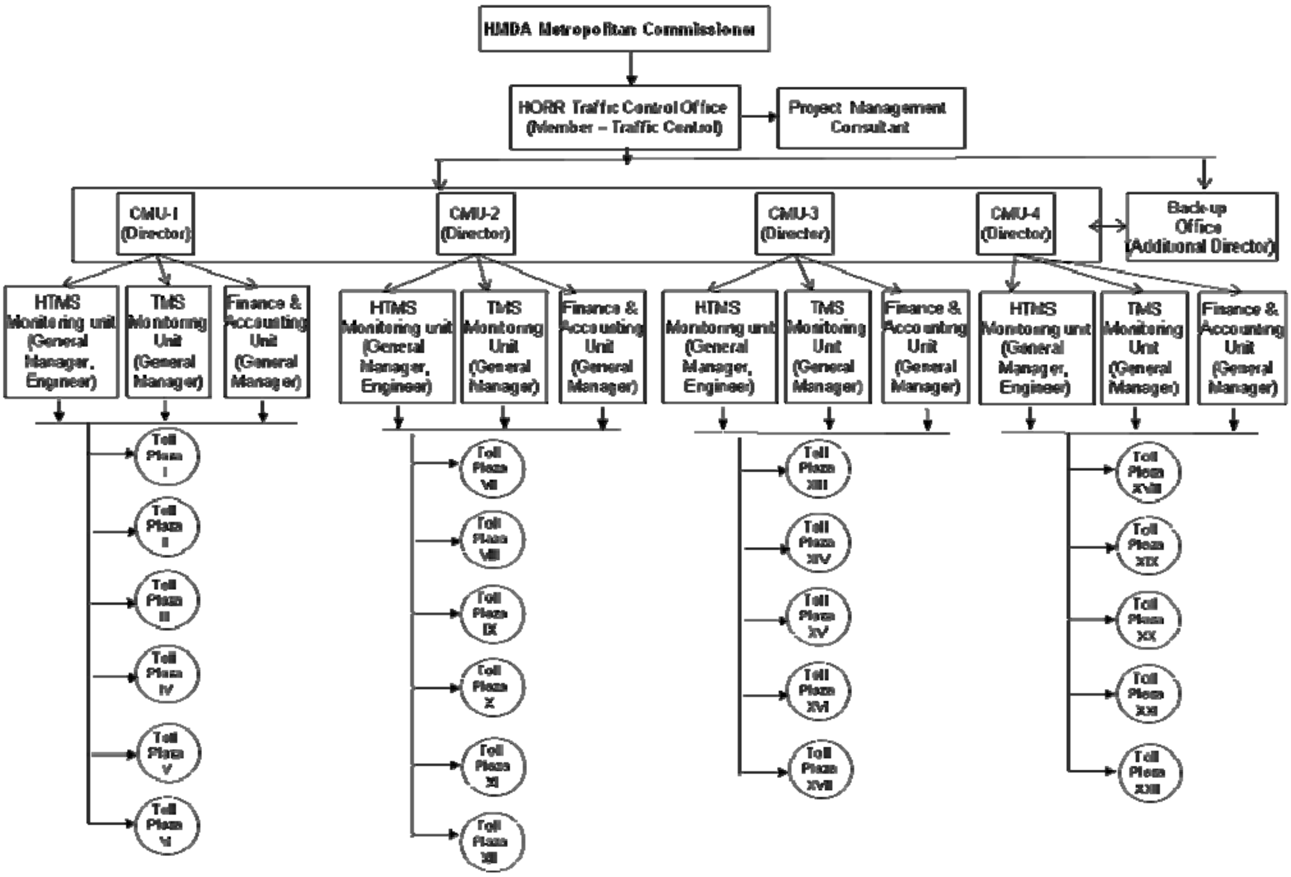
Directors of Corridor Management Units (CMUs) with a back-up Office of Additional Director. As Main Traffic Control Office is always backed up by Back-up Office, Directors of CMUs shall have day-to-day contact with Additional Director in charge of Back-up Office. Main Traffic Control Office should be the base camp for all intervention services such as patrolling activities, ambulances, towing/crane services etc. At the same time Member –Traffic Control will be assisted by Project Management Consultant who will be hired under JICA-funded Phase IIB, and Project Management Consultant will make necessary advice by providing TCO with technical assistance which includes preparation for ITS operation and management manuals.

Director(s) in charge of CMUs are supported by 3 monitoring sub-units viz. HTMS Monitoring Unit, TMS Monitoring Unit, and Finance & Account Monitoring Unit. Each such monitoring units are headed by General Manager who is closely supervising between 5 to 6 toll plazas on HTMS, TMS, and Finance & Account, and each toll plaza is managed by Manager working in shifts who will have 24 hours/day and 365 day/year communication with General Manager, Concessionaire and other officials concerned under 8 hours/3 shifting a day working system. Manager will be supported by Deputy Manager who is responsible for monitoring operation and maintenance of ITS-related facilities and equipment.

In order to promote commercial activities and asset management relating to ORR, respective Monitoring Units will be responsible with function of Public Relations, and promote a good relationship with local communities.

Director(s) of the respective CMUs with the approval of Member (Traffic Control) shall adopt modern procurement procedures guided by JICA, and set up computerized asset and financial management system. JICA is greatly concerned about capacity building of TCO towards efficient, safe and transparent management, and TCO's capacity will be strengthened under JICA technical assistance program.

Figure 5.2.1 Proposed TCO Organization Structure



5.2.3 ITS-related Organizational Setup Schedule with Identified Capacity Building Issues

The concerns about long-term knowledge and know-how accumulation in TCO are closely related to the number of staff recruited by HMDA and/or transformed from HGCL when HGCL's role is completed. HMDA should shall initiate the timely increase of the staff in TCO in line with the increasing new duty, and provide training opportunities for the staff to develop their skills in relevant fields. At the same time Directors, Additional Director, General Managers and Managers under TCO shall be delegated by adequate technical and administrative authority for fulfilling their obligations and duties.

In identifying capacity building issues in TCO, the role of Project Management Consultant (PMC) will be important, and PMC should play a certain role in assisting capacity building of TCO. Priority will be therefore given to accelerating PMC selection procedures paralleling with TCO's set-up. PMC will consider the necessary scope of training which will be agreed and provided under JICA Technical Assistance Program which includes the dispatch of JICA Expert(s).

<u>Schedule and Actions to be taken for TCO Set-up</u>

The preparation for TCO setting-up should be made in line with the timing of starting up the operation and maintenance work in the construction schedule on Phase I and II which is different from each package of the contracts. It closely relates the timing when toll collection begins, and under the current situation it is not clear whether the government of Andhra Pradesh decides tolling based on partial completion of ORR. In spite of such unknown factor which exists, the Phase I will be completed by the end of 2009 when contractors begins with maintenance work as defect liability which will last until the end of 2011. It will be preferable for TCO to set up by the time when phase I will be physically completed, and TCO should begin with monitoring work on the operation and maintenance which is executed by relevant contractors. However it should be noted that TCO will begin with the essential monitoring work at the beginning of 2012 when Phase IIB will be entirely completed. The period of 2 years (2010-2011) will be regarded for TCO to strengthen the capacity building by increasing necessary staff with skill, knowledge and know-how with assistance of PMC who will design the training program under JICA. Integrated schedule for TCO organizational set-up and capacity building is shown as below.

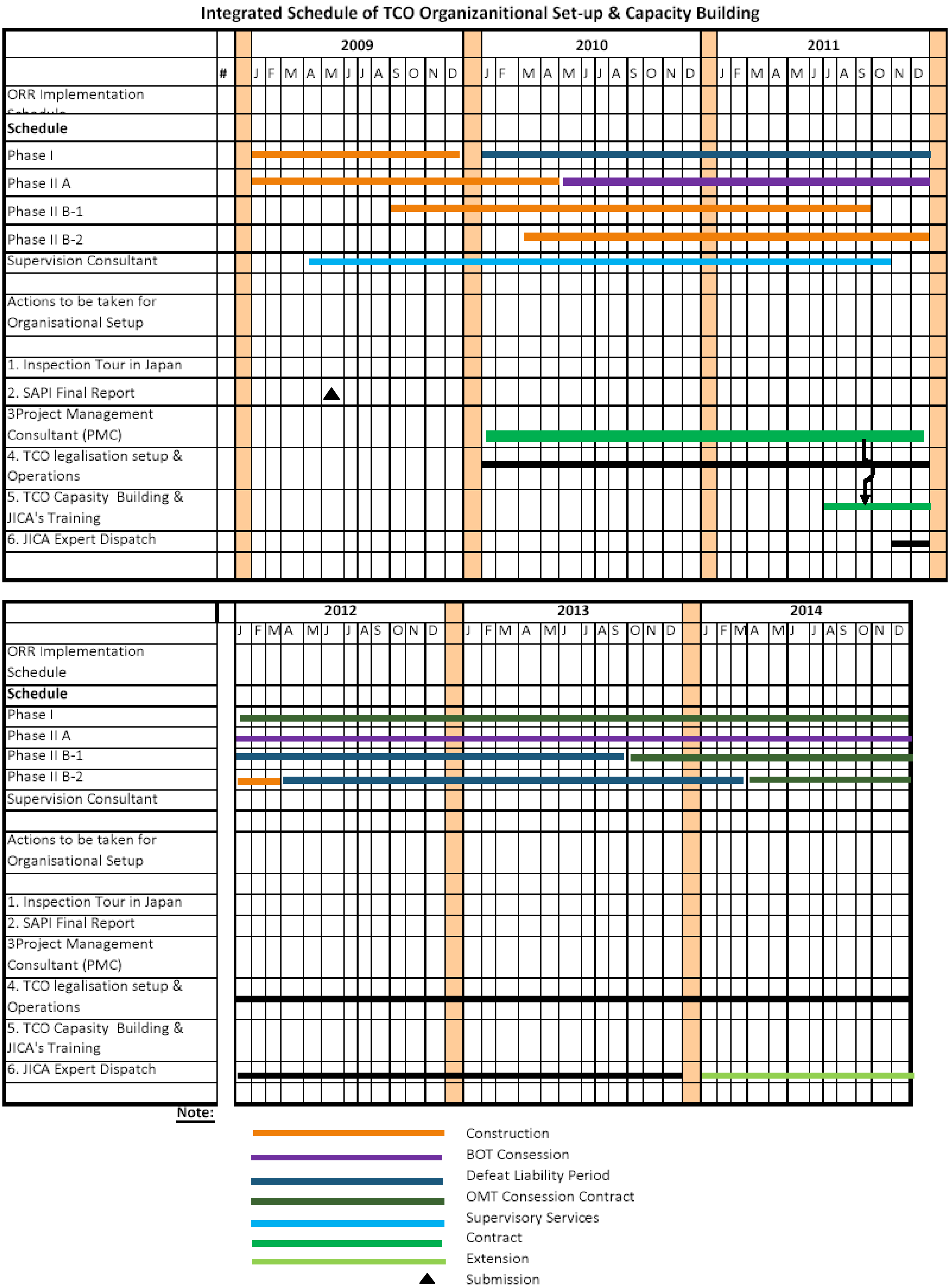
Identified Capacity Building Issues in TCO

As explained mentioned above, PMC will play an important role in designing the training program towards the capacity building of TCO, and it should be noted that PMC should hired by the time when TCO is set up. PMC will analyze the TCO's capacity as a monitoring organization through regular audits of all activities including TCMS, TMS and other general management, and prepare for training and follow-up program of key staff based on their performance.

Special consideration will be made on the following aspects in identifying capacity building issues in TCO:

- To strengthen TCO's capability to execute the relevant duties and obligations
- To enhance TCO's staff capability to secure TCO's mission through comprehensive manuals and continuing training program
- To advise TCO on necessary actions to be taken in solving issues identified
- To coordinate with JICA and the agencies concerned to materialize the training program and others

Figure 5.2.2 Proposed TCO Development Schedule



CHAPTER 6 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

The SAPI Study has been conducted since October 2008, and it has fulfilled its assigned tasks. Some significant conclusions are provided per task, as shown below and in the next pages.

Task 1: To Conduct Additional Works for ITS Implementation

- Firstly, the ORR development is significant under the context of urban growth management. As Hyderabad is a rapidly growing city, the ORR provides an urban development framework for city dwellers and investors. For example, the 34 SEZs which are strategically located along the ORR will definitely benefit once it becomes operational. Besides the ORR project, local efforts at metropolitan development and management are observed, remarkably the creation of GHMC, following the city's merger with 12 municipalities in 2007 and the launch of HMDA which replaced HUDA with an expansion of the HUDA's jurisdiction by 3.7 times in 2008.
- Traffic demand on and the economic feasibility of the ORR were analyzed. A supplementary traffic survey was conducted to check ORR traffic demand. Results showed a low traffic demand on the ORR alignment at present. There are two main factors at play here: (1) a large share of 2- and 3-wheel vehicles in the current traffic, ranging from 20% to 58%, which will not be allowed on the main ORR carriageway once it becomes operational; and (2) the likely diversion of only a small share of traffic from the present radial roads to the ORR to enjoy shorter travel distances, e.g. around 15% at the maximum of the existing radial road traffic. This makes it difficult to justify the ORR project as a bypass route. Therefore, the promotion of roadside developments in an orderly manner will be of utmost importance to make the ORR investment viable.
- The roadside interview survey showed a high expectation of the ORR among the local drivers; 87% of truck drivers and 72% of car drivers positively answered to ORR usage, while their willingness to pay for ORR usage is largely above Rs 20. The tariff levels most acceptable to potential users are Rs 30 among car drivers and Rs 40 among truckers. These toll payments could allow them to drive for 30–50km, based on the 2007 NHAI toll tariff system. With this, toll road business in Hyderabad is in a financially sustainable level.
- The original interchange design did not consider toll collection in a closed system. For example, major ORR interchanges were designed in a clover-leaf shape which logically requires at least four (4) toll plazas at ramp ways.

However, the original interchange designs illustrate no toll plazas at ramp ways and on the main carriageway.

- The SAPI Study modified the original interchange design to one with a closed toll system. Specifically, it modified five major interchanges connecting with the national highways of NH7, NH9, and NH 202 from a clover-leaf shape to a double-trumpet shape. Except for the Shamshabad Interchange which opened in December 2008, the HGCL accepted the SAPI's work on the other four interchanges. In regard to five more interchanges across state highways, the DPR Consultant similarly modified the designs under the supervision of the SAPI Team.

- As already stated, the interchange designs were modified primarily to ensure efficient tolling management. However, the modification produced some positive side effects because of the compactness of the new interchange design. HGCL needs to acquire a smaller land area, probably half of what the original design would have required. The new design also reduced the overall construction cost, i.e. it would cost only two-thirds of the original design.

Task 2: To Formulate the ITS Project Implementation Plan

- Along the Phase II-A section, which is 62.3km in length, HGCL made five BOT contracts up to August 2007 wherein highway traffic management services (HTMS) were included. The SAPI Team reviewed the HTMS specifications and made two proposals: (1) to upgrade the original HTMS systems to enable the control of all HTMSs from one traffic control center (TCC), and (2) to cancel HTMSs from individual BOT contracts to allow the HGCL to implement these services in an integral manner. Both proposals were accepted by the HGCL.

- Regarding toll collection, there was no document prepared for the ORR project. However, the HGCL has some principal ideas about it such as the introduction of a closed toll collection system with electronic toll collection (ETC) services. To provide efficient and convenient toll management, the SAPI Team and the HGCL agreed to collect toll using manual, smart card, and ETC systems. Taking the interchange design and future traffic demand into account, the SAPI Team designed the toll plazas. Results showed that 24 ETC lanes and 157 manual and smart card or 'touch & go' lanes would be needed at 18 interchanges and one main carriageway barrier.

- During the ITS development planning process, the SAPI Team worked along the line of two (2) development strategies: "integrated operation and management" and "basic and upper-system-compatible." To meet the first strategy, the proposed advanced HTMS features additional facilities and equipment compared with the original one, such as a TCC, optical fiber cable connection, and CCTV use. It is also designed in a way that all tolling services would be managed at the

TCC. To meet the second strategy, the global ETC system, consisting of microwave DSRC (5.8 Ghz) with active OBU, is recommended, after comparing technology alternatives in the aspects of performance, economy and expandability (refer to the sections 3.3.2 and 3.3.3) . Not only Hyderabad but also India is advantageous to deploy the most attractive ETC system where there is huge new investment need from now on compared with limitedly accumulated investment so far.

Task 3: To Assist the Executing Agency in Tender Preparation of ITS Items

- For effective project implementation, a broad knowledge of various ITS equipment was required from both consultants and contractors. However, there are only a few suppliers who can provide all the ITS equipment that the project will need. Thus, ITS equipment procurement should be undertaken in two contracts: one for advanced HTMS equipment and another for tolling management services (TMS) equipment. At the same time, one contract will be needed for project management consultant (PMC) services. These three contracts will be done for 15 months at the end of the ORR construction. If the ORR can be fully operational by the end of 2011, the contracts must commence from October 2010.
- To hold competitive ITS biddings, the HGCL has to prepare a set of tender documents. Toward this end, the SAPI Team drafted some documents which were based on specialized engineering knowledge and experience. These are the "Scope of Work" and "Technical Specifications" documents for ITS equipment procurement contracts. These documents are attached to this report as annexes 3 to 6. The SAPI Team also drafted a TOR for PMC services.
- To help select qualified bidders and PMC candidates, the SAPI Team, through this report, provided advice on eligibility and pre-qualification criteria, technical proposal evaluation criteria, and other bidding procedures.

Task 4: To Recommend ITS Organization

- To operate and manage the proposed ORR ITS, a new organization will be necessary. Since the future role of the HGCL after the completion of the ORR road construction is uncertain, the SAPI Team agreed with the HGCL to establish a new organization within the HMDA. The head office of this new organization will be located at the TCC, controlling both the advanced HTMS and TMS in coordination with branch offices such as sub-TCCs and toll gate offices.
- This new organization must be lean, efficient, transparent, and capable of utilizing modern technology and systems in its operation and management work. However, most routine work such as toll collection at booths, must be contracted out to competitive private firms. In this sense, the operation, management, and

transfer (OMT) concession for a certain period promotes public-private participation which is worth considering in the ORR ITS project.

In addition to the original TOR, an overseas training program was conducted. Between March 31 and April 7, the Japan ITS Tour involved five participants from HGCL, two from the Ministry of Shipping, Road Transport and Highways, and one from the National Highway Authority of India. The tour consisted of field surveys and workshops was informative in providing the participants with a better understanding of the SAPI Study. (Refer to Annex 8)

6.2 Recommendations

The SAPI Study provided recommendations to the ORR ITS project and its environs. These are briefly enumerated here.

(i) It is strongly felt that an integrated operation and management is key to project success. A new organization must be completely operationalized before the ORR's full opening or by the end of 2011. Full operationalization means the provision of both advanced HTMS and TMS on the whole stretch of the ORR.

(ii) The ORR ITS organizational development should be done in two phases. The HGCL intends to start toll collection between Phase I and Phase II-A sections by May or June 2010. Although no ETC equipment would be available at that time, a new organization will have to come in to be responsible for manual toll collection, as well as the provision of basic road information and rescue services when accidents occur. This is considered the first phase of organization development. Since the same organization will be expected to expand its scope of services (i.e. to include ITS services) and its coverage (i.e. from limited road sections to the whole ORR stretch), a smooth organizational expansion will be required.

(iii) The TCC has a strategic role in the project, be it in controlling the advanced HTMS or in managing the TMS. However, no such TCC has ever been established in India; therefore, local knowledge and experience are limited. It is thus recommended that local capacity for TCC operation be developed with the help of external support. Within the TOR for the PMC, therefore, ITS operation and management manual and ITS training program are included. Furthermore, during the initial operational phase of the ORR ITS after 2012, on-the-job training should be provided to local counterparts.

(iv) Compared with the cost estimates for the second loan agreement of the Hyderabad ORR project between JICA and India in the mid of 2008, the ITS procurement cost was estimated at 4.2 billion Japanese Yen or increased by 700 million Japanese Yen mainly due to the inclusion of the HTMS, which was originally under the BOT contracts, and the proposed installation of TMS equipment at all interchanges. However, this must be viewed together with the fact that the overall interchange construction cost decreased due to lower land acquisition and construction costs, as stated earlier.

(v) The technology strategy for the ORR project, which is ”basic and upper-system-compatible,” is quite crucial within the context of Hyderabad metropolitan development. It is broadly recognized that Hyderabad intends to strengthen IT investment and development. ITS development can push this move especially when ITS manufacturing and related services are encouraged as local industries. At the very least, basic ITS services in the sense of global ITS development will be provided through the ORR ITS project implementation. After the full operation of the ORR by 2012, it is recommended that continuous efforts be made to pave the way for a metropolitan-wide ITS development with ‘upper-system-compatible’ services. Since there are a lot of development opportunities for roadside equipment and OBUs in vehicles, the following are essential to realize them:

- Wide distribution of OBUs among the registered vehicles in HMDA. OBU is a strategic device to enable non-stop toll service which can alleviate traffic congestion in front of toll gates. Furthermore OBU will be able to allow vehicle users to access to various advanced IT services in line with the development of roadside ITS equipment; and
- Installation by the public sector of various kinds of roadside ITS equipment and smart card readers to meet various service needs such as traffic information provision, interactive communication between road operators and drivers, and settlement of various electronic payments such as toll road, parking, public transport use, etc.

(vi) For the blueprint of such an ITS-based metropolis, an ITS development plan at the metropolitan level is a prerequisite to show the way to a progressive and efficient evolution and expansion of the ITS services from the ORR to other metropolitan roads. At the national level, a standardization policy on ITS development is badly needed, particularly on ETC technology. In this sense, the Hyderabad ORR ITS project serves as a pioneering effort in the country. International experiences, including trials and errors in some advanced countries, and agreements with international organizations, like the ITU, must be reflected in both national and metropolitan policies and development planning.

(vii) Although the SAPI Study is completed, there are still some areas where the HGCL need to receive professional advice on before the PMC contract commences in October 2010. These include:

- Preparation of a new organization for the ORR ITS operation and management;
- Preparation of initial manual toll management services, including establishing the legal framework and procedure for toll fee transactions and provision of

ANNEXES

HMDA-Hyderabad Outer Ring Road Traffic Survey and Data Analysis Report

Submitted to

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1.0 TRAFFIC STUDIES

1.1 Introduction

Highways are an important facility in the development of infrastructure and they further facilitate the economic development. The decision to construct new roads or to up grade the existing road networks depends on the traffic volume and traffic intensity. In this context, traffic forms a key and an important element of feasibility study of any Highway Project. It has a direct bearing on several aspects -lane width: pavement thickness: design features and elements: and wayside facilities. All these signify the importance of traffic data and analysis. Presently the Hyderabad Metropolitan Development Authority has proposed the Construction of Outer Ring Road (ORR) for Hyderabad City. The proposed Outer Ring Road connects various National Highways, State Highways and Major District Roads. The main purpose or idea of providing an ORR for the city is to segregate the through traffic from local traffic and urban traffic from commercial traffic. In order to know the details, a detailed traffic study was carried out during the year 2006. However, to know the present traffic characteristics such as volume of traffic on main arterial roads leading to Hyderabad and the traffic travel characteristics, a fresh sample traffic survey was conducted by the Japan International Cooperation Agency (JICA) Study Team. The Japan International Cooperation Agency (JICA) Study Team is conducting "JICA Special Assistance for Project Implementation (SAPI) for Hyderabad Outer Ring Road Project Phase I".

To arrive at economical and technically feasible proposals, traffic studies need to be carried out for the project section. Present chapter deals with the details of the various studies conducted for the project. The data analysis includes the present day traffic, hourly variation for the day, composition, directional distribution and travel characteristics of the vehicles and loading characteristics of goods vehicles etc.

1.2 Objective of the Present Study

The primary objectives of the traffic surveys are

- To assess the present day traffic on all National Highways leading to Hyderabad

- To determine the travel characteristics of the traffic movement on all National Highways this is likely going to use the proposed ORR.
- Assess the future growth rate during the design life of the project and estimate the traffic likely using the proposed ORR.

1.3 Traffic Surveys Conducted

To fulfill the above mentioned objectives, the following traffic surveys were carried out.

- Traffic Volume Count Survey for 1 Day 24 Hours at five locations.
- Origin and Destination Survey for 1 Day 24 hours at five locations.

The locations where primary data collection has been conducted are indicated in **Figure-1.1** and the details are indicated in **Table 1.1**.

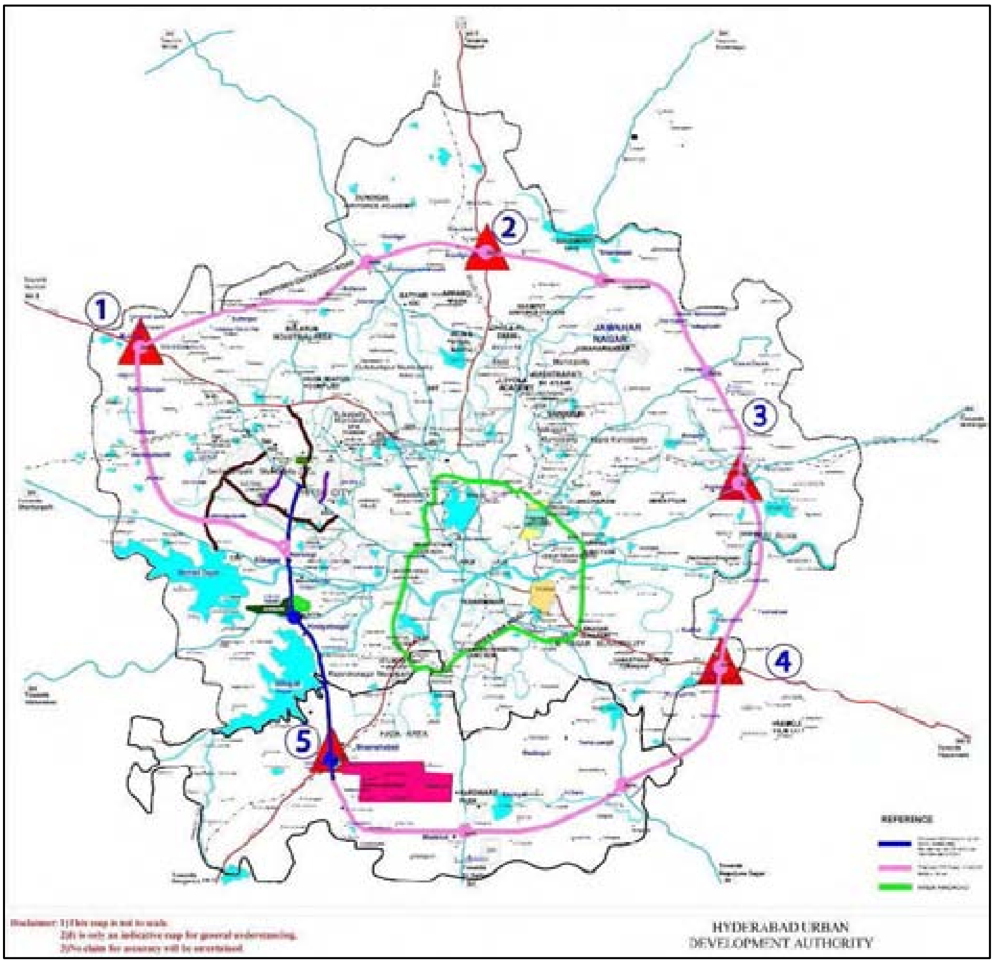


Figure 1.1: Traffic Survey Locations

Table 1.1: Details of the Survey Locations

Type of Survey	Duration	Location	Location Code for Volume Count Survey	Location Code for O-D Survey
Traffic Volume Count and Origin-Destination Survey (Road Side Interview Method)	24 hours for 1 Day	At Proposed Interchange for ORR with NH-9 towards Mumbai	VC-1	OD-1
		At Proposed Interchange for ORR with NH-7 towards Nagapur	VC-2	OD-2
		At Proposed Interchange for ORR with NH-202 towards Warangal	VC-3	OD-3
		At Proposed Interchange for ORR with NH-9 towards Vijayawada	VC-4	OD-4
		At Proposed Interchange for ORR with NH-7 towards Bangalore	VC-5	OD-5

1.4 Passenger Car Units (PCUs)

The present study area falls rural limits, the PCU factors as per the recommendations of IRC-64: 1990 were adopted in converting no. of vehicles to PCU. The PCU values for each type of vehicles are presented in **Table 3.1.**

Table 2.1: PCU Values

Vehicle Category	PCU Values Adopted as per IRC:64-1990
Car/Jeep	1.0
Mini-Bus	1.5
Bus	3.0
LCV	1.5
2-Axle	3.0
3-Axle	4.5
MAV	4.5

2.0 TRAFFIC DATA ANALYSIS

2.1 Classified Traffic Volume Survey

Classified traffic volume counts were conducted at the above mentioned five locations for a period of one day and 24 hours continuously. The survey was conducted from 21-01-2009 to 28-01-2009. Classified Traffic Volume Count Survey has been carried out with the proforma for collecting the data as specified by Japan International Cooperation Agency (JICA). This exhaustive survey was done manually by trained enumerators using hand tally. The data was collected for time interval of every 15 minutes. The data collected from the field studies are given as **Appendix A-1 to A-5**.

2.2 Classified Traffic Volume Characteristics

2.2.1 Present Day Traffic

The Average Daily Traffic (ADT) Volume for each location varies from location to location. The summary of the present one day traffic at each location is summarized in **Table 2.1** below.

Table 2.1: Present Day Traffic for All Locations (Both Direction)

Sl. No.	Location Code	Total Vehicles	Total PCUs
1	VC-1	11934	29052
2	VC-2	11236	25581
3	VC-3	12370	26642
4	VC-4	16031	44507
5	VC-5	14103	34642

2.2.2 Hourly Variation of Traffic

The present day Traffic is analysed for the hourly distribution of traffic. The traffic on the road sections will not be uniform for entire day (24 hours). The traffic differs from hour to hour. The data has been analysed for the hourly variation of traffic. Out of the 24 hour traffic at certain time of the day, the traffic will be maximum which will be termed as Peak Hour Traffic. The details of the peak hour on all the five locations are summarized in **Table 2.2** below from the present survey. The details of traffic intensity during the day, the hourly variation in terms of vehicles are represented graphically in **Appendix B-1 to B-5 and C-1 to C-5**.

Table 2.2: Peak Hour Traffic Details for All Locations (Both Direction)

Sl. No.	Location Code	Peak Hour	Total Vehicles	Total PCUs
1	VC-1	01.00pm to 02.00pm	567	1352
2	VC-2	11.00pm to 12.00am	657	1386
3	VC-3	04.00am to 05.00am	821	1597
4	VC-4	08.00am to 09.00am	888	2453
5	VC-5	04.00am to 05.00am	849	1995

2.2.3 Traffic Composition

The percentage shares of different category of vehicles in the total traffic stream in terms of number of vehicles at the survey locations are analysed. The traffic composition observed in these survey locations are plotted graphically and presented in **Figure 2.1 to 2.5** all locations.

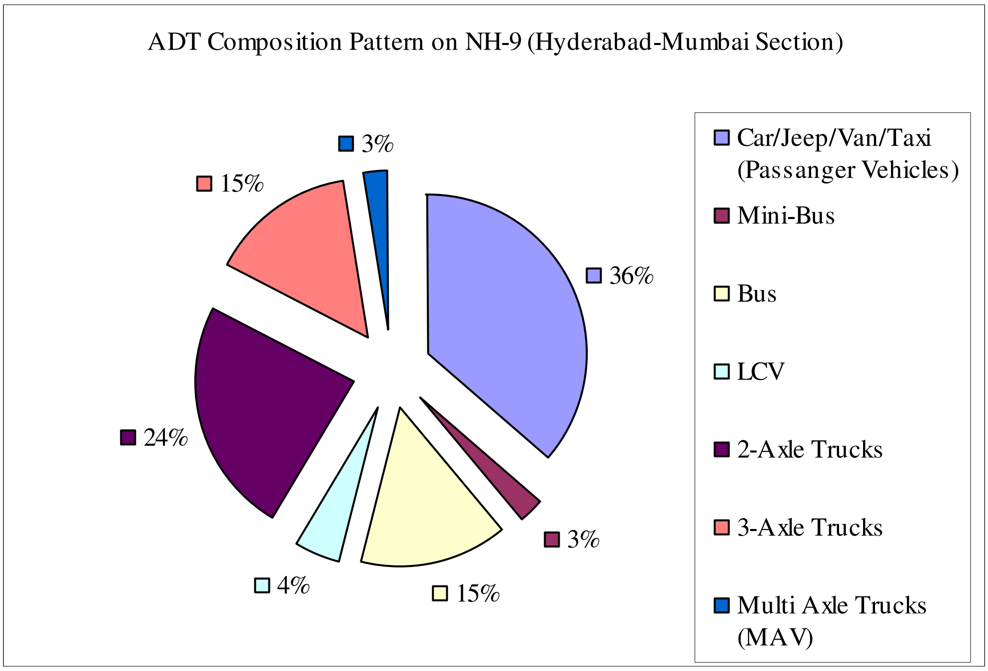


Figure 2.1: Traffic Composition on Hyderabad – Mumbai (NH-9) Road

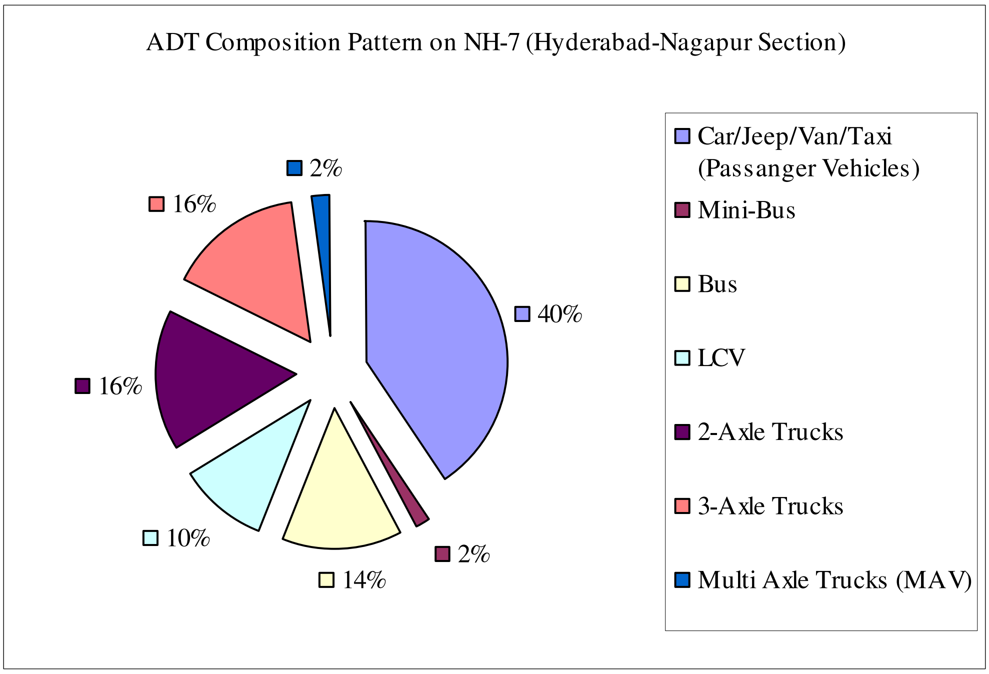


Figure 2.2: Traffic Composition on Hyderabad – Nagapur (NH-7) Road

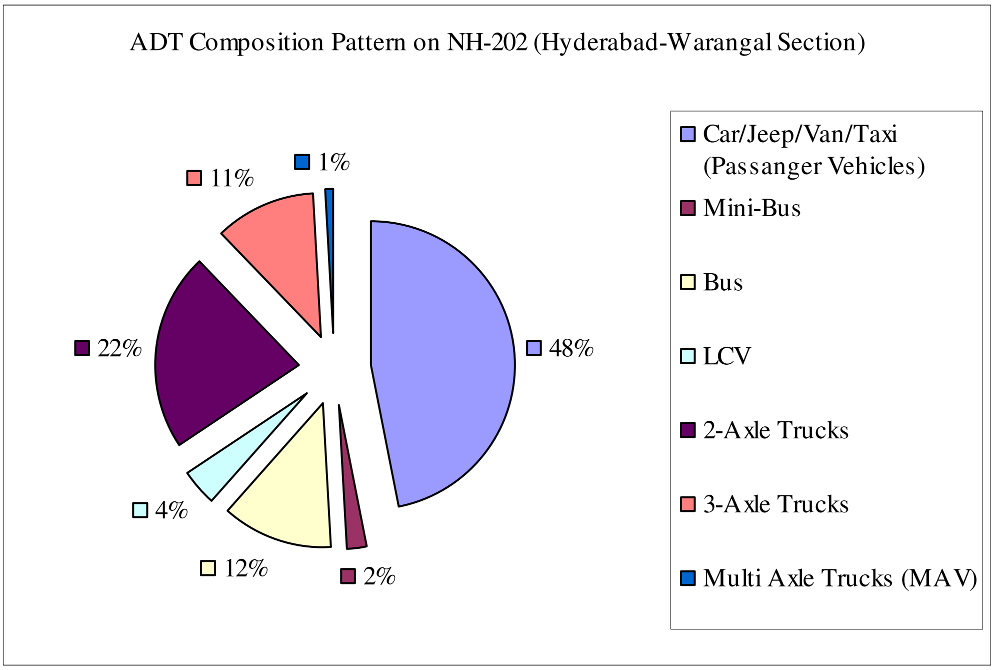


Figure 2.3: Traffic Composition on Hyderabad – Warangal (NH-202) Road

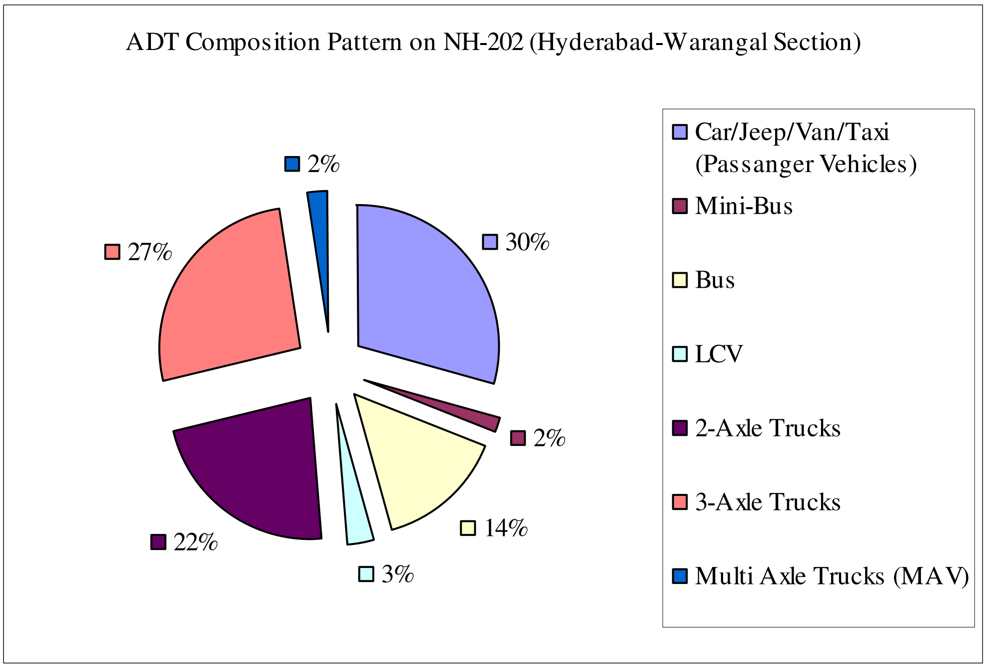


Figure 2.4: Traffic Composition on Hyderabad – Vijayawada (NH-9) Road

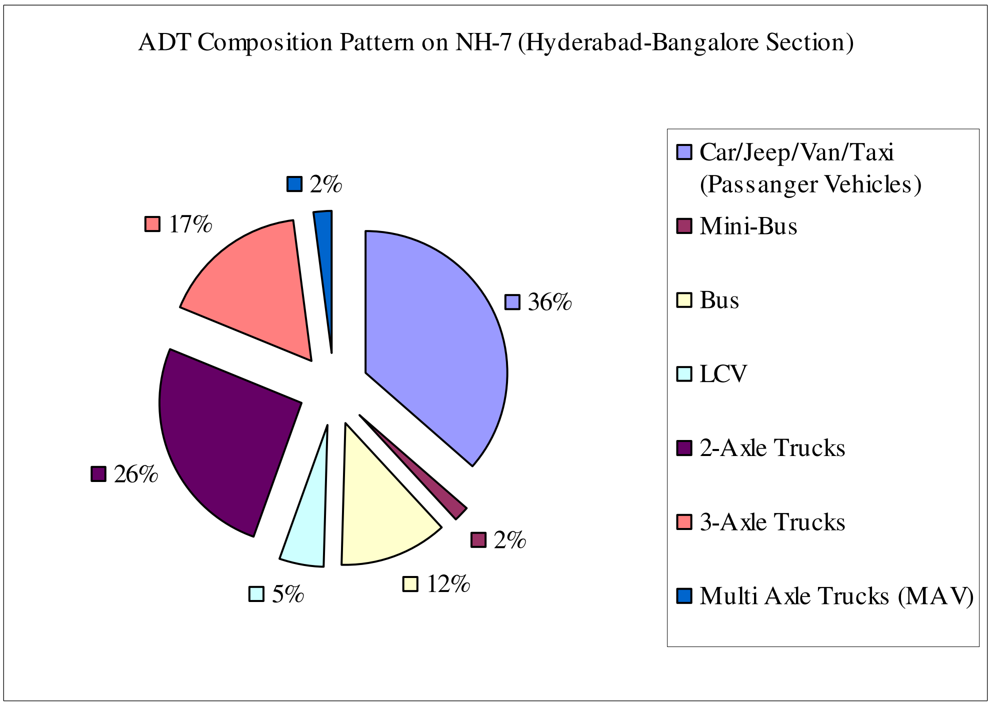


Figure 2.5: Traffic Composition on Hyderabad – Bangalore (NH-7) Road

For each location, the details of the vehicles for each direction, total traffic (category wise), directional distribution in percentage for each category of vehicles and composition of each category of vehicles in total traffic are presented in **Table 2.3 to 2.7** below.

Table 2.3: Present Day Traffic Summary for Hyderabad-Mumbai (NH-9) Road

Direction/Type of Vehicles	Car/Jeep/Van/Taxi (Passenger Vehicles)	Mini-Bus	Bus	LCV	2-Axle Trucks	3-Axle Trucks	Multi Axle Trucks (MAV)	Total Vehicles	Total PCUs
Hyderabad to Mumbai (D-1 to D-2)	2240	159	763	268	1538	953	116	**6037**	**14616**
Mumbai to Hyderabad (D-2 to D-1)	2096	154	1032	259	1332	832	192	**5897**	**14436**
Total Traffic From Both Direction	**4336**	**313**	**1795**	**527**	**2870**	**1785**	**308**	**11934**	**29052**
Direction Distribution, %									
Hyderabad to Mumbai (D-1 to D-2)	51.66%	50.80%	42.51%	50.85%	53.59%	53.39%	37.66%	50.59%	50.31%
Mumbai to Hyderabad (D-2 to D-1)	48.34%	49.20%	57.49%	49.15%	46.41%	46.61%	62.34%	49.41%	49.69%
Composition of Traffic, %	36.33%	2.62%	15.04%	4.42%	24.05%	14.96%	2.58%	**100.00%**	

Table 2.4: Present Day Traffic Summary for Hyderabad-Nagapur (NH-7) Road

Direction/Type of Vehicles	Car/Jeep/Van/Taxi (Passenger Vehicles)	Mini-Bus	Bus	LCV	2-Axle Trucks	3-Axle Trucks	Multi Axle Trucks (MAV)	Total Vehicles	Total PCUs
Hyderabad to Nagapur (D-1 to D-2)	2157	85	703	714	1195	1312	153	**6319**	**15664**
Nagapur to Hyderabad (D-2 to D-1)	2390	113	821	459	613	464	57	**4917**	**9917**
Total Traffic From Both Direction	**4547**	**198**	**1524**	**1173**	**1808**	**1776**	**210**	**11236**	**25581**

Direction/Type of Vehicles	Car/Jeep/Van/Taxi (Passenger Vehicles)	Mini-Bus	Bus	LCV	2-Axle Trucks	3-Axle Trucks	Multi Axle Trucks (MAV)	Total Vehicles	Total PCUs
Direction Distribution, %									
Hyderabad to Nagapur (D-1 to D-2)	47.44%	42.93%	46.13%	60.87%	66.10%	73.87%	72.86%	56.24%	61.23%
Nagapur to Hyderabad (D-2 to D-1)	52.56%	57.07%	53.87%	39.13%	33.90%	26.13%	27.14%	43.76%	38.77%
Composition of Traffic, %	40.47%	1.76%	13.56%	10.44%	16.09%	15.81%	1.87%	**100.00%**	

Table 2.5: Present Day Traffic Summary for Hyderabad-Warangal (NH-202) Road

Direction/Type of Vehicles	Car/Jeep/Van/Taxi (Passenger Vehicles)	Mini-Bus	Bus	LCV	2-Axle Trucks	3-Axle Trucks	Multi Axle Trucks (MAV)	Total Vehicles	Total PCUs
Hyderabad to Warangal (D-1 to D-2)	3034	172	771	231	1438	733	53	**6432**	**13829**
Warangal to Hyderabad (D-2 to D-1)	2778	103	757	264	1314	676	46	**5938**	**12813**
Total Traffic From Both Direction	**5812**	**275**	**1528**	**495**	**2752**	**1409**	**99**	**12370**	**26642**
Direction Distribution, %									
Hyderabad to Warangal (D-1 to D-2)	52.20%	62.55%	50.46%	46.67%	52.25%	52.02%	53.54%	52.00%	51.91%
Warangal to Hyderabad (D-2 to D-1)	47.80%	37.45%	49.54%	53.33%	47.75%	47.98%	46.46%	48.00%	48.09%
Composition of Traffic, %	46.98%	2.22%	12.35%	4.00%	22.25%	11.39%	0.80%	**100.00%**	

Table 2.6: Present Day Traffic Summary for Hyderabad-Vijayawada (NH-9) Road

Direction/Type of Vehicles	Car/Jeep/Van/Taxi (Passenger Vehicles)	Mini-Bus	Bus	LCV	2-Axle Trucks	3-Axle Trucks	Multi Axle Trucks (MAV)	Total Vehicles	Total PCUs
Hyderabad to Vijayawada (D-1 to D-2)	2601	61	1217	272	1820	2089	183	**8243**	**22463**

Direction/Type of Vehicles	Car/Jeep/Van/Taxi (Passenger Vehicles)	Mini-Bus	Bus	LCV	2-Axle Trucks	3-Axle Trucks	Multi Axle Trucks (MAV)	Total Vehicles	Total PCUs
Vijayawada to Hyderabad (D-2 to D-1)	2135	195	1090	228	1769	2185	186	**7788**	**22044**
Total Traffic From Both Direction	**4736**	**256**	**2307**	**500**	**3589**	**4274**	**369**	**16031**	**44507**
Direction Distribution, %									
Hyderabad to Vijayawada (D-1 to D-2)	54.92%	23.83%	52.75%	54.40%	50.71%	48.88%	49.59%	51.42%	50.47%
Vijayawada to Hyderabad (D-2 to D-1)	45.08%	76.17%	47.25%	45.60%	49.29%	51.12%	50.41%	48.58%	49.53%
Composition of Traffic, %	29.54%	1.60%	14.39%	3.12%	22.39%	26.66%	2.30%	**100.00%**	

Table 2.7: Present Day Traffic Summary for Hyderabad-Bangalore (NH-7) Road

Direction/Type of Vehicles	Car/Jeep/Van/Taxi (Passenger Vehicles)	Mini-Bus	Bus	LCV	2-Axle Trucks	3-Axle Trucks	Multi Axle Trucks (MAV)	Total Vehicles	Total PCUs
Hyderabad to Bangalore (D-1 to D-2)	2840	155	907	420	1786	1074	135	**7317**	**17246**
Bangalore to Hyderabad (D-2 to D-1)	2277	111	839	292	1817	1329	121	**6786**	**17396**
Total Traffic From Both Direction	**5117**	**266**	**1746**	**712**	**3603**	**2403**	**256**	**14103**	**34642**
Direction Distribution, %									
Hyderabad to Bangalore (D-1 to D-2)	55.50%	58.27%	51.95%	58.99%	49.57%	44.69%	52.73%	51.88%	49.78%
Bangalore to Hyderabad (D-2 to D-1)	44.50%	41.73%	48.05%	41.01%	50.43%	55.31%	47.27%	48.12%	50.22%
Composition of Traffic, %	36.28%	1.89%	12.38%	5.05%	25.55%	17.04%	1.82%	**100.00%**	

2.3 Comparison of Traffic Data

A detailed traffic surveys were conducted in the year 2006 for the purpose of analyzing and estimating the likely traffic using the proposed Hyderabad ORR. Now the traffic survey has been conducted at some of those locations where already the traffic volume counts were carried out. Table 2.8 shows the comparison of the year-2006 traffic data with the current traffic at those locations.

Table 2.8: Comparison of Year-2006 Traffic Data with Current Year Traffic Data

Sl. No.	Location Code	As per 2006 Traffic Survey		As per Current (2009) Traffic Survey		Growth in Traffic Volume, %	
		Total Vehicles	Total PCUs	Total Vehicles	Total PCUs	Vehicles	PCUs
1	VC-1	12228	26456	11934	29052	-2.46%	8.94%
2	VC-2	11008	21131	11236	25581	2.03%	17.40%
3	VC-3	8501	16483	12370	26642	31.28%	38.13%
4	VC-4	17764	40122	16031	44507	-10.81%	9.85%
5	VC-5	16945	37791	14103	34642	-20.15%	-9.09%

2.4 Origin-Destination Survey

The objective of the Origin-Destination (O-D) survey is to gather information regarding travel characteristics of different users on the project road. Results of the O-D surveys are used to describe the user characteristics of both passengers and goods vehicles.

Origin and Destination surveys were organised for both passenger and freight carriers over a period of 24 hours on a normal working day. Roadside interview (RSI) method was adopted with random sampling basis obtaining a minimum desired sample size.

The Origin-Destination survey gives the information regarding the various types of vehicle trips viz. Internal-Internal, Internal-External, External-Internal and External-External trips. The survey has been carriedout with pre defined questionnaire containing information regarding the following.

- Type of Vehicle
- Number of Passengers

- Purpose of trip
- Origin place
- Destination place
- Hours (Distance)
- Capacity (ton)
- Load Factor
- Major Commodity
- Driving through ORR (Y/N)
- Section of ORR will be drived
- Willingness to pay for toll (yes/No)
- Saving for driving time to pay as toll

For the purpose of classification of the trips into the various categories, totally 41 zones have been considered. Out of 41 zones 33 zones falls within the proposed outer ring road and rest of the 8 zones are outside the outer ring road.

The details of the 33 Zones within the study area have been listed below. The map indicating the all zones are presented in **Figure -2.6** below.

Table 2.9: List of Zones within Study Area

Zone Code	Coverage Area
01	Sanatnagar, Erraguda, Bobbuguda, Yusufguda, Ameerpet, Marredpalli, Meetuguda, Raniganj, Punjjagutta, Banjara Hills, Khairatabad, Ramnagar, Tolichowki, Ibrahimbagh, Mehdipatnam, Kachiguda, Karvan, Afzalgunj, Chadar Ghat, Charminar, Saidabad, Yakutpura, Aliabad, Falaknuma, Candrayana Gutta, Barkas
02	Potarum, Lothkunta, Bowanpalle, Hasmathpet, Tarbund, Begumpet, Kankhana, Paradise Patny
03	Suraram, Lal Sahebguda, Mattaladgudem, Gajulramaram, Kotta Cheruvu, Shahpurnagar, Jeedimetla, Kottapur, Namdanagar
04	Malkaram, Kavkur, Barsapet, Mecha Bolamar, Pedda Bashirabad, Chennapur, Yapral, Alwal, Venkatapuram, Manajiguda, Bon Cheruvu
05	Hydernagar, Kukatpalli, Kistapa Vagu, Musapet, Balanagar, Kaithalapur, Allapur, Bobbuguda
06	Maktamahbubpet, Peda Cheruvu, Taranagar, Chandanagar, Madinaguda, Lingampalli, Gopi Cheruvu, Alind, Nalagandla, Izzatnagar, Kothaguda, Gachibowli, Nanakram Guda, Hitec City, Gawaldaddi, Khaja Guda, Husain Shahwali Dargah
07	Ammuguda, Ramakrishnapuram, Malkajgiri, Naradmet, Sarilguda, Nadimin Cheruvu, Miryalguda, Gouthamnagar, Mirjalguda, Maula-Ali
08	Kandiguda, Yellareddiguda, Kapra Cheruvu, Sainikpuri, Kapra, Kushaiguda, Nagavaram, Cherlapalle, Bakshiguda, Mallapur, Nacharam, Tarnaka, Pedda Cheruvu

Zone Code	Coverage Area
09	Osmania University
10	Habsiguda, Birappagadda, Mohini Cheruvu, Indra Nagar, Uppal, Rajendranagar, Patel Nagar
11	Dilsuknagar, Saroornagar
12	Upperpalle, Bogvotguda, Budvel, Hymayathsagar Colony, Wramghar Jn, Rajendranagar, Katadhan, Mailardevpalle, Udamgadda, Sivarampalli, Gaganpahad
13	Kothapet, Nagol, Mattuguda, Sitaramguda, Bandlaguda, Annaram, Masoorabad, Lingojiguda, Bahadurguda Lalbahdurnagar, Champapet, Chintalkunta, Karmanghat Jn, Bhairamalguda, Chandrayana Gutta, Sahibnagar
14	Muttangi, Ganapatu Guda, Pocharam, Patancheruvu, Karadnur, Patti Ghanpur, Tigalnagar, Usikebhavi, Bandlaguda, Biramguda, Ramanchandraouram, Kachireddipalli, Rayasamudram, Town Ship, BHEL Factory
15	Sultanpur, Gandigudem delwarguda, Krishna Reddi Pet, Jankampet, Rameshwaram, Patel Gudem, Ayilapur, Naregudem, Aminpur, Bandamkammu
16	Mallampet, Kazipalli, Shambhupuram, Bollarum, Mahesawaram, Kathva Tank, Botam, Baspalli, Nizampet
17	Dundigal, Dommarapohcmpalli, Bowrampet, Sagilapur, Saragudem, Bahadurpalle, Badurpalle
18	Medchal, Gaudavalli, Pudura, Munirabad, Kandlakoi, Attali, Gimarpuram, Kistapur, Surarguda, Gyanapuram, Basuradi, Gundla Pochampalli, Maisammaguda, Dulapalle, Kompalle
19	Shamirpet, Ghanapur, Bomraspet, Tumkunta, Babaguda, Akhtaraliguda, Yamjal, Potayapalli, Antapalli, Hakimpet, Turkapalle, Singaipalli
20	Gandi Narsampalli, Dharmaram, Yadagirpalli, Cherial, Kisara Dayara, Kundanpalli, Ankireddipalli, Dharmaram, Timmaipalli, Keesaragutta, Dammaiguda, Turkadayara, Bandlaguda, Nagavaram
21	Ghatkesar, Rampallidayara, Rampalli, Padma Saiguda, Yemnampet, Mazherguda RS, Pocharam, Boduuppal, Ganapuram, Choudhariguda, Annojiguda, Waniguda, Bhogawaram, Laianguda, Godamakunta, Cherpalli, Erimullu Vagu, Rampalli Cheruvu, Gantiguda, Kondapuram, Ismailkhanguda, Aushapur, Sivareddyguda, Ankshahpur, Sandupatlaguda, Chengicharla, Bonkoniguda, Narrepalle, Nalla Cheruvu
22	Baharam, Gourvelly, Taramatipet, Pasmamla, Kuntlur, Korremal, Marpalliguda, Edulabad, Venkatapuram, Hajialiguda, Firazadiguda, Sadataligud, Patvatap Puram, Masjidpuram, Mutialguda, Prathap singaram, Bandaraviyal, Marripalli, Kotlapuram, Timmalguda, Chinna Raviralla
23	Ambarpet, Hayathnagar, Kawadpalli RF
24	Munuganuru, Turur, Koheda, Jilavarkhan Cheruvu, Upparguda
25	Mangalpalli, Injapur, Gurramguda, Masab Cheruvu, Kammaguda, Patiguda, Brahmanapalli
26	Turka Yamjal, Adibatla, Bongulur, Naimmaguda, Kongarkalan, Badangipet, Kammaguda, Kurmalaguda, Nadergul, Manimuttalkunta, Mamroiguda, Patelguda, Sahibguda, Kadirabad
27	Mankhal, Tukkuguda, Raviryal, Srinagar, Malkadanguda, Imamguda, Bandlaguda, Kottapeta, Balapur, Lakshmiguda, Umda Sagar, Venkatapur, Mallapur, Pahadisharri, Imarat Kancha, Sadarnagar, Harshagudam, Jannaiguda
28	Hamidullahnagar, Raikunta, Bahadurguda, Sangiguda, Jalapalli, Mamidipalli, Antireddigudam, Gollapalli, Pochireddiiguda, Kottaguda, Golvagudam, Golkondakhurd, Shankarpuram, Golkondakalan, Golkondakhurd
29	Shamsabad, Kishan Guda, Tondapalli, Oothapally, Tondapalli, Kawaguda, Sidenti, Undanagar, Narkhuda, Chaudarguda, Kamuni Cheruvu, Gundiguda, Ghasmiyaguda, Pedda Shahpur, Sangiguda
30	Narsinggi, Bairagiguda, Kismatpur, Kilaskhandarga, Mahulva, Mahalneknapur, Faridabad, Gandamguda, Peerancheru, Devalvenkatapur, National Forest, Chilkur, Moinabad, Diwanguda, Venkepalle, Nagireddiguda, Bakaram, Himayat Sagar
31	Kokapet, Wattinagupally, Mirzaguda, Pedda Cheruvu, Kanapur, CBIT, Gandipet, Appojigudem
32	Kollur, Janwada, Gopanapalli, Osman Nagar, Dontanrapalle, Maharajpet, Goplaram
33	Velmala, Idulnagalapalli, Yemkunta, Mandmu, Chanduguda, Tellapuram, Nagalopelli, Metta Cheruvu, Imampur

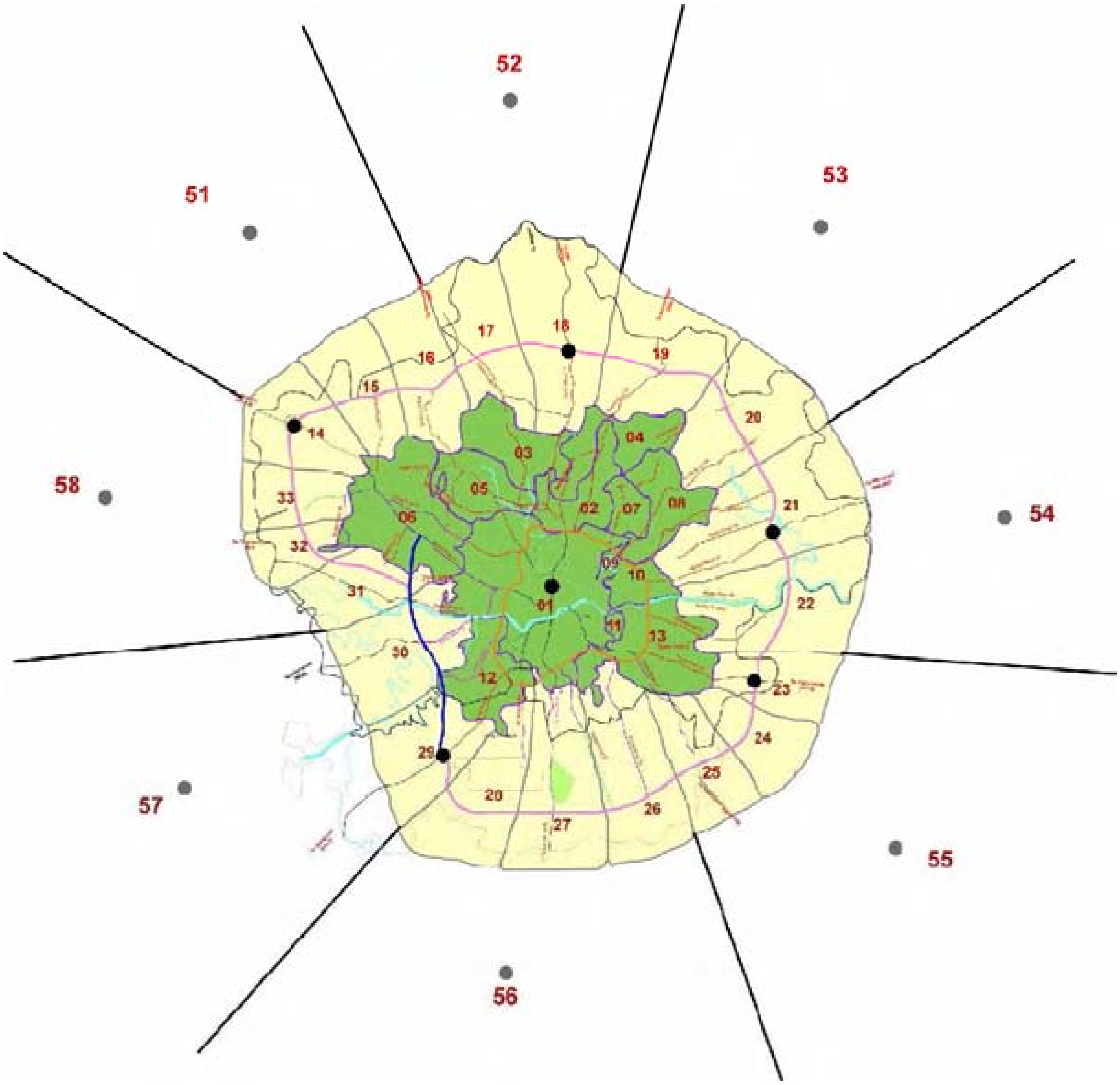


Figure 2.6: Map Indicating the Zones

The data collected during the road side interview with respect to the points mentioned above has been analysed in systematic way to finalise the origin-destination matrix for the entire study area as a whole. The data collected is analysed in the following steps as mentioned below.

- Formulation of Base O-D Matrix

- Sample Size Calculations
- Calculation of Raising Factors
- Raising of Base O-D Matrix
- Compilation of O-D Matrix for the entire Network

2.4.1 Formulation of Base O-D Matrix

The base O-D matrix has beeen generated from the information collected with respect to origin and destination and has been coded according to the zone number. The number of vehicles originating from particular zone and destinating to particular zone are grouped. After having done the coding, the same is repeated for all the zones to formulate the base O-D matrix.

2.4.2 Sample Size of O-D Data

During the survey it will not be possible to collect the information from all the vehicles using the road. Sample Size is defined as ratio number of Vehicles Interviewed to the Actual number of Vehicles counted at the location. Care is taken to obtain information from all categories of vehicles. Sample size of the data collected for all the locations have been presented in the **Table 2.10** below.

Table 2.10: Sample Size of the O-D Survey for All Locations

Vehicle Type	Sample Size, %									
	OD-1		OD-2		OD-3		OD-4		OD-5	
	Hyderabad to Mumbai (D-1 to D-2)	Mumbai to Hyderabad (D-2 to D-1)	Hyderabad to Nagapur (D-1 to D-2)	Nagapur to Hyderabad (D-2 to D-1)	Hyderabad to Warangal (D-1 to D-2)	Warangal to Hyderabad (D-2 to D-1)	Hyderabad to Vijayawada (D-1 to D-2)	Vijayawada to Hyderabad (D-2 to D-1)	Hyderabad to Bangalore (D-1 to D-2)	Bangalore to Hyderabad (D-2 to D-1)
Car/Jeep/Van/Taxi	4.69%	4.25%	7.65%	6.11%	10.91%	10.69%	6.23%	4.73%	2.50%	7.77%
Mini-Bus	13.84%	3.25%	18.82%	32.74%	1.16%	2.91%	9.84%	0.51%	4.52%	0.90%
Bus	16.78%	12.50%	19.06%	10.23%	11.15%	41.08%	18.08%	39.45%	17.86%	7.39%
LCV	1.49%	15.06%	19.61%	28.10%	53.68%	17.42%	34.93%	14.04%	27.14%	22.95%
2-Axle Trucks	20.55%	15.24%	14.64%	32.46%	19.19%	22.68%	18.41%	11.98%	12.93%	16.90%
3-Axle Trucks	10.81%	20.67%	21.42%	66.38%	34.79%	28.85%	13.69%	18.90%	27.19%	20.24%
Multi Axle Trucks	47.41%	28.13%	23.53%	89.47%	30.19%	30.43%	24.59%	29.03%	15.56%	12.40%

2.4.3 Raising Factors

The sample size calculated for the vehicle is used in calculating the raising factors to raise the base matrix developed for the vehicle to actual number of vehicles counted. Logically, the raising factor will be inverse of the Sample size. The raising factors for all the locations are given in **Table 2.11** below.

Table 2.11: Sample Size of the O-D Survey for All Locations

Vehicle Type	Raising Factors									
	OD-1		OD-2		OD-3		OD-4		OD-5	
	Hyderabad to Mumbai (D-1 to D-2)	Mumbai to Hyderabad (D-2 to D-1)	Hyderabad to Nagapur (D-1 to D-2)	Nagapur to Hyderabad (D-2 to D-1)	Hyderabad to Warangal (D-1 to D-2)	Warangal to Hyderabad (D-2 to D-1)	Hyderabad to Vijayawada (D-1 to D-2)	Vijayawada to Hyderabad (D-2 to D-1)	Hyderabad to Bangalore (D-1 to D-2)	Bangalore to Hyderabad (D-2 to D-1)
Car/Jeep/Van/Taxi	21.33	23.55	13.07	16.37	9.17	9.35	16.06	21.14	40.00	12.86
Mini-Bus	7.23	30.80	5.31	3.05	86.00	34.33	10.17	195.00	22.14	111.00
Bus	5.96	8.00	5.25	9.77	8.97	2.43	5.53	2.53	5.60	13.53
LCV	67.00	6.64	5.10	3.56	1.86	5.74	2.86	7.13	3.68	4.36
2-Axle Trucks	4.87	6.56	6.83	3.08	5.21	4.41	5.43	8.34	7.73	5.92
3-Axle Trucks	9.25	4.84	4.67	1.51	2.87	3.47	7.30	5.29	3.68	4.94
Multi Axle Trucks	2.11	3.56	4.25	1.12	3.31	3.29	4.07	3.44	6.43	8.07

2.4.4 Raised Matrix

After the base matrix is prepared from the raw data collected during the field work was analysed with respect to the total number of vehicles observed in each category. Hence, the base O-D Matrices were prepared are being raised by the raising factors in order to make the number of trips to the volume of traffic counted at that location and also to account the vehicles missed in the interview. The details of the matrix developed for each location for each category of vehicles and combined matrix for entire region as a whole are given in **Appendix D-1 to D-6**.

2.4.5 Vehicular Trip Characteristics

The travel characteristics of each category of vehicles has been analysed for the following. The trip characteristics considered are

- Purpose of Trip
- Load Factor

- Commodity
- Willingness to Use Proposed Outer Ring Road
- Willingness to Pay the Toll
- Toll Payment

Following tables indicates the salient features of each trip characteristics of the vehicles in the entire network.

Table 2.12: Details of the Trip Purpose of All Categories of Vehicles

Vehicle Type/Trip Purpose	Commuting/Work/School	Business	Sightseeing	Bus driver, Truck Driver, Taxi Driver	Others (please specify)	Total
Car/Jeep/Van/Taxi	411	736	153	215	97	**1612**
Percentage, %	**25.50%**	**45.66%**	**9.49%**	**13.34%**	**6.02%**	**100%**
Mini-Bus	51	21	13	7	3	**95**
Percentage, %	**53.68%**	**22.11%**	**13.68%**	**7.37%**	**3.16%**	**100%**
Bus	33	91	23	1353	0	**1500**
Percentage, %	**2.20%**	**6.07%**	**1.53%**	**90.20%**	**0.00%**	**100%**
LCV	203	395	27	141	9	**775**
Percentage, %	**26.19%**	**50.97%**	**3.48%**	**18.19%**	**1.16%**	**100%**
2-Axle Trucks	436	1054	49	979	16	**2534**
Percentage, %	**17.21%**	**41.59%**	**1.93%**	**38.63%**	**0.63%**	**100%**
3-Axle Trucks	480	1280	19	722	20	**2521**
Percentage, %	**19.04%**	**50.77%**	**0.75%**	**28.64%**	**0.79%**	**100%**
Multi Axle Trucks	54	176	3	129	0	**362**
Percentage, %	**14.92%**	**48.62%**	**0.83%**	**35.64%**	**0.00%**	**100%**

Table 2.13: Load Distribution Details for Goods Vehicles

Vehicle Type/Load Factor	Full Loaded	3/4 Loaded	1/2 Loaded	1/4 Loaded	Less than 1/4 Loaded	Empty	Total
LCV	278	94	72	41	19	269	**773**
Percentage, %	**35.96%**	**12.16%**	**9.31%**	**5.30%**	**2.46%**	**34.80%**	**65%**
2-Axle Trucks	1023	408	266	133	86	589	**2505**
Percentage, %	**40.84%**	**16.29%**	**10.62%**	**5.31%**	**3.43%**	**23.51%**	**76%**
3-Axle Trucks	1403	290	189	95	58	452	**2487**
Percentage, %	**56.41%**	**11.66%**	**7.60%**	**3.82%**	**2.33%**	**18.17%**	**82%**
Multi Axle Trucks	187	41	40	19	8	49	**344**
Percentage, %	**54.36%**	**11.92%**	**11.63%**	**5.52%**	**2.33%**	**14.24%**	**86%**

Table 2.14: Commodity Distribution Details of Goods Vehicles

Vehicle Type/Type of Commodity	Agriculture Product (Rice, Vegetable, Fruit, etc.)	Plantation Product (Cacao, Coffee, Clove, etc.)	Forest (Log, Timber, Plywood, etc.)	Fishery (Fish, Shell, Prawn, etc.)	Mineral (Salt, Coal, Nickel, Iron, etc.)	Metal & Machine (Steel, Generator, Car, Motorcycle, etc.)	Chemical (Petroleum, Alcohol, Acid, etc.)	Industry/Electronics (Machine parts, Garment, HP, etc.)	Construction (Sand, Gravel, Concrete, Beam, etc.)	Others (please specify)	Total
LCV	142	67	55	44	53	45	28	28	27	38	**489**
Percentage, %	**29.04%**	**13.70%**	**11.25%**	**9.00%**	**10.84%**	**9.20%**	**5.73%**	**5.73%**	**5.52%**	**7.77%**	**108%**
2-Axle Trucks	328	217	209	151	242	186	193	74	277	82	**972**
Percentage, %	**33.74%**	**22.33%**	**21.50%**	**15.53%**	**24.90%**	**19.14%**	**19.86%**	**7.61%**	**28.50%**	**8.44%**	**100%**
3-Axle Trucks	359	183	163	118	272	216	194	95	418	71	**1195**
Percentage, %	**30.04%**	**15.31%**	**13.64%**	**9.87%**	**22.76%**	**18.08%**	**16.23%**	**7.95%**	**34.98%**	**5.94%**	**100%**
Multi Axle Trucks	39	35	12	18	47	55	23	29	47	5	**201**
Percentage, %	**19.40%**	**17.41%**	**5.97%**	**8.96%**	**23.38%**	**27.36%**	**11.44%**	**14.43%**	**23.38%**	**2.49%**	**100%**

Table 2.15: Details of Willingness to Use Proposed Outer Ring Road

Vehicle Type/Willingness to Drive	Willing to Drive through ORR-YES	Willing to Drive through ORR-NO	Total
Car/Jeep/Van/Taxi	924	367	**1291**
Percentage, %	**71.57%**	**28.43%**	**100.00%**
Mini-Bus	90	4	**94**
Percentage, %	**95.74%**	**4.26%**	**100.00%**
LCV	645	121	**766**
Percentage, %	**84.20%**	**15.80%**	**100.00%**
2-Axle Trucks	2116	409	**2525**
Percentage, %	**83.80%**	**16.20%**	**100.00%**
3-Axle Trucks	2270	242	**2512**
Percentage, %	**90.37%**	**9.63%**	**100.00%**
Multi Axle Trucks	320	37	**357**
Percentage, %	**89.64%**	**10.36%**	**100.00%**

Table 2.16: Details of Willingness to Pay Toll for Using Proposed Outer Ring Road

Vehicle Type/Willingness to Pay	Willing to Pay for Using ORR-YES	Willing to Drive through ORR-NO	Total
Car/Jeep/Van/Taxi	897	369	**1266**
Percentage, %	**70.85%**	**28.58%**	**99.44%**
Mini-Bus	86	9	**95**
Percentage, %	**90.53%**	**9.47%**	**100.00%**
LCV	657	134	**791**
Percentage, %	**83.06%**	**16.94%**	**100.00%**

Vehicle Type/Willingness to Pay	Willing to Pay for Using ORR-YES	Willing to Drive through ORR-NO	Total
2-Axle Trucks	2101	431	**2532**
Percentage, %	**82.98%**	**17.02%**	**100.00%**
3-Axle Trucks	2250	300	**2550**
Percentage, %	**88.24%**	**11.76%**	**100.00%**
Multi Axle Trucks	319	40	**359**
Percentage, %	**88.86%**	**11.14%**	**100.00%**

Table 2.17: Details of Willingness to Pay Toll Amount for Using Proposed Outer Ring Road

Vehicle Type/Toll Amount	Willingness to Pay Toll Amount for Using ORR							Total
	Rs. 10	Rs. 20	Rs. 30	Rs. 40	Rs. 50	Rs. 60	Above Rs. 60	
Car/Jeep/Van/Taxi	1	75	310	213	53	68	105	**825**
Percentage, %	**0.12%**	**9.09%**	**37.58%**	**25.82%**	**6.42%**	**8.24%**	**12.73%**	**100.00%**
Mini-Bus	0	4	10	25	13	10	11	**73**
Percentage, %	**0.00%**	**5.48%**	**13.70%**	**34.25%**	**17.81%**	**13.70%**	**15.07%**	**100.00%**
LCV	2	25	162	158	44	90	91	**572**
Percentage, %	**0.35%**	**4.37%**	**28.32%**	**27.62%**	**7.69%**	**15.73%**	**15.91%**	**100.00%**
2-Axle Trucks	8	116	420	589	209	277	364	**1983**
Percentage, %	**0.40%**	**5.85%**	**21.18%**	**29.70%**	**10.54%**	**13.97%**	**18.36%**	**100.00%**
3-Axle Trucks	1	57	337	518	162	336	592	**2003**
Percentage, %	**0.05%**	**2.85%**	**16.82%**	**25.86%**	**8.09%**	**16.77%**	**29.56%**	**100.00%**
Multi Axle Trucks	0	12	40	43	37	70	100	**302**
Percentage, %	**0.00%**	**3.97%**	**13.25%**	**14.24%**	**12.25%**	**23.18%**	**33.11%**	**100.00%**

2.5 Traffic Estimation for Proposed Outer Ring Road

Presently, the traffic data has been collected at the National Highway sections which cuts or leads to Hyderabad. Totally five national sections have been considered and traffic volume count and Origin-Destination survey has been carriedout at these five locations.

The collected data has been analysed for the present day traffic and travel characteristics. Based on the preliminary data analysis now, traffic likely to use the proposed Outer Ring Road of Hyderabad City has been estimated.

As mentioned in previous section, the O-D matrixes have been generated for each location for each vehicle type. The generated matrices for all locations have been raised with respect to respective raising factors to arrive at the total traffic and total trips. After raising matrices, the

ANNEX 2 COUNTRYWIDE PRACTICES OF ETC SYSTEMS USE

Western Europe

(1) Austria: Videomaut/go-maut/Type 5

Tolls for vehicles whose maximum admissible weight exceeds 3.5t will be collected electronically. The toll system which does not require the driver to stop or use a certain lane while toll is being collected has been in operation since January 1, 2004.

The GO-Box is installed inside the vehicle and is commonly mounted inside the windshield. The system has two vital components both visible to the driver, namely the toll gantries and the on-board units. The GO-Box is the size of a cigarette pack and ensures proper toll collection from inside the vehicle. Signals between the small unit and the toll gantries are based on microwave technology. The vehicle with the GO-Box passes underneath the gantry.

The toll charging procedure is done in two ways: The data processing center (e.g. ASFINAG Maut Service GmbH) either saves the invoice data and the customer/driver pays the toll at a later date, or the toll is collected directly from a credit stored inside the GO-Box.

This globally tried and tested technology guarantees a user-friendly and simple system. This all-electronic tolling system was set up by ASFINAG Maut Service GmbH and is the first global countrywide, multilane, free-flow tolling system to come on line.

(2) Italy: Telepass

Telepass, introduced in 1989, can be used for all types of vehicles traveling on Italian motorways. Telepass consists of a battery-powered on-board unit (OBU) mounted at the top of the vehicle's windshield. It communicates with electronic toll booths through dedicated short-range signals.

Telepass is both used on motorways in open and closed systems. Toll charging in an open system consists of a flat fee charged for using a motorway or a part thereof regardless of distance traveled. The toll in a closed system is charged per distance. In both systems, the toll varies according to the type of vehicle (car, bus, lorry, etc.) and the upkeep of the motorway.

Telepass users must use lanes designated with the Telepass logo and travel no faster than 30 km/h when inside the Telepass lane. Once the OBU has been identified and verified, the OBU emits a single high beep, and the barrier blocking the lane is lifted. When the user exits the toll lane, the OBU emits a second single high beep. A series of three high beeps indicates the OBU's battery is running out and the OBU or its battery should be replaced. A low beep indicates the OBU has not been able to communicate with the toll station and is blocked, or, in the case of Telepass Ricaricabile, does not have sufficient funds left to pay for the toll incurred. In all these cases, the barrier remains closed, and the user must signal the toll station supervisor by pressing the red help (Assistenza) button. The license plate is then photographed, and the vehicle is allowed to pass through. The vehicle is subsequently identified by its license plate, and the owner is sent a bill for the toll which could not be collected automatically.

(3) France: Telepeage

The system has 1,423 automatic vehicle detection antennas and 670,000 tags circulating throughout France, making it the most common tag in Europe.

The private companies of Cofiroute, ESCOTA, SAPN, and AREA have operated ETC systems for 10 years, but these systems were not compatible with one another because each company selected its manufacturer technology.

The TIS (Telepeage Inter-Societes) program supported by toll road operators allowed drivers to use standardized ETC services on all toll roads starting in June 2000. The new system is based on CEN standards.

(4) Portugal: Via Verde

Via Verde, or "green lane", is an electronic toll collection system used in Portugal since 1991 and was extended to every toll system covering all freeways/motorways and bridges in the country since 1995.

Upon passing a non-stop lane at a toll plaza, a radio frequency identification (RFID) tag attached to the vehicle's windshield transmits its identifier signal and the toll amount is debited directly from the client's bank account. If the tag is invalid (or non-existent) or the vehicle's class (as detected by the lane sensors) does not correspond to the class encoded in the tag, it is photographed and the proper legal procedure is initiated.

This system provides for a good flow of traffic: the non-stop lanes have a 40 or 60 km/h speed limit, although the system has been proven to work at speeds above 200 km/h (which are obviously unsafe, especially on the narrow non-stop lanes).

The Via Verde system was the first to be widely applied to all the tolls in a country. It has gained widespread use in Portugal mainly because it can operate with any bank in the country. Banks are fully integrated under the Multibanco network.

United Kingdom and Ireland

(1) Ireland: eToll

The eToll is an interoperability system run by the National Roads Authority and allows cashless payment on all of Ireland's toll roads. Based on an RFID tag attached to the windshield of a vehicle, it allows drivers to travel on the tolled sections of the M1, M4/M6, M8, and M50 freeways, including the East Link and Dublin Port tunnel, without having to present cash at toll booths.

Prior to the introduction of the eToll, operators had their own toll systems specific to their own road sections and they were incompatible with one another. However, all five toll operators are currently issuing eToll tags, as well as one private firm that does not operate any toll roads.

Costs are charged to tags at the same rate as cash prices for the same class of vehicle, and purchase/administrative fees for tags vary by tag issuer. Some tags also operate for other cashless systems, such as car parks, but this also varies by issuer.

The M50 motorway has moved to a "barrier free" tolling, and the use of an eToll tag is required for use in the motorway at its lowest price. The eFlow system was introduced on the motorway on August 30, 2008 and is operated by BetEire Flow. In 2007, the NRA awarded BetEire Flow the contract to construct and operate the barrier-free tolling system.

eFlow uses overhead cameras and detectors to record motorists' electronic tags or vehicle license plates. The technology involves two sets of gantries over the motorway. The first gantry detects the vehicle, and the second has antennae and cameras to read the tags and license plates.

The system has led to the removal of toll booths that used to cause notoriously long queues. Drivers are now able to pass through the toll points at normal driving speeds.

(2) United Kingdom: DART-Tag (Dartford River Crossing)

The toll gates for both directions of travel are located on the south side of the crossing. Tolls can be paid in cash or through a pre-paid DART-Tag. Cash toll charges vary per type of vehicle; they fall into standard categories for cars, larger 2-axle vehicles, and larger vehicles with more than two axles. However, they are free for motorcycles. Two rates of cash tolls are charged: a day period from 6 a.m. to 10 p.m., and a night period from 10 p.m. to 6 a.m. From November 15, 2008, the night period is free of charge for all vehicles.

The DART-Tag is a device that enables drivers to pass through the tolls without paying in cash and provides discounted toll charges. Normally inserted into a holster that is stuck to the side of a vehicle's windshield, it is detected by sensors at the toll booths and automatically deducts the toll fee from the driver's pre-paid account.

Under the 2008 Charging Order, on November 15, 2008, cash fares were to be increased, DART-Tag discounts would be increased, and the night charges as well as the double charging for trailers would be scrapped. In addition, a local residents’ scheme was being planned for introduction wherein favorable pricing would be given to qualified local residents using the DART-Tag.

(3) UK: M6 Toll tag (the Midlands)

The M6 Toll connects M6 Junction 4 at the NEC to M6 Junction 11A at Wolverhampton, a 27-mile (43-km), six-lane motorway. The M6 Toll is part of the (unsigned in the UK) E-road E5 and is subject to the same regulations and policies as other motorways in the UK.

Tolls can be paid by one of four means: automated coin payments, payment at a staffed toll booth, automated credit/debit card payments, or in advance via an M6 Toll tag. An M6 Toll tag is an electronic toll collection device attached to a vehicle's windshield which records the vehicle's passage through toll plazas on the M6 Toll.

Each tag can only be used with the registered license plate and has a unique account. All accounts on the M6 Toll are pre-paid and must contain sufficient credit to cover the cost of the vehicle's toll so that it can pass through the toll gate. If the balance is adequate, the tag will beep once and the barrier at the toll gate will automatically rise. If the balance is low (fewer than three journeys remaining), the tag will beep twice. If the balance of the account cannot cover the cost of the toll, the barrier will remain closed and an alternative method of payment must be used. Balances can be topped up automatically once a month using Direct Debit or a credit card, or a check.

The tags contain a microchip which uses RFID technology. Physically, the tag resembles a DART-Tag which is used to pay the tolls on the Dartford Crossing. However, the two systems do not interoperate.

(4) UK: Severn TAG (Severn Bridge Crossing and Second Severn Crossing)

The Severn TAG is a payment system for collecting bridge tolls from drivers using either the Severn Bridge Crossing or the Second Severn Crossing over the Severn Estuary between England and Wales. The system was made by Amtech. To use the system, drivers must place a transponder unit on their windshield to identify their vehicles as they drive through the toll lane.

Scandinavia

(1) Norway: Autopass

Autopass is an electronic toll collection system used in Norway which allows collecting road tolls automatically from cars. It uses electronic radio transmitters and receivers operating at 5.8 GHz (MD5885) supplied by the Norwegian companies Q-Free and Fenrits.

The system involves the installation of a DSRC-based radio transponder on the windshield of a vehicle and requires the signing of an agreement with one of the toll collection companies in Norway. Tolls are charged in the same manner as they were done before but cars can drive past up to 80 km/h. The system is administrated by the Norwegian Public

Roads Administration. Twenty-three of the 45 toll roads in Norway use the system in addition to tests for introducing the system on car ferries. The primary reason that some toll roads don't support Autopass is that they charge both for the car and for passengers, which the system cannot support. All toll roads using Autopass can only charge per car. Autopass also has manual payment methods, although the booths are not necessarily manned.

Each Autopass unit contains a microcontroller which processes requests from the road side and replies with the proper information.

There are five generations of cryptographic key pairs inside each Autopass unit, which are unique to each unit. The cryptographic keys are used for authenticating the unit when passing a toll plaza, thus making it difficult for fraudulent copies of an Autopass unit. Unlike similar DSRC-based tolling systems used in other countries, there is no access control in the Norwegian system; the unique ID within the unit can be read only by those who have the proper DSRC equipment.

There is an internal storage space for 100 log entries, which are normally updated each time a vehicle owner is charged when passing a toll plaza. This is a collection of receipt entries which includes the time, date, and station identity of the toll plaza which did the tolling transaction.

Each Autopass unit features a movement detection mechanism. When the unit is removed from the windshield, an electrical switch will be activated causing a flag to be set in the processor within the Autopass unit. This flag will be registered when doing a tolling transaction the next time the unit passes a toll plaza.

(2) Sweden: Stockholm Congestion Tax / Type 4

The Stockholm congestion tax is a congestion pricing system implemented as a tax which is levied on most vehicles entering and exiting central Stockholm, Sweden.

The vehicles passing the control points are identified through an automatic license plate recognition. The equipment, consisting of cameras, laser detectors, antennas, and information signs are mounted on a set of gantries at each control point. There are no payment booths at the control points; they are all unmanned and payment is done by other means later. In a traditional toll booth, a substantial percentage of the toll goes to personnel costs, which is avoided in this system.

For those living on the island of Lidingo or otherwise often traveling there, an optional DSRC transponder can also be used to more accurately identify the vehicles. An incorrect identification results in the Lidingo exemption rule not taking effect. The DSRC transponders that were used during the congestion tax trial period are useless now and should be returned to the Swedish Road Administration.

North America

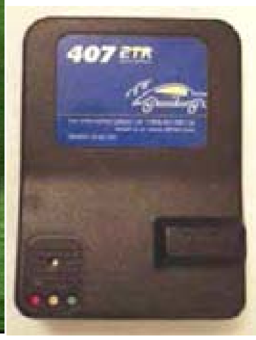
(1) Canada and the United States: E-Z Pass / Type 1

E-ZPass is an electronic toll collection system used in most toll roads, bridges, and tunnels in the northeastern United States. Air interface is 915 MHz active. Enforcement is conducted by photographing license plates using digital cameras. There are 24 agencies spread across 13 states that make up the E-ZPass Interagency Group (IAG). All member agencies use the same technology, allowing travelers to use the E-ZPass transponder throughout the IAG network. Various independent systems that use the same technology have been integrated into the E-ZPass system. These include the Fast Lane in Massachusetts, Smart Tag in Virginia, I-Pass in Illinois, i-Zoom in Indiana, and the defunct M-Tag in Maryland.

(Pennsylvania Turnpike)

In Canada, E-ZPass is widely adopted under the North American Free Trade Agreement. Car usage rate reaches 70% while all large vehicles are required to use ETC.

407 Electronic Toll Route (ETR) is the world's first all-electronic, barrier-free toll highway. It stretches 108 km from Burlington (in the west) to Pickering (in the east) in Canada.



(407ETR)

(2) Mexico: IAVE

A complete toll collection system, which can provide real-time statistical and financial information regarding traffic volumes and revenues for all cars nationwide, was started in November 1999 between Mexico City and Queretaro. By April 2002, this expanded to cover the entire network.

(3) US: SunPass network

SunPass is an electronic toll collection system used by the State of Florida and was originally created by the Florida Department of Transportation's Florida's Turnpike Enterprise. The system uses Amtech’s active RFID windshield-mounted transponders manufactured by TransCore along with lane equipment designed by several companies including SAIC and TransCore. SunPass is fully interoperable with E-Pass (from the Orlando-Orange County Expressway Authority), The Osceola Parkway (owned and operated by Osceola County, although O-Pass operations have been absorbed by E-Pass), LeeWay (from Lee County toll bridges), and Miami-Dade Expressway Authority (MDX) toll roads. SunPass Plus may also be used at the Orlando International Airport to pay for parking. There are plans for other major Florida airports to utilize the SunPass system for parking fees in the near future.

(4) US: TxTAG network

TxTag (pronounced "textag"), operated by the Texas Department of Transportation (TxDOT), is one of three interoperable electronic toll collection systems in Texas. TxTag uses at least two types of transponders manufactured by TransCore: a legacy hard case AT5100 transponder and the newer eGo Plus flexible sticker-type transponder. The transponders are mounted on the inside of the vehicle at the top center of the windshield.

(5) US: FasTrak

FasTrak is the electronic toll collection system used in the state of California in the United States. The system is used statewide on all toll roads and bridges along the California freeway and expressway system.

As with other ETC systems, FasTrak is designed to eliminate the need for cars to stop at the toll booths, thus decreasing traffic congestion traditionally associated with toll roads. Its use of technology to improve transit is in line with the U.S. Department of Transportation's ITS initiative.

FasTrak uses RFID technology to read data from a transponder placed in a vehicle (usually mounted by Velcro strips to the windshield) moving at speeds that may exceed 70 mph (112 km/h). The RFID transponder in each vehicle is associated with a prepaid debit account; each time the vehicle passes underneath a toll collection site, the account is debited to pay the toll. If a vehicle does not have a transponder a Violation Enforcement System triggers cameras that take photos of the vehicle and its license plate for the processing of legal procedures.

Anybody with a FasTrak transponder can use it to pay tolls on any California toll road or bridge using the system. But people are encouraged to open their accounts with the local agency in charge of the toll facility that they use the most.

(6) Washington State, US: Good To Go!

Good To Go! is the electronic toll collection system used by the Washington State Department of Transportation on all current and future toll projects in the state. Good To Go! customers prepay their tolls into an account, and the tolls are then electronically deducted as the customer passes through an electronic toll collection location. The system debuted in July 2007 on the new Tacoma Narrows Bridge and is part of the high-occupancy toll (HOT) lanes on State Route 167 which opened in the spring of 2008. The Good To Go! system is similar to other electronic toll technology already in place around the country such as FasTrak in California and E-ZPass in the eastern United States.

(7) Kansas, US: K-Tag

K-Tag was introduced in 1995. K-Tag customers can proceed slowly through the toll plaza without stopping and collecting a ticket or paying toll. The toll is instead paid through one of two payment plans, namely K-Tag I or K-Tag II. K-Tag I accounts are subject to a US$1 monthly fee per tag, while K-Tag II account holders pay a US$5 annual fee per tag. K-Tag I users also receive a 10 percent discount on tolls.

The Kansas Turnpike Authority (KTA) reports that the Kansas Turnpike is completely self-sustaining. All costs are paid for by the tolls collected; no tax money is used for construction, maintenance, or administration. The KTA estimates that 120,000 drivers use the turnpike each day.

(8) Minnesota, US: MnPass

MnPass is an electronic toll collection system operated by the Minnesota Department of Transportation. As of 2005, the only place the system is used is on the HOT lanes of Interstate 394. There are no traditional toll roads in the state.

The MnPASS transponder has a minimum first time recharge of US$40 with an additional charge of US$1.50 per month for leasing transponders. The price of the toll is determined by traffic density. When there is more traffic, the toll is priced higher. Electronic sensors monitor traffic density, and tolls are changed every three minutes.

South America

(1) Brazil: Via Facil

The public corporation BHTRANS has authority over regional transportation and shipping in the Belo Horizonte region and is responsible for planning, adjusting, and operating public transportation, taxis, and school buses. This public corporation has introduced ITS systems for controlling traffic, automatic public transportation fare collection, management of city traffic, and other such operations.

During the construction of the Lihna Amarela (22km), an automatic toll collection system with changeable signboards, systems for measuring traffic volume and vehicle types, as well as monitoring cameras were introduced. At the toll gate, an automatic collection system was introduced in two of the 20 lanes. Its unique characteristic is that ITS equipment was introduced during the actual construction of the road.

When it was privatized, improvements were made to the Rio-Teresopolis Toll Road (145km), which passes through the country and the mountains. In particular, an ETC system was introduced for two of the 12 lanes at the toll collection area along the Mainline Plaza section, which has comparatively large traffic volumes.

(2) Colombia: Free Flow

The Free Flow system (also known as Televia in Spanish-speaking countries), is an electronic deposit system used to pay for the passage of automobiles on toll roads. With the tag, cars do not need to stop or slow down for payments.

The tag is no larger than a wallet and is extremely light. It is normally placed behind the rear view mirror of the car, but can also be installed in a more visible location such as on the windshield. Its electromagnetic system allows easy payment and a more rapid transit.

Countries like Argentina, Australia, Canada, Chile, and Israel, among others, employ it in their urban and rural highway systems.

Toll collection is performed by installing "collection booths," which are no more than a frame erected over the path of the highway, with an electronic sensor suspended over each lane accompanied by cameras. As the vehicle nears the frame, the cameras snap a picture of the license plate, the individual driver's tag is detected by the sensor, and the payment is processed in a fraction of a second. At the moment the payment is processed, the tag generates a characteristic whistle-like sound. The sound indicates that the transaction was successful and the toll has been charged; if the tag remains silent, this means that the transaction failed and a ticket will be sent to the violator.

(3) Chile: Free Flow

Chile was the world's first country to run all payments through a single tag system. Presently they are used in four of the highways of Santiago de Chile, and some other highways currently under construction are set to employ it.

East Asia

(1) Japan: ETC

Nineteen million vehicles (ratio of 70%) use the ETC system in Japan. The ETC has been the main solution to congestions on toll gates.

The specification and the agreement of the transaction are united in all tollways. The international standard of 5.8GHz-active band system DSRC of interactive accurate communications is used.

The separation of OBU and IC card for various usages was adopted. A verification of the OBU and the IC card for high security is done. Discount rates, reaching up to 50%, are given to various trips (commuting and midnight, etc.) to increase the number of users.

(Separate OBU and IC card)

(2) South Korea: Hi-pass Plus

The charge collection system in South Korea is adopted for tollways outside Seoul’s ring road. The technology involves separating the card and the OBU by using HiPass. The card adopts the prepayment system like the Touch 'n Go and Smart Tag Touch 'n Go of Malaysia. The international standard of 5.8GHz-active band system DSRC and IR (870nm) is used to ensure interactive accurate communication.

(3) Hong Kong: Autotoll

This covers toll roads and tunnels in Hong Kong and has 220,000 users making 320,000 daily transactions.

Southeast Asia

(1) Malaysia: Smart Tag Touch 'n Go / Type 6

This ETC system consists mainly a touch-and-go type using contactless IC cards or smart tags for vehicle communication. Both use pre-paid methods. When registration is made in advance, the cards can be automatically recharged once their credit of 20 RM is used up.

(2) Philippines: E-pass Tag

A suspended roadway called Skyway is built on a section of the South Luzon Expressway in Metro Manila (currently 11km of the planned 35km section has been opened).

The Skyway is a toll road using an ETC system. Besides the Skyway, there are tolled sections on the main route of the expressway. An ETC system, similar to that used on the Skyway, has been introduced in these sections.

(3) Singapore: Area Licensing Scheme and Electronic Road Pricing

Area licensing scheme (merged with electronic road pricing or ERP) was the world's first to implement congestion charges to enter a downtown area. In 1995, congestion pricing was also implemented in urban segments of three major freeways, starting with the East Coast Parkway (ECP). The road pricing schme (RPS), as it was called, was operated manually with paper licenses to enter the expressways. In 1997, the RPS was implemented in the Central Expressway and the Pan Island Expressway. After the implementation of the RPS, the average speed on the Central Expressway at peak hour rose to 67 km/h from the previous average of 31 km/h. This extension was necessary because some through traffic was diverted by the ALS to routes that bypassed the restricted zone, increasing demand on these arterials and creating a need for expanding the capacity of the road network outside the restricted zone. Because of heavier demand only the Central Expressway required a separate license which was not valid for the restricted zone. During this time, a more modern system was being planned to allow toll charging every time a user entered the restricted zone; thus, charges would reflect the true cost of driving at congested times.

Overall, the ALS was successful in ensuring smooth traffic flows in the central business district. After 10 years of planning and testing, in September 1998, the scheme was terminated as Singapore upgraded to its current ERP system, which is completely automatic and allows passing the control gantries at normal speeds.

The scheme consists of ERP gantries located at all roads linking to Singapore's central business district. They may also be located along expressways and arterial roads with heavy traffic to discourage usage during peak hours. A device known as an In-vehicle Unit (IU) is affixed on the lower right corner of the front windshield within sight of the driver, in which a stored-value card, the CashCard, is inserted for payment of the road usage charges. It is mandatory for all Singapore-registered vehicles to be fitted with an IU if they wish to use the priced roads. Foreigners driving foreign-registered cars on priced roads during the ERP operating hours could choose to either rent an IU or pay a daily flat fee of S$5. The gantry system is actually a system of sensors on two gantries, one in front of the other. Cameras are also attached to the gantries to capture the rear license plate of vehicles which do not have sufficient funds in their CashCards.

According to a paper presented in the World Roads Conference 2006, Singapore’s Land Transport Authority has been testing a GPS-based system that may eventually replace the current ERP system.

(Singapore ERP)

(4) Thailand: ASCOM

Battery capacity for the current tag is small, so only between 20,000 to 40,000 vehicles are controlled out of the some 800,000 transactions each day.

(5) Australia: e-Tag

The e-Tag is an electronic toll collection system used on tollways throughout Australia. Based upon the DSRC protocol, it was originally developed by Transurban for use on their CityLink tollway in the early 1990s. The system has since been adopted by all electronic tolled roads, bridges, and tunnels in Australia. At present, there are over 850,000 e-Tag account customers and over 1 million e-Tags issued. The e-Tag tolling is based on a modified IFF (identification friend or foe) system.


(CityLink Melbourne)

Annex 3 Scope of Work for the Advanced HTMS Equipment

1. General

1.1 The work includes design, supply, installation, commissioning, documentation, training and maintenance of advanced Highway Traffic Management Services (HTMS) equipment on Hyderabad Outer Ring Road project.

1.2 A brief list of various works indicating the vital items that are included, but not limited to, is given in the subsequent Clauses.

1.3 However, to achieve the end objective, if the Bidder feels that additional items of supply and/or execution are required, he shall mention the same in the Bill of Quantities against "ANY OTHER ITEM" and indicate the quantities and unit as well as total cost of same in his price bid. He shall provide detailed justification for addition of such items of supply/execution in the bid; otherwise his offer shall be liable for rejection.

2. Design

2.1 Site survey and design of the system duly taking into consideration future expansion both in terms of traffic and future facilities needs to be done by the bidders. All the system software (sub-system and integrated ITS software) shall meet the present requirements and shall also support at least 100% capacity expansion of the traffic management system without up-gradation of the hardware platform. This shall be possible through re-configuration of the above mentioned software.

2.2 There shall be one Main Traffic Control Center and one Sub Control center for the ITS. The Control Center shall be used for centralized monitoring and control of the Expressway. Both the control rooms would have the necessary hardware servers and workstations for communication with the sub systems equipments. The Main Traffic control center would be always in operation. Only in case of the Main TCC being down for technical reasons; the sub control center would take over the operations. Also the sub control center computer hardware would be used for the data back up at all the times. The system shall be designed to meet the requirement of the Main traffic control center and the sub-control center specified as above.

3. Supply

3.1 Supply of all equipment, material, components, accessories, mounting hardware, software, etc., for the following sub-systems of advanced HTMS:

a) Emergency Call Management System

b) Variable Message Sign System

c) Video (CCTV) Surveillance System along with Video Incident Detection System

d) ATCC System

e) Meteorological Data System

f) Fibre Optic Communication system and its NMS

g) ITS Main Traffic Control Centre, Sub control center & Integrated ITS Software

h) Transmission Cabling System

i) Power Supply and Air Conditioning system

j) Electrical distribution network for all equipments

3.2 Supply of power distribution/back-up equipments for the entire main and the sub systems of the ITS categories.

3.3 Supply of tool kits and instruments required for all the sub-systems.

3.4 Supply of all types of wires and cable for connection, wire ways, cable conduit and trays, equipment racks, nuts & bolts, etc.

4. Installation & Wiring

4.1 Installation & wiring of all equipment, components and accessories of sub-systems. The bidder shall submit location-wise list of all equipment, components and accessories with the bid. All equipment shall conform to the specifications mentioned in the particular technical specs.

5. Testing

5.1 Testing of equipments/systems to be carried out as per the specification provided for individual equipments in each section.

5.2 Factory Acceptance tests shall be carried out in line with the documentation to be submitted by the Contractor. Prior approval of the documents shall be obtained by the contractor from the EMPLOYER as per the tender requirements and specifications.

5.3 Site Acceptance Testing shall be carried out in line with the documentation to be submitted by the contractor. Prior approval of the documents shall be obtained by the contractor from the EMPLOYER as per the tender requirements and specifications.

6. Progress Review

6.1 The Contractor shall carry out the works as per the PERT Chart submitted by him in his bid (which would become a part of the Contract Agreement) showing details of activities to be finalized in Consultation with the EMPLOYER. The Contractor shall furnish progress report every fortnight to the EMPLOYER. However, depending on the progress, the progress may be discussed at shorter intervals if so desired by the EMPLOYER.

6.2 A coordination meeting shall be held every month in the office of CGM HGCL, at Hyderabad to assess the progress of work and set out the targets for the next month.

7. Site Order Book

7.1 A site order book shall be kept at the site(s) of work. As far as possible, all orders regarding the works are to be entered in this book. All entries therein shall be signed by the Employer and the contractor. The site order book shall not be removed from the work site except with written permission of the Employer. And the contractor or his representative shall be bound to take note of all instructions and directions meant for the contractor as entered in the site order book without having to be called on separately to note them. The Contractor shall submit periodically copies of the remarks in the site order book to the Employer for review and for submitting suggesting compliance report.

8. Documentation

9.1 Supply of documents with regard to design basis of the system, functional design specifications, installation drawings for all equipment, details of fault diagnostics, Operating and Maintenance manuals, FAT(Factory acceptance Test) and SAT(Site acceptance Test) reports of all equipment shall be submitted by the Contractor.

9. Operation And Maintenance During Warranty

9.1 The contractor shall carry out comprehensive operation and maintenance of the entire ITS system for a period of 2 (two) years from the date of successful commissioning within the quoted cost.

9.2 The contractor is required to depute a dedicated team of maintenance engineers on ORR during general shift and also to be available on phone call when not on duty during the night time. The team should be made up of three categories as team leader, site engineers and assistance staff. 4 such teams should be deployed on the whole ORR for the duration of 2 years during the warranty period.

9.3 The contractor shall be wholly responsible for all activities relating to ITS including operation and maintenance of Main Traffic control centre and the sub control center.

9.4 The contractor shall, at all times, extend his full cooperation to the Employer or its nominated agency to facilitate effective and smooth operation of the ITS system.

9.5 The contractor shall maintain a detailed log of all events round the clock, duly signed by his Maintenance engineers on duty.

9.6 The contractor shall provide weekly/monthly/annual MIS reports (or as required by the Employer) in both hard and soft copy formats.

9.7 The contractor shall submit the following with his offer

a) Maintenance Plan for all equipment

b) Manpower proposed to be deployed, together with their qualification, experience, etc., and their CV's for scrutiny and approval by the EMPLOYER.

c) Location-wise deployment plan at all locations (Traffic Control Room, Sub-Control room, Interchanges etc.)

d) List of tools, instruments, accessories and spares and locations where they would be locate

e) List of vehicles (types) including description such as equipped OFC maintenance van, etc.

9.8 The manpower approved by the EMPLOYER shall not be changed except under unavoidable circumstances, and only with written approval of the EMPLOYER. The replacements, if proposed by the selected Bidder, shall have equal or better qualification and experience than those originally proposed in the Bid.

9.9 The cost for operations & maintenance shall be deemed inclusive of all expenses related to the work such as cost of fuel (for vehicles), repair expenses, watch and ward manpower, all applicable taxes/duties/levies, etc.

10. Operation and Maintenance after Warranty

10.1 The bidder shall quote separately for AMC (Annual Maintenance Contract) charges for a further period of 3 (three) years beyond the Warranty Period with responsibilities as at Clauses 9.2 to 9.9 above.

10.2 No additional amount would be paid to the selected Bidder under any circumstances over and above the price agreed to be paid by the EMPLOYER for post-Warranty Operation and Maintenance upon award of the work.

11. Consignee and Security of Material

11.1 The EMPLOYER shall be the consignee for all material. The contractor shall supply all material to the consignee or at the site of work as mutually agreed with the EMPLOYER in writing.

11.2 Exchange of proper requisition between the contractor and theEMPLOYER and receipt of all material shall be done on the prescribed proforma.

11.3 All material whether imported, procured indigenously, booked by rail, sea, road, etc., shall be supplied either at the consignee's depot or at the site of work as agreed by the Employer. The necessary customs formalities, if any, shall be completed by the contractor.

11.4 Security of all material in the section where the work is in progress shall be the contractor's responsibility and he shall arrange to guard the same from theft/pilferage/vandalism. The cost of providing such security shall be deemed included in the offer, whether or not explicitly mentioned so. In the event of any loss the contractor shall be responsible for the same. The contractor shall insure the materials. Any stores lost, prior to formally taking over by the EMPLOYER, shall be made good by the contractor at no cost to the EMPLOYER.

12. Care of Packing

12.1 All equipment & subassemblies containing active components liable for damage while handling due to Electrostatic discharge, etc., or otherwise fragile shall be wrapped in a conducting wrapper & placed in bubble packing. Any other internationally accepted method shall also be accepted subject to prior approval by the Employer.

13. Program

13.1Major milestones for achieving different targets shall be guided by the following program. Any deviations shall be explained with justification, but the Employer is not bound to consider/accept the same.

D	Date of issue of LOA(Letter of Acceptance)
D + 45 Days	Submission of detailed design & drawings including amendments if any
D + 100 Days	FAT & Supply of all indoor hardware, software modules.
D + 245 Days	FAT & Supply of all outdoor equipment, transmission system, accessories
D + 265 Days	Installation of all indoor equipment at Control Centre & other locations & loading of major software modules.
D + 350 Days	Installation of outdoor equipment and cabling works
D + 355 Days	Joint Testing of all software modules
D + 365 Days	Integration of complete ITS system
D + 365 Days	Start of Trial Run for 3 months
D + 455 Days	Start of warranty period

13.2 Based on the above, the Bidder shall submit a detailed BAR/CPM/PERT chart to establish how he plans to meet this schedule. This chart shall include the contractor's proposed manpower deployment schedule during project implementation as well as during Operation and Maintenance.

13.3 The works shall be carried out as per the above Chart submitted by the Contractor showing details of activities which shall be finalized by the Contractor in consultation with the EMPLOYER.

13.4 Transportation of material from depot to the site of the work shall be done by the Contractor with his own labour and transport arrangements.

14. Installation Practice and Method of Work

14.1 The work shall be executed to the highest standards using best quality material. The system design shall use state of art techniques. The contractor shall ensure that the entire specification is complied with. It shall be the responsibility of the contractor to demonstrate compliance of technical as well as functional specifications.

14.2 The completed installation shall be subject to checks at all stages and tests as prescribed in the bid or as deemed necessary by the Employer. The same shall be done by the EMPLOYER and the contractor shall be liable to rectify such defects as brought out by the EMPLOYER during these checks and tests and make good all deficiencies at his own cost.

14.3 During system & application software loading on the system and during data input, EMPLOYER's personnel shall be fully associated right from the beginning.

15. Documentation

15.1 The following documents required for installation, operation and maintenance shall be supplied:

a) Installation manual

b) Equipment layout drawings

c) Cabling and wiring diagrams

d) Overall system specification and description of hardware, software, explaining facilities, functions & principles

e) Schematic drawings of all circuits in the system, with circuit explanation and timing sequence charts wherever applicable

f) Equipment installation drawings (site-wise)

g) Adjustment procedures for all field adjustable units

h) Installation instructions and testing procedures

i) Fault location/troubleshooting instructions incl. Fault Dictionary

j) Operations Manual

k) Acceptance testing schedules

l) Test procedure with auxiliary test equipment, if any

m) Emergency action procedure

n) Catalogue of parts including detailed information regarding

o) individual component values, tolerance, etc., to enable procurement of spares from alternative sources

15.2 The documents required for installation and those required for operation and maintenance shall be supplied in separate sets. Three sets of each shall be supplied for each installation.

15.3 Two sets of Factory Test results of the equipment together with information on the method of the testing shall be supplied.

15.3 Documents / plans listed below shall be submitted (at the minimum) at various phases of the work (Approval of EMPLOYER shall be obtained for all documents):

a) Detailed Design & User Specification

b) Equipment Manuals

c) System test plan

d) Unit test plan

e) Unit testing document

f) System testing document

g) Integration testing document

h) Details of hardware used at the Control Centre including those for

i) interfacing

16. Software Documents

16.1 The software documents shall be user-friendly. The documents shall be complete and as detailed as possible to enable the EMPLOYER to carry out the functions of planning, installation, operation maintenance and system support.

16.2 The following software documents shall be supplied.

a) Detailed description of the software describing principles and practices employed, functions performed, its interaction with the hardware and its structure in terms of program and data packages.

b) Detailed description of each individual software package indicating its functions and its linkage with other packages, hardware and data.

c) Detailed description of the program and/or data modules in each package indicating their function interlinking with other programs modules and the input signals of each module.

d) Program and data listings

e) Source files and software code details for all the packages developed for EMPLOYER

f) Graphical description of the system in addition to the narrative description, a functional description of the system in graphical form shall also be supplied.

g) The state transition diagrams (if any) shall use standard symbols and rules. The description shall reflect in detail the internal software structure and logical processes within the system. The overall functional description shall be partitioned into Functional Description Blocks (FDB’s) each relating to a process. The processes shall be described in terms of INPUTS, STATES, TRANSMISSION, DECISIONS, TASKS and OUTPUTS.

h) Flow charts for each program modules

i) Planning and system engineering documents

j) Hardware details at field stations including details of software and hardware used for interfacing purposes

k) In case of third party software like database, operating systems, NMS, etc., adequate number of user licenses are to be provided along with original license documents

17. Drawings to Be Submitted by Contractor

17.1 Equipment layout plan

17.2 Design of entire system for Traffic Control Centre, Sub Control Center and site locations in detail at least up to terminal numbers

17.3 Networking arrangement

17.4 In-house test reports by the manufacturer concerned

18. Document Quantities Be Submitted

18.1 All drawings and documents to be submitted by the contractor shall be in TEN sets duly placed in plastic folders / laminated and in CD.

18.2 The tracing of all drawings on quality tracing paper shall be submitted in TEN sets of hard copy and also in CD

18.3 All maintenance manuals shall be submitted in TEN sets of hard copy and also in CD for each installation.

18.4 The quantity of the documentation shall be assessed on the type and variety of the systems used and not on the number of such modules used. Approval of the EMPLOYER shall be obtained for the same.

18.5 Manuals for installation shall be in TEN sets of hard copy and also in CD.

19. Training to Employer's Personnel

19.1 The contractor shall arrange for training of at least five (5) of EMPLOYER's personnel at any one site where similar system has been implemented by the contractor in the past and also at the principal contractor's premises. Hands-on operational and diagnostic training in all aspects of software and hardware pertaining to the ITS shall be covered in the training. The training shall also cover system design and engineering, its functioning including planning, management and supervision.

19.2 Training, the contents of which shall be finalized in consultation with the EMPLOYER, shall be of two-week' duration.

19.3 The Contractor shall ensure that the EMPLOYER's personnel who undertake training are able to modify & reconfigure the system to accommodate changes in traffic patterns etc. in foreseeable future after such training. Such personnel should be able to maintain the system effectively on their own.

19.4 The training shall continue during the period of actual installation of the system. The contractor shall also ensure that the trained EMPLOYER's personnel are able to diagnose and rectify the faults completely and quickly.

19.5 The entire cost of training of EMPLOYER's personnel including travel, lodging, boarding and other incidental expenses, etc., shall be borne by the Contractor as per their entitlement.

19.6 The courses shall be in English and complete documentation of the courses shall be supplied to the trainees. The EMPLOYER however reserves the right to vary the number of personnel as well as course modules and training period.

19.7 The contractor shall supply two sets of training documents to each of EMPLOYER's trainees. FOUR additional sets of the same shall be submitted to EMPLOYER.

19.8 The bidder shall include recommended training program and schedule for the same in his offer.

20. Inspection

20.1 The inspection and tests shall be carried out to ensure that all the requirements of the specifications are complied with. The EMPLOYER reserves the right to reject any equipment or parts thereof considered defective in any respect.

20.2 Testing may be made at the place of production, at destination or at both locations as decided by the EMPLOYER. All equipment/instruments/accessories and facilities required for testing, simulation shall be arranged by the Contractor at his own cost.

20.3 The EMPLOYER shall depute engineers to inspect all equipment at location of manufacturing of all hardware components (systems/subsystems). The contractor shall give clear 21 days' notice to the EMPLOYER for such inspection at manufacturers' works. The entire cost of inspection including travel, lodging, boarding, etc. shall be borne by the contractor.

20.4 In house results/reports shall be furnished by the Contractor for each module prior to such inspection.

21. Acceptance Testing of Installation

21.1 The EMPLOYER shall carry out all the tests detailed in the Acceptance Test Schedule to be furnished by the Contractor to confirm that the performance of the different modules, sub-systems and the entire installation satisfies the specification requirements. The EMPLOYER reserves the right to include any other tests which in his opinion is necessary to ensure that the equipment meets the specifications.

21.2 Any components or modules failing during the acceptance tests shall be replaced free of cost by the Contractor. These replacements shall not be made out of spares supplied by the Contractor as part of supplies under this Contract. This shall also not entitle the contractor to any extension of completion time.

21.3 The cost of all test and / or analysis shall be fully borne by the contractor. The contractor shall provide all test instruments/gadgets required for testing.

21.4 Material put up for inspection shall be those to be supplied and in quantities laid down in the Schedule of Quantities. Any variation shall require the prior approval of the EMPLOYER before the material is manufactured/ offered for inspection.

21.5 The EMPLOYER shall inspect and test the work at all stages and shall have full powers to reject all or any work that may be considered defective or inferior in quality or material of poor workmanship or design. The Contractor shall carry out any additional tests at his cost as are necessary in the opinion of the EMPLOYER to ensure that the specifications of the Contract are being complied with.

21.6 All material brought to site shall be permitted to be erected only after inspection and acceptance by the EMPLOYER.

21.7 The completed installation at all stages shall be subjected to checks and tests as decided by EMPLOYER. The contractor shall be liable to remedy all of such defects as discovered during these checks and test and make good all deficiencies brought out. The complete installation shall be taken over finally on successful commissioning in entirety.

21.8 The contractor shall advise the EMPLOYER at least 21 days in advance for inspection when a portion of the work is offered for inspection. The EMPLOYER shall carry out inspection upon receipt of such advice and of in house results/reports for the equipment/material so offered.

21.9 Even after inspection by the EMPLOYER as indicated above, the Contractor shall be liable for rectification of any defects observed during the course of installation or in use during Warranty Maintenance period at his own cost.

22. Tests

22.1 The contractor shall carry out such tests as may be necessary to demonstrate full compliance to the specifications and the Contract clauses to the satisfaction of the EMPLOYER.

23. Review Meetings during Maintenance

23.1 The contractor shall apprise the EMPLOYER about system performance/incident management & send routine (daily/weekly/monthly/ etc.) status at least once a fortnight.

24. Spares

24.1 The Contractor shall submit a list of spares which he considers essential to be stocked for proper upkeep of the system along with their costs. He shall also mention the shelf life of these spares.

24.2 These spares shall be in the EMPLOYER’s custody, and may be utilized by the contractor during Warranty/ guarantee and Maintenance Contract period (if any). However, the same shall be replenished within 45 days thereafter.

24.3 If the EMPLOYER feels that additional spares are required during the system lifetime, it reserves the right to procure additional quantities from the Contractor during warranty / guarantee period at the same unit cost as accepted.

24.4 Any item not included as spares in the offer and subsequently found to be necessary during warranty/guarantee period OR during Maintenance Contract period (if any) shall be supplied by the contractor FREE OF COST.

25. Long Term Availability of Spares and System Support

25.1 The bidder shall undertake to supply on payment all maintenance spares and tools required for the equipment during lifetime. He shall also undertake to supply additional equipment required for replacement/expansion of the system that may become necessary due to additional traffic requirements. The Bidder shall quote price of such spares for third year, fourth year and fifth year from the date of commissioning of the system. Beyond fifth year the prices of additional supply that may be ordered in future shall be decided by mutual discussion. If the cost of future procurement is not indicated, Contractor shall make available all spares at the price accepted at the time of issuing the Letter of Acceptance for this Bid.

25.2 The contractor shall guarantee that the system shall not become obsolete for a minimum period of 8 years after the acceptance of the system. During this period the contractor shall ensure the availability of all working equipment and parts thereof. The Contractor shall give 12 months’ prior notice in writing to the EMPLOYER before discontinuing manufacture of any sub-system/component. This would enable the EMPLOYER to procure life time requirement of spares needed and order in sufficient quantities prior to stoppage of manufacture.

25.3 The Contractor shall depute adequate number of competent engineers/qualified staff to install, test and commission the equipment/systems at the sites.

25.4 The Contractor shall furnish progress report every fortnight to the EMPLOYER. However, depending on the progress, the progress may be discussed at shorter intervals if so desired by the EMPLOYER.

25.5 A coordination meeting shall be held each month in the office of CGM, HGCL at HGCL office at Hyderabad, to assess the progress of work and set out the targets for the next month.

Annex 4 Technical Specifications for the Advanced HTMS Equipment

A. GENERAL SPECIFICATIONS FOR THE ADVANCED HTMS

1. Introduction

1.1 It is proposed to provide the advanced Highway Traffic Management Services (HTMS) on the Hyderabad Outer Ring Road for collection and dissemination of information and for providing efficient traffic movement for users. The system shall have one Main Control Centre for ITS and one sub-center for back up if needed.

1.2 The sub-centers shall be connected over fiber optic communication system to the main Control Centre. These sub-centers shall house all the in-station equipment required for communication & power supply to the indoor / outdoor equipment installed in that area. All the indoor equipment required for communication & power supply to outdoor equipment like VMS. ECB, ATCC, MET, Video Surveillance and Video Incident Detection System shall be located in these control centers only.

2. Scope

2.1. This Specification covers the Performance, Functional and Design requirements of the advanced HTMS.

3. System Configuration

3.1. The system architecture shall follow the guidelines as below:

a) Control of mobile radio communication

b) Control of emergency call system

c) Traffic manager interface for control and information of following sub-systems:

(i) Variable Message Signs
(ii) Automatic Traffic Counter and Classifier
(iii) Meteorological system
(iv) CCTV Surveillance
(v) Video Incident Detection System
(vi) Emergency Call Management System
(vii) Mobile Radio System
(viii) Variable Message System

3.2 In case of emergency situations such as failure of traffic manager terminal it should be possible to manage (exchange of data, commands & configuration) individual sub-systems independently from main control center. However after rectification of fault the control shall be restored to the traffic manager terminal.

4. Emergency Communication System:

4.1 The system shall have:

a) Emergency Call Boxes (ECB`s)

d) Dedicated fiber based transmission System

e) Emergency Call Management system

f) Digital Voice Recorder

4.2 The emergency calls from ECB’s shall be received at the Main Control Centre/Sub centers at the Emergency call manager’s desk through the transmission system for getting necessary assistance in case of accident, emergency or breakdown. The detailed specification of Emergency Call Box, Emergency Call Management System, Copper-based Transmission System as well as the required interfaces in the Fibre Optic Communication System shall be as per specification of the respective portions.

4.3 Further, the Traffic Manager shall respond to calls from mobiles of expressway users on an independent set of four hunting landlines as an additional communication channel, and shall be capable of archiving such calls in a non-erasable format as for calls on the ECB system.

5. Mobile Communication System and its NMS

5.1 The system shall have (i) mobile sets (GSM based handsets) and (ii) call management system.

5.2 The mobile communication sets shall be provided on ambulances, cranes and patrolling vehicles for facilitating speedy communication even when they are on the move. The Mobile communication system shall cover the entire length of the expressway. The details of Mobile Communication System shall be as per attached specification. A Network Management System shall be provided at the Main Control Centre for the Mobile Radio Network and shall be managed on a real time basis. The GSM service provider would be chosen to provide special network for the Hyderabad ORR.

6. Variable Message Signs

6.1 The system shall have:

a) Variable Message Signs.

g) Transmission System to provide connectivity.

h) The signs shall be managed by the traffic manager through the Integrated ITS Software.

6.2 The variable signs shall be provided at suitable locations at the interchanges and the approaching national highways and some of the state highways to guide the road users about the condition/location of the road. The system shall allow Traffic Manager to modify messages on the VMS using the Integrated ITS Software based on the data received on the road via transmission system from the various subsystems. The details of the Variable Message Signs, Integrated ITS Software and Transmission System shall be as per attached specification.

7. Meteorological Data System

7.1 The system shall have:

a) Meteorological Sensors for temperature, wind, humidity and visibility

b) Transmission System for providing connectivity.

c) The Met sensors shall be managed by the traffic manager through the integrated ITS Software

7.2 The meteorological sensor shall be installed at suitable locations in the Main control centre or sub centers to provide meteorological information from the ORR through Control Centre via Transmission System. These Sensors are for temperature, wind speed, humidity and visibility. The details of the Meteorological Data System, Integrated ITS Software and Transmission System shall be as per attached specification.

8. Automatic Traffic Counter cum Classifier

8.1 The system shall have:

a) ATCC Equipment

b) Transmission System for connectivity between ATCC & Control Centre.

c) The ATCC shall be managed by the traffic manager through the integrated ITS Software

8.2 The ATCC shall be installed at locations on the ORR for traffic data collection and monitoring from the Control Centre via transmission system. The details of ATCC System, Integrated ITS Software and Transmission System shall be as per attached specification.

9. CCTV Surveillance System

9.1 The system shall have:

a) Video Cameras & monitors

b) Video switcher and Recorder

c) Transmission System for providing connectivity between Camera and Control centre.

9.2 The video camera system shall be installed at suitable locations on the ORR, for acquisition of visual information in the Main Control Centre through transmission system. The details of Video Camera, Integrated ITS Software and Transmission System shall be as per attached specification.

10. Fiber Optic Communication System with NMS

10.1 The system shall have:

a) A dedicated Fiber Optic Communication System which shall be used to transport data / voice / images from information points to the main Control Centre.

b) A Network Management System located at the Main Control Center for the Fiber Optic Network managed on a real time basis.

c) The Fiber Optic Communication System shall be as per attached specification.

11. Control Centre and ITS Software

11.1 **Control Centre Equipment** consisting of control equipment for transmission system and mobile radio system. This shall also include the control equipment for the Emergency call management system, and the ITS Software (for controlling VMS, ATCC and Meteorological equipment and status display of ITS sub-systems including emergency phones). The Main Control center shall house the control equipment for CCTV (Video) Surveillance and Video Incident Detection System & large display board, power supply including UPS, DG Sets and Air conditioning System.

11.2 **The Integrated ITS Software** shall manage the following on a single server platform:

a) Variable Message Signs System

b) Meteorological Data System

c) Automatic Traffic Counter cum Classifier System

d) Emergency telephones (Operation of the telephones however shall be done by the Emergency Call System)

e) Video Incident Detection system

f) Traffic/access Control System

g) CCTV Surveillance System

11.3 All the above subsystems shall be displayed and managed from a single display terminal managed by the traffic manager which will show the status of all the above subsystems simultaneously as graphic symbols / icons. Integrated ITS terminal shall provide the following information/data to traffic managers for efficient & effective traffic handling. This Software shall be operated from the Traffic Manager's console and:

a) Provide information regarding location of caller through incoming calls on the Emergency Call System.

b) Pre-warn the Expressway users about unusual condition on the road through Variable Message signs.

c) Integrated with the Emergency Call Management Software to enable the traffic Manager gets first hand information of status of Emergency telephones.

d) Obtain information from the Video Incident detection system, CCTV, Traffic control system, Met System & ATCC

e) Integrated with the Mobile Communication System to enable the Traffic Manager to communicate with the vehicle mounted or hand - portable GSM Mobile sets. This system shall be integrated with the Emergency Call Management Software to enable the traffic Manager to get first hand information on the health of Emergency telephones. All operations shall be performed on a real time basis. The Integrated ITS Software shall be as per attached specifications.

11.4 **Transmission System** consisting of PIJF cable, Communication cable, Video cable, Power supply cables, Optical fiber cable and hardware/software. The system shall be as per attached specifications. The back bone fiber optic communication cable shall be terminated only at sub-centers/interchanges. Intermediate tapping of backbone communication cable is not permitted. It shall be used for back bone communication only. If any sub-system design requires similar cables separate cables shall be used.

11.5 **Video Incident Detection System:** The system shall have:

a) Video Cameras & Monitors

b) Video Switcher, Integrator and Recorder

c) Transmission System for providing connectivity between Camera and Control Centre.

11.6 The video Incident system shall be installed at suitable locations on the ORR, for acquisition of visual information in the Control Centre through the transmission system. The details of Video Camera and of transmission system shall be as per the attached specifications.

11.7 **Power Supply and Air Conditioning Equipment** consisting of AC supply with generators and redundant UPS at the Main Control Centre and sub centre. Also Air conditioning equipment shall be supplied and installed at the Main Control center and the sub-centers. The DG’s and Air conditioning system shall be designed as to cater to the loads for 24 hours. The details of load calculations for AC, DG’s and UPS systems shall be submitted with the bid document. The systems shall be as per attached specification.

12. Reliability Requirement

12.1 The inability to perform any required function, the occurrence of unexpected action or degradation of performance below the specifications shall all be considered as a failure.

12.2 The Mean-time-between-failures (MTBF) shall be the average operating time accumulated by the total population of identical items between failures. The bidder shall submit MTBF and MTTR figures with the bid.

13. Availability Requirement

13.1 The system shall be considered unavailable when any of the following conditions persist for more than 8 hours on the entire stretch.

a) Variable Message System Failure: No display / Improper Display in more than five nos. of VMS or failure of their related transmission / control system which would render the VMS inoperative

b) Emergency Call System Failure: Failure of more than 10 Emergency call boxes or failure of their related transmission system which would render the call boxes inoperative.

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

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

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

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

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

13.2 In addition to the above the system shall be considered unavailable when failure of the Integrated ITS Software OR its hardware persists for more than 8 hours.

13.3 The ITS shall have an overall system availability of better than 95%.

14. Maintainability Requirement

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

14.2 The service life of the ITS shall not be less than 10 years. Service life shall be counted from the commencement date of commissioning.

15. System Standards

15.1 The ITS is classified as a safety related system and shall be per international standards. These standards have been specified later in this document.

15.2 All equipment must comply with and be installed in accordance with the aforesaid standards.

16. Environmental Specifications

16.1 Indoor Equipment is set at as follows:

a) Temperature (Operating) : $0^{\circ}C$ to $+50^{\circ}C$

b) Relative Humidity up to 95% (non-condensing)

16.2 Outdoor Equipment is set at as follows:

a) Temperature (Operating) : $-5^{\circ}C$ to $+60^{\circ}C$

b) Relative Humidity up to 95% (non-condensing)

B. SPECIFICATIONS OF VARIABLE MESSAGE SIGN

1. Scope

1.1 This Specification lays down the general, functional and technical requirement of the Variable Message Signs to be used as a sub-system of Advanced Traffic Management System. VMS shall include variable message signs, gantries and foundations for the same.

2. Function

2.1 The Variable Message Signs shall provide road users the advance information of road conditions ahead and shall be controlled from the Main Control centre.

3. Technical Requirements

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

3.2 The display panel must contain a corrosion resistant panel with LED pixels in “X”, “Y” (row, column) matrix.

3.3 The LED Cluster shall consist of individual LED`s encapsulated in a resonated plastic housing proving protection to the elements.

3.4 The system shall use high lumen LEDs and shall be suitable for outdoor ambient sunlight.

3.5 The Display board shall have full graphics display capability to display bilingual messages (English and Hindi) and standard IRC road signs.

3.6 The display board shall be formed using individual modules

3.7 The modules shall be individually addressable and field replaceable.

3.8 Failure of one LED module should not affect the output of any other LED cluster.

3.9 The system design shall be such so as the display is legible from a distance of 200 meters.

3.10 The equipment will comply with the following:

a) Overall Size Board: length minimum 5000 mm, height minimum 1800 mm, depth min 200 mm

b) Number of Display Lines 3

c) Number of Character per line 18

d) Displaying dot pitch 10mm

e) Height of Characters minimum 400 mm English font and dot pitch of the characters should be 10mm

f) Language English, Hindi & Telugu with facility for display of standard road signs

g) Color, Luminance & Luminance shall be min L2 and Luminance ratio shall be R2 as per beam width min. B3 according to EN12966

h) Housing: Powder coated housing with ingress protection class P2 as per EN12966; IP55 or other equivalent international standards for protection against dust, rain & wind

i) Mounting Gantry supported on both side at a min. height of 5.5m from the road surface.

j) Interface Standard RS485 or TCP/IP interface

k) Interface should support the fiber integration.

l) Additional Features Incorporation of temperature sensor. Also a brightness sensor shall be provided. In addition it shall be possible for the Traffic Manger to change the brightness level of the signs from the Main Control centre using the ATMS Software. All communication failures of messages triggered by the Control room shall be reported to the Integrated ATMS Software by the VMS.

m) Luminous Intensity (LED) Minimum of 3000 mcd

n) Life of components of VMS Minimum of 10 Years

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

- Power Failure at VMS
- Processor PCB Failure
- LED Cluster Failure
- Loss of incoming message / data not properly received.
- Temp. Monitor

3.12 The structure on which the VMS is mounted shall be sturdy and aesthetically designed and capable of bearing wind loads up to 200 kmph. The lowest hung part of the display board shall have vertical clearance of at least 5.5 mtrs. from the road level. It shall be provided with a walkway to allow at least six persons to carry out maintenance of the VMS.

3.13 The controller unit shall provide brightness control.

3.14 The controller unit shall provide the monitoring of housing ambient temperature.

3.15 All PCB`s shall be made of 1.6mm thick epoxy laminate and designed and manufactured for use in environment conditions specified.

3.16 The controller shall be capable of automatically diagnosing and reporting component failure or any electronic fault.

3.17 The controller shall be provided with a test port for local diagnostics via laptop.

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

3.19 The LED Clusters shall be mounted at a particular angle for providing better viewing angle.

3.20 The communication shall be using RS485 full duplex, multi drop configuration connected to the main control center. Communication cable to main/sub centre shall be suitable for installation requirements.

3.21 Each display module shall have its own display interface to the Central processor.

4. Environmental Specifications

4.1 The VMS housing shall be of minimum 1.6mm thickness of corrosion resistant steel

4.2 Environmental specifications shall be as per EN 12966 class T1

4.3 The housing shall provide the environment protection in accordance with a minimum rating of IP55

4.4 The housing shall be capable to withstand the following conditions:

a) Temperature and humidity: As stipulated in “**A. General Specifications for the Advanced HTMS**”**.**

b) Damp heat test:

- Minimum: 25 Deg Celsius
- Maximum: 50 Deg Celsius
- Relative Humidity: +95%

c) Vibration Test:

- Frequency range: 10- 50Hz
- Vibration amplitude: 0.35mm

- Duration of endurance: 20 sweeps cycle
- No. of axes: 30 co-ordinate axis
- Duration at resonant frequency: 30 min + 1 min

4.5 Maintenance panels shall be provided on the rear of the housing.

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

NMCS2, MESSAGE CONTROL, TR2070D, NTCIP Version 2 or other equivalent international protocols

4.7 The RS485 link protocol should permit the following:

(i) Broadcast messages
(ii) Specific address messages
(iii) The two types must differ only in the address field, with broadcast message being transmitted only by the master. With point to point connectivity the slave shall place the address which could be identified by the master.
(iv) The inter-message delay period, (the minimum time between the receipt of a message and the transmission of a reply) must not be less than 1.5 multiplied by the time taken to transmit a single character.

5. Testing

5.1 The equipment shall be tested for functional requirements as below:

Messages shall be displayed using the central software& local terminal

5.2 The fault conditions shall be simulated. Messages / fault logs shall be checked for:

- LED Fault
- Communication failure
- Power failure
- Brightness of Pixels

6. Installation Requirements

6.1 Variable Message Signs shall be installed on a gantry on the side of the carriage way. All Civil works like foundation, etc., as specified shall be done as per relevant standards.

6.2 Final locations of VMS equipment shall however be finalized after consultation with HGCL.

6.3 The power supply shall be fed from the nearest interchange.

C. AUTOMATIC TRAFFIC COUNTER CUM CLASSIFIER

1. Scope

1.1 This Specification lays down the General, Functional and Technical requirement of Automatic Traffic Counter cum Classifier to be used as sub-system of Advanced Traffic Management System.

2. Function

2.1 This system is used for identifying and recording all types of vehicles on the ORR for effective monitoring and data collection at Control Centre.

3. General requirements

3.1 The system shall be capable of detecting and recording all types of vehicles plying on Indian Roads, and be adaptable to the classification defined by the Indian Roads Congress.

3.2 Besides the above vehicle classes, 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 system shall be robust and be capable of operating with minimum maintenance. The system shall interface with the ITS/ITS Software for central monitoring.

4. Technical specifications

4.1 Installation: The vehicle counter/classifier equipment shall be installed at the median of the carriageway or on the side of the highway at a distance of 2 to 3 meters from the soft shoulder.

4.2 CABINET: The equipment cabinet shall be rugged, tamper-proof, rust resistant, weather proof, lockable. The cabinet shall be permanently fixed/grouted.

4.3 ENVIRONMENT: The equipment shall be able to perform to the specifications under all types of climatic conditions ranging from hot, humid, coastal to desert dry and cold. The operating temperature range shall be as defined under “**A. General Specifications for the Advanced HTMS**”**.**

4.4 SENSORS: The sensors shall be based on inductive loops, enabling counting/classification of upto 4-lane traffic (Expandable to at least six-lane traffic). The sensors offered with the system shall be permanent in-road sensors.

4.5 ELECTRONICS: The requisite number of entry and exit ports to communication system shall be provided. The logic unit shall be micro-processor based. The system shall be able to count and classify vehicle in each lane. It shall be possible for the Employer to configure the detector cards for different sensing levels using either onboard set of selector switches. The LED`s on the detector cards shall indicate the presence of vehicles over the sensors.

4.6 DATA COLLECTION: The system shall be capable of sending data to the ITS/ITS Software which shall enable the ITS/ITS Software to classify the vehicles, detect average speed per lane, vehicle occupancy and headway as a minimum. Data collection shall be by RS232, RS422 or RS485 interface or IP connection.

4.7 DATA STORAGE: The system should be able to upload data to the system as it occurs. The unit shall store data for at least one week in event of communication failure.

4.8 OPERATING LANGUAGE: English

4.9 SYSTEM ACCURACY: The accuracy of the system in recording speeds and headways/gaps shall be indicated below.

Parameter	Accuracy	Condition
Average Speed	10%	There are at least 25 vehicles in the group, individual vehicle speeds are between 10kmph and 195kmph and the vehicles conform to normal ORR driving behavior
Average Headway	10%	There are at least 25 vehicles in the group, individual vehicle speeds are between 10kmph and 195kmph, individual vehicle head-ways are between 1 and 10 seconds and the vehicles conform to normal ORR driving behavior
Flows	5%	There are at least 100 vehicles of each category in group and vehicles conform to normal ORR driving behavior.
Occupancy	10%	There are at least 25 vehicles in the group, individual vehicle speeds are between 10kmph and 195kmph, individual vehicle headways are between 1 and 10 seconds and the vehicles conform to normal ORR driving behavior

4.10 DATA RETRIEVAL: The system shall be capable of data retrieval, direct data transfer through the fiber Optic Network.

4.11 MODE OF OPERATION: This shall be user programmable upto 6 classes of vehicle by length and / or detuning of the loop inductivity for vehicle counting, speed & headway.

4.12 RECORDING CAPABILITY: The system shall have capability of recording vehicle counting and classification, speed, headway at set interval of 1-10 minutes.

4.13 COMPATIBILITY: The system shall have compatibility to transmit data over PIJF/Optical Fibre Cable.

4.14 Specifications: The system proposed shall meet the following specification:

a) Electrical safety: BS EN 60950 or equivalent EU / US Standards

b) Telecommunication safety requirement EN 41003 or equivalent EU/US Standards

c) Environmental specification: The system shall conform to environmental specification as defined under "**A. General Specifications for the Advanced HTMS".**

d) Lightning protection: CCITT K20, or equivalent EU / US Standards

e) Loop Detectors: UK Highways specification TR0100A, or equivalent EU / US Standards

f) EMC : UK Highways specification TRG 1068, or equivalent EU / US Standards Type Approval Certificate/s shall be provided with the Bid.

4.15 Testing

- Earth resistance : < 0.1Ω in any climatic condition
- Insulation resistance: > 100MΩ in any climatic condition
- Communication: capable of communication with the central software

D. SPECIFICATIONS OF METEOROLOGICAL SYSTEM

1. Scope

1.1 This Specification covers the Performance and functional requirements of the Meteorological Data System.

2. Function

1.2 The Meteorological Data System provides data regarding atmospheric temperature, humidity, visibility, wind speed & direction, temperature of road surface, rain detection (on/off).

3. Installation Requirements

3.1 The meteorological sensors shall be located near one of the control center preferably at the main control center.

3.2 The power supply shall be fed from Control centres/ sub centres.

3.3 The meteorological sensors shall be installed with specific attachment.

4. Technical Requirements

4.1. The Meteorological Data System shall have the facility to communicate through PIJF/Optical fibre cable.

4.2. The Meteorological Data System shall be compact, rugged in design and have ease of maintenance.

4.3. The Meteorological Data System shall be capable of detecting and keeping track of the surface temperature of the Expressway. The Sensor data shall be monitored from the ITS/ITS Software at the main Control Centre.

4.4. Sensor Specifications mounted on mast: All sensor housings shall be made of *anodised Aluminium* or Stainless Steel.

a) Relative Humidity Sensor

- Range: 0- 100%
- Minimum Accuracy: +/- 2% RH
- Resolution: 0.1%
- Sensor Mechanism: The sensor shall be adequately protected against dust/pollution and shall provide a linear output voltage for 0 –100% humidity
- Radiation Screen to be used

b) Air Temperature Sensor

- Range -30^{0}C to +60^{0}C
- Sensing Element: Should provide a linear output for the entire temperature range
- Resolution: 0.1% of range
- Accuracy: +/-0.1% of range
- Radiation Screen to be used

c) Visibility Sensor

- Range: 10 to 1000m
- Wavelength: 880nm
- Sensor Type: Infrared sensor, source & detector
- Accuracy: 15%

d) Wind Direction Sensor

- Threshold Speed: Less than 0.3 m/s
- Accuracy: Better than +/-5%
- Damping ratio: 0.7
- Sensing mechanism: Compass magnetically coupled to Vane

e) Wind Speed Sensor

- Range: Up to 79 m/s
- Threshold speed: Less than 0.3m/s
- Accuracy: +/-2% or +/- 2m/s whichever is greater
- Output Signals: Average Wind / Average Gust

f) Road Condition Sensor

- Temp. Sensor Range: -10^{0}C to +60^{0}C
- Resolution: 0.1^{0}C
- Accuracy: +/-0.2 ^{0}C

g) Wet / Dry Sensor

- Output: ON/OFF

E. SPECIFICATION OF CCTV SURVEILLANCE

1. General

1.1 This specification lays down the general, functional and technical requirements of Closed Circuit Television (CCTV) System to be used as a sub-system of Advanced Traffic Management System.

2. Function

1.2 The System monitors the movement of vehicles on the ORR.

3. System Configuration

3.1 The system at various locations shall comprise:

a) Camera location: 1 Video Camera, 2 Video Camera Housing, 3 Pan & Tilt heads, 4 Optical transmission units for video and data (if required), 5 Mounting poles

b) Control centre: 1 Monitors for individual camera's Matrix switcher, 2 Multiplexer & digital video recorder with interface for the integrated ORR network, 3 Optical interface units to the Backbone communication system wherever required (where the video and data cannot be transported from camera location to the Sub-centre on co-axial cable)

4. Installation Requirement

4.1 The Video Cameras shall be located along the ORR. Installation points shall be both sides of ICs and Kokapet junction in order to monitor merging and diverging section. In addition, installation of CCTV both at black spots and frequent congestion points in future should be considered in the design.

4.2 The Video Cameras shall be mounted at a minimum height of 12 meters from the road surface. Mounting frames, brackets and associated accessories as required for the pole structure shall be provided and installed as per best engineering practice.

5. General Requirement

5.1 The Video Camera shall be of dome type to avoid pilferage, be resistant to vandalism and weather-proof.

5.2 The Video Camera location shall be easily identifiable.

5.3 The mounting and equipment housing shall be able to withstand adverse weather conditions and the Video Camera shall be capable of performing as per specifications under environmental specification as defined under "**A. General Specifications for the Advanced HTMS**".

5.4 The Video Camera and associated units shall be dust-proof and protected against water ingress.

5.5 The Video Camera mounting shall have easy accessibility for maintenance purposes while being protected from unauthorized access.

6. Technical Requirement

6.1 The Video Camera shall have the following minimum technical specification:

- Image Sensor 1/4" CCD with 22 x optical zoom and 12 x digital zoom
- Active Pixels 752(H) x 582(V)
- Horiz. Resolution 460 lines
- Sensitivity. 0.02 lux @ 1/1.5 second shutter speed
- Focus Automatic (with manual override/preset facility)
- Signal to Noise >46dB
- AGC: Automatic with manual override
- White Balance: Automatic with manual override
- Auto Shutter: Y
- Signal Format: NTSC/PAL
- Video Output: VBS 0.7V +/-0.07V
- Power Req.: 12/24V DC / AC + 10%

6.2 The Video Camera shall have angular travel as below:

- Horizontal 360^{0} continuous pan
- Vertical Tilt +2^{0} to -92^{0}

6.3 The Video Camera shall have speed as below:

a) Manual Speed

- Pan 1/10$_0$ to 80$_0$/second (Variable)
- Tilt 1/10$_0$ to 40$_0$/second (Variable)

b) Preset Speed

- Pan 250$_0$/second
- Tilt 200$_0$/second

6.4 The dome drive shall have 40 presets with labels. The dome drive shall have an accuracy of +/-0.25$_0$ preset accuracy

6.5 There shall built-in protection against Power Line Surge and Lightning

6.6 There shall be provision for Onscreen-compass and Tilt display

6.7 The unit shall have integral, auto sensing multi-protocol receiver / driver

6.8 There shall be provision for Auto-flip dome rotation

6.9 There shall be programmable limit stops for Auto/ random/frame scan modes.

6.10 The Video Camera shall have zoom lens with minimum power of 22X, auto iris.

6.11 The Video Camera shall also have facility for text in the picture

6.12 The Video Camera shall have remotely selectable operating modes and shall be operated from the Control Centre.

6.13 The Video Camera shall have sensitivity better than 0.05 lux for reflected scene illumination.

6.14 The video images from camera shall be transmitted in real time.

6.15 The Video Camera shall be connected to the control centre / sub-centre through co-axial cable & data cable / optical fiber cable as per the site requirement.

6.16 Optical Transmitter and receivers shall be used.

6.17 Wherever optical transmitters are used the same shall support a minimum transmission rate of 25 frames/sec. The video image shall be made available at the control centre without any distortion or loss of information.

6.18 The video camera system shall have the facility for zone blanking, auto identification of zones when the pan movement of camera is active.

7. Control Office Equipment:

7.1 Monitors: Individual color monitors shall be provided for each of the video camera installed on the ORR.

7.2 Matrix, Digital video recorder, Multiplexer and Keyboard shall be provided for control, monitoring & recording of the video images.

7.3 The matrix equipment shall be connected over the LAN to the Integrated ITS system for transfer of video and data. The images from all the cameras shall be displayed on the Integrated ITS terminal.

7.4. The Matrix, Digital Video Recorder and Multiplexer shall have at least 100% spare capacity for interfacing of the Video cameras.

7.5 The Matrix shall be connected to the Backbone communication system for analog video signals and PTZ Control signals.

7.6. The Video Switching Facility (Matrix) shall be capable of enabling switching of any video signal to any of the monitors.

7.7. The matrix shall be easily expandable by addition of extra modules.

7.8. One separate monitor shall be provided to display the recorded images/ incidents as and when required.

7.9. Video and textual information shall be displayed on all video monitors in use.

7.10 Monitors shall be 21” and either rack mounted or free standing type. Video shall be routed through the matrix switcher. The nominal input impedance of the terminated monitor shall be 75 Ω.

7.11 The following controls shall be provided in the monitor: (i) Picture height, (ii) Focus, (iii) Picture width, (iv) Vertical hold, (v) Vertical linearity, (vi) Picture centering.

7.12 The matrix keyboard shall provide for the following minimum controls: (i) Pan Left / right control , fast /slow, (ii) Zoom IN /OUT Control, (iii) Camera select, (iv) Monitor select, (v) Pre-set camera position, (vi) Digital / VCR Recording operation, (vii) Camera control ON/OFF, (viii) Multi – Picture display, and (ix) Auto Cycle

7.13 It shall be possible to display at least 4 camera pictures on to one screen.

7.14 Video and textual information shall be capable of being displayed on all monitors.

7.15 The use of video and overlay character generation techniques shall be used to provide camera identity, location, etc.

7.16 The Digital recorder shall have the facility to record images on the hard disk and also on external recording devices such as DVD, etc. The digital video recorder shall have minimum of 480GB data storage capacity and shall have interface to archive the data on to the DVD / Tape for back-up.

7.17 The Digital recorder shall be suitable for a minimum of 16 video signal inputs, capability for motion detection, alarm / event based recording and shall have the facility for high speed searching based on inputs such as date, time, etc.

F. SPECIFICATIONS OF ECB

1. Scope

1.1 This Specification lays down the General, Functional and Technical requirement of Emergency Call System to be used as sub-system of Advanced Traffic Management System.

2. Function

2.1 This is a communication medium to be installed on the ORR and to be used by the road users to make alarm call to the Control Centre in case of accidents & other emergency problems on the road.

3. System Configuration

3.1 The system shall be suitable for working on a Fiber Optic / dedicated Copper transmission network and shall comprise:

- Loud Speaker
- Microphone
- Activation Button

- Ringing Tone to indicate progress of call when button is pressed;
- Confidence Tone to indicate call is still connected when on hold
- Recorded message in case the Line is busy
- FRP (Fibre Reinforcement Plastic) /Metallic Housing for the above
- Solar panel with battery backup (3 days) for power supply in case Fiber optic based ECBs are offered.

4. Installation Requirement

4.1 The ECB's shall be:

a) installed at intervals of 2 km (+/- 200m) on each side of the ORR

b) placed along the left side of the carriage-way for each direction of travel next to the Crash Barrier for easy accessibility

c) located on opposite sides of the ORR

5. General Requirements

5.1 The ECB's shall:

a) be weather proof type made of metal as per IP65 standards

b) have the front of the housing protected by a metallic grill to protect the box from dust, moisture, etc.

c) be designed for use through dedicated Fiber Optic backbone for communication with the main control centre

d) be identified by illuminated guide signs placed approx. 10m ahead of the ECB

e) work satisfactorily under adverse conditions like storm, etc.

f) be compact & rugged in design having ease of maintenance

g) have a single PCB design with minimal serviceable parts

h) be designed for hands free operation

i) have provision for mounting on a pole on a concrete base with cast-in bolts, nuts and washers and the whole unit shall be installed so as the persons using the instrument shall normally be facing the oncoming traffic

j) have provision for operating instructions to be written clearly on the inside surface of the cover in two languages.

5.2 The PCB`s used shall be specially designed to prevent pilferage & misuse in a highway environment and it shall not be possible to use the components in normal phones even after modifications.

5.3 A Digital Voice Recorder shall be used for recording of messages. The voice recorder should have adequate interfaces for recording purposes. The recording should be independent of the operator interface.

5.4 The system should have DAT drive for automatic archiving of the data on these tapes. The system should have elaborate safety features, password protection, tape-overwrite facility etc.

5.5 The voice recorder shall check for following minimum fault conditions:

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

5.5 The recorded message shall be in synchronization with system clock as time reference.

5.6 It shall be possible to communicate to ECB`s from more than one operator stations

5.7 The ECB System shall have a product support guarantee of 10 years from the manufacturer.

6. Technical Requirements

6.1 Fiber optic/Polyethylene Insulated Jelly-filled (PIJF) cables shall be used for connecting the ECB's to the sub-centers.

6.2 The PIJF/Fiber Cable for ECB communication shall have a minimum of 20% spare pairs for future use / maintenance. These spare pairs shall be available throughout the length of cable.

6.3 All calls from ECB's shall invariably be recorded at the Control Centre without any missing record, together with the date/time stamp and the identity of the ECB concerned. No missed calls shall be permitted under any circumstances.

6.4 Once initiated, it shall not be possible to terminate the call except by the operator at the control centre.

6.5 The ECBs shall:

a) work on DC supply

b) operate in full duplex mode

c) be suitably protected against external EMI/ESI Interference through shielding / grounding

d) have in-built programming port / feature for addressing. The same must be capable of being addressed using Laptop or Palmtops in fields. The ECB Central software shall use this address for identification of ECB.

e) be able to operate in a noise level of up to 95 db

f) use signaling which is inaudible to the user

g) have external protection against lightning

h) be powered from the communication cable/solar panel.

6.6 In-built diagnostic feature shall be available for fault detection in case of any damage such as (i) line faulty, (ii) low DC voltage on line, (iii) cross talk in lines, and (iv) short circuit in lines.

6.7 Emergency Call Management Terminal: This shall be managed by the Emergency Call Manager. The terminal shall be PC-based and shall display a map of the ORR with all Emergency telephones marked in accordance with their actual locations. The following features are required:

(i) password protected & accessible only with relevant passwords
(ii) data logging with the currently logged user/ operator details
(iii) different levels of authorization for logging into the system
(iv) automatic Call location identification
(v) call disconnection by operator only
(vi) operator call back facility
(vii) automatic testing facility running in the background at operator selectable intervals
(viii) operator initiated ECB test facility
(ix) facility for holding unlimited calls from ECB's

6.8 Calls, events & Faults logging, including (i) Time of incoming call, (ii) Time of call answering, (iii) Time of call termination, (iv) Time of fault occurrence, and (v) Time of happening of events.

6.9 The system shall not permit cancellation of any call before answering.

6.10 The ECB Icon of the location from where the call originates shall start flashing with change in color along with the ringing tone

6.11 The window shall pop up on answering the call, and shall display following information:

- currently connected call with location and time
- total number of incoming calls with location and time
- Number of calls ON HOLD.
- It shall also be possible without logging out from the window, to :
- connect to any of the Calls on Hold
- hang up the call
- put on Hold the currently connected call
- call back any of the ECB
- monitor Faults
- monitor events

6.12 Faults in the System shall be annunciated in the operator window.

6.13 The ECB System shall be interfaced with the Backbone Fiber optic communication system at the Sub-centre / Main Control Centre. This shall be a proven configuration, operational for more than 1 year for similar use in a Highway environment.

6.14 The ECB`s shall be able to communicate to at least two operator stations.

6.15 The ECB`s shall meet the specification as per the following:

a) Electromagnetic compatibility: EN 50081 & EN50082 or equivalent

b) Lightning Protection: CCITT K17 & CCITT K20 or equivalent

c) Environmental specifications: The system shall conform to environmental specification as defined under "**A. General Specifications for the Advanced HTMS".** In addition, the following requirements must also be met:

- Dry Heat : BS2011 (16 Hours at +60 ^{0}C) or equivalent
- Damp Heat : BS2011 (Two cycles with upper temperature limit +40^0 C) or equivalent
- Random vibration Test : BS2011 or equivalent
- Drop & topple : BS2011 or equivalent
- Enclosure : IP65

Test certificates for the above shall be provided along with the bid.

d) Testing :

- Earth continuity
- Insulation resistance
- Call from phone to operator - Ringing tone
- Check for the speech path
- Check for hold tone
- Check for busy message
- Check for call back facility from operator station to phone
- Check for phone test facility from operator station
- Check for Programming of ECB address

G. SPECIFICATIONS OF CONTROL CENTER

1. Scope

1.1 This Specification covers the performance, functional and design requirements of the Control Centre of the advanced HTMS.

1.2 The primary objective of the system is to provide the real-time information and assistance to the ORR users, collect data for the use of ORR authorities and to monitor and control the Traffic on the ORR as per the requirements.

1.3. Within the scope of this work the Advanced Traffic Management System is defined as a system with a capacity to provide the following:

a) Real time images of the ORR locations (from camera locations) to the control centre

b) Emergency communication system for communication from the predefined ECB locations to the control centre.

c) Real time information to the users from control centre (about the route conditions, traffic situation, etc) using variable message signs installed on gantries.

d) Real time monitoring of the traffic situation and collection of traffic data using traffic counting and classifying system

e) Real time monitoring of the critical locations using incident detection technology (video based)

f) Monitoring of the weather conditions

g) Dedicated Mobile communication system for coordination between the control centre, ambulances, patrol vehicles, etc.

h) Traffic Control System at the interchanges

i) Dedicated fiber optic communication system for data, voice and video transmission

j) Improvement of road safety

k) Facilitating the ORR traffic movement using state-of-the-art technologies, strategic controls and algorithms, it should consist of a combination of at least two well known and widely used algorithms

l) Monitoring and control of the ORR traffic from the main control centre using integrated ORR system

m) Compilation, recording, analysis, processing, storage of traffic information and data.

n) Monitoring and control of the various sub-systems and devices installed on the ORR. The basic architecture shall be open, modular, scalable client / server in nature, controllable from different levels, integrated and shall have high degree of resilience implying that failure of any one sub-system other than backbone communication system shall not affect the functioning and control of other sub-systems. In event of emergencies such as failure of the integrated ORR operator station (central server) it shall be possible to control the different sub-systems individually from the control centre. However on restoration of the system the control from the integrated ORR terminal shall automatically be restored.

1.4. The Advanced Traffic Management System shall comprise of following Sub- Systems.

- Emergency Call Management System

- Integrated ORR System – MET, VMS, ATCC, Emergency Telephones, Traffic Control, etc.
- Mobile Communication system
- CCTV System
- VIDS System
- ATCC System
- Large Projection Screen
- Power Supply

1.5 The Advanced Traffic Management System shall be operated from three operator stations as below:

(i) Emergency Call Operator Station (Emergency calls from ECB's)
(ii) Mobile Call Operator Station (Mobile communication calls)
(iii) Integrated ORR Management / Traffic Manager Station (Operating Variable Message Signs, Traffic Counting & Classifying System, Weather Station, Traffic Control System, CCTV & Video Incident Detection)

2. Functional Requirement

2.1 The Control Centre of ITS shall carry out the following functions:

a) Provide information & data management system for the overall control, supervision, maintenance and configuration of entire ITS.

b) Attend to incoming calls from ECB's, control incoming speech circuits and navigate the ORR Section under supervision using graphical representation of the network.

c) Monitor and record online all data from Meteorological Data System installed on the ORR.

d) Monitor online video information from the Video Camera installed on the ORR

e) Retrieve data from traffic sensors (ATCC), meteorological sensors, ECBs, CCTV & process it for making necessary changes in VMS.

f) Monitor online video information from the Video Camera installed for video incident detection system (VIDS).

g) Monitor and control traffic at the interchanges using intelligent traffic control technologies such as ramp metering.

h) Monitor the Transmission System and provide continuous fault diagnostics & alarm facilities for Control Centre Equipment, transmission Equipment & all other Equipment.

i) Process above referred data acquired through above system for decision taking, display information on respective VDU monitors and central Large Display Board

j) Monitor and control mobile communication System and provide continuous fault diagnostics & alarm facilities.

k) Transfer necessary information to the concerned agencies like ambulance, ORR police, cranes etc. on the ORR and third parties like hospitals, police, information Centers etc.

l) Provide continuously clear & comprehensive displays and print log of event status.

m) Provide continuously the voice & related information with time and date stamp for records and off-line analysis.

n) Provide at least four hunting lines (GSM) for exclusively responding to calls from mobiles permitted to operate in the area in event of distress or other urgent requirement by ORR users.

2.2 This would be over and above the ECB System. All calls to such numbers shall be recorded and archived at the Control Room with date and time in on-erasable format.

2.3 The Sub-centre of ITS shall carry out the following functions:

- house the nodal equipment like back bone communication equipment, mobile communication equipments etc. for ITS.
- house power supply equipment such as DG, AMF panel, UPS, Batteries, etc.
- provide adequate accommodation for ambulances, police vehicles and emergency cranes as required.

3. Control Centre Equipment and Software

3.1 The Control Centre shall accommodate following:

- Emergency call management system equipment and software
- Integrated ITS Equipment and software
- CCTV Console and other Equipment
- Mobile radio operator and configuration equipment and software
- Video incident detection system console and other equipment
- Backbone communication equipment and NMS for the same.
- Large Display Board
- Line Printer
- Uninterrupted Power Supply
- Power supply equipment

4. Emergency Call Management

4.1. The Emergency Call Management system located at the Control Centre shall carry out the following functions:

a) Attend to incoming calls from ECB’s using a PC based console, and navigate the

ORR section under supervision using graphical representation of the network which shall be displayed on the PC monitor.

b) Provide audible and visual alert on the screen for any incoming calls from the Emergency call boxes. In this case the color of the icon representing the Call boxes on the graphical map shall change indicating (i) Phone healthy, (ii) Phone faulty, (iii) Incoming call, (iv) Conversation in progress, and (v) Call on hold.

c) Provide for call waiting signal to the ECB and put the call on queue in case of several calls at the same time.

d) Create a log and record all conversations from and to the Control Centre from the ECB's. This shall be common for the Emergency Call system and the Mobile Radio.

e) Further the system shall automatically check periodically (the interval of which shall be operator selectable) the health of phones and generate an audio visual alarm in case of faults.

f) The system shall generate a unique call number for each and every call and allow the operator to provide annotation.

g) There shall be one Emergency Call Manager's terminal easily expandable to more operator stations by connecting more operator terminals.

h) holding of any call by the operator.

i) terminating any call by the operator.

j) seamless configuration on addition / deletion of ECB's on the network.

k) database generation, display on the monitor and logging of all parameters of call

l) recording of communication between the operator and road users.

5. Integrated Its Software

5.1 The ITS shall manage the following on a single server platform:

- Emergency Communication System
- Variable Message Signs System
- Meteorological Data System
- Automatic Traffic Counter cum Classifier System
- Video Incident Detection System
- Traffic Control System (Ramp Metering)
- CCTV Surveillance System

6. System Architecture

6.1 Hardware for central server: The system shall run on a powerful dual-processor server with RAID facilities to provide continuity of hard disk storage. Storage capacity should be large and comfortably sufficient to cater for the demands of a modern traffic management system. The system shall have client-server architecture so that multiple users may access the system simultaneously. Minimum hardware specification shall be as follows:

- Server from HP / IBM / Fujitsu / Dell
- Dual 2.2 GHz Processor or Higher
- Eight 73Gb SCSI disks configured as two RAID 1 sets (2 disks each), one RAID 5 set (3 disks) and a hot standby or higher
- 4Gb RAM or higher
- Operating system Linux / Windows-2003 Server
- Database Server Oracle/ SQL Server 2000
- A tape drive for backup/archive
- VERITAS Backup Exec backup software
- An Ethernet connection to a LAN
- Facility for remote diagnosis and support

6.2 Hardware for Work stations/operator console: The client workstations shall have the following specification:

- IBM/Siemens Fujitsu / DELL /Compaq
- Pentium IV 2.0GHz
- 512Mb RAM
- 40GB Hard Drive
- 10/100 NIC (Twisted Pair)
- Graphics Card
- CD Drive
- Windows 2000 or Windows XP
- Internet Explorer 6

6.3 FUNCTION: The Operator Console shall monitor overall and manage functions of ITS operations. The Operator Console shall:

- use graphical user interface with VDU
- provide decision support system as suggested settings for signs after an alarm has been raised.
- monitor and control sub-systems as detailed earlier.
- monitor system operation through diagnostic tool.

7. System Software

7.1 The System software shall run on industry standard Server platform incorporating either MS Windows or Linux operating system in a client server mode. All the above subsystems shall be displayed and managed from a single display terminal managed by the traffic manager which will show the status of all the above subsystems simultaneously as graphic symbols / icons. The graphic operator interface shall be menu driven for ease of operation. The operator shall be able to configure, set values, commands, perform database operations, reports, archive using these menus. The Integrated ITS software shall monitor and record online all data from ATCC, Met sensors, VMS, Traffic control system, CCTV, VIDS and ECB's. It shall be possible to configure the sub-systems as well as add/delete components of the system such as ECB, VMS, MET sensor, ATCC,VIDS ,CCTV in the ITS software online seamlessly.

7.2 The Integrated ITS Software shall also have following features:

a) The system server shall be configured so as to minimize the risk of data loss in the event of system failure or power loss. It shall support client terminals operating on a LAN, WAN or remote connection. Access to the database and client terminals shall be username and password controlled. Access level shall be determined by the system supervisor and shall range from "read only" to full edit / supervisor rights. The system shall not bypass / violate access rights setup on slave systems. It shall not be possible to send shut down or "kill" commands from the database management system.

b) For system monitoring it shall be possible to configure a view only user with access to the map and embedded / linked data only. Such a terminal could be used by police, ORR engineers, emergency services, etc. It shall be possible to relay urgent faults / incidents / System alarms (supervisor configurable) to remote operators / staff via an SMS message for any requirements in future.

c) The system shall have proven and modular Web interfaces. It should be possible to integrate the same for providing ORR information such as CCTV images, traffic flow, journey time, etc., to the general public via internet web pages.

d) The system shall have proven and modular interfaces to automatic license plate recognition system. It shall be possible to integrate the same in future if required.

8. System Functions

8.1 Sub –System Monitoring & Control: The System software shall monitor & control ITS sub-systems as below:

a) It shall monitor and record online all data from Meteorological Data System installed on the ORR. The data shall be updated every five minutes.

b) It shall monitor and record online all data from the ATCC. The system shall provide the user with the information / display of traffic flow conditions on the MAP. The data shall be updated after a frequency configurable by the supervisor.

c) It shall monitor health of the Emergency telephones on a continuous basis.

d) It shall monitor & control the variable message signs. The operator shall be able to generate new messages for signs. The system shall react intelligently and automatically to the ORR conditions and set up suitable messages on the VMS. These shall be based on proven & working algorithms. It shall also be possible to schedule the pre-defined messages to be displayed on the VMS.

e) The display period shall be operator selectable. The priorities of the messages shall also be operator selectable.

f) The System software shall provide information regarding incidents (VIDS) and store/archive them for future use.

g) The system shall interface with intelligent traffic control systems for traffic control and monitoring specially at interchanges and access points.

h) The system shall interface to CCTV system to select cameras for display and control of images.

i) The system shall process above referred data acquired through above system for decision taking, display information on respective VDU monitors and central Large Display Board.

j) Provide continuously clear & comprehensive displays and print log of events.

k) Access to historical data files of ITS.

l) Execution of operator commands with access code security.

m) Generation of reports at specified times (operator selectable)

n) System timekeeping.

o) Connectivity and data transfer to other control centers if required.

8.2 Graphic User Interface (GUI): The GUI for the system shall be map based and menu driven. The changes in commands/menu shall be simple to be executed by the operator. There shall be a screen depicting the map of the ORR along with other equipment installed on the route.

8.3 System Map: The ORR map shall be capable of displaying an overview level showing the whole area covered by the system. It shall then be possible, with no loss of definition, to zoom to a detailed map. It shall be possible to display both static and dynamic data on the Map. Two levels of mapping shall be supported as a minimum: (i) ORR overview and (ii) ORR section wise detailed view.

8.4 The system shall have facility for access of different maps for different levels of log on. The software shall be proven for use of assigning access of different sub-system controls for different levels of user access.

8.5 Icons shall be placed on the map to identify different equipment types.

8.6 Both shall be automatically tagged with grid reference data to allow them to appear in the correct relative positions at both levels of map.

8.7 Positioning the mouse pointer over an icon or poly-line shall display the corresponding equipment status information.

8.8 For poly-lines representing route data, the user shall be able to configure a number of thresholds for the different data types available. An example would be congestion for links where up to x% percentage thresholds can be defined. Each threshold shall be represented by a distinct color or changed shapes. The map shall use this scheme to display the poly-lines based on comparisons with the current real-time data.

8.9 The user shall have the ability to configure the map view to display the data layers of choice, for example to show Met Sensors only or ATCC together with current incidents.

8.10 It shall be possible for the operator to place icons or "active" symbols on the map to represent

a. Access control / ramp metering System.
b. Traffic control system.
c. Variable Message signs
d. CCTV cameras
e. Incidents: i) Accident, ii) Roadwork's, iii) Event, iv) Diversion, v) Breakdown, and vi) Road closure.
f. Strategy
g. Weather station data
h. Flow, speed classification information
i. User defined fields

- Icons will be either active or non-active.
- Active icons will link to the associated system and show their current status by change of state (color or flash) and by displaying detailed information triggered by user action.

9. Data Management

9.1 The database used by the ITS software shall be a standard database like ORACLE or SQL. The system shall have facility to perform certain selected database operations only by authorized users.

9.2 Data Presentation and Storage

a) The presentation of data shall reflect the use of the system as a real time tool for the operator to monitor and control the ORR. It shall be possible to present current data (day) in comparison with profile data or date comparison (same day last year).

b) It shall be possible to create predictive traffic data and trends. The data shall be stored in the system in a format to present weekly and monthly average for congestion and summary flow for weeks and months. The system shall store at least 12 months of data in such a way that it may be immediately retrieved. Older data may be archived however the system shall provide tools for the retrieval, manipulation and presentation of data.

c) Data stored shall be clearly marked with an indicator to show day or period type e.g. normal, holiday, weekly off; by reference to the system calendar.

d) It shall be possible to export data to an external system for further analysis. Transfer shall be available in .xls and .csv format.

e) It shall be possible to display data or combinations of data in a graphical manner and to print graphs, e.g., Graphs of current, profile, historic, and combinations for Flow Occupancy Congestion

9.3 **Archive and Restore**

a) This facility shall allow the archiving of the database in one month periods to a tape. The data archived shall then be deleted from the database. Data may only be archived when it is more than two years old. Only one archive request may be outstanding at a time.

b) Once archived, part or all of the data may be restored by copying from the tape back onto the system, where it remains for 30 days. Only one restore request may be outstanding at a time.

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

9.4 **Database backup**: The system management procedures for producing daily and weekly backups shall not need any operator intervention.

9.5 **Reports**: The system shall have detailed reports for:

(i) Status reports for all the sub-systems (alarms, faults etc.)
(ii) Detailed traffic reports – speed, count, occupancy etc.
(iii) Detailed weather report for all variables from weather sensor
(iv) Detailed report of emergency calls

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

9.7 **Strategic Control**

a) It shall be possible to create strategies to implement single or multiple commands to one or more sub-systems.

b) Strategies may be activated by one or more triggers which may be simple on / off events or flows, congestion or time of day etc. meeting or exceeding pre specified thresholds.

c) Removal / cancellation of strategies may be activated by one or more triggers which may be simple on / off events or flows, congestion etc meeting or exceeding pre specified thresholds.

d) Trigger events may be combined and subject to Boolean logic to determine if the strategy should be initiated.

e) Strategies may be manually or automatically initiated or cancelled.

f) Automatic selection of strategies may be subject to timetable restriction (time or day type).

g) Strategies may be initiated by timetable request.

9.8 **System Log**

a) The system shall retain a log of all events, alarms, timetable actions, and operator actions (together with operator username).

b) In addition to system generated events the operators shall have facilities to enter events or incidents into the log.

c) It shall be possible to search the log by time / date, event type, operator user name, strategy, location.

d) The log facility shall provide the means to:

- Record all important events that occur in the operation of the Integrated ORR management system, both manual and automatic
- View and manage the status of alarm & events.
- Collect and collate incident information from both manual and automatic sources
- Allow the user to record routine operational messages
- View all changes and actions taken on the ITS.
- Record and view useful contact names and other details.

9.9 **Asset management**: The system shall incorporate a facility to store records of assets for ITS. The asset register shall store data relating to location, type, and number of equipments as well as electricity ratings.

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

10. Operator Interface and Control

10.1 **Fault and Alarm Monitoring (FAM)**: FAM for ITS shall have following features:

a) The FAM system shall be provided with the capabilities to monitor system alarm status on a real-time basis.

b) The FAM system shall have the ability to store alarms in the database for future enquiries, and to access the fault alarm history database for retrieval of alarm data in the alarm history memory.

c) All ITS controlled equipment as well as VMS display boards shall be provided with fault monitoring and reporting to the FAM system.

d) The subsystems should be depicted on the ITS screens as icons on the bitmap of the ORR. Fault conditions should be represented by change of color of the icons.

10.2 **Alarm Handling**: The following alarm conditions shall be provided to the FAM system as a minimum:

- Loss of communication link.
- Loss of the entire ITS facilities at a location.
- Loss of interface link with the ECBs.
- Alarm from MET Sensor – Air Temperature, Visibility, Humidity, Road Surface temperature, Road Surface wet / dry, Wind Speed, wind direction etc.
- VMS Faults – E.g. Communication Fault, LED Fault, Data parity fault, Power supply fault, Protocol polling fault to I/O Device, etc.
- ATCC faults e.g. Sensor fault, communication link failure etc.
- CCTV faults
- Traffic control system faults- Lamp LED Fault, Sensor fault, communication link failure, etc.
- Power supply unit failure
- Automatic Message priority conflict.
- All failure alarms shall be stamped with time and date.

10.3 All failure alarms shall remain on the active alarm display list until they have been acknowledged by the operator on the FAM system via the management workstation.

10.4 All alarms resulting from equipment faults shall be latched alarms.

10.5 All alarms removed from the active alarm display list shall automatically be inserted into the alarm history database when they occur.

10.6 The alarm history database shall be provided with sufficient storage capacity to store the anticipated alarms for a period of at least four weeks without carrying out any housekeeping function.

10.7 **Alarm Displays**

a) Alarms shall be displayed on the workstation via a detailed full screen alarm browser application (ABA). The ABA shall be one of the window display screens and shall provide a form in which multiple alarms and alarm history can be managed.

b) The Alarm Display shall provide as a minimum the following general capabilities and characteristics for the ABA for alarm display list and alarm history.

c) A color coding scheme indicating the alarm severity according to the alarm classifications.

d) The display of the alarms with their associated time stamps.

e) Scrolling capabilities to enable the operator to view more alarms that can be displayed on one single screen.

f) The facilities to acknowledge alarms

g) The facilities to clear alarms from the display.

10.7 **Fault Diagnostics**: The fault diagnostics system shall perform the following diagnostics features as a minimum.

(i) The fault diagnostics system shall detect the alarm conditions as listed in Alarm Handling Para.

(ii) All fault status information and associated equipment test results shall be presented to the workstation immediately after the alarms are triggered.

10.8 **Failure Modes**: When power is restored following a power failure to the system, the system shall perform all necessary self-testing processes and then resume functioning fully in the same configuration as before the shutdown. This shall be completed automatically within 5 minutes of power restoration.

11. Mobile radio communication System

11.1 The operator for mobile radio system shall be located in the main control room. The operator shall be able to perform following functions:-

- Receive from / make call to any mobile phone on the ORR network.
- Audio-visual indication on the Operator monitor with identification of the mobile phone
- Queuing and wait indication of calls from mobile phone.
- Holding of any call by operator
- Termination of any call by operator
- Recording of all conversations between ECB and operator & mobile and operator shall be provided.
- Seamless configuring on adding / deletion of mobile numbers on the Network
- Database generation, display on the monitor and logging of all parameters of call progress.

11.2 Equipment: The mobile system shall have following equipment at the main control center:

- Mobile vehicle mounted devices
- Operator console
- Engineering terminal

11.3 The specifications for first among the above are covered under detailed specifications of the mobile communication system. The specifications for operator console and engineering terminal shall be as follows:

- Operator Console: The operator console shall provide the operator with capability to handle all communication, select and monitor one or more mobile calls and to answer and make calls from one single operator station. The PC or work station used for operator console shall have following specs as minimum. PC Base unit, 15” Touch screen monitor, audio unit, headset, connecting cables, s/w licenses etc.
- Engineering terminal: Engineering terminal shall be provided for configuration/ re-configuration of the system. The PC or work- station used for engineering terminal shall be of standard configuration used for the application

12. CCTV System

12.1 **Function**: The CCTV System Equipment shall remotely control movement of all CCTV Cameras installed at various locations on the ORR. The CCTV System shall have following features:

- The system equipment shall be able to control tilt, pan and zoom movement of the Cameras individually.
- Transmission of video, audio and data to a predefined location on the ORR.
- Superior video image quality with up to 752 x 582 pixels and max 25 frame/s
- Data transmission from cameras to Console at the Control Centre and vice versa
- Easy to use – “plug and play”
- IP 65 rated enclosure
- Connectivity to the Integrated ITS System for control of cameras, transfer of video images to the Integrated ORR system.

12.2 **Equipment**: The CCTV System equipment shall comprise:

- Console Operating Table ergonomically designed for operation by two operators controlling up to six or more monitors connected to individual remote cameras
- Console with suitable key and joystick.
- Color Monitors (separate for each camera)
- Associated Video Transmission equipment with minimum transmission facility of 25 frames per second for each camera
- Multiplexer equipment for display of video images on the monitors
- Matrix and Digital video recorder system for recording of images.
- Connectivity to the Integrated ITS System for video and control data.

13. Video Incident Detection System

13.1 The system shall be based on machine vision technology i.e. video imaging with computerized pattern recognition. Video cameras and processing computers emulate the human eye and therefore provide a platform for remote traffic management and incident detection. The control center video detection system shall consist of:

13.2 Incident Detection:

- Measurement of traffic flow speed between 0 and 150 Km/ Hr. for upto 6 lanes
- Detection of vehicles driving in wrong direction
- Automatic detection of 5 types of traffic flow: normal, dense, delayed, congested and stop & go.
- Detection of stopped vehicles, within 10 secs and for upto 16 detection zones.
- Monitor zone occupancy of the detection area
- Detection of deceleration
- Detection of fog / smoke.

13.3 Alarms shall be done when the following events happen: Queue, Stop, Inverse direction, Speed drop, Fog / smoke, No. video signal, Error

14. Back Bone Communication System

14.1 The backbone communication system shall connect the sub-centers for peripheral systems like ATCC, CCTV, mobile radio, emergency call management system, VIDS, Traffic Control System, Mobile Radio & LAN interface for Tolling Systems to main control center. There shall be a node for the backbone communication system at every sub-center and the main control center. The network management system shall be located at main control center. It shall however be possible to connect the NMS at any sub-center location which houses the communication node.

14.2 The NMS shall be installed on a PC with minimum configuration as below:

- IBM Compatible PC with Pentium-IV processor, key board, mouse, colour monitor, floppy drive & CD drive.
- The capability of the NMS has been outlined in the detailed specification for the backbone transmission system.

15. Large Display Board

15.1 The large display board shall be used for display of a bird's-eye-view of the ORR Section with display of management information. The large display board shall be displayed on the wall of the Control Centre. The Application software shall consist of a built-in module for display board. This function can be used for creating complex process diagrams using basic drawing entities and a library of pre-defined symbols. It shall be possible to represent a measurement as a digital readout, horizontal bar, and vertical bar.

15.2 It shall be possible to create a detailed customized data acquisition screens by simple click and drag icons.

15.3 It shall be possible to create backgrounds using scanned photographs, maps, one-line diagrams, engineering drawings, etc., using popular graphics or engineering applications which can save images in bitmap formats.

15.4 It shall be possible to create new process diagrams that represent various sections of the ORR at different levels of details using the package

15.5 **Equipment**: The Large Display Board shall be highly reliable for installation and round the clock operation in the Control Centre. The Display Board shall be driven by the Central Computer using the main console. The design of the Display Board system shall be modular and expandable. The display Board shall use high gain trans-reflective LCD's for ambient indoors. The Board shall meet following specification:

(i) Overall board size: Length minimum 3000mm
(ii) Height minimum 1200mm
(iii) Display: Graphic
(iv) Contrast Ratio: > 30:1 perpendicular to board face, and >10:1 at + 70_0 to perpendicular
(v) Housing: Structure coated housing with IP54 protection casing against dust, sprayed water
(vi) Interface Standard: RS422, RS485 (Ethernet compatible)
(vii) Special Features: Automatic diagnostics & failure reporting

16. Line Printer

16.1 LaserJet printer, with a page output rate of at least ten pages per minute and a resolution of at 1200 dots per inch, shall be provided for creating paper copies of Workstation screen displays, reports etc.

16.2 The Operator shall be able to generate a print out of any display page at any time. The print out data shall be a snapshot of the displayed plant data at the instant the print command is executed.

16.3 The screen display, report, log, etc. shall be spooled to the printer and the workstation shall be returned immediately to normal operation. Where the screen display is part of a multi-page log it shall be possible to select the range of pages to be printed and to cancel the print job at any time before it is completed.

16.4 Paper stocks, (A4 cut sheet for all printers and also continuous feed for line printers), and printed output shall be stored in hoppers. The bidder shall finalize the details regarding paper size in consultation with Employer's representative.

17. Office Computer

17.1 **Function**: The office computer shall be used for general, administrative functions and shall be connected to the local lane of the Control Centre along with other operational Equipment.

17.2 **Equipment**: IBM Compatible PC with Pentium IV processor, key board, mouse, colour monitor, floppy drive & CD drive, PC Tele-Fax and LaserJet Printer.

18. Uninterrupted Power Supply

18.1 **Function**: The uninterrupted power supply shall be installed at the Control Centre for providing clean uninterrupted power supply to all the operational Equipment at the centre. The uninterrupted power supply shall be capable of providing full load for the operational equipment for a minimum period of 60 minutes. The Control Centre shall be powered from 230 VAC from the State Electricity Board supply. Any loss of AC power to the Control Centre from the SEB shall not cause loss of any data on the computers or any resetting of system parameters.

18.2 **Features**:

- Rating: 10 KVA (or as assessed to meet the load requirements)
- Input Voltage: 230 V AC (+10% to - 15%)
- Input Frequency: 50 Hz +10%
- Inverter Type: High frequency switching sinusoidal multiple pulse width modulation
- Output Voltage: 230 V
- Output Frequency: Free running 50 Hz + 0.1%
- Tracking bypass +2%
- Output Voltage Waveform: Sinusoidal
- Output Voltage Regulation Better than +1% for simultaneous variation of no. to full load and input Voltage to any extremes
- Total harmonic distortion: <5%
- Inverter efficiency: >87%
- Transmit Response : for 100% step load
- Dip – Typical 5% max. <8%
- Peak - Typical 5% max. <8%
- Recovery to normal up to 60 msec. i.e. 3 cycles
- Overload capacity: 125% for 10 min.
- 800% on static bypass for 10msec
- Audible indication : <55 DBA at 1 meter. Distance for Mains OK, Inverter OK, Overload, On battery, Low battery and Inverter trip

18.3 Four extra LED indications shall be available with automatic bi-directional static switch for:

- By pass OK
- Load on inverter
- Load on By Pass
- By Pass frequency out of range
- Metering for voltage, frequency and current
- Battery capacity required for minimum 1-hour back up at full load (calculations to be submitted by the bidder)

19. Control Centre Equipment

19.1 The Control Centre shall accommodate following equipment:

- Central Computer Server (with Integrated ITS/ITS Software)
- Traffic Manager terminal for operation of integrated ORR system
- Call Centre Equipment – Operator PC along with sub –systems & Digital Voice Recorder.
- Mobile radio terminal – Operator PC & Engineering terminal.
- Computers for Fibre Optic Communication System NMS.
- CCTV Console Equipment
- VIDS console Equipment
- Computers for VMS, ATCC, MET, Traffic Control/ramp metering etc.
- Screen
- Line Printer
- Office Computer for Supervisor.
- Power supply & back up system

H. SPECIFICATIONS OF OPTICAL FIBER BACKBONE

1. General

1.1 The contractor shall install a backbone communications system based on active access nodes linked by optical fibres forming a reliable and redundant high speed medium for the transparent transport of voice, data, LAN and video services. As the transmission system would be used as a backbone network, the system shall have following characteristics:

- High Availability
- High Reliability
- Dual ring configuration
- Easy to install and operate
- Scalability
- High degree of flexibility with respect to the types of interfaces

1.2 A digital transmission system, based on state of the art fibre optic technology, is required to carry all voice, data, LAN and video information. Usage of copper cable for long-distance transmission purposes is not allowed due to the inherent disadvantages of copper cable. A transmission system based on TDM (Time Division Multiplexing) shall carry all channels for voice, data, LAN and video communications. As virtually all information is transmitted via the TDM system, the system must be implemented using two physically independent cable routes. In case of a partial network failure, this will ensure that the remaining part is not affected.

2. System Requirements

2.1. **Topology**: The backbone shall consist of access nodes interconnected by a dual fibre optic ring. The dual ring structure is essential for redundancy purposes. In normal operation, only one of the two rings will carry the user information, while the other ring shall be in hot standby. The two rings shall be counter rotating. The standby ring shall take over automatically with minimum delay whenever a problem occurs on the active ring. If a complete cable break occurs, which means that both the active and standby rings are interrupted, the system shall automatically perform a loop-back operation, isolating the fault, and maintaining communications of all user equipment connected to the network.

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

2.3 **Availability and Reliability**: To ensure maximum system availability and minimum downtimes, special precautions must be taken on the system:

2.4 Dual ring operation is compulsory. The standby ring shall automatically take over whenever a fault occurs on the active ring. Moreover, the system must be able to create a ring structure in case of a cable break or a node failure (loop-back operation).

2.5 The maximum reconfiguration time, in case of a node failure or cable break, shall not exceed 150 msec. A dual hot swappable power supply with separate power cords shall be provided. Configuration data and specific software shall be stored locally in every access node to ensure an automatic and quick restart after a power outage. The database holding all relevant information on the system configuration shall be backed up in the Network Management System. If configuration data is lost in a particular node, the Network Management System must be able to restore the data.

2.6 The high reliability shall be established by submitting MTBF and MTTR values of each individual module of the system, and by overall MTBF and MTTR calculations of the system.

2.7 **Node Interconnection**: It shall be possible to connect the nodes in the ring via an optical connection. Different types of lasers (range 1300-1550 nm) and receivers shall be available to cover different distance requirements. List of all relevant optical specifications and link budget calculations to establish the above must be submitted along with the bid.

2.8 **System Bandwidth and Bandwidth Allocation**: The backbone bandwidth shall be 2500 Mbps. The allocation of the bandwidth to the virtual channels shall be flexible and easy to perform via the Network Management System.

2.9 The bandwidth granularity shall be such that low speed signals do not consume unnecessary bandwidth. The smallest amount of bandwidth that can be allocated shall not exceed 50 Kbps.

2.10 The backbone shall also support following ITU-T/ANSI standard interfaces: STM-1/OC-3 and STM-16/OC-48.

3. Hardware Requirements

3.1 **General**: The optical backbone communications system shall be the combination of a passive part, i.e. the optical fibres, and an active part, i.e. the access nodes. Each node shall be equipped with circuitry regenerating the optical signal, providing interfaces to the applications and monitoring and controlling the access node. The access node shall be of a modular design allowing the installation of additional modules or the replacement of modules. The access node shall consist of a chassis, one or two hot swappable, redundant power supplies, slots for interface cards (4 or 8 per chassis), the system module and optical transceivers for the optical links. The slots shall allow a mix of interfaces to be installed.

3.2 **Node Chassis**: The chassis shall be 19" rack mountable and distinguish itself through an industrial quality design. The interface modules shall be easy to install. It shall be possible to insert and remove interface cards during system operation.

3.3 **System Module**: Every chassis shall be equipped with a system card that is responsible for the TDM (de)multiplexing. The system card shall control, monitor and maintain the ring(s) and shall pass and receive status information from the other nodes. The internal logic and software will discover a fault in the ring(s) and will cause the ring to reconfigure in the most optimal way. The system card shall have a display on the card facilitating quick diagnostics.

3.4 **Optical Transceivers**: The optical transceivers shall interconnect the nodes using the optical infrastructure. The transceivers shall support single mode or multimode fibre cables and operate at 1300 nm or 1550 nm.

3.5 **Power Supplies**: The node chassis shall be equipped with one or two (redundant and load balancing) power supplies out of the group of 24 VDC, -48 VDC, 115 VAC and 230 VAC, which, each by itself, must be able to feed the node. If one power supply in the redundant node chassis fails, the other power supply shall automatically take over.

4. Network Management

4.1 **General:** The Fibre Optic Transmission System shall be equipped with a user friendly, Microsoft Windows-based Network Management System (NMS). The NMS shall allow the operator to manage and monitor multiple sub- networks in an efficient way. The NMS shall have the following functionality: network configuration, configuration of services, monitoring, diagnostics, activation-deactivation of interface modules, bandwidth allocation, alarms and event logging and graphical network representation. The network management hardware shall consist of a Personal Computer, which at the time of installation is the current industry standard. The NMS architecture shall be based on client-server technology. It shall be possible to connect multiple active clients to the NMS server allowing network management from multiple and/or remote locations or by multiple users.

4.2 **Configuration Management**: It shall be possible to connect the NMS system to the network at any node via Ethernet. Using the NMS, it shall be possible to configure the hardware modules that make up the network: nodes, network cards, interface cards and optical transceivers. The Network Management System shall allow the user to activate or deactivate an interface module. It shall be possible to create various services over the network. The NMS shall allocate the transmission channels to virtual point-to-point or multi- point services in order to achieve an optimal bandwidth allocation. It shall be possible to configure the network and the services without being connected to the network, either via the Graphical User Interface (GUI) or via scripting.

4.3 **Automatic reconfiguration**: The management platform shall not be critical in the reconfiguration sequence of the system. It will only report the event in detail to the network operator. Relevant configuration details shall be stored in the Random Access Memory (RAM) module of each node. After configuration, the network shall continue to work autonomously and shall reconfigure in error situations. It is therefore necessary that the reconfiguration algorithm resides in the nodes themselves.

4.4 **NMS database**: The NMS shall contain the network database containing all kinds of information: sub-network names, node names, node configurations including installed network and interface cards. It shall be possible to make the following on-line changes: activation or deactivation of interface cards, addition or removal of interface cards, and addition, changing or removal of services. Each change shall automatically update the database on the hard disk of the network management PC and the RAM memory of the relevant node(s). It shall be possible to use the database to restore the network configuration in case settings in one or more nodes are lost due to a hardware defect.

4.5 **Fault and Alarm Management**: It shall be possible to easily monitor the operation of the different sub- networks that make up the network. During normal operation, the

NMS shall continuously poll all the network nodes. It shall compare the status of the network with the information resident in its network database. If a fault or change occurs, the GUI screen on the NMS PC will display an alarm message indicating the nature and location of possible errors or changes. The alarm messages shall include at least the date, time, node, interface slot and/or interface port, alarm severity and description. Via the GUI, it shall be possible to register following events: loss of synchronization, network reconfiguration, node failure, interface card errors and external alarms. It shall be possible to store the events in the NMS database. Errors and unexpected conditions shall be reported by the network management system in another colour than the one used upon correct operation.

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

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

5. Interfaces

5.1 **General**: The following interfaces shall be available: Voice, Data, LAN and Video.

Preferably, only native interfaces shall be used. The interfaces shall be fully transparent to all higher layer protocols.

5.2. **Voice Interfaces** includes Analog Voice, 2/4-wire Voice, Digital Voice, E1/T1 interfaces, E1/F1 Grooming at 64 Kbps and High Quality Audio. There characteristics are as follows:

a) Analog Voice

- The access nodes shall provide native 2-wire analog voice interfaces compliant with ITU-T recommendations G.712.
- The interfaces shall be transparent to all inband PBX features.
- The ports shall support DP and DTMF signalling.
- The number of ports per cards shall be flexible: 2, 4, 6, 8 or 12 ports per interface card.
- It shall be possible to eliminate distance limitations of conventional analog telephone networks.
- It shall be possible to configure a party-line whereby one operator is logically connected to multiple analog phones at different locations.

- The system shall support direct connections between telephones for hotline applications without PBX.
- The ports shall support 12 or 16 kHz metering pulses
- It shall be possible to connect the analog phones as well as the PABX to the access nodes
- The system shall provide the following status information: card active/inactive, card type, on/off hook, ringing voltage status.
- The voice communication card shall have LED's to indicate proper functioning of the individual interfaces.
- The Voice communication card shall perform the self test and the status shall be available on the front LED `s on the card.

b) 2/4-wire Voice

- The access nodes shall provide native 2/4-wire analog voice interfaces compliant with ITU-T recommendations G.712.
- The ports shall have E&M signalling functionality at –48V.
- The number of ports per cards shall be flexible: 2, 4, 6, or 8 per interface card.
- The 2/4-wire analog voice interface must be able to handle analog signals in the range of 300 to 3400 Hz.
- The ports shall support E&M multidrop connections
- The system shall provide the following status information: card active/inactive, card type, E&M status, Carrier Alarm (E&M), ringing voltage availability.
- The system shall comply with following specifications for Crosstalk: < -60 dB (paths on the same circuit) < -70 dB (paths on different circuits)

  Solid State Relays:
  Voltage: max. 56 V
  Current: max. 100 mA
  Closed resistance: max. 16 Ω
  Open resistance: min. 10^{8} Ω
  Disruptive voltage b/w M leads & control logic: 3750V min.

- It shall be possible to have 2/4 wire analog voice interfaces on the same interface card.
- The voice communication card shall have LED's to indicate proper functioning of the individual Interfaces.
- The Voice communication card shall perform the self test and the status shall be available on the front LED `s on the card.

c) Digital Voice

- The access nodes shall provide native ISDN S_0 interfaces. S_0 is a standard

4-wire 2B+D interface specified at the S-reference point (ITU-T). This terminal interface shall offer two 64 Kbps B- channels for voice and data and a 16 Kbps D-channel for signalling or packet data.

- The interface card connected to the PBX shall be equipped with at least 6 ports.
- The interface card connected to the terminals shall be equipped with at least 3 ports. This interface shall enable/ disable the line voltage per circuit.
- The access nodes shall provide interconnection to a digital PABX and its digital telephone sets. These terminal interfaces shall offer two 64 Kbps B-channels for voice and data and a 16 Kbps D-channel for signalling.
- It shall be possible to eliminate distance limitations of conventional ISDN networks (ITU-T recommendation I.430)
- The system shall at least provide the following status information: card active/inactive, card type, circuit active, ringing voltage status, circuit reset, card reset.

d) E1/T1 interfaces

- The access nodes shall provide native E1 interfaces (2048 Mbps) compliant with ANSI T1.102, OFTEL OTR001 and ITU-T recommendations G.703 and G.823.
- The access nodes shall provide native T1 interfaces (1544 Mbps) compliant with Bellcore 000499, ANSI T1.102, T1.403 and T1.408, and ITU-T recommendations G.703, G.824 and I.431.
- Each E1/T1 interface card shall be at least equipped with 4 ports.
- The E1/T1 ports shall be fully transparent to all higher protocols (standard and proprietary)
- The system shall provide at least the following status information: card active/inactive, card type, input fail alarm, remote alarm, code violation alarm, synchronization alarm.

e) E1/T1 Grooming at 64 Kbps

- The access nodes shall provide an E1 interface (2048 Mbps) compliant with ANSI T1.102, OFTEL OTR001 and ITU-T recommendations G.703 and G.823.
- The access nodes shall provide a T1 interfaces (1544 Mbps) compliant with Bellcore 000499, ANSI T1.102, T1.403 and T1.408, and ITU-T recommendations G.703, G.824 and I.431.
- Each E1/T1 grooming interface card shall be at least equipped with 1 port.
- It shall be possible to multiplex RS232/RS422 data and analog voice signals onto an E1/T1 frame.
- The interface card shall at least support CAS signalling.
- Point to point as well as multi-drop connections shall be possible

f) High Quality Audio

- The high quality audio interface shall connect audio equipment without compromising on the quality of the analog audio signal.
- The high quality audio interface shall transport audio signals with link quality up to 15 kHz (e.g. for high quality speech and music transmission).
- The interface card shall be equipped with at least 2 mono audio channels per card. The two simplex mono channels can be used to broadcast stereo audio.
- The High Quality audio interface cards shall work in fixed or switched mode.
- In fixed mode each interface card shall be equipped with at least 4 full duplex RS422 ports for point to point connections or 2 full duplex RS422 ports for multi-drop connections.
- In switched mode each interface card shall be equipped with at least 3 full duplex RS422 ports for point to point connections or 1 point to point and 1 multi-drop connection.
- It shall be possible to pass the switching commands coming from the external audio control system to the fibre optic transmission system in a direct way via RS422 (19,2 Kbps).
- It shall be possible to define several sub-networks or audio systems on the same optic fibre transmission system.
- For each sub-network it shall be possible to have at least 60 simultaneous audio connections.
- It shall be possible to send an audio signal to multiple audio ports residing on the same interface card.
- It shall be possible to send an audio signal to multiple cards residing in the same access node.
- It shall be possible to send an audio signal to multiple cards residing in the same access node as the source.
- It shall be possible to put an audio port in mute via the Network Management System.
- The interface card shall support the following data rates for RS422 control connections: 4.8 kbps, 9.6 kbps, 19.2 kbps, 38.4 kbps, 76.8 kbps, 100 kbps, 153.6 kbps, 307.2 kbps and 614.4 kbps.
- The interface card shall provide the following status information: card active/inactive, card type, mute, loss of connection, overflow, pilot tone in, TX/RX (RS422) and RTS/CTS (RS422).
- The data communication card shall have LED's to indicate proper functioning of the individual interfaces.
- The communication card shall perform the self test and the status shall be available on the front LED `s on the card.

5.3 Data Interfaces

a) RS232

- The RS232 interface shall comply with standards EIA RS232 and V.24/V.28.
- Each RS232 port shall support asynchronous and synchronous data transmission.
- Each RS232 port shall support full duplex transmission.
- Each RS232 port shall support the following data rates in a transparent way: DC-100 kbps.
- Each interface card shall be equipped with at least 12 ports for point to point connections, 6 ports for multidrop connections or any combination of the two between the two limits.
- 4 separate RTS/CTS circuits shall be provided per interface card.
- It shall be possible to configure the RS232 interface for external alarm monitoring.
- It shall be possible to monitor 9 external alarm contacts per interface card.
- It shall be possible to provide a connection between RS232 and RS422 over the fibre optic transmission system.
- The interface card shall provide the following status information: card active/inactive, card type, receive data, transmit data, RTS status.

b) RS422

- RS422 interface shall comply with standards EIA-422 and V.11.
- Each RS422 port shall support synchronous and asynchronous data transmission.
- Each RS422 port shall support full duplex transmission.
- Each RS422 port shall support the following data rates in a transparent way: DC-614.4 kbps.
- Each interface card shall be equipped with at least 12 ports for balanced point to point connections, 6 ports for multi drop connections or any combination of the two between the two limits.
- It shall be possible to provide a connection between RS422 and RS232 over the fibre optic transmission system.
- The interface card shall provide the following status information: card active/inactive, card type, receive data, transmit data.

c) RS485

- The RS485 interface shall Comply with standard EIA-485 (April 1983)
- Each port shall support the following data rates: 1.2 kbps, 2.4 kbps, 4.8 kbps, 9.6 kbps, 19.2 kbps, 38.4 kbps, 64 kbps, 93.75 kbps, 128 kbps, 187.5 kbps, 256 kbps, 384 kbps, 500 kbps, 512 kbps, 1.5 Mbps and 2 Mbps.
- Each interface card shall have at least 3 ports.
- Each port shall support asynchronous and half duplex transmission
- It shall be possible to configure point to point or multi drop connections over the transmission network.
- The interface card shall provide the following status information: card

active/inactive, card type, monitoring setting, monitoring status, receive data, transmit data, internal/external clock input.

5.4. **LAN Interfaces**

- The access nodes shall provide physical layers supporting Ethernet service interfaces.
- It shall be possible to eliminate distance limitations of conventional Ethernet networks.
- Each interface card supporting a direct Ethernet connection shall provide at least six switched ports.
- Each port shall support IEEE 802.3 compliant 10Base-T and IEEE 802u compliant 100Base-TX twisted pair interfaces, with RJ-45 connector.
- The ports shall support auto sensing of 10Base-T vs. 100Base- TX.
- Each port shall support 10/100 Mbps half/full duplex operation mode.
- The operation mode shall be selected via the auto negotiation feature or manually via the Network Management System.
- The fibre optic transmission system shall support multiple independent Ethernet networks.
- The bandwidth per Ethernet network on the fibre optic transmission system should be selectable from 1Mbps to 180 Mbps.
- It shall be possible to use the Ethernet interface card in point to point or multipoint configuration.
- The Ethernet interface card shall support flow control according to IEEE 802.3x.
- The system shall provide at least the following status information: card active/inactive, card type, monitor selection, monitor active, data in input buffer, data in output buffer, excessive collisions, packet too long, buffer status, packet removed, input buffer overflow.
- The system shall have a 100 Mbps LAN interface at each of the Toll Plaza locations along the route including at interchanges (total 4 locations)
- The bidder shall list any additional types of Ethernet interfaces (e.g. 10Base-2, 10Base-5) that are supported by the system. For completeness, the bidder shall identify any other LAN technology options supported by the proposed equipment (e.g. Token Ring).
- The LAN communication card shall have LED`s to indicate proper functioning of the individual interfaces.
- The communication card shall perform self test and the status shall be available on the front LED `s on the card.

5.5. **64Kbps Interface card**

- It shall be possible to transport a 64Kbps digital stream between any two points in the transmission system.

- The 64Kbps interface shall be compliant with ITU-T recommendations G.703 (Co-directional) and G.823
- The interface card shall have 6 independent ports.

5.6. **Video Interfaces** shall:

- Offer high-quality full resolution full motion color video image transmission by means of a digital video channel across the network, requiring a bandwidth of no more than 6 Mbps and with a latency of less than 100ms.
- Be based on the M-JPEG video compression algorithm, because of its fault tolerance and disturbance immunity.

5.7 The video interface codec shall comply at least with the following specifications:

- Colour information: 4:2:2 or 4:0:0 (B/W); Horizontal resolution: 704, 352 or 176 pixels per line; Vertical resolution: 576 or 288 active lines/frame (PAL); 480 or 240 lines/frame (NTSC) Field rate: 1.5 / 6.25 / 12.5 / 25 and 50 fields/s (PAL); 2 / 3.75 / 7.5 / 15 / 30 / 60 fields/s (NTSC)
- Provide analog inputs and outputs with a standard PAL or NTSC signal for interfacing to peripheral video equipment : PAL-B/G or NTSC-M with CVBS signal format.
- Provide at least one accompanying full duplex RS-422 port for camera control (PTZ) or for control of other external CCTV equipment
- Provide at least the following status information: interface card active/inactive, interface card type, initialisation status, firmware version, codec parameters (e.g. PAL/NTSC), Video Signal Present/Not Present.
- Provide a test video signal that can be remotely controlled from the NMS to input to any video input port.

5.8 The network shall:

- be able to switch input ports to output ports, both in point-to- point and in multipoint configurations
- support semi-permanent and switched video connections. The semi-permanent video connections shall be configurable from the NMS system.
- The switched video service shall be configurable from the NMS system and the video connections within that service shall be controllable by an external video management system.
- Provide access to at least 15 analogue input or output video interfaces in every node; 15 analogue inputs per node must be available independently and simultaneously.
- Provide at least 96 video channels @ 6Mbps or 48 channels @ 12Mbps.
- Provide a network expansion scenario to up to 18 video interfaces per node and up to 378 video channels @ 6 Mb/s (189 video channels @ 12 Mb/s)

- Provide appropriate video interfaces for connecting video signals from surveillance cameras at the Toll Plazas (Video Image and PTZ Control) for viewing and control for cameras at the interchanges and the Toll Plazas).

5.9 **CCTV Applications & Integration**:

- The switched video service on the network shall be controllable by an external video management system as if it is a (distributed) CCTV matrix switcher.
- At least a message-based protocol on a serial link shall be made available to allow an external video management system to interface the switched video service.
- The controllable functionality shall at least comprise connection between any network video input and (one or more) video output(s), and on-screen display (camera titling).
- The switched video service control function of the network shall support (or shall be able to support upon order) the host protocol of some popular analogue CCTV matrix brand, in order to integrate the network with a commercial independent video management system out-of-the-box, i.e. without adaptation of the latter product. Functionalities supported by this host protocol are: video connection between any network video input and video output(s) on the network, on-screen display (camera & alarm titling), PTZ control, alarm collection and auxiliary control.
- Also, the switched video service control function of the network shall be able to support upon order protocol conversion to other manufacturer's camera PTZ receivers, dome cameras and matrices, to allow for integration of CCTV equipment of various brands within the same network installation.
- The CCTV communication card shall have LED's to indicate proper functioning of the individual interfaces.
- The card shall perform the self test and the status shall be available on the front LED `s on the card.

I. SPECIFICATIONS OF POWER SUPPLY

1. Power Supply System

1.1 At the sub –centers, the power supply equipment shall consist of the following:

i) Diesel Generators (DG's) in (1+1) redundant configuration
ii) UPS in (1+1) redundant configuration
iii) Utility Electric Supply connection

1.2 The DG's shall be as per the following specifications:

a) DG's shall be rated for minimum of 18 hrs of continuous operation.

b) DG's shall be rated for 200% of UPS / Electronics load or 150% of the total loads whichever is higher.

c) DG's shall be rated for 50^{0}C ambient operating temperature.

d) Exhaust piping with adequate thermal insulation shall be carried out.

e) Auto Mains Failure shall be supplied with minimum of following:

- Suitable interlocking for auto start of the DG's Annunciations for alarm and trip conditions
- Safety interlocks for the DG's adequate number of feeders with suitably-rated MCB's for power distribution

1.3 The UPS shall be designed for 125% of the total connected load. The power supply to all electronics equipment (Indoor & outdoor) shall be fed from UPS.

1.4 At the Main Control Center, the power supply equipment shall consist of the following:

(i) Diesel Generators (DG's) in (1+1) redundant configuration
(ii) UPS in (1+1) redundant configuration
(iii) Utility Electric Supply connection

1.5 The DG's shall be as per the following specifications:

a) DG's shall be rated for minimum of 18 hrs of continuous operation.

b) DG's shall be rated for 200% of UPS / Electronics load or 150% of the total loads whichever is higher.

c) DG's shall be rated for functioning under environmental conditions mentioned in "**A. General Specifications for the Advanced HTMS**"**.**

d) Exhaust piping with adequate thermal insulation shall be carried out.

e) Auto Mains Failure shall be supplied with minimum of following:

- Suitable interlocking for auto start of the DG's Annunciations for alarm and trip conditions
- Safety interlocks for the DG's adequate number of feeders with suitably-rated MCB's for power distribution

1.6 The UPS shall be designed for 125% of the total connected load. The power supply to all electronics equipment (Indoor & outdoor) shall be fed from UPS.

2. Air –Conditioning System

2.1 At the sub-centers, the AC system shall be provided in the equipment room. The size of the room shall be 12' X 10' while there shall be 2 nos. AC's each of 1.5 Ton capacity. The AC's shall be rated for a continuous operation of 18 hrs.

2.2 At the Main Control Center, the Air conditioning facility shall be provided in the Control Room & the Equipment Room. The size of the equipment room shall be at least 14’ x 12’ & the size of the Control Room shall be 20’ x 25’. The rooms shall be provided with false ceiling by the Contractor. There shall be a minimum of 3 nos. of AC of at least 7.5 ton capacity with one unit as standby.

Annex 5 Scope of Work for the TMS Equipment

1. General

1.1 The work includes design, supply, installation, commissioning, documentation, training and maintenance of Toll Collection system inclusive of manual, Touch & Go & ETC system on Hyderabad Outer Ring Road project.

1.2 A brief list of various works indicating the vital items that are included, but not limited to, is given in the subsequent Clauses.

1.3 However, to achieve the end objective, if the Bidder feels that additional items of supply and/or execution are required, he shall mention the same in the Bill of Quantities against "ANY OTHER ITEM" and indicate the quantities and unit as well as total cost of same in his price bid. He shall provide detailed justification for addition of such items of supply/execution in the bid; otherwise his offer shall be liable for rejection.

2. Design

2.1 Site survey and design of the system duly taking into consideration future expansion both in terms of traffic and future facilities needs to be done by the bidders. All the system software (sub-systems and integrated Toll Collection system software) shall meet the present requirements and shall also support at least 100% capacity expansion of the system without up-gradation of the hardware platform. This shall be possible through re-configuration of the above mentioned software.

2.2 There shall be one Main Traffic Control Center and one Sub Control center for the Toll Collection system. The Control Center shall be used for centralized monitoring and control of ETC on the Expressway. Both the control rooms would have the necessary hardware servers and workstations for communication with the individual PCS systems equipments. The Main Traffic control center would be always in operation. Only in case of the Main TCC being down for technical reasons; the sub control center would take over the operations. Also the sub control center computer hardware would be used for the data back up at all the times. The system shall be designed to meet the requirement of the Main traffic control center and the sub-control center specified as above.

3. Supply

3.1 Supply of all equipment, material, components, accessories, mounting hardware, software, etc., for following sub-systems of Toll Collection system:

a) Manual Lane equipments

b) Smart Card based Touch & Go Equipments

c) ETC lane equipments

d) Plaza Computer system (PCS)

e) Plaza surveillance system

f) Toll collection Main Traffic Control Centre, Sub control center & Integrated TCC Software

g) Power Supply and Air Conditioning system

h) Electrical distribution network for all equipments

3.2 Supply of power distribution/back-up equipments for the entire main and the sub systems of the ITS categories.

3.3 Supply of tool kits and instruments required for all the sub-systems.

3.4 Supply of all types of wires and cable for connection, wire ways, cable conduit and trays, equipment racks, nuts & bolts, etc.

4. Installation & Wiring

4.1 Installation & wiring of all equipment, components and accessories of sub-systems. The bidder shall submit location-wise list of all equipment, components and accessories with the bid. All equipment shall conform to the specifications mentioned in the particular technical specs.

5. Testing

5.1 Testing of equipments/systems to be carried out as per the specification provided for individual equipments in each section.

5.2 Factory Acceptance tests shall be carried out in line with the documentation to be submitted by the Contractor. Prior approval of the documents shall be obtained by the contractor from the EMPLOYER as per the tender requirements and specifications.

5.3 Site Acceptance Testing shall be carried out in line with the documentation to be submitted by the contractor. Prior approval of the documents shall be obtained by the contractor from the EMPLOYER as per the tender requirements and specifications.

6. Progress Review

6.1 The Contractor shall carry out the works as per the PERT Chart submitted by him in his bid (which would become a part of the Contract Agreement) showing details of activities to be finalized in Consultation with the EMPLOYER. The Contractor shall furnish progress report every fortnight to the EMPLOYER. However, depending on the progress, the progress may be discussed at shorter intervals if so desired by the EMPLOYER.

6.2 A coordination meeting shall be held every month in the office of CGM HGCL, at Hyderabad to assess the progress of work and set out the targets for the next month.

7. Site Order Book

7.1 A site order book shall be kept at the site(s) of work. As far as possible, all orders regarding the works are to be entered in this book. All entries therein shall be signed by the Employer and the contractor. The site order book shall not be removed from the work site except with written permission of the Employer. And the contractor or his representative shall be bound to take note of all instructions and directions meant for the contractor as entered in the site order book without having to be called on separately to note them. The Contractor shall submit periodically copies of the remarks in the site order book to the Employer for review and for submitting compliance report.

8. Documentation

8.1 Supply of documents with regard to design basis of the system, functional design specifications, installation drawings for all equipment, details of fault diagnostics, Operating and Maintenance manuals, FAT and SAT reports of all equipment shall be submitted by the Contractor.

9. Operation and Maintenance during Warranty

9.1 The contractor shall carry out comprehensive operation and maintenance of the entire Toll Collection system for a period of 2 (two) years from the date of successful commissioning within the quoted cost.

9.2 The contractor is required to depute a dedicated team of maintenance engineers on ORR during general shift and also to be available on phone call when not on duty during the night time. The team should be made up of three categories as team leader, site engineers and assistance staff. 4 such teams should be deployed on the whole ORR for the duration of 2 years during the warranty period.

9.3 The contractor shall be wholly responsible for all technical activities relating to Toll Collection system including operation and maintenance of Main Traffic control centre and the sub control center.

9.4 The contractor shall, at all times, extend his full cooperation to the Employer or its nominated agency to facilitate effective and smooth operation of the Toll Collection system.

9.5 The contractor shall maintain a detailed log of all events round the clock, duly signed by his Maintenance engineers on duty.

9.6 The contractor shall provide weekly/monthly/annual MIS reports (or as required by the Employer) in both hard and soft copy formats.

9.7 The contractor shall submit the following with his offer

a) Maintenance Plan for all equipment

b) Manpower proposed to be deployed, together with their qualification, experience, etc., and their CV's for scrutiny and approval by the EMPLOYER.

c) Location-wise deployment plan at all locations (Traffic Control Room, Sub-Control room, Interchanges etc.)

d) List of tools, instruments, accessories and spares and locations where they would be located

e) List of vehicles (types) including description such as equipped OFC maintenance van, etc.

9.8 The manpower approved by the EMPLOYER shall not be changed except under unavoidable circumstances, and only with written approval of the EMPLOYER. The replacements, if proposed by the selected Bidder, shall have equal or better qualification and experience than those originally proposed in the Bid.

9.9 The cost for operations & maintenance shall be deemed inclusive of all expenses related to the work such as cost of fuel (for vehicles), repair expenses, watch and ward manpower, all applicable taxes/duties/levies, etc.

10. Operation and Maintenance after Warranty

10.1 The bidder shall quote separately for AMC (Annual Maintenance Contract) charges for a further period of three (3) years beyond the Warranty Period with responsibilities as at Clauses 9.2 to 9.9 above.

10.2 No additional amount would be paid to the selected Bidder under any circumstances over and above the price agreed to be paid by the EMPLOYER for post-Warranty Operation and Maintenance upon award of the work.

11. Consignee and Security of Material

11.1 The EMPLOYER shall be the consignee for all material. The contractor shall supply all material to the consignee or at the site of work as mutually agreed with the EMPLOYER in writing.

11.2 Exchange of proper requisition between the contractor and the EMPLOYER and receipt of all material shall be done on the prescribed proforma.

11.3 All material whether imported, procured indigenously, booked by rail, sea, road, etc., shall be supplied either at the consignee's depot or at the site of work as agreed by the Employer. The necessary customs formalities, if any, shall be completed by the contractor.

11.4 Security of all material in the section where the work is in progress shall be the contractor's responsibility and he shall arrange to guard the same from theft/pilferage/vandalism. The cost of providing such security shall be deemed included in the offer, whether or not explicitly mentioned so. In the event of any loss the contractor shall be responsible for the same. The contractor shall insure the materials. Any stores lost, prior to formally taking over by the EMPLOYER, shall be made good by the contractor at no cost to the EMPLOYER.

12. Care of Packing

12.1 All equipment & subassemblies containing active components liable for damage while handling due to Electrostatic discharge, etc., or otherwise fragile shall be wrapped in a conducting wrapper & placed in bubble packing. Any other internationally accepted method shall also be accepted subject to prior approval by the Employer.

13. Implementation Program

13.1 Major milestones for achieving different targets shall be guided by the following program. Any deviations shall be explained with justification, but the Employer is not bound to consider/accept the same.

D	Date of issue of LOA
D + 45 Days	Submission of detailed design & drawings including amendments if any
D + 100 Days	FAT & Supply of all indoor hardware, software modules.
D + 245 Days	FAT & Supply of all outdoor equipment, accessories
D + 265 Days	Installation of all indoor equipment at Control Centre & IC Plaza buildings & loading of major software modules.
D + 350 Days	Installation of outdoor equipment and cabling works
D + 355 Days	Joint Testing of all software modules
D + 365 Days	Integration of complete Toll Collection system
D + 365 Days	Start of Trial Run for 3 months
D + 455 Days	Start of warranty period

13.2 Based on the above, the Bidder shall submit a detailed BAR/CPM/PERT chart to establish how he plans to meet this schedule. This chart shall include the contractor's proposed manpower deployment schedule during project implementation as well as during Operation and Maintenance.

13.3 The works shall be carried out as per the above Chart submitted by the Contractor showing details of activities which shall be finalized by the Contractor in consultation with the EMPLOYER.

13.4 Transportation of material from depot to the site of the work shall be done by the Contractor with his own labour and transport arrangements.

14. Installation Practice and Method of Work

14.1 The work shall be executed to the highest standards using best quality material. The system design shall use state of art techniques. The contractor shall ensure that the entire specification is complied with. It shall be the responsibility of the contractor to demonstrate compliance of technical as well as functional specifications.

14.2 The completed installation shall be subject to checks at all stages and tests as prescribed in the bid or as deemed necessary by the Employer. The same shall be done by the EMPLOYER and the contractor shall be liable to rectify such defects as brought out by the EMPLOYER during these checks and tests and make good all deficiencies at his own cost.

14.3 During system & application software loading on the system and during data input, EMPLOYER's personnel shall be fully associated right from the beginning.

15. Documentation

15.1 The following documents required for installation, operation and maintenance shall be supplied:

a) Installation manual

b) Equipment layout drawings

c) Cabling and wiring diagrams

d) Overall system specification and description of hardware, software, explaining facilities, functions & principles

e) Schematic drawings of all circuits in the system, with circuit explanation and timing sequence charts wherever applicable

f) Equipment installation drawings (site-wise)

g) Adjustment procedures for all field adjustable units

h) Installation instructions and testing procedures

i) Fault location/troubleshooting instructions incl. Fault Dictionary

j) Operations Manual

k) Acceptance testing schedules

l) Test procedure with auxiliary test equipment, if any

m) Emergency action procedure

n) Catalogue of parts including detailed information regarding

o) individual component values, tolerance, etc., to enable procurement of spares from alternative sources

15.2 The documents required for installation and those required for operation and maintenance shall be supplied in separate sets. Three sets of each shall be supplied for each installation.

15.3 Two sets of Factory Test results of the equipment together with information on the method of the testing shall be supplied.

15.4 Documents / plans listed below shall be submitted (at the minimum) at various phases of the work (Approval of EMPLOYER shall be obtained for all documents):

a) Detailed Design & User Specification

b) Equipment Manuals

c) System test plan

d) Unit test plan

e) Unit testing document

f) System testing document

g) Integration testing document

h) Details of hardware used at the Control Centre including those for

i) interfacing

16. Software Documents

16.1 The software documents shall be user-friendly. The documents shall be complete and as detailed as possible to enable the EMPLOYER to carry out the functions of planning, installation, operation maintenance and system support.

16.2 The following software documents shall be supplied:

a) Detailed description of the software describing principles and practices employed, functions performed, its interaction with the hardware and its structure in terms of program and data packages.

b) Detailed description of each individual software package indicating its functions and its linkage with other packages, hardware and data.

c) Detailed description of the program and/or data modules in each package indicating their function interlinking with other programs modules and the input signals of each module.

d) Program and data listings

e) Source files and software code details for all the packages developed for EMPLOYER

f) Graphical description of the system in addition to the narrative description, a functional description of the system in graphical form shall also be supplied.

g) The state transition diagrams (if any) shall use standard symbols and rules. The description shall reflect in detail the internal software structure and logical processes within the system. The overall functional description shall be partitioned into Functional Description Blocks (FDB's) each relating to a process. The processes shall be described in terms of INPUTS, STATES, TRANSMISSION, DECISIONS, TASKS and OUTPUTS.

h) Flow charts for each program modules

i) Planning and system engineering documents

j) Hardware details at field stations including details of software and hardware used for interfacing purposes

k) In case of third party software like database, operating systems, NMS, etc., adequate number of user licenses are to be provided along with original license documents

17. Drawings to Be Submitted by Contractor

17.1 Equipment layout plan for manual and mixed lanes.

17.2 Design of entire system for Traffic Control Centre, Sub Control Center and all interchange plaza buildings and toll lanes.

17.3 Networking arrangement

17.4 In-house test reports by the manufacturer concerned

18. Document Quantities Be Submitted

18.1 All drawings and documents to be submitted by the contractor shall be in TEN sets duly placed in plastic folders / laminated and in CD.

18.2 The tracing of all drawings on quality tracing paper shall be submitted in TEN sets of hard copy and also in CD

18.3 All maintenance manuals shall be submitted in TEN sets of hard copy and also in CD for each installation.

18.4 The quantity of the documentation shall be assessed on the type and variety of the systems used and not on the number of such modules used. Approval of the EMPLOYER shall be obtained for the same.

18.5 Manuals for installation shall be in TEN sets of hard copy and also in CD.

19. Training to Employer’s Personnel

19.1 The contractor shall arrange for training of at least five (5) of EMPLOYER’s personnel at any one site where similar system has been implemented by the contractor in the past and also at the principal contractor’s premises. Hands-on operational and diagnostic training in all aspects of software and hardware pertaining to the ITS shall be covered in the training. The training shall also cover system design and engineering, its functioning including planning, management and supervision.

19.2 Training, the contents of which shall be finalized in consultation with the EMPLOYER, shall be of two-week’ duration.

19.3 The Contractor shall ensure that the EMPLOYER’s personnel who undertake training are able to modify & reconfigure the system to accommodate changes in traffic patterns etc. in foreseeable future after such training. Such personnel should be able to maintain the system effectively on their own.

19.4 The training shall continue during the period of actual installation of the system. The contractor shall also ensure that the trained EMPLOYER's personnel are able to diagnose and rectify the faults completely and quickly.

19.5 The entire cost of training of EMPLOYER's personnel including travel, lodging, boarding and other incidental expenses, etc., shall be borne by the Contractor as per their entitlement.

19.6 The courses shall be in English and complete documentation of the courses shall be supplied to the trainees. The EMPLOYER however reserves the right to vary the number of personnel as well as course modules and training period.

19.7 The contractor shall supply two sets of training documents to each of EMPLOYER's trainees. FOUR additional sets of the same shall be submitted to EMPLOYER.

19.8 The bidder shall include recommended training program and schedule for the same in his offer.

20. Inspection

20.1 The inspection and tests shall be carried out to ensure that all the requirements of the specifications are complied with. The EMPLOYER reserves the right to reject any equipment or parts thereof considered defective in any respect.

20.2 Testing may be made at the place of production, at destination or at both locations as decided by the EMPLOYER. All equipment/instruments/accessories and facilities required for testing, simulation shall be arranged by the Contractor at his own cost.

20.3 The EMPLOYER shall depute engineers to inspect all equipment at location of manufacturing of all hardware components (systems/subsystems). The contractor shall give clear 21 days' notice to the EMPLOYER for such inspection at manufacturers' works. The entire cost of inspection including travel, lodging, boarding, etc. shall be borne by the contractor.

20.4 In house results/reports shall be furnished by the Contractor for each module prior to such inspection.

21. Acceptance Testing of Installation

21.1 The EMPLOYER shall carry out all the tests detailed in the Acceptance Test Schedule to be furnished by the Contractor to confirm that the performance of the different modules, sub-systems and the entire installation satisfies the specification requirements. The EMPLOYER reserves the right to include any other tests which in his opinion is necessary to ensure that the equipment meets the specifications.

21.2 Any components or modules failing during the acceptance tests shall be replaced free of cost by the Contractor. These replacements shall not be made out of spares supplied by the Contractor as part of supplies under this Contract. This shall also not entitle the contractor to any extension of completion time.

21.3 The cost of all test and / or analysis shall be fully borne by the contractor. The contractor shall provide all test instruments/gadgets required for testing.

21.4 Material put up for inspection shall be those to be supplied and in quantities laid down in the Schedule of Quantities. Any variation shall require the prior approval of the EMPLOYER before the material is manufactured/ offered for inspection.

21.5 The EMPLOYER shall inspect and test the work at all stages and shall have full powers to reject all or any work that may be considered defective or inferior in quality or material of poor workmanship or design. The Contractor shall carry out any additional tests at his cost as are necessary in the opinion of the EMPLOYER to ensure that the specifications of the Contract are being complied with.

21.6 All material brought to site shall be permitted to be erected only after inspection and acceptance by the EMPLOYER.

21.7 The completed installation at all stages shall be subjected to checks and tests as decided by EMPLOYER. The contractor shall be liable to remedy all of such defects as discovered during these checks and test and make good all deficiencies brought out. The complete installation shall be taken over finally on successful commissioning in entirety.

21.8 The contractor shall advise the EMPLOYER at least 21 days in advance for inspection when a portion of the work is offered for inspection. The EMPLOYER shall carry out inspection upon receipt of such advice and of in house results/reports for the equipment/material so offered.

21.9 Even after inspection by the EMPLOYER as indicated above, the Contractor shall be liable for rectification of any defects observed during the course of installation or in use during Warranty Maintenance period at his own cost.

22. Tests

22.1 The contractor shall carry out such tests as may be necessary to demonstrate full compliance to the specifications and the Contract clauses to the satisfaction of the EMPLOYER.

23. Review Meetings during Maintenance

23.1 The contractor shall apprise the EMPLOYER about system performance/incident management and the status of routine (daily/weekly/monthly/ etc.) works at least once a fortnight.

24. Spares

24.1 The Contractor shall submit a list of spares which he considers essential to be stocked for proper upkeep of the system along with their costs. He shall also mention the shelf life of these spares.

24.2 These spares shall be in the EMPLOYER's custody, and may be utilized by the contractor during Warranty/ guarantee and Maintenance Contract period (if any). However, the same shall be replenished within 45 days thereafter.

24.3 If the EMPLOYER feels that additional spares are required during the system lifetime, it reserves the right to procure additional quantities from the Contractor during warranty / guarantee period at the same unit cost as accepted.

24.4 Any item not included as spares in the offer and subsequently found to be necessary during warranty/guarantee period OR during Maintenance Contract period (if any) shall be supplied by the contractor FREE OF COST.

25. Long Term Availability of Spares and System Support

25.1 The bidder shall undertake to supply on payment all maintenance spares and tools required for the equipment during lifetime. He shall also undertake to supply additional equipment required for replacement/expansion of the system that may become necessary due to additional traffic requirements. The Bidder shall quote price of such spares for third year, fourth year and fifth year from the date of commissioning of the system. Beyond fifth year the prices of additional supply that may be ordered in future shall be decided by mutual discussion. If the cost of future procurement is not indicated, Contractor shall make available all spares at the price accepted at the time of issuing the Letter of Acceptance for this Bid.

25.2 The contractor shall guarantee that the system shall not become obsolete for a minimum period of 10 years after the acceptance of the system. During this period the contractor shall ensure the availability of all working equipment and parts thereof. The Contractor shall give 12 months' prior notice in writing to the EMPLOYER before discontinuing manufacture of any sub-system/component. This would enable the EMPLOYER to procure life time requirement of spares needed and order in sufficient quantities prior to stoppage of manufacture.

25.3 The Contractor shall depute adequate number of competent engineers/qualified staff to install, test and commission the equipment/systems at the sites.

25.4 The Contractor shall furnish progress report every fortnight to the EMPLOYER. However, depending on the progress, the progress may be discussed at shorter intervals if so desired by the EMPLOYER.

25.5 A coordination meeting shall be held each month in the office of CGM, HGCL at HGCL office at Hyderabad, to assess the progress of work and set out the targets for the next month.

Annex 6 Technical Specifications for the TMS Equipment

A. GENERAL SPECIFICATIONS FOR ETC

1. General

1.1 This Particular Technical Specification covers the design, manufacture and testing, shipping to site, installation, testing, setting to work, commissioning, training, documentation and warranty of the tolling management services (TMS) for the Hyderabad Outer Ring Road.

1.2 This document shall be read in conjunction with the Conditions of Sub-Contract, the General Technical Specification for Electrical and Mechanical Works and all other Tender Documentation and any other document referred to therein.

2. System and Equipment

2.1 The equipment and services to be supplied under the Sub-Contract shall be for close type toll collection systems at the various plazas and shall comprise:-

(i) Manual entry lane equipment
(ii) Manual exit lane equipment
(iii) Cards used with the system
(iv) Information signs and ancillary equipments
(v) Automatic Vehicle Classification equipment
(vi) Automatic and manual lane barriers
(vii) Plaza computer systems and peripherals
(viii) Booth communication systems
(ix) Traffic Control Center System (TCC) & peripherals
(x) Lightning surge suppressor system
(xi) Power distribution, isolation and protection equipment
(xii) Closed Circuit Television System
(xiii) Spare parts, test and maintenance equipment
(xiv) Security Control System
(xv) Training equipment and/or materials
(xvi) Routine inspection and maintenance of equipment

2.2 The associated documentation to be provided includes a Functional Specification, Hardware Specification, a Software System Specification, programmes, drawings, list of spare parts and operating and maintenance manuals and as-built drawings.

2.1 The services to be provided include routine inspection, maintenance and warranty of the equipment during defects liability periods and for training of the Contractor's staff.

3. Sub-Contractor's Responsibility for Design

3.1 The Sub-Contractor shall be entirely responsible for the design of all equipment and systems provided under this Sub-Contract and shall guarantee the correct operation of the same under the environmental conditions specified.

3.2 All the plant provided under the Sub-Contract shall be subject to the approval of the Engineer. The Sub-Contractor shall be responsible for obtaining approval from the Engineer in good time to allow completion of the Works within the Sub-Contract Period. The granting of approval by the Engineer to an item or design submission shall not relieve the Sub-Contractor of any his responsibilities under the Sub-Contract

3.3 The Sub-Contractor shall be responsible for any discrepancies, errors or omissions in the drawings and information supplied by him, whether they have been approved by the Engineer or not, provided that such discrepancies, errors and omissions are not due to defective drawings or information furnished by the Turnkey Contractor or the Engineer.

4. Abbreviations and Definitions

4.1 The following abbreviations have been defined in relation to the Toll Collection Equipment:

AVC	Automatic Vehicle Classification
ALB	Automatic Lane Barrier
CCTV	Closed Circuit Television
ETC	Electronic Toll Collection
FSW	Emergency Footswitch
TCC	Traffic Control Room
ISDN	Integrated Services Digital Network
LCS	Lane Controller System
LSDU	Lane Status Display Unit
LTL	Lane Traffic Light
MLB	Manual Lane Barrier
OTL	Overhead Traffic Light
PCS	Plaza Computer System
PDB	Power Distribution Board
POS	Point Of Sales
TCT	Toll Collector's Terminal
TFI	Toll Fare Indicator
TOD	Tour of Duty

4.2 The Plaza Computer System (PCS) shall be understood to be the computer system installed at each plaza building and shall consist of the following:

a) Plaza Servers
b) Audit Workstations
c) LSDU Terminals
d) Tour of Duty Terminals

e) Snapshot Image Workstation
f) CCTV Monitoring Workstation
g) POS Workstation
h) LAN
i) Printers

The operational and functional requirement of the PCS is described in other sections of the specifications.

4.3 The Traffic Control Center (TCC) shall be understood to be the computer system installed at the main operation centre building on ORR and shall consist the following:

a) TCC Central Server
b) ETC Central Server
c) Snapshot Image Server
d) Financial Management Workstation
e) TCC Monitoring Workstation
f) ETC monitoring Workstation
g) Snapshot Image Workstation
h) LAN
i) Printers

The operational and functional requirement of the TCC is described in other sections of the specifications.

5. Outline Design Parameters

5.1 The work under this Sub-Contract is to install toll equipment at the following Toll Plazas: *(List to be obtained from HGCL)*

5.2 The lane system shall be modular and programmable to allow the operation of close system, manual or electronic toll collection. The system shall work 24 hours a day and 7 days a week.

5.3 Tolls will be collected from, or authorization will be required for, all motorized vehicles using the ORR with the exception of Emergency, Service, High Personages and Military Convoys.

5.4 In a ‘closed’ toll environment, on entry to the Expressway, the driver of each vehicle will be required to collect a transit card. This card will be issued by manually operated entry lane equipment installed in a toll booth and passed to the motorist by an operator. The card will be referred to as a transit card.

5.5 The driver will surrender the transit card on exit from the ORR to a toll collector manning a toll booth containing exit lane equipment. The collector will manually classify the vehicle and insert the card into a reader. The reader shall read the data encoded on the card and associated equipment shall determine the toll due according to the class of the vehicle and the plaza of entry by referring to a “look-up” fare table.

5.6 Payment of tolls under the system described in this Specification will be by cash in Indian Rupees (INR). Vehicles which are not required to pay in cash, may be required to carry a document or card to confirm their right to this privilege. All payments, including document or card will be handed to the collector manning the manual lane equipment for registration.

5.7 Signs, traffic signals, detection equipment and barriers shall be mounted/provided in the lanes for motorist information and traffic control purposes. The operation of all lane equipment shall be monitored continuously by a plaza computer system that shall also compile audit and statistical data for print out, for display in the Supervision Building or onward transmission to TCC.

5.8 The plaza computer system shall also provide management facilities such as attendance recording, reconciliation between declared and expected toll collection and control of cash transferred from the plaza to the bank.

5.9 For identification purposes lanes will be numbered sequentially with lane one being nearest from the Supervision Building. All toll lanes and associated equipment shall be identified by the lane number. This approach shall be adopted for the purposes of identifying all equipment, displays and print outs that are relevant to this Sub-Contract. The general arrangement of the toll plazas is included in the Drawings.

5.10 Each plaza shall operate as an autonomous system with no data communication between plazas being necessary. A data communication network, via fiber optic shall be provided under a separate Sub-Contract and shall not be included as part of the scope of works. However, a complete data communication link from the lane controller to the PCS, workstations to the PCS and all the necessary interfaces to this data communication network shall be provided under this Sub-Contract. All functionalities of the system shall be designed as separate module and the module should not be dedicated to a specific workstation. The access to the system shall be managed by user privilege and not by a dedicated hardware.

5.11 The primary objectives of Contract shall be to ensure, in so far as the various options are exercised, that correct tolls are collected and registered for all vehicles passing through the toll lanes, that all monies collected are correctly brought to account, that all transactions are individually recorded for subsequent billing and analysis via the TCC, that all journeys for which payment are carefully controlled and that all resulting accounts, records, displays and other data are accurate. Performance of the systems and equipment shall not be affected by the rate of traffic flow and all practicable means shall be incorporated to prevent incorrect collection, registration or recording.

5.12 The toll lane equipment shall be capable of processing a minimum numbers of vehicles per hour on a continuous basis as follow:

(A) Manual Entry Lane (Closed System) 400 vehicles

(B) Manual Exit Lane (Closed System) 250 vehicles

(C) ETC Tag Toll Collection System 800 vehicles

5.13 The design of the equipment shall not limit the throughput that can be achieved and it is expected that local throughputs at higher rates for short periods will be experienced, particularly during peak periods.

5.13 Whatever the type and arrangement of the equipment, it is required that failure of a PCS, other than through failure of all maintained supplies to the whole toll collection system, shall not prevent the proper collection and registration of tolls. The systems shall thus make the best practicable use of individual lane control equipment for registering tolls on an 'autonomous lane equipment' concept.

5.14 These are intended to assist in the interpretation of the Specification and it is expected that these procedures will be the subject of a dialogue between the Contractor, the Concessionaire / Turnkey Contractor and the Engineering consultant during the period of approving the Contractor's designs. Requirements for computer system displays, print outs and operating procedures are similarly included and its is expected that these will also be discussed in detail between the Contractor, the Concessionaire / Turnkey Contractor and the Engineering consultant as design work progresses.

6. Entry Lane Equipment

6.1 The indoor lane equipment shall comprise of the following:

a. Lane Controller and Cabinet
b. Toll Collector Terminal (TCT)
c. Contactless Card Dispenser
d. Contactless Identity Card Reader
e. Intercom

6.2 The outdoor lane equipment comprises of the following:

f. Manual Lane Barrier
g. Overhead Traffic Light
h. Lane Traffic Light
i. Automatic Lane Barrier
j. Siren Beacon
k. Incident Capture System Camera
l. Vehicle Detection & Classification Equipment

7. Operational Procedures for Toll Registration

7.1 The operational procedures and the functions of various modules are described below. Basic steps are given first, then the infringements and alternative procedures which can arise. The descriptions assume that all power is correctly available, the exit lane equipment is switched on ready for use, appropriate data has been down-loaded from the PCS, the lane is unidirectional and is initially not in use. Reference is necessarily made to other items of equipment which are described elsewhere in this Specification.

7.2 Under the above conditions, the following situation shall exist:

a) The lane closed aspect of the overhead traffic light (OTL) shall be illuminated.

b) The manual lane barrier will be in the closed (horizontal) position.

c) The traffic signal on the toll fare indicator shall show the red aspect.

d) The toll due and method of payment displays on UFD shall be blank.

e) Vehicle detection, automatic vehicle classification equipment shall be operational and shall detect and record all violations (unauthorized vehicles passing through the lane).

f) Display on the TCT shall show that power is available, the lane is closed and the current date and time assumed by the equipment.

g) All keys on the TCK shall be disabled expect for the toll collector login keys.

8. Log-On and Lane Open Procedure

8.1 To commence his job the collector is expected to perform an attendance log-in at the TOD terminal before proceeding to the booth. The collector will then unlock the booth, arrange his float etc, and then place or insert his identity card into the contactless ICR on the TCT. The collector shall not be allowed to log-in at the lane should the attendance log-in at the TOD have not been performed. An override shall be included where the supervisor assisted log-in is employed should there be a failure in the link between the TOD and lane. Assuming the card is valid and the alphanumeric display is proposed, the collector's identification number shall be shown on the TCT display for a period of five seconds and the keyboard shall be enabled for password input. Should the identity card be invalid or unable to be read then an appropriate message shall be shown on the display and an alarm will be raised in the Control Room of the Supervision Building. Once the identity card has been accepted by the equipment along with the correct password, the collector will be deemed to be 'logged-on' to the manual entry lane equipment. For TCT with VDU displays, all information relating to the toll collector identity, name, lane number, etc shall be included in the display.

8.2 In the event of the identity card being unable to be read by the lane equipment, the operator shall be able to enter manually his identification number and password. The manual entry key and decimal keypad will be used for this purpose. The 'Cancel' key will be used to correct erroneous entries and the 'Enter' key will be used to confirm correct input. Suitable prompts shall be shown on the TCT and confirmation of identification code inputs shall also be displayed. Asterisks (*) shall be displayed as each digit of the password is keyed into the system. Once the operator's identity number and the password have been verified, the operator will be deemed to have 'logged on'.

8.3 The operator will raise the manual lane barrier and then operate the lane open control on the TCT. This action shall cause:

- (i) The lane closed aspect of the OTL to be extinguished.
- (ii) The lane closed indication on the TCT to be canceled.
- (iii) The lane open aspect of the OTL to be illuminated.
- (iv) The lane open indication to be displayed on the TCT.

8.4 The sequence of insertion of identity card, opening of the manual lane barrier and operation of the lane open control may be performed in any order. The lane open condition shall be dependent on all conditions having been met.

9. Card Issuing Process

9.1 A vehicle will arrive in the lane and stop adjacent to the toll booth. The operator will enter the appropriate classification by pressing one of the keys on the keyboard. This action shall cause the selected classification to be shown on the display on the TCT and an encoded card to be issued together with other data relevant to the transaction

9.2 The card issuing process shall involve a card which is been initialized from the IC card reader, the data being encoded on the card which is detailed elsewhere in this Specification, the encoded data being check-read should be handed over to the vehicle driver.

9.3 In the event of the 'read after write' operation indicating that data has not been correctly encoded, up to two further attempts shall be made to encode the data. Should either attempt prove successful as detect by the check read operation the card shall be issued in the normal manner. Should the card could not be encoded it should be noted to the control room through the TCT.

9.4 The operator will take a correctly encoded card from the lane equipment and hand it to the motorist. The act of removing the card from the reader shall cause the red aspect of the traffic light signal to be extinguished and the green aspect to be illuminated.

9.5 The vehicle will move forward and, when it exits the field of detection of the exit vehicle detector, the green aspect of the traffic signal shall be extinguished and the red aspect shall be illuminated.

9.6 As the vehicle leaves the lane, the classification shall be determined by the automatic vehicle classification system and shall be compared with that entered by the collector. In the event of there being a difference, a discrepancy shall be deemed to have occurred. The procedure for giving alarms and recording discrepancies is described elsewhere in this Specification. The automatic lane barrier shall be lowered as the vehicle leaves the field of detection of the vehicle detector.

9.7 The entry lane equipment and the plaza computer system shall record separately the number of card, issued by the equipment, the number of non-verified cards routed to the receptacle and the number of vehicles detected as leaving the entry lane.

10. Violation

10.1 A violation shall be signaled if a vehicle is detected as entering the fields of detection of the exit vehicle detector when the red aspect is displayed in the traffic signal. This shall be independent of an operator being logged on to the equipment.

10.2 On detecting a violation, the entry lane equipment shall raise an alarm in the Control Room of the Supervision Building and shall cause the amber siren for that lane to be energized. The siren alarm shall be canceled either on acknowledgment of the alarm by the supervisor as described elsewhere in this Specification or on expiry of the violation alarm time-out period currently in force.

10.3Incidents shall be recorded by the entry lane equipment and the plaza computer system. In the lane, the lane enforcement camera shall take a picture of the incident. The plaza computer system shall have a system to record and input details of the incident.

11. Lane Close Procedure

11.1 The operator will operate the 'lane closed' control on the TCK which shall cause:

(i) The lane open aspect on the OTL to be extinguished
(ii) The lane closed aspect on the OTL to be illuminated
(iii) The lane open display on the TCT to be extinguished
(iv) The lane closed display in the TCT to be illuminated

11.2 It shall be possible for the operator to process any vehicles still queuing for the lane whilst the OTL is displaying the lane closed aspect providing the operator is still logged on to the TCT. In addition to operating the lane closed control, the operator may also close the manual lane barrier to present a physical obstruction to vehicles trying to enter the lane.

12. Log Out Procedure

12.1 At the end of a job, the collector will press the `log out' key followed by the `enter' key as confirmation. The manual lane equipment shall close the current job for that collector and the lane equipment and PCS shall produce and store end of job statistics.

12.2 After pressing the `log out' key but before pressing the `enter' key, the collector may press the `cancel' key. In this case, the current job shall not be terminated and the collector may continue to operate the lane.

12.3 It shall be possible for the manual lane equipment to be left in the lane closed condition as above without the collector logging out. Subsequent operation of the lane open control, and manual lane barrier if appropriate, shall restore the lane open condition and allow continuation of the collector job.

13. Data Communication with Plaza Computer System

13.1 All data lane equipment shall be interfaced to the plaza computer system (PCS) installed in the Supervision Building at each plaza via a Local Area Network (LAN). Data shall be transmitted from and stored by the entry lane equipments at various times during card issuing operations so as to allow compilation of statistical data and monitoring of lane operation and equipment status. The following information shall be both stored by the lane equipment on an individual event basis and transferred to the PCS in real time under normal operating conditions :-

- System status and operational status including alarms.
- Lane opening and closing events
- Operating shift statistics.

13.2 The following data shall be transferred to the PCS in real time but need not be stored on an individual event basis by the lane equipment:

- Individual transaction details
- On demand messages
- Images of incidents

13.3 The lane equipment shall include comprehensive automatic self-testing routines which shall be implemented on a frequent basis during all periods when power is available to the equipment. Any detected fault condition shall be reported via the peripherals of the PCS system within one second of being detected and subsequently via the transmission link to the TCC.

13.4 It is recognized that there will be occasions when either the PCS system off-line or data communication between one or more entry lane equipments and the PCS is not possible. Under these conditions the lane equipment shall continue to store data for a minimum of ninety (90) days operation for later transmission to the PCS. Facilities for data transfer to PCS by way of floppy disks and USB ports shall be provided to allow upload of all lane data. Under such circumstances, uploaded data to PCS shall not be duplicated at the lane or PCS when communication with the PCS system recovers.

13.5 The entry lane equipment shall include an internal real time clock which shall receive data and time synchronization form the PCS on a regular basis and on any event no less than once every hour. The equipment shall use data from its real time clock to drive the clock display on the TCT and for time flagging of events and data. In the event of PCS failure, the entry lane equipment shall continue to update its own internal clock from the last synchronization data received. The accuracy of the lane equipment clock under such conditions shall be to within + 1 minute per month. When data communication with the PCS is restored, the entry lane equipment shall assume the date and time next advised by the PCS. Means shall be provided to allow authorized personnel to set up and adjust the time assumed by the lane entry equipment in the event of data communication with the PCS not being possible.

13.6 All collector jobs shall be allocated a `job number', which, together with the date of the operational day shall uniquely identify that job at that plaza. The first job which commences after the start of an operational day shall be allocated number 01 and this shall be incremented for each successive job started before the start of the next operational day. The job number shall be used as the prime means of identifying collector actions and for generation of data. It is acknowledged that the number of jobs per lane per day may not be greater than 99.

13.7 Transactions within a job shall be allocated a four digit serial number starting at 0001 for each job and being incremented for each transaction during that job. The Sub-Contractor's attention is drawn to the need for various data to be identified by job number and serial number for monitoring and recording purposes.

13.8 The entry lane equipment shall also receive data relating to operational parameters from the PCS. This shall comprise:

(i) list of authorized operator, supervisor, inspector and maintenance personnel identification numbers
(ii) number of vehicle classifications currently in use
(iii) security key to be encoded on all cards issued
(iv) violation alarm 'time out' period
(v) parameter values for equipment alarms
(vi) the three digit code and three character code for the plaza
(vii) identification number to be used when 'manual' log-on of operator is necessary

Downloading of all operational parameters shall be completed within 30 seconds under all circumstances.

13.9 Operating parameters received from the PCS shall be stored in secure read write memory modules which allow the integrity of stored data to be maintained for a minimum of ninety (90) days under power fail conditions. Checks shall be performed in the integrity of the memory at regular intervals and, if necessary, the lane equipment shall request the PCS to retransmit these data to ensure their validity. The contents of this read-write memory shall be refreshed at least once every 24 hours. The proposed method of providing this storage of operating parameters shall be stated by the Sub-Contractor at time of submitting his Tender.

13.10 The security key will be used as a security check on cards being used by motorists. This key as set by input to the HQCS computer will be downloaded to the PCS and from there to entry and exit lane equipments. The entry lane shall encode this key in the assigned location on the transit card. The key shall be checked against that currently in force when the card is processed by the exit lane equipment. The exit lane equipment shall record as a total the number of cards for which the key is different from that currently in force and shall include this in the end of shift file.

14. Maintenance Facilities

14.1 Maintenance mode shall exist for the entry lane equipment which will allow full operation of the equipment with the lane control signal showing closed, irrespective of the status of the various controls and interlocks. The maintenance mode shall be entered when authorized identity cards, similar to those used by operators but having a unique range of numbers, are used to enable the equipment.

14.2 Details of all 'transactions' performed in maintenance mode shall not be included in summary data files produced by the PCS but ‘end of shift' files, clearly identified as relating to maintenance mode, shall be available in respects of each period of operation. All monitoring and alarm facilities shall be available in maintenance mode.

14.3 All cards in maintenance mode shall be encoded as detailed elsewhere in this Specification but shall not be valid for journeys made on the Expressway.

14.4 Once maintenance mode has been entered, special test facilities shall be available which shall assist in routine testing or fault diagnosis. These facilities shall allow verification of correct operation of the following as a minimum:-

- full functioning of the entry lane as a whole
- operation of the TCT and its various sub-assemblies
- vehicle detectors,
- output interfaces for all equipments,
- card issuing cycle,
- data communication with PCS,
- internal memory
- inputs from sensors and equipments

14.5 These tests shall be initiated using the keyboard (TCK) and display (TCD) forming part of the TCT. It shall be possible for each of the functions to be checked separately and independently. All software necessary for the implementation of this facility shall be included in the Tender Sum regardless of the approach adopted.

14.6 The Sub-Contractor shall submit details of the proposed method of meeting the above requirements at time of submitting his Tender and shall include details of any additional facilities which are available from the equipment proposed.

15. Operation by Supervisor and Inspectors

15.1 Supervisors and inspectors will be issued with the cards similar to those issued to operators but having unique ranges of numbers which will serve as an automatic means of identification to the entry lane equipment. All toll personnel shall use a contactless identity card for identification.

15.2 A list of authorized supervisor and inspector number shall be downloaded from the PCS to the entry lane equipment as part of the Operating parameters. Authorized supervisors and inspectors shall be allowed to operate the entry lane equipment in an identical manner to the operators and shall not have access to any other facilities.

16. Electrical Connections and Installation

16.1 All electrical connections to and from the entry lane equipment shall include for 1.5 meters of slack cable to be arranged beneath the floor of the booth such that if the booth is carried away as a result of vehicle impact, damage does not result to the equipment or cables.

16.2 The installation of all equipment and wiring within the booths under this Sub-Contract shall be carried out in such a way that all wiring is concealed and all wiring and equipment is readily accessible.

16.3 Cabling shall be brought to the equipment cabinet from the ducts formed under the booth via suitable glands and cable supports through the culvert box.

17. Exit Lane Equipment

17.1 The indoor lane equipment shall comprise of the following:

- Lane Controller and Cabinet
- Toll Collector Terminal (TCT)
- Contactless Card stacker
- Contactless Card Reader
- Intercom

17.2 The outdoor lane equipment comprises of the following:

- Manual Lane Barrier
- Overhead Traffic Light
- Lane Traffic Light
- Automatic Lane Barrier
- Siren Beacon
- Incident Capture System Camera
- Vehicle Detection & Classification Equipment

18. Operational Procedures for Toll Registration

18.1 The operational procedures and the functions of various modules are described below. Basic steps are given first, then the infringements and alternative procedures which can arise. The descriptions assume that all power is correctly available, the exit lane equipment is switched on ready for use, appropriate data has been down-loaded from the PCS, the lane is unidirectional and is initially not in use.

18.2 Under the above conditions, the following situation shall exist:

a) The lane closed aspect of the overhead traffic light (OTL) shall be illuminated.

b) The manually lane barrier will be in the closed (horizontal) position.

a) The traffic signal on the toll fare indicator shall show the red aspect.

b) The toll due and method of payment displays shall be blank.

c) Vehicle detection, automatic vehicle classification equipment shall be operational and shall detect and record all violations (unauthorized vehicles passing through the lane).

d) Display on the TCT shall show that power is available, the lane is closed and the current date and time assumed by the equipment.

e) All keys on the TCK shall be disabled expect for the toll collector login keys

19. Log-On and Lane Open Procedure

19.1 To commence his job the collector is expected to perform an attendance log-in at the TOD terminal before proceeding to the booth. The collector will then unlock the booth, arrange his float etc, and then placed or insert his identity card into the contactless ICR on the TCT. The collector shall not be allowed to log-in at the lane should the attendance log-in at the TOD have not been performed. An override shall be included where the supervisor assisted log-in is employed should there be a failure in the link between the TOD and lane. Assuming the card is valid and the alphanumeric display is proposed, the collector's identification number shall be shown on the TCT display for a period of five seconds and the keyboard shall be enabled for password input. Should the identity card be invalid or unable to be read then an appropriate message shall be shown on the display and an alarm will be raised in the Control Room of the Supervision Building. Once the identity card has been accepted by the equipment along with the correct password, the collector will be deemed to be 'logged-on' to the manual exit lane equipment. For TCT with VDU displays, all information relating to the toll collector identity, name, lane number, etc shall be included in the display.

19.2 In the event of the identity card being unable to be read by the lane equipment, the operator shall be able to enter manually his identification number and password. The manual entry key and decimal keypad will be used for this purpose. The 'Cancel' key will be used to correct erroneous entries and the 'Enter' key will be used to confirm correct input. Suitable prompts shall be shown on the TCT and confirmation of identification code inputs shall also be displayed. Asterisks (*) shall be displayed as each digit of the password is keyed into the system. Once the operator's identity number and the password have been verified, the operator will be deemed to have 'logged on'.

19.3 The collector will operate the lane open control on the TCT and raise the manual lane barrier. This action shall cause:

- The lane closed aspect of the OTL to be extinguished.
- The lane closed indication on the TCT to be canceled.
- The lane open aspect of the OTL to be illuminated.
- The lane open indication to be displayed on the TCT.

The sequence of insertion of identity card, opening of the lane barrier and operation of the lane open control may be performed in any order. The lane open condition shall be dependent on all conditions having been met.

20. Classification and Card Processing

20.1 A vehicle will arrive in the lane and stop adjacent to the toll booth. The collector will enter the appropriate classification by pressing one of the keys on the keyboard. This action shall cause the selected classification to be shown on the display on the TCT and the TFI. It should be noted that the collector may enter the classification prior to the vehicle arriving at the toll booth.

20.2 The motorist will pass the transit card collected on entry to the collector who will put it on the transit card terminal in the correct orientation. The reader will 'accept' the card from the collector, read the encoded data and cause the following to be displayed.

a) The description for the entry lane and plaza on the TCT display.

b) The date and time of issue of the transit card as encoded on the card on the TCT display.

c) The toll amount for the selected classification from the entry plaza on the TCT display.

d) The toll amount for the selected classification from that plaza on the UFD

21. Payment by Cash and Vehicle Exit

21.1 The motorist will offer the collector coins and/or notes as payment for the toll. The collector will take the amount tendered and provide change as necessary. Having received full payment the collector will press the 'cash' key whereupon:

- The red traffic signal in the TFI shall be extinguished.
- The green traffic signal in the TFI shall be illuminated.
- A receipt shall be produced automatically upon keying of the 'Receipt Request' key.
- The method of payment shall be shown on the TCT display and on the TFI.

21.2 Data relevant to the transaction as described elsewhere in this Specification shall be encoded onto the transit card. The encoded data shall be checked by a 'read after write' process and the ticket shall be deposited in the secure place within the booth.

21.3 The vehicle will move forward, enters and exits the field of detection of the automatic vehicle classification equipment. Upon such operation, the following shall occur:

a) The green traffic signal in the TFI shall be extinguished.

b) The red traffic signal in the TFI shall be illuminated.

c) The classification, entry plaza, toll due and method of payment displays on the TCT shall be canceled.

d) The equipment shall be ready to receive a further classification input.

e) The toll due, method of payment, and classification displays on the TFI shall be canceled.

21.4 As the vehicle leaves the lane, the classification shall be determined by the automatic vehicle classification system and shall be compared with that entered by the collector. In the event of there being a difference, a discrepancy shall be deemed to have occurred. The procedure for giving alarms and recording discrepancies is described elsewhere in this Specification. The automatic lane barrier shall be lowered as the vehicle leaves the field of detection of the vehicle detector.

22. Correction

22.1 At any time during the transaction up to the selection of the cash method of payment, the collector may use the 'correction' key to abort the current transaction. On pressing this key:

a) The information on the TCT display and TFI relating to the previous classification shall be canceled.

b) The transit cards, if already entered, shall be returned to the collector with the encoded data unaltered.

c) The keyboard shall be ready to accept a further classification input.

23. Cards Not Read Correctly

23.1 In the event of the exit lane equipment being unable to read the data encoded on a card or detecting an error in the 'read' process by way of the cyclic redundancy check character. The following shall occur:

a) The card shall be returned to the collector.

b) An appropriate error message shall be shown on the TCT display.

c) The toll collector will enquire from the expressway user the entry point of the user’s journey. This operation is only applicable if the condition of the transit card is found to be in good condition without any signs of purposeful damage

23.2 It shall be possible to simulate a 'non-readable card' by using the Toll Monitoring byte encoded in entry on the card, in order to allow and recorded in the control room. It may be possible to interrogate the PCS or HQCS by input of the number of the contactless transit card. If the central system does not answer within 30 seconds the user shall be orientated to the plaza by the lane attendant for more investigation. IOU procedures shall be applied to the specific transaction.

23.3 The collector will press the 'manual input' key on the TCT and will use the decimal keypad to enter the three digit code applicable to the entry plaza. Should the collector make an error in entering the plaza code, used of the 'cancel' key associated with the decimal keypad shall clear the erroneously entered code and allow the collector to enter a new code. Once the collector has entered three digits the TCT display shall show the appropriate three character plaza abbreviation corresponding to that particular code. The collector will verify a correctly entered plaza code by using the 'enter' key associated with decimal keypad.

23.4 When the collector has verified a correctly entered plaza code, the TCT display shall prompt the collector to re-enter the card. Thereafter the transaction shall proceed as described above. The correction facility shall be available in the same manner as for transactions where the card is read automatically.

24. Service Transaction

24.1 Drivers of all authorized vehicles will be required to collect a transit card on entry to the Expressway. Should a driver of an authorized vehicle arrive at the exit lane toll booth and

a) present some form of documentation in lieu of payment, the collector will classify the vehicle in the same manner as all other vehicles and `payment' will be registered by the collector pressing the `service' key followed by the `accept' key. This document will not be magnetically encoded and its receipt will be acknowledged by the collector pressing the `service' key followed by the `accept' key.

b) present service transaction card in lieu of payment, the `payment' will be registered by the collector by inserting the card to the card reader and followed by the `accept' key. The vehicle class shall be obtained from the card and shall be used as the registered class. The fare shall be as per the vehicle class encoded in the card. A discrepancy shall be recorded in the system should the registered class does not match the detected class.

25. Exempt Transactions

25.1 Certain vehicles, such as police patrol vehicles, ambulance, fire trucks, etc as per the Govt. notification are exempted from paying toll. These vehicles shall be classified by the collector in the same manner as all other vehicles and `payment' will be registered by the collector pressing the `Exempt' key. The exempt transactions should be authorized by the supervisor placing his card on the card reader. No receipt shall be issued. The ALB would not open if the supervisor does not authorize the exempted passage of the vehicle. The transaction shall proceed in a similar manner to that outlined above for cash payments.

26. Hp & Mc Convoy Sequence

26.1 High personages convoys and military convoys are exempted from paying toll by Government legislation. These vehicles shall registered by the collector by pressing the `HPMC' key followed by the `accept' key. When the `accept' key is pressed the following shall occur:

a) the toll due for the selected classification displayed on the TFI and TCT shall be blanked.

b) the red traffic signal shall be extinguished and the green traffic signal shall be illuminated.

c) no receipt shall be issued.

d) each vehicle that passes through the lane during a HPMC activation shall be registered as a HPMC transaction.

e) the class registered shall be recorded as 0 while the class detected by the AVC for each vehicle shall be considered as the detected class.

f) the automatic lane barrier shall be maintained in open position until the end of convoy process

26.2 The HP & MC sequence shall be terminated by pressing the HPMC key followed by the `accept' key when the last vehicle arrives at the level of the toll collector. The system shall close the rising barrier after the passage of the last vehicle. Upon termination of the HP & MC sequence the green traffic signal shall be extinguished and the red traffic signal shall be illuminated.

27. Lost Card

27.1 Should a motorist arrive at the plaza without a transit card, the collector will press the appropriate 'unusual occurrence' key on the TCT keyboard after having classified the vehicle. The equipment shall indicate that the journey made was the maximum distance possible to the plaza and the toll due shall be as defined elsewhere in the Specification. In all other respects, the transaction shall proceed as any other with all methods of payment being available to pay the toll due.

28. U-TURN

28.1 In the event that a motorist presents a transit card where the exit plaza is the same as the entry plaza, an alarm shall be given to the collector when the transit card is processed or the entry plaza code is manually entered. The collector will then press the appropriated 'unusual occurrence' key on the TCT keyboard. The same toll amount will be charged to the user as is currently in force for 'lost ticket' transaction being imposed. An option for additional fine could be added to the fare on top of the maximum fare for an attempt of fraud.

28.2 The system shall also include an ‘Authorized U-Turn’ and ‘Non-Authorized U-Turn’ Functions. If required, an option which the collector will ascertain the reasons for the motorist entering and leaving at the same plaza and select the appropriate option using the digital keypad and 'enter' and 'cancel' keys. The transaction shall then proceed as any other with all methods of payment being available to pay the toll due for the selected option.

29. Excessive Journey Time

29.1 In processing the transit card, the equipment shall calculate the time taken for the journey and shall check it against that allowed by the system for any journey. There is an authorized over-time journey when the driver may give evidence that the car was retained in the expressway for maintenance reason. The authorized over-time journey could be authorized by the supervisor only.

29.2 In the event of the actual journey time being greater than the allowed, an alarm shall be given to the collector and two options shall be shown on the TCT display. One option shall impose the appropriate toll for the journey and the other shall impose that currently in force for 'lost card' transactions. The two options shall be identified by a single digit code and the collector will use the digital keypad to select the appropriate option after satisfying himself of the circumstances. Once the selection has been made the transaction shall proceed as any other with all methods of payment being available to pay the appropriate toll.

30. Violation

30.1 A violation will be deemed to have occurred if a vehicle enters the field of detection of the automatic vehicle classification equipment before the collector or the equipment has registered a valid payment as having been made. This shall apply in cases where the vehicle passes through the lane without a transit ticket being handed in and processed or for 'unpaid toll' transactions or when no collector is 'logged-on' to the exit lane equipment. Details of all such 'transactions' shall be recorded by the lane equipment, the PCS and alarms shall be raised as described elsewhere in the Specification.

31. Use of ‘Forget’ or ‘Late Transaction’ Key

31.1 There may be occasions where a violation is signaled as a result of the collector not having pressed the `accept' key but where he has actually collected the toll from the motorist. In such case the collector will press the `late transaction’ key to confirm this situation. Use of the `late transaction’ key shall only be possible when a violation has been signaled but before the next classification input is made. When this facility is used, the transaction shall not be recorded as a violation but shall be included as a normal transaction with the partially recorded method of payment or, in the event of no input having been made after the classification, as a cash transaction. The number of times the 'late transaction' facility is used shall be recorded as part of the end of shift statistics. It shall only be possible to use the `late transaction' key once for any transaction.

32. Lane Close Procedure

32.1 The collector will operate the 'lane closed' control on the TCT keyboard which shall cause:

- The lane open aspect on the OTL to be extinguished.
- The lane closed aspect on the OTL to be illuminated.
- The lane open display on the TCT to be extinguished.
- The lane closed display on the TCT to be illuminated.
- The automatic lane barrier to be lowered.

32.2 It shall be possible for the operator to process any vehicles still queuing for the lane whilst the OTL is displaying the lane closed aspect providing the operator is still logged on to the TCT. In addition to operating the lane closed control, the operator may also close the manual lane barrier to present a physical obstruction to vehicles trying to enter the lane.

33. Log Out Procedure

33.1 At the end of a job, the collector will press the `log out' key followed by the `enter' key as confirmation. The manual lane equipment shall close the current job for that collector and the lane equipment and PCS shall produce and store end of job statistics.

33.2 After pressing the `log out' key but before pressing the `enter' key, the collector may press the `cancel' key. In this case, the current job shall not be terminated and the collector may continue to operate the lane.

33.3 It shall be possible for the manual lane equipment to be left in the lane closed condition as above without the collector logging out. Subsequent operation of the lane open control, and manual lane barrier if appropriate, shall restore the lane open condition and allow continuation of the collector job.

34. Receipt Printing

34.1 Receipts shall be issued automatically for each transaction, except those 'EXEMPT', 'HPMC', 'EMERGENCY', 'T&G' OR 'ETC' is used in lieu of payment on the registration of completed payment. It is possible that at some future date the Employer will only issue receipts on demand. It shall be possible to change the operation of the exit lane equipment so that receipts are only issued in response to a request by the collector using the appropriate push-button on the keyboard. This change shall require only a single parameter in the software to be altered. Receipts shall be produced automatically in respect of all transactions for which a penalty charge is invoked.

34.2 Spaces shall be incorporated into the printing to assist in easy interpretation of the receipt. It is expected that a printed line shall have up to 40 characters including spaces and that this will result in receipt of approximately 80mm in width being necessary. The receipt shall be printed by the equipment and presented to the collector for tearing off from the printer cutter.

34.3 The receipt shall be printed on a thermal paper roll. Once a receipt has been issued, the equipment shall automatically advance the paper so that the space for the first line of printing is aligned under the print head thus reducing the time taken to produce a receipt.

34.4 For design purposes it should be assumed that receipts will be approximately 70mm in length with two printed columns. The Concessionaire's information will occupy approximately 30mm on the top, the area under this shall be used for particular printed data and the remaining paper shall form a lower border. The time taken to produce such a receipt and present it for tearing off by the collector shall be not more than 2 seconds for a cash transaction.

35. Data Communication with Plaza Computer System

35.1 All exit lane equipment shall be interfaced to the plaza computer system (PCS) installed in the Supervision Building at each plaza via a Local Area Network (LAN). Data shall be transmitted from and stored by the exit lane equipments at various times during collection activities so as to allow compilation of audit and statistical data and monitoring of lane operations and equipment status. The following information shall be both stored by the lane equipment on an individual event basis and transferred to the PCS in real time under normal operating conditions:

- (i) System status and operational statues including alarms.
- (ii) Start of collector shift.
- (iii) End of collector shift data including the origin / destination vector per class of vehicles.
- (iv) Hourly traffic statistics.
- (v) Individual transit ticket transactions.
- (vi) Individual payment transactions.
- (vii) Exceptional transactions (Violations, U-turns, Lost Ticket and etc).
- (viii) Summarized daily traffic and revenue reports.
- (ix) Images of incidents.

35.2 The data storage available within the lane equipment shall be sufficient to store the above data for a minimum period of ninety (90) days operation. The data shall be sufficient to allow all requirements of the Specification to be met with respect to monitoring, report generation, data transfer to the TCC computer, retransmission of selected messages 'on demand' and the like.

35.3 The lane equipment shall include comprehensive automatic testing routines which shall be implemented on a frequent basis during all periods when power is available to the equipment. Any detected fault condition shall be reported via the peripherals of the PCS system within one second of it being detected and subsequently via the transmission link to the TCC.

35.4 It is recognized that there will be occasions when either the PCS system off-line or data communication between one or more exit lane equipments and the PCS is not possible. Under these conditions the lane equipment shall continue to store data for a minimum of ninety (90) days operation for later transmission to the PCS. Facilities for data transfer to PCS by way of floppy disks and USB ports shall be provided to allow upload of all lane data. Under such circumstances, uploaded data to PCS shall not be duplicated at the lane or PCS when communication with the PCS system recovers.

35.5 The exit lane equipment shall include an internal real time clock which shall receive data and time synchronization form the PCS on a regular basis and on any event no less than once every hour. The equipment shall use data from its real time clock to drive the clock display on the TCT and for time flagging of events and data. In the event of PCS failure, the exit lane equipment shall continue to update its own internal clock from the last synchronization data received. The accuracy of the lane equipment clock under such conditions shall be to within + 1 minute per month. When data communication with the PCS is restored, the exit lane equipment shall assume the date and time next advised by the PCS. Means shall be provided to allow authorized personnel to set up and adjust the time assumed by the lane exit equipment in the event of data communication with the PCS not being possible.

35.6 All collector jobs shall be allocated a `job number’, which, together with the date of the operational day shall uniquely identify that job at that plaza. The first job which commences after the start of an operational day shall be allocated number 01 and this shall be incremented for each successive job started before the start of the next operational day. The job number shall be used as the prime means of identifying collector actions and for generation of data. It is acknowledged that the number of jobs per lane per day may not be greater than 99.

35.7 Transactions within a job shall be allocated a four digit serial number starting at 0001 for each job and being incremented for each transaction during that job. The Sub-Contractor's attention is drawn to the need for various data to be identified by job number and serial number for monitoring and recording purposes.

35.8 The exit lane equipment shall also receive data relating to operational parameters from the PCS. This shall comprise:

(i) 'current' and 'future' fare tables for each classification with date and time of implementation for 'future' tables.

(ii) List of authorized collector, supervisor, inspector and maintenance personnel identity and numbers.

(iii) Number of classification currently in use and their definition in terms of number of axles and wheels.

(iv) Violation alarm time out period.

(v) Penalty charge for 'lost tickets' including method of application.

(vi) Maximum time allowed for any journey.

(vii) Maximum and minimum time allowed for each particular journey.

(viii) Transit cards to be accepted by the equipment in the form of six digit codes (maximum of 25 codes).

(ix) Blacklist for specific transit or e-purse cards.

(x) Toll monitoring control character.

(xi) Parameter values for equipment alarms.

(xii) Definition of journey restriction codes as may be included on transit cards.

(xiii) Three digit codes and three character codes for all plaza included in the network.

(xiv) Four digit codes to be used when 'manual' log-on of collector is necessary.

Downloading of operating parameters shall be completed within 30 seconds under all circumstances.

35.9 Operating parameters received from the PCS shall be stored in secure read write memory modules which allow the integrity of stored data to be maintained for a minimum of ninety (90) days under power fail conditions. Checks shall be performed in the integrity of the memory at regular intervals and, if necessary, the lane equipment shall request the PCS to retransmit these data to ensure their validity. The contents of this read-write memory shall be refreshed at least once every 24 hours. The proposed method of providing this storage of operating parameters shall be stated by the Sub-Contractor at time of submitting his Tender.

35.10 Fare tables giving toll rates for each possible journey for each classification shall be held in the form of two tables, one current and one future, together with a date and time for implementation of the future table. In the event of no future rates being defined both tables shall contain the same data for security. Routines in the lane equipment shall ensure that once a change in toll rates has been implemented, data relating to previous rates is deleted from memory.

35.11 The violation alarm time out period shall be started at the determination of a violation by the exit lane equipment and shall be the period for which the alarm signal is given before being automatically reset. In the event of the alarm being acknowledged by input to the monitoring console of the PCS within this period, the alarm shall be canceled immediately. All alarms whether terminated by acknowledgment or time out shall be recorded by the PCS.

35.12 The security key will be used as a security check on cards being used by motorists. This key as set by input to the TCC computer will be downloaded to the PCS and from there to entry and exit lane equipments. The entry lane shall encode this key in the assigned location on the transit card. The key shall be checked against that currently in force when the card is processed by the exit lane equipment. The exit lane equipment shall record as a total the number of cards for which the key is different from that currently in force and shall include this in the end of shift file.

35.13 The maximum and minimum time allowed for each particular journey shall be used to detect possible irregularities in card processing. For each transit card processed by the exit lane equipment, the actual journey time, determined from the date and time encoded at entry and exit, shall be calculated and compared with the upper and lower limits for that journey. The exit lane shall record as a total the number of card for which the journey time does not fall within these limits and shall include this in each end of shift file. No alarms shall be given at the toll plaza if an inconsistent journey time is detected. This facility shall be in addition to that for excessive journey time described elsewhere which uses a common upper time limit for all journeys. The checking of journey times against the maximum and minimum allowable times shall not be implemented where transit cards have been issued in the pre-coded mode of operation at the entry lane.

35.14 The penalty charge data for 'lost card' transactions will be considered in a similar manner to toll fares with both current and future charges being given. It shall be possible for the fare for 'lost card', 'excessive journey time', 'U-turn' transactions to be either the toll for the longest journey or a penalty charge or the summation of both. The value to be adopted shall form part of the parameter. Separate penalty charges may be levied in respect of each vehicle class.

35.15 The three digit and three plaza character codes shall be used to indicate those plaza from which valid journeys may be made. The codes may also be used to determine the journey restrictions for the various transit smartcards issued by the Concessionaire.

35.16 The proposed method of providing the storage of operating parameters shall be stated by the Sub-Contractor at times of submitting his Tender.

36. Maintenance Facilities

36.1 A maintenance mode shall exist for the exit lane equipment which will allow full operation of the equipment with the lane control signal showing closed, irrespective of the status of the various controls and interlocks. The maintenance mode shall be entered when authorized identity cards, similar to those used by collectors but having a unique range of numbers, are used to enable the equipment.

36.2 Details of all 'transaction' performed in maintenance mode shall not be included in summary data files produced by the PCS but 'end of shift' files, clearly identified as relating to maintenance mode, shall be produce in respect of each period of operation. All monitoring facilities shall be available in maintenance mode.

36.3 Once maintenance mode has been entered, special test facilities shall be available which shall assist in routine testing or fault diagnosis. These facilities shall allow verification of correct operation of the following as a minimum:-

- full functioning of the exit lane as a whole
- operation of the TCT and its various sub-assemblies
- vehicle detectors,
- automatic vehicle classifier system
- output interfaces for all equipments,
- card issuing cycle,
- data communication with PCS,
- internal memory
- inputs from sensors and equipments

36.4 These tests shall be initiated using either the portable computer terminal described or using the keyboard (TCK) and display (TCD) forming part of the TCT. It shall be possible for each of the functions to be checked separately and independently. All software necessary for the implementation of this facility shall be included in the Tender Sum regardless of the approach adopted.

36.5 The Sub-Contractor shall submit details of the proposed method of meeting the above requirements at time of submitting his Tender and shall include details of any additional facilities which are available from the equipment proposed.

37. Operation by Supervisors and Inspectors

37.1 Supervisors and inspectors will be issued with the cards similar to those issued to operators but having unique ranges of numbers which will serve as an automatic means of identification to the exit lane equipment. All toll personnel shall use a contactless identity card for identification.

37.2 A list of authorized supervisor and inspector numbers shall be down-loaded from the PCS to the exit lane equipment as part of the operating parameters. Authorized supervisors and inspectors shall be allowed to operate the exit lane equipment in an identical manner to the collectors and shall not have access to any other facilities.

38. Vehicle Classification and Toll Rates

38.1 The TCS system to be provided under this Contract shall accommodate nine vehicle classifications. All software, display formats and print-outs shall be designed to cater for these nine classifications although it will be preferred if any reports or displays relating to classifications included automatic suppression of those parts which relate to currently unused classifications. The number of classification to be implemented at any time will be downloaded from the TCC computer as part of the operating parameters.

38.2 The Sub-Contractor's attention is drawn to the requirement for the definition of classes to form part of the operating parameters for the toll equipment. It may be assumed that discrimination between vehicle classifications by the AVC equipment will be based solely on the number of axles and the height.

38.3 Toll rates applicable to each journey for each classification will be confirmed by the Concessionaire within thirty (30) days of opening of each section of the Works. For testing purposes, toll rates shall be used which allow full exercising of the toll fare indicator.

39. Electrical Connections and Installation

39.1 All electrical connections to and from the exit lane equipment shall include for 1.5 meters of slack cable to be arranged beneath the floor of the booth such that if the booth is carried away as a result of vehicle impact, damage does not result to the equipment or cables.

39.2 The installation of all equipment and wiring within the booths under this Sub-Contract shall be carried out in such a way that all wiring is concealed and all wiring and equipment is readily accessible.

39.3 Cabling shall be brought to the equipment cabinet from the ducts formed under the booth via culvert boxes via suitable glands and cable supports.

B. ELECTRONIC TOLL COLLECTION EQUIPMENTS

1. General

1.1 The ETC lanes shall provide for regular users a facility whereby tolls may be collected via deduction of Smart Card purse accurately and reliably while reducing dramatically the time taken for each transaction. This objective shall be achieved by way of the toll registration process being totally automatic and not requiring the vehicle to stop to make payment.

1.2 The Sub-Contractor shall provide robust and durable ETC lane equipment with minimal maintenance to the requirements of the Specifications. The ETC system shall be based on the principles of read / write technology.

1.3 The ETC equipment operation shall include two (2) component parts for their namely ground equipment or the antenna, installed in each lane, and the on board unit, which is a 'tag' or transponder with smart card insertion installed within vehicles which are entitled to use the lane. The communication between the ground equipment and the tag shall employ 5.8GHz microwave dedicated short-range communication link (DSRC) as per ITU-R M.1453, ISO/IEC 8802-2, ISO 15628 and ISO 14906.

1.4 The ETC system shall be able to manage a complete sequence of read/write transaction with minimum of 1000 vehicle per hour. The Sub-Contractor shall, in the presence of the Turnkey Contractor or Supervising Consultant, demonstrate and provide the necessary evidence relating to the operation and completeness of the transaction performed by the ETC lane equipment under the specified requirements.

1.5 The accuracy of the system shall exceed 99.99% (9999 out of 10000 transactions) of the transactions between the OBU and the ETC lane equipment. The ETC lane equipment shall include adequate protection against cross lane transactions.

1.6 Comprehensive measure shall be taken to prevent occurrence of double deduction in all circumstance or exceptional events. It is expected that the ETC lane system shall be capable to prevent double deduction and operate continuously as normal in the following events in the lane at the minimum:-

- Violation
- Force Reset
- Two or more badge / tags in the detection lobe at the same time

1.7 The Sub-Contractor shall provide all mounting brackets, fixing and accessories necessary to complete the installation of all lane equipment.

2. Equipment Architecture and Reliability

2.1 The ETC lane equipment shall be based on multi-processor system architecture with separate processors being used to control well-defined modules. These processor controlled modules shall be connected to an executive control module which shall coordinate and schedule the activities of the individual module processors and handle all data communication with the PCS.

2.2 Each individual control shall be connected to the executive control module either by a recognized serial communication channel or by a standard network communication.

2.3 Sufficient spare capacity shall be provided in the executive control processor in terms of physical circuitry, connection points, software construction and processing power to allow the subsequent connection of at least three further modules, including implementation of the future optional facilities which may be required by the Turnkey Contractor during the life of the equipment. The Sub-Contractor shall describe, at time submitting his Tender, the architecture of the proposed ETC lane equipment and the means by which additional modules may be interfaced to the executive control processor.

2.4 The documentation provided under the Sub-Contract shall be sufficient in every respect to allow the Turnkey Contractor to implement such future expansion of the

ETC lane equipment without resource to the Sub-Contractor, his Sub Sub-Contractors or agents should be so wish.

2.5 Each processor shall monitor the operation and availability of items under its direct control. Detected errors or failures shall be relayed to the executive control processor and from there to the plaza computer system. Failure of any one module shall not affect the operation of any other modules as far as is practicable, and shall not prevent the processing of transactions and recording of data in as far as they are not dependent on that module.

2.6 The equipment and its software shall be designed so that there is no noticeable delay between a transaction sequence of the antenna with the OBU or event which relates to the equipment and its confirmation being either on the TCT display and/or on signs and ancillary equipment connected to the executive control module. The equipment shall be designed to allow the continuous recording and processing of transactions as described in this Specification.

2.7 Notwithstanding the above, the following parameters shall relate to the ETC lane equipment including those options which are taken up by the Turnkey Contractor:

2.8 The various processors shall perform checks on the integrity of their associated memory on power-up, on initial connection to other processors and thereafter on a regular basis. In the event of a failure being detected, an error message shall be relayed from the relevant module to the PCS via the executive control module, if appropriate, and the particular module shall be assumed to be faulty.

2.9 The MTBF of the ETC lane equipment as an entity shall be not less than 5000 hours or the passage of 100,000 vehicles whichever is greater and the MTTR shall be not more than 60 minutes from of attendance on site with a range of replacement modules to restoration of normal shall be assumed to be faulty.

3. ETC Lane Controller

3.1 The ETC lane equipment shall comprise lane control computer complete with interface board, keyboard, lane peripherals, readers and communication modules neatly housed in a steel enclosure. The Sub-Contractor shall at the time of tender indicate the manner of maintenance of the lane controller and the requirement of maintenance facilities such as maintenance screen, keyboard and mouse.

3.2 The internal arrangement of components with regard to the division of circuitry within the lane controller shall be determined by the Sub-Contractor but shall be consistent with the requirements of the Specification with respect to modularity and access for the maintenance purposes.

3.3 Enclosure shall be of stainless steel sheet and shall be of pleasing style and appearance. The working surface of keyboards and other areas subject to frequent handling shall be brushed finish stainless steel or other resistant material to the approval of the Turnkey Contractor or the Supervising Consultant.

3.4 The following items of equipment at the minimum shall be neatly accommodated within the lane controller cabinet:-

- (i) A 'lane open' and 'lane closed' control.
- (ii) Indication to show that equipment at the minimum shall be neatly accommodated within the lane controller cabinet:-
- (iii) Terminal, keyboard and mouse for man-machine interface.
- (iv) Lane control computer with a removable media or USB storage drive.
- (v) Interface with all lane peripherals.
- (vi) Readers and communication modules associated with antenna.

3.5 All displays and indications shall be clearly visible under all ambient lighting conditions.

3.6 All necessary ventilation, cooling and dust filtering equipment shall be fitted within the lane controller cabinet to form self-contained units. It is essential that the need for filter changing shall be reduced to a minimum and therefore cooling is to be achieved by recirculation as far as practicable. The Sub-Contractor shall provide details of the necessary ventilation, cooling and the dust filtering arrangements at time of submitting his Tender. The Sub-Contractor's attention is drawn to the environmental conditions at lane level.

3.7 All items necessary for the autonomous operation of the ETC lane equipment as required by the Specification shall be accommodated within lane controller equipment cabinet. All data relating to the jobs, transactions and alarms shall be kept in the lane controller for a minimum of thirty (30) days.

3.8 The antenna shall be used to broadcast and receive signals from OBU's and shall have symmetrical read pattern which confine coverage to a single lane width. Vehicle with valid OBU and card shall encounter the antenna and on reading the valid OBU and card, the ALB will be opened for passage of vehicle. Information read from OBU and card shall include but not limited to the following:

- OBU ID
- Card no
- Card type
- Card Expiry
- Vehicle Class
- Last Transaction
- Card purse

The date/time of transaction, plaza/lane number shall be written onto the card during the communication process.

3.9 The Sub-Contractor shall provide all mounting brackets, fixings and accessories necessary to complete the installation of the antenna.

3.10 Other than the requirements specified above the ETC Lane Controller shall:

a) Be the controller of all lane equipment.

b) Receive detection of vehicle approaching in the lane from the Lane Peripherals.

c) Read the card data in the ETC tag inside the vehicle's windscreen via the ETC Transceiver.

d) Verify that the card data by checking a blacklist. If the card number is found in the blacklist the ETC tag is not valid.

e) Calculate the fee based on the entry and exit plaza and vehicle class read from the card.

f) Verify that the card balance read from the card is sufficient to cover the fee to be charged.

g) Display the transaction result on the User Fare Display.

h) Open the Automatic Lane Barrier and turn the Lane Traffic Light to green if successful transaction.

i) Close the Automatic Lane Barrier and turn the Lane Traffic Light to red when the vehicle has passed the barrier.

j) Send an alarm to the Plaza Computer System in case a vehicle is detected in the lane and no successful transaction has been performed within 10 seconds.

k) Record and store the transaction and passage data.

l) Record and store the transaction and passage statistics

m) Send transaction and passage data and statistics to the Plaza Computer System via the local area network using TCP/IP messages.

n) Receive configuration data from the Plaza Computer System at start-up.

o) Receive blacklist and reload data from the Plaza Computer System at start-up, and the blacklist and reload list shall be updated whenever the Plaza Computer System sends data to the ETC Lane Controller.

p) Receive 'lane open' and 'lane close' commands from the Plaza Computer System and the ETC Lane Controller shall operate the Overhead Traffic Light (OTL) accordingly.

q) Have a user interface for access of operators and maintenance personnel. The access shall be protected to a sufficient level.

r) Have alarm handling and status check for its replaceable parts.

s) Receive alarms from all lane equipment and report any alarms to the PCS.

t) Regularly check the status of itself and the lane equipment, and report status to the PCS.

3.11 The ETC Lane Controller hardware shall be of Industrial PC-type with enough processing capacity to perform ETC transactions in less than 200 ms. The ETC Lane Controller operating systems shall be a commercially available real-time operating system.

4. ETC TAG

4.1 The ETC Transceiver (antenna) shall communicate with the ETC tag and card placed inside the wind screen of the passing vehicles.

4.2 The ETC Tag shall be 2 piece tags consist of tag and ISO/IEC14443A card.

4.3 The ETC Tag shall communicate with the ETC Transceiver (Antenna) using microwaves at 5.8 GHz frequency complying to the following standards and specifications for dedicated short-range communication (DSRC):-

4.4 The ETC Tag shall be outlined as follows:

No.	Descriptions	Remarks
1.	OBU Type	2 piece (Applicable to ISO/IEC14443A IC card)
2.	Communication Type	ITU-RM. 1453
3.	Frequency	5.8GHz
4.	Application Interface	ISO/IEC14906
5.	Modulation	ASK *1
6.	Transmission Data Rate	1,024kbps *2
7.	Power supply	Battery cell

Note) *1 QPSK: Upgradable for the Next Generation use
*2 Option for upgrading to 4Mbps must be available for the Next Generation use.

4.5 A blacklist card can be either one of the single users or the fleet user type. In both cases, the lane controller shall process the transaction in the same manner as if it is a normal card except shall trigger an audible alarm at the Toll Supervisor Desk and at the plaza, like any other irregular transactions described here below. The exit barrier shall remain lowered and a message given on the User Fare Display given to instruct the driver to wait.

4.6 Whenever the local controller detects a vehicle through the entry loop detector but not the presence of a readable tag, an audible alarm shall be generated at the Toll Supervisor Console and at the plaza, the exit barrier shall remain lowered and a message given on the Toll Fare Indicator given to instruct the driver to wait.

5. ETC Transceiver (Antenna)

5.1 The ETC Transceiver shall communicate with the ETC tags placed inside the windscreen of the passing vehicles.

5.2 The ETC Transceiver shall communicate with the ETC tags using microwaves at 5.8

GHz frequency complying with the standards and specifications for dedicated short-range communication (DSRC).

5.3 The ETC Transceiver may be mounted overhead in the middle of the lane on a gantry or at other positions proposed by the Sub-Contractor and acceptable to the turnkey contractor to allow optimum performance of the ETC lane system.

5.4 The specifications of the Antenna should be as follows:

No.	Descriptions	Remarks
1.	Weight	25kg or less
2.	IP Protection Rating	IP54
3.	Power	AC100V/200V±10%, 50Hz/60Hz
4.	Power Consumption	40VA or less
5.	Communication Type	ITU-RM. 1453
6.	Frequency	5.8GHz
7.	Transmitter Power	6.3mW or less
8.	Modulation	ASK *1
9.	Transmission Data Rate	1,024kbps *2
10.	Operating Ambient Condition	-10^{0} C to +50^{0} C

Note) *1 QPSK: Upgradable for the Next Generation use
*2 Option for upgrading to 4Mbps must be available for the Next Generation use.

6. Data Communication with Plaza Computer System

6.1 All lane controllers shall be interfaced to the PCS installed in the Supervision Building at each plaza via a Local Area Network (LAN). Data shall be transmitted from and stored by the lane controllers at various times during collection activities so as to allow compilation of audit and statistical data and monitoring of lane operation and equipment status. The following information shall be both stored by the lane controller on an individual event basis and transferred to the PCS in real time under normal operating conditions:

- System status and operational status including alarms
- daily traffic and revenue data
- job information
- hourly traffic statistics
- individual transactions
- exceptional events (violations, lane closure, ALB manual opening etc)

6.2 The data storage available within the lane equipment shall be sufficient to store the above data for a minimum period of 90 days in operation. The data shall be sufficient to allow all requirements of the Specification to be met with respect to monitoring, report generation, data transfer to the PCS. The length of time for which data is retained by elapsed time.

6.3 The lane controller and its peripherals shall include comprehensive automatic testing routines that shall be implemented on a frequent basis during all periods when power is available to the equipment. Any detected fault condition shall be reported to the PCS within one second of it being detected.

6.4 It is recognized that there will be occasions when either the PCS system is off-line or data communication between one or more lane controller and the PCS is not possible. Under these conditions the lane controller shall continue to store data for later transmission to the PCS. During prolong data communication failure, data can be extracted from the lane equipment using removable media and subsequently transferred to the PCS.

6.5 The lane controller shall include an internal real time clock which shall receive date and time synchronization from the PCS on a regular basis in any event no less than once in every hour. The equipment shall use data from its real time clock to drive the clock display on the terminal of the lane controller and for time flagging of events and data. In the event of PCS failure, the lane controller shall continue to update its own internal clock from the last synchronization data received. The accuracy of the lane equipment clock under such conditions shall be to within + 1 minute per month. When data communication with the PCS is restored, the manual lane equipment shall assume the date and time advised by the PCS. Means shall be provided to allow authorized personnel to set up and adjust the time assumed by the lane controller in the event of data communication with the PCS not being possible.

6.6 Transaction within a job/shift shall be allocated a 4 digit serial number starting at 0001 and being incremented for each transaction during that job. The Sub-Contractor's attention is drawn to the need for various data to be identified by job/shift, day (operational and calendar) and serial number for monitoring and recording purposes.

6.7 The lane controller shall receive operating parameters from the PCS. These shall at the minimum include:

(i) badge list (five digit identity number and single digit to indicate personnel level)
(ii) plaza identity code (three digits and three characters)
(iii) payment type
(iv) acceptable card/tag
(v) blacklist of card

Downloading of operating parameters shall be completed within 30 seconds under all circumstances.

6.8 Operating parameters received from the PCS shall be stored in secure read-write memory modules which allow the integrity of stored data to be maintained for a minimum of 90 days under power fail conditions. Checks shall perform on the integrity of the memory at regular intervals and, if necessary, the lane equipment shall request the PCS to retransmit these data to ensure their validity. The content of this read-write memory shall be refreshed at least once every 24 hours. The proposed method of providing this storage of operating parameters shall be stated by the Sub-Contractor at time of submitting his Tender.

6.9 Toll fare tables giving toll rates for each classification shall be held in the form of two tables, one current and one future, together with a date and time for implementation of the future table. In the event of no future rates being defined both tables shall contain the same data for security. Routines in the lane equipment shall ensure that once a change in toll rates has been implemented, data relating to previous rates is deleted from memory.

6.10 The additional fare table shall be in a matrix form and as far as applicable including all toll plazas compatible to the ETC system. The Sub-Contractor shall take into account interoperability of the ETC system and shall include toll plazas of all sections of ORR and all possible routes of the origin plaza to the next plaza in the table regardless of which section.

6.11 Each authorized member of staff will be identified by a five digit identify number. This number will be part of the data encoded on the badge cards as details elsewhere in this specification. Associated with each personnel number will be a further single digit number that identifies the authorization level of individual. The authorization level is not encoded on the identity card to facilitate rapid re-designation of staff. A minimum of nine levels of authorization are to be available, identified by digits 1 to 9. One of these levels shall be allocated to maintenance facilities as described elsewhere in this specification.

6.12 The removable media drive installed in the lane controller allows updating of operating parameters when the lane equipment is unable to communicate with the PCS.

7. Maintenance Facilities

7.1 A maintenance mode shall exist for the ETC lane equipment which will allow full operation of the equipment with the lane control signal showing closed, irrespective of the status of the various controls and interlocks. The maintenance mode shall be entered when authorized badge cards, similar to those used by collectors but with the identify number being relevant to the maintenance access level. Are used to enable the equipment.

7.2 Details of all ‘transaction’ performed in maintenance mode shall not be included in summary data files produced by the PCS but ‘end of job’ files, clearly identified as relating to maintenance mode, shall be available in respect of each period of operation. All monitoring facilities shall be available in maintenance mode.

7.3 Once maintenance mode has been entered, special test facilities shall be available via the keyboard of the console that shall assist in routine testing or fault diagnosis. The Sub-Contractor shall submit full details of the facilities available at time of submitting his Tender.

C. PLAZA COMPUTER SYSTEM

1. System Philosophy

1.1 A plaza computer system (PCS) shall be installed in the Supervision Building of each toll plaza. These systems shall operate in a supervisory mode and shall exert no direct control over the operation of the associated lane equipment. The principal functions of the PCS shall be to: -

a) provide real time monitoring facilities

b) correlate data from lane equipment into audit and statistical reports and files

c) serve as an alarm monitoring and acknowledgement system

d) transmit operational data to the HQCS

e) act as a revenue collection system

f) receive from the HQCS, and download to lane equipment, parameters relating to operation of that plaza

g) serve as a time recording system for the attendance of toll personnel at site

h) provide traffic data to the HQCS, on a sampling period programmable from five minutes to one hour.

i) To produce back-up containing data files which may be further processed off-line

1.2 Each PCS shall comprise various inter-linked modules, one being used for real time functions, such as data acquisition from lane equipment and provision of facilities for detailed monitoring of lane operation, and the other being used for plaza management and data processing functions. The real time function process will be referred to as a lane data concentrator process and the other as the plaza management and data processing. These processes shall be installed in the PCS Server at the computer room of the Supervision Building at each plaza.

1.3 It is expected that the hardware server shall be microprocessor based system with components and circuit boards supplied by manufacturers of international repute. Custom built or non-standard equipment will not be acceptable to the Concessionaire/Turnkey Contractor.

1.4 In the event of power failure to the central, the system shall restart automatically on restoration of power without the need for operator intervention, other than a log-on operation if necessary, and with no long term loss of data or reduction in security. UPS shall be provided to ensure that the integrity of all memory modules is maintained under conditions of power failure.

1.5 Prime consideration shall be given in the design of the various items of equipment and their configuration into an overall toll collection system at each location to ensuring that no data are lost under any circumstances.

1.6 The PCS shall be interfaced to all lane equipment and shall receive from them details of transactions, collector actions and equipment status in real time so as to allow monitoring to be performed by staff in the Control Room of the Supervision Building on an individual transaction basis using the Real-time monitoring workstation.

1.7 The PCS shall also be interfaced via a communication network, to the ORR TCC. Data transmission between the TCC and PCS will be controlled by the TCC.

1.8 Diagnostic software, in a suitable format for immediate loading and running, shall be provided to allow tests to be performed on all PCS system equipment, interfaces and peripherals. Such tests shall be performed with the systems 'off-line' and shall have no adverse effects on the operation of the toll lane equipment.

1.9 Operating parameters' such as toll rates, classification definitions, authorized personnel badge numbers, card & ETC blacklist and the like will normally be downloaded from the TCC. In case of communication failure between the TCC, program inputs will also be contained on a separate removable media or thumb drive and facilities shall be provided to allow them to be loaded into the PCS in the event of failure of the data communication link with the TCC. It shall be possible for implementation of amended inputs to be included and for the data to be checked for correct programming before execution in sequence. Further details of the parameters and their use are given elsewhere in this Specification.

1.10 Any fault of one module of the server shall be recorded and alarmed by the system. A 'watchdog' facility shall be included as part of the processor system with an alarm being given at the tolls surveillance desk in the event of fault of the PCS.

1.11 A Toll Supervisor Console shall be provided and shall be installed in the plaza supervision room in such a position to allow a supervisor seated at the console having the best possible view of the toll plaza.

1.12 The Toll Supervisor Console shall encompass the following:

- Lane status Display Unit
- Supervisor Audit Workstation
- Snapshot Image Workstation
- CCTV Monitoring Workstation
- Booth Intercom System

1.13 A Console shall be constructed in the control room at each toll plaza. The console shall be used to house the supervisor audit workstation, real-time monitoring workstation, snapshot image workstation and CCTV monitoring workstation. The console shall be laid out ergonomically and shall employ high quality wood materials with amination finishing. The overall design of the plaza control room furniture shall be to a high standard and each item shall be compatible to give a pleasant appearance. The console must also include cable management designs to ensure cabling are organized neatly. Standard off the shelf computer tables shall not be acceptable unless otherwise approved by the Engineering consultant. An outline of the proposed console in the control room shall be provided and approved by the HGCL or Engineering consultant prior to construction at site. The console shall include security alarm buzzers and up to fifteen (15) indicators such as alarms from the plaza generator set and UPS equipment

1.14 Four workstations shall be provided in the Control Room of the Supervision Building. One unit, designated the lane status monitoring workstation or real-time terminal, shall be interfaced to the lane data concentrator process and shall be the primary aid to supervision of plaza operation in real time. The second unit, designated the supervisor audit workstation, shall allow authorized staff to monitor particular aspects of the operation and access data stored by the PCS. The third unit, works as a CCTV monitoring workstation to monitor the building perimeter, supervision building and the toll lanes. Fourth, a snapshot image workstation is used to capture the image of discrepancy & violated vehicles via the signal from the toll lanes.

1.15 TOD workstations shall be provided in each plaza for the purposes of attendance recording and input of cash collection data by toll collectors following completion of a toll collection job using manual lane equipment. ISO 14443 contactless card readers, preferably of a desktop type, shall be provided and installed adjacent to each TOD workstation. Staff will scan their badge cards through these readers as a means of identification when using the terminals. The TOD workstation may be implemented in any workstation.

1.16 One printer shall be provided in the Control Room for production of hard copy. The Control Room unit, designated the operations printer, shall produce operating logs, alarm messages, traffic statistics and details of shift reports or the shift closing activities as required.

2. Particular Design Parameters

2.1 The PCS shall support multi-task, multi-operations functions so that the various requirements of the system can be carried out simultaneously with no perceivable delay to persons making inputs to the system.

2.2 The main memory of each CPU shall have a redundancy of at least 33% with all online programs resident and active in the memory. This shall apply to all PCS sub-systems and shall take account of manufacturer's recommendations on usable capacity for efficient running of programs.

2.3 The online system CPU time loading shall not exceed 40% when operating under the following conditions:

(i) The online system under peak loading conditions with all monitoring point in the shortest scanning interval
(ii) Simultaneous requests for various operator functions from all the interactive workstations
(iii) The printer generating a long listing

The contractor shall provide a resident program to measure the CPU time loading.

2.4 The disk capacity of the PCS shall be calculated taking account of the need to store the operating system, the application software and other software packages necessary for operation of the system and the data generated by the system to meet the requirements of the specification and to adhere to the manufacturer's recommendations on usable disk capacity for efficient running of programs. Taking account of these criteria, not more than approximately 60% of the available hard disk capacity shall be used. The figure of 60 % stated above, shall relate to the usable, and capacity of the disk in accordance with the manufacturer's recommendations for efficient running of programs.

2.5 The loading of the central processors of PCS shall be of the order of 50% when working in accordance with the Specification and assuming concurrent implementation of all tasks the Sub-Contractor shall indicate at time of submitting his Tender, the means by which he proposes to demonstrate that this requirement has been met.

2.6 Data transmission between the lane equipment and the PCS shall use recognized standard interfaces and communication protocols that shall be stated at time of Tender submission. The error rate of the transmission shall be better than 1 in 10,000,000 for first time reception of a message. The LAN shall be Gigabit Ethernet.

2.7 The data transmission shall follow the following standards:

(i) BS 6701/ BS EN 50174 (1 to 3): Information Technology Installation
(ii) BS EN 50310: Equipotential Bonding
(iii) BS EN 60825-2: Safety of Optical Fibre Communication System
(iv) IEEE 802.x: Institute of Electrical and Electronic Engineers
(v) IEEE 829: Institute of Electrical and Electronic Engineers, ‘Software Test Documentation’
(vi) IEEE 1063: Institute of Electrical and Electronic Engineers, ‘Standard for Software User Documentation’
(vii) ISO 9660: Volume and File Structure for Information Interchange

2.8 Data transmission between the lane and PCS and their various peripherals shall be arranged such that failure of any one item, including component failures that affect the data transmission link, does not render any other peripheral inoperative.

2.9 The computer hardware including printers and display terminals shall be readily available in Hyderabad, India. Full maintenance support services and ready availability of consumable, spare parts or replacement units shall also be assured from a third party, based in India, who are not connected with the Contractor, his agent or Sub- Contractors.

2.10 The central processing unit of the PCS shall have an integral real time clock that shall be used for the timing of all reports, print-outs, data transfer and the like. It shall be possible for authorized personnel to set the current date and time by following a specified procedure at the real-time monitoring workstation. Once set the clock shall remain accurate to within half a minute in one calendar month. In the event of power failure to the PCS, the real time clock shall be maintained to the same degree of accuracy for a period of not less than 48 hours.

2.11 The PCS shall send, at intervals of no less than once an hour, it's currently assumed date and time to the toll lane computer which shall use this data for their time synchronization purposes as described elsewhere in this Specification. The PCS shall receive, at intervals of no less than once on hour, from HQCS the date and time for synchronization purposes.

2.12 Time signals shall be used for the automatic recording of date in the form DD/MM/YYYY (e.g. 13/01/2009). Years shall be automatically adjusted with arrangements made for leap years up to at least the year 2040. All times shall be displayed and printed in 24 hour format.

3. Monitoring Facilities of the Plaza Computer System

3.1 The four workstations designated are the real-time lane status monitoring workstation, supervisor audit workstation, CCTV monitoring workstation and Snapshot image workstation in the Control Room of the Supervision Building shall be ergonomically installed into the supervisors' console. The real-time lane status monitoring workstation shall allow supervisory staff to display the status of all lanes on a single screen, to indicate alarm conditions as they arise and to perform detailed monitoring of lane equipment operation and collector performance in real time. The supervisor audit workstation shall allow authorized staff to access on demand, various traffic, revenue and management related data, including operational data in the form of equipment and operating parameters, both in real time and from archive data files. The CCTV monitoring workstation is used to monitor the building perimeter, supervision building and the toll lanes. The snapshot image workstation is used to capture the image of violated vehicles via the signal from the toll lanes.

3.2 The various functions available from the consoles shall be selected from 'menu' type displays through use of cursor controls, programmable function keys, `mouse', track all or similar to the approval of the Engineer. Access to data and functions via the supervisor audit workstation shall be controlled by way of a `password' feature with separate passwords being used for each of the seven levels of staff identified in the badge number table downloaded from the HQCS as part of the operating parameters. Passwords shall neither be displayed nor printed but shall be masked by asterisks or other symbols.

3.3 It shall be possible for any combination of functions to be made available to any level of staff and for this combination to be readily changed by keyboard input to the Supervisor audit workstation by the persons having the highest access level. Passwords for each level shall be considered as operating parameters of the system and will be downloaded from the HQCS as part of the system constant table. It shall not be necessary to differentiate between display and print of a particular function for the purposes of access control to that function.

3.4 All games, media players and the possibility to be connected to the internet by WIFI to download and programs and files shall be removed and disabled.

3.5 Where a function contains too much data for display on a single screen of the supervisor audit workstation, it shall be possible to use cursor and page control keys to scroll, both vertically and horizontally, the display until the desired data is shown.

3.6 The real-time monitoring workstation shall display the following as a minimum for the plaza status display: -

No	Task	Details
1	status of each lane	open, closed, failed, maintenance, no data communication etc
2	collector identity	badge number of collector currently logged on to TCT in each lane.
3	classification	all classifications entered by the collector
4	method of payment	as recorded for each transaction
5	AVC classification	class of vehicle as detected by the AVC equipment
6	Exceptional items	violation, discrepancy, force reset, etc. when these conditions arise
7	Correction	when collector corrects a classification input
8	Toll Booth emergency	when emergency footswitch in the toll booth is pressed.

The supervisor may check the present and the previous status the lanes with the time of the last technical incident by pressing on a key or function.

3.7 It shall be possible to select, by keyboard input or use mouse, any individual lane for detailed monitoring. Once such a selection has been made, the relevant details from the plaza status display for that lane shall be shown together with more particular information relating to the equipment within that lane. The sub-contractor shall propose a process to fit such requirements. This information shall include: -

a)	manual lane barrier	Open Or Closed
b)	traffic signal	Red Or Green
c)	card reader	Failure Or Jammed
d)	AVC equipment	Operations or Failure of Modules
e)	lane equipment	Failure of Module or Units
f)	footswitch	Activation & Release
g)	toll fare indicator	Failure
h)	automatic lane barrier	Interstate, Error

3.8 For a selected lane it shall be possible to display details of all transactions and events, such as alarms, lane open and closed, in sequence on the real-time monitoring workstation using a scrolling type display. This display shall be updated in real time and a function to produce a hard copy of the screen display at any time.

3.9 Current alarms shall be displayed on the lower part of screens on the real-time monitoring workstation. Alarms shall be shown in chronological order of the condition arising and shall be scrolled so that the most recent information is shown. The console 'bell' tone shall be used to attract the supervisory staff's attention each time a new alarm item is raised. Alarms to be raised shall include:

- exceptional items
- card reader failure or jam or read error
- AVC failure including identification of failed element
- Other equipment alarm/failures
- toll booth emergency
- printer terminal out of paper
- printer terminal failure
- communication link failure/recovery

All alarms shall include date and time of occurrence, lane number and collector identity number where appropriate.

3.10 It shall be possible to set parameter values in respect of those alarms which may occur without affecting overall operation of system, e.g. card read error. The alarm condition shall only be signaled when the frequency of occurrence of the event exceeds the parameter value. The parameter values shall be independent for each alarm of this type and shall be considered as operating parameters of the system.

3.11 Full use shall be made of the color graphic facilities available on the real-time monitoring workstation to provide displays which are easily interpreted and which draw attention to exceptional items and alarm conditions. Use of inverse video and blinking of displays shall also be included where appropriate. The displays shall, in particular, ensure that meaningful information is given for example, when several vehicles of the same class using the same method of payment, are processed in sequence in one lane. Use of different colors or momentary cancelling of displays will be an acceptable method of achieving this.

3.12 When an emergency alarm is raised in a toll booth, it shall be indicated on the real-time monitoring workstation and the bell tone shall sound. The supervisor shall be required to acknowledge the alarm by way of keyboard input and the bell tone shall only be cancelled when this has been done.

3.13 Use of the supervisor audit workstation shall require the operator to log on by entering his identity number and a password. The identity number shall be verified as being one included in the badge number table and the password shall be checked as being correct for the allocated access level. Only those functions which are available to the access level of the person currently logged on to the console shall be shown in the menu displays.

3.14 The following screens shall be available on the supervisor audit workstation: -

NO	Main Menu	Activity
1	Traffic Menu	Hourly Lane Traffic
		Hourly Class Traffic
		Histogram
		Sum of Entrance/Exit Lanes: Per hour/day/month/year
2	Plaza Activity Menu	List of Jobs
		End of job
		Transactions
		Display Criteria
		Lane Events
		Collector Activity
3	Plaza Revenue Menu	Revenue by Class Traffic
		Revenue Report
		Collector Revenue
		TOD Reports
		Bag Bank Transfer
		Return Bank Slip
		Revenue Updating
4	Maintenance Menu	Alarm Criteria
		Alarm Log
		Alarm Summary
		Fault History
		% of Accuracy of the AVCS per class
		Request of Corrective Maintenance
		Purchase and Store Management
5	System Menu	Backup PCS Data
		Restore Data
		Backup Parameter
		Restore Parameter
6	Message Menu	Message Send
		Message Receive

3.15 Formats for all displays shall be agreed as part of the Functional Specification. Functions available will depend on the privileges given to the supervisor. The supervisor shall manage the ETC lanes or the entrance lanes equipped with an Automatic Card Issuing Machine (ACIM) to 'open shift', 'close shift', toggle the status of overhead canopy sign (red and green) or even open & close the automatic lane barrier.

3.16 It is expected that once an operator has logged on the console, he will be presented with an initial menu, also identified as 'Scrolling' menu, containing each of the seven groups identified above together with a log out option. When a group is selected, a second level menu showing each of the available functions and an option to return to the initial menu will be displayed. For all groups apart from the system functions there shall also be an option to request for a print out of data without the data being displayed.

3.17 Once an item has been selected for display or print, the operator will enter information such as date, lane number, collector number or any relevant combination of these to define the selection criteria which are to be displayed or printed. A simple input screen that prompts the operator to confirm as to the required information may be provided. When a request for display of data has been completed, the first or only screen of data shall be prompt up and there shall be no perceivable delay when paging or scrolling the data to view that which is not currently shown. In the event that no data is available for the requested item, a message shall be displayed to that effect.

3.18 It shall be possible by single key input to cancel the currently displayed data and return to either the input screen for that display, the second level menu for that display or the initial menu or to log out from the terminal.

3.19 All data display screens shall include both the current date and time assumed by the PCS and the time period for the data which is being displayed.

3.20 The traffic screens shall allow the operator to specify an interval during which the number of vehicles passing through each lane shall be counted and recorded. The operator shall also be able to specify a date and time at which the counts should commence.

3.21 The operator shall be able to request display or print of the traffic volume data for any completed period in a similar manner to other data retained by the PCS. It shall not be necessary for the exact start time to be entered to the input screen following selection of the traffic screens from the second level menu.

3.22 It shall be possible to display traffic volume data by individual lanes, bound and all the plazas.

3.23 The real-time data shall be available for all time periods and collector jobs which are in progress at the time of a request for the display. The displayed data shall be `frozen' at time of request and shall not be updated in real time on screen. The display, and any requested printouts of the data, shall be highlighted to indicate the period or job is still in progress and thus the data is likely to be updated as time passes and further transactions occur.

3.24 ‘Help’ shall be included and shall be accessible through use of a function key regardless of the display that is currently being shown on the console. The help shall relate specifically to the current display and shall include instruction on all inputs that may be made to that screen.

3.25 The data compiled by the PCS shall use different time bases for the various functions. There shall be four such time bases, namely, calendar day, operational day, filing day and revenue banking period.

3.26 The calendar day shall start at midnight (0000 hours), run for 24 hours. The date allocated to the calendar day shall be that determined from a conventional calendar. Hourly traffic volume data for both plaza and individual lanes shall be compiled on the basis of calendar days and shall be available from the PCS following input of the required date.

3.27 The operational day would start at the time set in the TCC parameters. Normally there would be option to enter the shift information in the TCC along with the timing for the individual shift. The reports for the operations day would be printed for the 24 hours period starting from the first shift of the operational day and till the last shift or the job completed on the same operational day.

3.28 The daily collected revenue is the corresponding sum of the toll paid by each of the various methods of payment for the jobs allocated to that operational day.

3.29 The collector jobs are allocated to operational days. The cash collection and cash collection discrepancy shall be compiled by operational day and, where relevant, related to the corresponding collector job. Where there is no corresponding collector job, for example for alarms in lanes where no collector is logged on, the operational day shall be the 24 hour period from the last nominated start time.

3.30 A revenue banking period shall be the period between two sequential implementations of termination of the revenue banking summary with the provision that such termination may only occur once during an operational day. A revenue banking summary shall include the total cash declared by the collectors for each job by using the cash collection input facilities of the TOD workstation.

3.31 Final Day Closing: The Tours of duty (TOD) of the collectors shall be closed when all end of shift reports are ‘consistent’ which means that all supervisor‘s acknowledgements of discrepancies are implemented and when the system has checked that no message is lost during the shift.

3.32 Termination of the revenue banking summary, and thus the revenue banking period, shall be available when display of the current revenue banking summary is selected via the keyboard of the supervisor audit workstation. It is intended that operational procedures will dictate that the revenue banking summary be terminated when a security van arrives to transfer cash from the plaza to the bank. The summary will thus contain details of all declared cash since the last such occurrence and will, providing procedures are strictly implemented, be a record of the total cash transferred to bank in each shipment.

3.33 A screen asking the operator to confirm whether the revenue banking summary is to be terminated shall be automatically displayed when the display for the current summary is requested. In the event of the operator declining to terminate the summary, the current `to date' data shall be displayed. If the summary is terminated, a print out giving details of the declared cash for all jobs in the revenue banking period shall be produced and a new revenue banking period shall be started.

3.34 Each display or print of the revenue bank-in summary shall include details of the start and end of the period. The start date shall be the date of the operational day on which the last period was terminated. The end date of the period shall be the date of the operational day prior to that on which the period terminated.

4. Print Terminals and Printing Functions

4.1 The printer terminals in the Control Room shall be provided complete with floor stands that incorporate need and convenient accommodation for printer paper. A paper tray shall be provided for each printer which shall accumulate the various reports in a neat and tidy manner until they are removed.

4.2 All print outs shall be allocated a four digit serial number to allow ready detection of unauthorized removal of print outs and shall include date and time of printing and that of the event occurring or the period to which the data relates. The print out after number 9999 shall have the serial number 0000.

4.3 All printouts including alarms and audit reports shall be parametered and configured to control the manner of printing either by ‘on demand’ or automatically. This control shall include the following printers:

- Operation Printer
- Maintenance Printer

4.4 Automatically produced print-outs shall take priority over `on demand' prints. In the event of an `on demand' print being requested while no automatic prints are pending, printing shall commence within ten seconds of the request to print being made and shall be continuous until the report is completed. Automatic print-outs of alarms shall commence within one second of the alarm condition arising providing no other print out is in progress.

4.5 The precise format and content of all print outs shall be agreed with the Engineer after award of Sub-Contract. All print-outs shall, where appropriate, include for individual row and column totals to be given as well as combined totals of the rows or columns. The Sub-Contractor shall submit at time of Tender, outline details of any additional prints which might be available from the proposed system. It is envisage that the EOJ report shall be printed most frequently and as such, each EOJ printout report shall be fitted on a single page of A4 size to minimize usage of paper.

5. Tour of Duty Workstation

5.1 Tour of duty (TOD) terminals shall be provided in the End of Shift Office or Cash Counting Room of each plaza. These workstations shall be used by staff to register their arrival and departure for attendance recording and to enter details of cash collected during each job carried out on manual lane equipment. Each terminal shall have a contactless desktop card reader that shall read data from the badge cards as a means of identifying individual members of staff.

5.2 Operation of the TOD terminals shall be especially straightforward since it is unlikely that persons using them will be computer literate. It is envisaged that the required function will be selected from a simple menu and the person shall be instructed by suitable display, to pass their badge card through the reader. Confirmation of correct operation or the need to re-try the card shall be given as appropriate.

5.3 The operation of the TOD terminals as attendance recording devices shall be straightforward and shall require the minimum of input via the associated terminal. A procedure whereby a single key input is followed by passing the appropriate badge card through the reader is preferred. Similar procedures shall be used for `signing on' when the various personnel report for duty and `signing off' immediately prior to their departure at the end of their tour of duty. The badge number shall be checked for validity against the table of authorized staff that forms part of the operating parameters.

5.4 The plaza computer system shall compile attendance records and shall make these records available for transfer to the TCC together with other data.

5.5 Confirmation of the identification number of each card passed through the reader, together with an indication of whether the action was for arrival or departure, and the name of the person shall be given on the display screen of the terminal. A facility shall be provided to allow a re-try operation in the event of incorrect reading of the encoded data and to allow manual input of a badge number followed by a `key' number in a similar manner to that available at the manual lane equipment. In particular, the supervisors attention shall be drawn to the fact that an identification card has been incorrectly read or an attempt has been made to `sign off' a person who was not recorded as having previously `signed on'. This shall be achieved at the real-time monitoring workstation in a similar manner to equipment alarms.

5.6 In the event of failure of the TOD Terminal, it will not be possible for staff to use the TOD terminals for attendance recording purposes. In this case, the required task may be implemented in any other available workstation connected to the same network. In the case of the If the case of full server failure, the supervisor will record in an appropriate form, details of staff arriving and departing. A facility shall be provided which allows these details to be entered manually to the PCS after it has been restored to an on-line condition.

5.7 It shall be possible, following appropriate keyboard input, for the identity of all staff currently `signed on' to be displayed on the supervisor audit workstation and, following a further request, to be printed on the operations printer. A facility shall be provided to allow authorized staff to `sign out' staff who may have omitted to do so or who have left the plaza at a time when the PCS was off-line.

5.8 All manual inputs shall be logged against the person who made the inputs. Manually entered data shall be highlighted as such when transmitted to the HQCS.

5.9 At the end of his job the collector will use the tour of duty VDU to enter details of cash collected. The collector will select the `enter cash collected' item from the menu shown on the TOD terminals and pass his badge card through the associated card reader. The screen shall then show a `Cash Declaration Menu' which includes details of the relevant job and a separate field for each denomination of note and each value of coin. The collector will enter the number of each type of coin and note which is to be banked. The PCS shall calculate the total for each denomination and overall and shall display these. Means shall also be provided to allow the collector to enter a bag or seal identification number which shall be used as part of the `cash transferred to bank' facility. The collector will acknowledge correct input or amend incorrect entries by simple keyboard input that does not involve re-entering all data.

5.10 After the ‘Cash Declaration’ form has been filled in, supervisor will display the cash up report in which are noted the declared and the computerized revenues, the debt of the collector for positive discrepancy with the link to the corresponding incident picture. The collector shall acknowledge the printed cash report. To be valid, the end of shift report shall be consistent which means that the system has checked all messages corresponding to the shift and the supervisor has acknowledged all incidents which came up in the lane during the duty turn.

5.11 A facility shall be provided whereby if the amount entered by the collector differs from the ‘computed’ amount, a warning to this effect is given to the collector and he is given the opportunity to recheck his declaration and amend previous data entries. The ‘computed’ amount calculated by the PCS shall not be displayed to the collector and the ‘allowable variance’ shall form an operational parameter of the system.

5.12 Once the collector has acknowledged that all data entered by him is correct, an automatic print out of the `cash for banking' containing all details entered by the collector shall be produced on the tour of duty printer on a new fold of paper. This print out shall include space for both collector and supervisor to sign.

6. Data Communication with TCC

6.1 The PCS shall be interfaced via fiber optic line for data communication with TCC. The Contractor shall supply and install the data cable from the PCS to the data transmission network equipment that will be installed in the toll plaza.

6.2 It is essential that all data transmitted to the HQCS are sent automatically. The date records shall be organized in sequential files or data packets that are opened and closed in an arbitrarily defined period. Data records shall be stored in the appropriate current days file even if the event to which they relate occurred on a different day and the transmission of data from lane equipment to the PCS, for example, has been delayed.

6.3 The sub-contractor shall define and submit in detail the manner of data transmissions from the PCS to the TCC. It is extremely critical that all data transmission shall be validated and errors occurring during data transmission shall be automatically detected, corrected and rectified and shall not in any way affect the integrity of data uploaded to the TCC.

6.4 Separate files shall be provided for data transmission from PCS to TCC and operating parameter files from TCC to PCS. The format and content of each data record in the files shall be agreed between the Contractor and the engineering consultant and documented within the functional specification.

6.5 Operating parameter tables, in the form of a number of discrete files, will be downloaded from the HQCS to the PCS. The tables that will be used should be provided under the parameter menu. The format and content of these files shall be agreed between the Contractor and the Engineering consultant and documented within the functional specification.

6.6 The badge number table will include, for each member of staff authorized to use the equipment; the five digit identity number, the name of that person (up to 25 characters) and the access level afforded to that person. The system shall accommodate up to 300 authorized staff at each plaza.

6.7 The vehicle classification table will indicate the number of classifications currently in use and the definition of each class. The table shall accommodate up to 9 vehicle classes.

6.8 There will be two sets of toll fare tables, current and future. Once this date and time has been reached, the specified table shall be adopted for the purpose of determining tolls for all transactions. All references to the previous current table shall be deleted. If no change in toll rates is pending both tables will contain the same data and no date and time for implementation will be included.

6.9 For management purposes, each of the above mentioned tables will include a header, the date and time of the last revision, a table type code and a revision number. The revision number will be changed each time the contents of a table are changed. The revision number table will indicate the current revision number of each of the other tables. It will, thus, be possible for the PCS to check on a frequent basis, the revision number of the revision number table to determine if updated parameters have been downloaded and if so to analyses the revision numbers of the other tables contained therein, to determine which table has been modified. The fare table is valid for all plazas same as the kilometer table. The system shall provide a function that calculates the price as per the fare table and the kilometer table.

6.10 Each of the sequential files shall include a 'flag' to indicate whether they have been transferred to the TCC or backed up to removable media or thumb drive. When the available disk capacity becomes fully utilized, the PCS shall delete files containing the oldest data, thereby allowing continuous operation of the system. Only those files which are flagged as having been transferred to the TCC or backed up to removable media or thumb drive shall be deleted.

6.11 In the event of all available disk capacity being used and the files not having been transferred to the HQCS or backed up to removable media or thumb drive, the PCS shall suspend data communication with the lane equipment until such time as either event has occurred and further disk capacity can be made available for new data.

7. Data Storage and Security, Operation under PCS Fault Conditions

7.1 All data generated by lane equipment and stored by the PCS shall be totally secure against failure of the lane equipment, failure of the PCS, breakdown of the data communication link between the lane and the PCS or the PCS and the HQCS, and failure of the HQCS itself. This shall be achieved by storing all such data at two different levels and performing regular cross checks on the integrity of stored data and processing to ensure that any failures are promptly detected and may be reported.

7.2 Each data message sent from the lane equipment to the PCS shall contain an identification number that shall be incremented for each successive message. This number shall be supplemented by the plaza code and lane number so that the source of the message may be readily traced.

7.3 All messages shall be individually stored by the lane equipment in a first in first out rolling buffer which shall have sufficient capacity to store messages for that equipment for a period of 90 days. This throughput and duration shall only be used for design purposes and the limit of the available memory shall be the determining factor of the time for the actual data storage achieved.

7.4 All message issued by the lane controller shall have a message number (M_number) and the content of the message shall encompass a specific number corresponding to a special event or incident (Transaction number – incident number). The sub-contractor shall describe the method used for the numbering of the message.

7.5 A chronology check which comprises of continuity check and length of message check shall be performed. For any discrepancy of these checks, the server will display a lock of 'non consistent' which shall be checked by the supervisor. The controller lane shall normally retransmit all missing messages or to be done on supervisor request.

7.6 The PCS shall monitor all received message and shall compare the identification number of the most recently received message with that of the immediately preceding message from that lane. In the event of the identification numbers not being sequential the PCS shall implement automatically a request for any missing messages to be transmitted from the lane equipment.

7.7 Each message sent from and stored by the lane equipment shall be additionally labeled with date and time of generation of the message, whether the message was sent in real time or deferred and the collector badge number where relevant.

7.8 Non-essential data messages need not be retained by the lane equipment or the PCS and, other than normal protocol checks, no special procedures need be incorporated to ensure that all of these messages are received by the PCS.

7.9 The PCS shall group the essential data messages received from the various lane equipment into uniquely identified files for storage as well as processing these to achieve the operating requirements of the system as detailed in this Specification. Details of all print outs, collector jobs and the like which are compiled by the PCS shall be similarly stored as uniquely identified files as well as being made available for transfer to the TCC. Sufficient storage capacity shall be provided within the PCS to allow all such files to be stored for a minimum of 180 days operation under the design criteria specified.

7.10 It shall be possible for any file to be transmitted from the PCS to the TCC on receipt of a request from the latter as a means of further cross checking. The Sub-Contractor shall include details of the proposed arrangement and labeling of files in the first draft of the Software System Specification to be submitted as part of the design approval process. These initial proposals shall be discussed and agreed with the Engineer and the Concessionaire as part of the approval of the Software System Specification.

7.11 The Sub-Contractor shall explain fully as part of his Tender submission, the way in which the requirements of the above Clauses will be met and shall provide details of memory capacity, error detection and correction and security of data storage and transmission throughout the system.

7.12 Notwithstanding the inherent reliability of processor systems, it is recognized that there will be occasions when either the PCS is off-line resulting in failure of data communication between the PCS and one or more lane equipment or all available disk capacity of the PCS has been utilized but files have been neither transferred to the HQCS nor backed up. Under such conditions the lane equipment and all associated signs, interlocks and detection devices shall continue to operate with no indication to the collector or motorists that a failure has occurred.

7.13 On restoration of data communications between the PCS and a lane equipment or disk capacity becoming available at the PCS, all essential data messages stored by lane equipment which have not been previously transferred to the PCS and acknowledged as being correctly received shall be transferred automatically to the PCS within half an hour.

7.14 The received data shall be processed by the PCS in a similar manner to that received in real time and once this has been completed, display and print out of the data shall be available via the supervisor audit workstation. This data shall also be included in files that are to be transferred to the TCC. The Contractor's attention is drawn to the arrangement of such data in files designated by filing day.

7.15 The data communication protocol and the sequence of bringing booth equipment back into communication with the PCS shall take due account of the fact that there may be large amounts of data to be transferred. The primary aim of the system is to ensure that all reports and data files are correctly compiled, data is available for print out, display and files are available for transfer to the TCC and that no data are lost.

7.16 Hard disk and USB port drive shall be provided under the Sub-Contract for the purpose of extracting data stored by the lane equipment under conditions of PCS failure. Such equipment will be used when the limit of available data storage in the lane equipment is being reached and the intention is to provide a means of continuing operation of the system with no long term loss of audit and statistical data.

7.17 Only if the PCS server has failed, implementation of attendance recording, cash transferred to bank and start and end of tour of duty procedures will require staff to make manual records of all relevant data on special forms provided by the Concessionaire. If the required workstation has failed, the tasks could be performed or recorded at an alternative workstation which is connected to the network. Operation thereafter will be the same as under normal operating conditions. The PCS shall determine which collector shifts are current and shall accept data input by collectors via a TOD workstation when these are terminated.

D. TRAFFIC CONTROL CENTER SYSTEM (TCC)

1. System Philosophy

1.1 The TCC systems shall be provided in the main and the sub control rooms to monitor the operation of all PCS and to provide audit control and statistical data relating to the plaza operation.

1.2 The principle functions of the HQCS shall be to:-

a) Receive data from all PCS systems. The data shall be from Manual, POS and ETC system.

b) Allow input of Bank-in data

c) Correlate data from PCS and bank-in into summary and statistical reports and files

d) Produce archive disks containing data files that may be further processed off-lined.

e) Allow maintenance of operation parameters at Headquarters and subsequent download to PCS

f) Allow regeneration of traffic

g) Allow to update the sub control center systems.

1.3 TCC systems shall comprise but not limited to the followings:-

- Database server (TCC Server)
- Local Area Network (LAN)
- Financial Management Workstations
- Snapshot Image Server
- TCC Monitoring Workstation
- High speed laser printer

1.4 The system shall be designed such that comprehensive facilities will be available but that operation is straight forward and can be easily understood by suitably trained, non-technical personnel. In the event of power failure, the system shall auto reboot on restoration of power without need for operation intervention, other than a log-on operation.

1.5 The TCC shall be linked to all PCS at the plaza via a communication network. Data transmission between TCC and the PCS will be controlled by the TCC.

1.6 The LAN that connects all equipment at the HQCS centre shall be Gigabit Fast Ethernet.

1.7 The system shall have a sequence of checks against known functions so that a malfunction in processing or recording is automatically detected by an interrogation procedure and suitable alarm given to the system console of the database server as well as logging to an error log file.

2. Technical Requirements

2.1 The HQCS Server shall be configured as a two-node cluster with a primary and a stand by node (where only one node will be active at any given time). The currently active node will host the toll administration processes. In the event of a serious hardware or software problem on the primary node, the clusters will failover to the secondary node, whereby the secondary node will become the active node. In this situation, the HQCS processes and database will be stopped on the primary node, and will be restarted on the secondary node. Note, that failover can also happen from secondary node back to primary node (often called failback).

2.2 The shared RAID disk array is a storage device for when the HQCS server reaches the limits of its internal storage capacity. It is a data storage scheme that divides and replicates data among multiple hard drives. It offers, depending on the scheme, increased data reliability and I/O performance. The RAID array device shall be used to set RAID levels 0, 1, 5, 10 and 50 and to expand storage to multiple terabytes in a variety of computing environments.

2.3 The Tape Backup servers are available for daily system backup. The servers use an Autoloader to automatically change tapes. The tape format is DAT, with a capacity of 160GB.

2.4 There is a requirement of two servers, one primary server and one stand-by server. The toll administration server shall synchronize the time of all workstations at central level and at all plazas.

2.5 Two numbers of high-speed laser printers shall be used for the production of hard copy. The laser printers shall be suitable for an A3 and A4 size printout at the speed of 30 pages per minute.

2.6 The HQCS 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.

3. Particular Design Parameters

3.1 The TCC systems shall support multi-task, multi-operations functions so that the various requirements of the system can be carried out simultaneously with no perceivable delay to persons making inputs to the system.

3.2 When fully loaded under design conditions, approximately 40% spare capacity random access memory (RAM) shall be available for future enhancements or modifications to the programs. This takes account of manufacturer’s recommendations on usable capacity for efficient running of programs.

3.3 Not less than 40% spare capacity shall be provided for the program storage memory of the TCC equipments taking account, where necessary, of the manufacturer’s recommendations on usable capacity.

3.4 The hard disk capacity of the Database server shall be calculated taking account of the need to store the operating system, the application software and other software packages necessary for operation of the system and the data generated by the system to meet the storage of one (1) year. The Sub-Contractor shall indicate at time of submitting his Tender, the calculations by which the hard disk capacity is chosen.

3.5 The loading of the central processors shall be of the order of 50% when working in accordance with the Specification and assuming concurrent implementation of:-

- the system program for normal operation
- processing of on-demand display and print out function
- upload and validation process

3.6 The Sub-Contract shall indicate at time of submitting his Tender, the means by which he proposes to demonstrate that this requirement has been met.

3.7 Protection against the effects of lightning shall be incorporated at TCC terminals of data communication links. It is accepted that protection devices may require replacement after lightning strike and therefore these devices shall readily accessible. Once any necessary replacements have been carried out, no further maintenance shall be necessary before the system can be brought on-line. No loss of data shall occur as a result of the effects of lightning.

3.8 All VDU shall be the minimum of 17 inches LCD Flat screen.

3.9 Each terminal shall have a full QWERTY keyboard which incorporates group of numerical keys for data entry and dedicated, programmable function keys and a mouse.

3.10 The computer hardware including printers and display terminals shall be readily available in Hyderabad, India. 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 are not connected with the Contractor, his agent or Sub-Contractors.

3.11 The Database server of the HQCS shall have an integral real time clock that shall be used for the timing of all reports, print-outs, data transfer and the like. Once set the clock shall remain accurate to within 2 seconds in one calendar month. In the event of power failure to the HQCS, the real time clock shall be maintained by its own internal battery.

3.12 Time signals shall be used for the automatic recording of date in the form DD/MM/YYYY (e.g. 13/01/2009). Years shall be automatically adjusted with arrangements made for leap years up to at least the year 2040. All times shall be displayed and printed in 24 hour format.

3.13 The system should have sufficient growth capabilities that allow for protection of investment in software and hardware. The software acquired should be capable of running on all the models in the range of equipment offered. The equipment proposed should have an adequate growth path in terms of increasing the power of the CPU, the capacity of external disk storage, and number of attachable peripherals, as well as additional CPUs.

3.14 The latest model/version of hardware/software at the time of award of works shall be provided / implemented.

3.15 The Sub-Contractor shall utilize a reputable RDBMS for the management of Database at the HQCS. All RDMBS tables shall be organized exactly in the same format as that of PCS except for bank in data that shall be a new RDMBS table at the HQCS.

3.16 The software shall be designed so that there is no noticeable delay between the operator action of event and subsequent display on screen, printout, backup and other activities.

3.17 Communication between TCC and every PCS will be carried out via fiber optic network.

4. Detailed Functional Requirement

4.1 The HQCS application shall consist of the following modules:-

- Parameter
- Traffic
- Plaza Activity
- Revenue
- Badge
- Maintenance
- System
- Incident
- Reports
- Intercommunication with Sub Control Room

5. Selection Criteria Definition

5.1 The following defines the various types of selection requirements in the HQCS:-

No	Criteria	Description
1	Lane Type	Manual, Touch & Go, ETC
2	Period Type	Daily, weekly, monthly, yearly
3	Payment Type	Cash, T&G, ETC, Exempt, IOU, HPMC
4	Day Type	Monday to Sunday
5	Job Type	Normal or maintenance
6	Collection Type	Lane or POS
7	Badge Type	ETC Tag, T&G Card, transit card
8	Transaction Type	Sale, reload, modification, replace, return
9	Travelling Journey	Different phases on ORR

6. Parameter Maintenance

6.1 The functions available in this module are:-

(i) Enquiry/Reporting
(ii) Maintenance of parameter tables

6.2 The parameter tables managed under this module are:-

(i) Access Level Setup
(ii) Authorized Magnetic Cards
(iii) Automatic Print Out
(iv) System Constant
(v) Staff List
(vi) Fare Table
(vii) Versions
(viii) Blacklist for Payment Cards
(ix) Class Axle
(x) Currency Denomination
(xi) Auto Reload
(xii) Acceptable Bank
(xiii) Badge Price
(xiv) Blacklist

- Blacklist Badge
- Blacklist Badge Reloading

(xv) Valid Serial Number
(xvi) Remarks

6.3 Maintenance function allows the addition and editing of the parameter tables. The versions of the tables shall automatically define by the respective parameter counters and shall increment in single step. Editing of parameter table version numbers shall be prohibited.

6.4 Revision number table is generated automatically by the system when any of the tables is modified and subsequently downloaded.

6.5 Each Plaza shall have its unique set of parameter tables.

6.6 Overwriting of a revision previously downloaded/transferred is not allowed. Instead, a new revision will be available for editing.

6.7 Enquiry/Reporting function allows the display/printing of parameter table for the selected range of dates and revision number.

7. Traffic Management

7.1 This function provides statistics for traffic at every plaza and regeneration of traffic from collected revenue based on traffic trends.

7.2 The traffic management function allows the operator to obtain traffic data based on the required time period, location, vehicle class and lane specified under the selection criteria available on every screen.

7.3 A Traffic Chart screen shall be made available to provide graphic and charting functions for analysis purposes. At a minimum, the type of charts/graphic provided shall be as follows:-

- Bar chart (Horizontal and Vertical)
- Pie chart
- Line chart
- Histogram

7.4 The traffic chart 'attribute' and 'chart data' function shall allow the operator to select or omit data selected for graphic representation to simplify or enhance the display of the required charts. Option to display legend, values and axis naming used in a particular chart shall be provided. Different shades and colors shall be used to clearly distinguish the chart display.

7.5 The period type field under the selection criteria shall be daily, weekly, monthly and yearly, according to the selection criteria definition. As such, the sub-contractor shall ensure that the data length for traffic values shall be sufficient to display and print fully under all criteria.

7.6 This facility allows the traffic to be generated based on:-

- Reference dates for traffic
- Bank in amount

7.7 Traffic regeneration with reference date different from collection date. The following is the regeneration method for the above:-

a) Bank in revenue of the collection date multiplied by cash revenue percentage (%) of the reference date by class divided by the toll fare for the class:

A - Bank in of collection date
B - Cash revenue % by class of reference date
C - Toll fare by class
Traffic = (A x B)/C
Class revenue = Cash traffic for each class of vehicle x C

b) The computation of the cash traffic & revenue is illustrated below:-

A = 360,000 INR.

	Class 1	Class 2	Class 3	Class 4	Total
B	80%	10%	5%	5%	100%
C	20	40	60	80	
Traffic	7,000	2000	1000	1000	11000
Cash Revenue	140,000	80,000	60,000	80,000	360,000

7.8 Cash Traffic regeneration for reference date = collection date: The following is the regeneration method for the above for cash traffic and cash revenue:

a) Sum of EOJ traffic by class of collection date add difference in the bank in revenue and computer generated revenue from the toll collection system of the collection date multiplied by cash revenue percentage of collection date by class divided by the toll fare for the class:-

F = Sum of EOJ traffic by class
G = Difference of bank in revenue and computer generated revenue
H = Cash revenue percentage by class of reference date
I = Toll fare by class
Traffic = F + (G X H)/l
Cash revenue = Traffic X I

b) The computation of the traffic & revenue is illustrated below:-

Bank in of collection date = 360,000
Computer Generate Revenue = 359,000
G = Difference = 1,000

	Class 1	**Class 2**	**Class 3**	**Class 4**	**Total**
H	80%	10%	5%	5%	100%
G x H	80,000	10,000	5,000	5,000	-
I	20	40	60	80	-
(G x H)/I	4000	250	84	62	-
F	3,000	1,750	917	938	6,604
Traffic	7,000	2,000	1,000	1,000	11,000
Cash Revenue	140,000	80,000	60,000	80,000	360,000

7.9 Regeneration of traffic of other payment types: For the traffic of other payment types the regeneration will replace the collection date traffic with the reference date traffic.

7.10 Replacement of actual traffic/revenue: The operator will have the option to replace the actual traffic/revenue with regenerated ones.

7.10 The calendar screen shall function to provide information on type of day (e.g. holiday, festivals) for traffic trends required under the traffic regeneration processes. The regeneration of traffic shall give priority to the calendar information and shall regenerate traffic accordingly. In the case where a specified date is not recorded in the calendar, the regeneration function shall process the input revenue based on the traffic trend on non-special day traffic.

8. Plaza Activity

8.1 The primary functions available in this module are:-

(i) Enquiry/Reporting
(ii) Audit reporting of maintenance activities
(iii) Status

8.2 Enquiry/Reporting function performs the display and printing of the following:-

(i) List of Job
(ii) End of Job
(iii) Transactions
(iv) Display Criteria
(v) Plaza Activity Summary
(vi) POS Collection Summary
(vii) Daily POS Transaction Summary
(viii) POS List of Jobs
(ix) POS End of Job
(x) POS Transaction
(xi) Collection Performance Summary
(xii) Exceptional Transaction Summary
(xiii) Plaza Performance Evaluation

8.3 The display of End of Job for both Lane and POS shall include the possibility to zoom into the Individual Transactions of the same job or to the List of Job where another job can be selected.

8.4 Enquiry/Reporting function allows the display/printing for selected date, plaza, lane, job, badge, bag no, transaction number, transaction time, bag no. where applicable.

8.5 The Plaza Activity Display Criteria screen shall provide additional selection filters for the lane Individual Transaction screen. The additional selection filters are based on two criteria namely the observation of events at lanes and payment type. The logical control between the two criteria may also be specified as an 'OR' or 'AND' function. The logical control between the three categories under observation of events namely payment monitoring, sequence and passage shall be an 'OR' function.

9. Revenue

9.1 The functions available in this module are:-

(i) Revenue by Class Traffic
(ii) LOJ Revenue by Class Traffic
(iii) Monthly Revenue

(iv) Computed Revenue Summary
(v) Declared Revenue Summary
(vi) Cash Reconciliation
(vii) Bank-in History
(viii) Bank-in Reconciliation
(ix) Revenue Recovered/Refunded
(x) Miscellaneous Revenue

9.2 The entry of data for Bank-in Reconciliation consists of the following: -

(i) Data entry of bank-in slip/total bank-in for a collection date under 'Modify Bank Count'
(ii) Zooming into cash collection facility
(iii) Zooming into plaza TOD declaration

9.3 The following data are to be entered:-

a) The amount bank-in by the bank for each collector daily

b) The total bank-in per bank-in slip

c) If discrepancy occurs between declared and bank-in, the operator will be prompted and there will be an option to proceed or abort. If the operator proceeds, there is a remark column that has to be filled to indicate the reason for discrepancy.

9.4 The Revenue Outstanding Amount Recovered/Refunded screen shall provide a facility to record and print revenue recovered or refunded during operation of the toll collection system. The data entered, deleted or edited shall not affect all other reports or screens provided in the HQCS.

9.5 The Miscellaneous Revenue screen shall provide a facility to record and print other sources of revenue from other services such as towing, repairing etc other than collection of toll. The data entered, deleted or edited shall not affect all other reports or screens provided in the HQCS.

10. Badge Management

10.1 This module allows the operator to manage and keep track of badge stock at HQCS or PCS and the usage of badge under single accounts.

10.2 The functions available in this module are:-

(i) Stock Management

- Stock-in from Manufacturer
- Badge Transfer to Plaza
- Badge Deletion
- Transfer History
- Stock Master

(ii) Single Management

- List of Single Accounts
- Single User Information
- Single User Transactions History
- Balance Report
- Transaction Statement Printing

(iii) Fleet Management

- List of Corporate Accounts
- Corporate Account Information
- Corporate Account Badge Listing
- Corporate Transaction History
- Balance Report

10.3 Under the stock master screen, the operator shall be able to obtain the current badge stock at all sale and storage location.

10.4 The single and fleet management module shall allow the operator to:-

- List all active or inactive accounts/badge
- View user account/ badge information
- Query the transaction history of each badge
- Obtain list of accounts/badge with a required minimum balance
- Printing of account/badge statement

10.5 During implementation, the Turnkey Contractor / Concessionaire shall finalize and provide the statement print out format to the Sub-Contractor. The format shall be incorporated into the TCC system.

10.6 The Badge Single Management Statement Print screen shall allow the operator to print statements for individual or batch of accounts/badge.

11. System Administration

11.1 This module shall allow the operator to administer the TCC system through management of data and parameter including verification of data. It is expected that the TCC shall receive data via fiber optic network on a continuous basis from all plazas and provide completed statistical data on end of every operational day.

11.2 This module has the following functions:-

- Copy Parameter for PCS
- Load PCS Data to HQCS
- Backup HQCS Data
- Restore HQCS Data
- Backup HQCS Parameter

- Restore HQCS Parameter
- Data Upload Verification
- Data Verification

11.3 It is envisaged under unforeseen circumstances that the fiber optic network may fail to allow transmission of data. Under such circumstances, the 'Copy Parameter for PCS' function shall enable the operator to transmit manually via DAT or disks the new parameters for every PCS. Similarly, the 'Load PCS Data to HQCS' function shall enable the operator to load data from every PCS to the HQCS.

11.4 The 'Copy Parameter for PCS' and 'Load PCS Data to HQCS' functions shall not in all circumstances result in deletion or duplication of HQCS and PCS data. The PCS and HQCS systems shall be capable of segregating and distinguish the newly inserted data from other data already located in the database and files to avoid duplication or deletion of data.

11.5 The 'System Data Upload Verification' screen shall provide a means for the operator to check and verify the status of data upload at the HQCS. The information on this screen shall be updated automatically at least once daily on every operational day.

11.6 The number of jobs for lane and POS shall be determined at plaza level and shall be transmitted as 'data' to the HQCS. It shall not be a value calculated at the HQCS. On the contrary, the number of jobs at HQCS for lane and POS shall be determined at the HQCS.

11.7 The 'System Data Verification' screen shall provide the operator a checking facility to verify the status of summary data at the PCS and at the HQCS. The information on this screen shall be updated automatically at least once daily on every operational day.

11.8 The summary data shall be determined at plaza level and shall be transmitted as 'data' to the HQCS. It shall not be a value calculated at the HQCS. On the contrary, the summary data at HQCS shall be determined at the HQCS.

12. Incident

12.1 This module shall provide facility to record and generate statistics on incidents occurred on the highway. The incidents shall be defined by the operator and may be under the following categories:-

- Breakdown
- Landslide
- Floods
- Accidents
- Earthquake
- Typhoon

All information or data entered and generated by this module shall be independent from other module.

13. Reports

13.1 This function shall provide facilities to generate print-outs for reports under a specified selection criterion. All information entered and generated by this module shall be independent from other module.

14. Organization of Database

14.1 Data files to be organized with a RDBMS at the HQCS shall be such to enable: -

- Efficient retrieval of information for display and production of reports
- Identical RDBMS table as PCS
- Methodical storage space management

14.2 With retrieval of data by various selection criteria including any combination of at least the following:-

- Range of dates
- Range of plaza
- Range of job number
- Range of lanes
- Range of badge number
- Range of bag number

E. SPECIFICATION OF TOLL COLLECTION SYSTEM

1. Scope

1.1 The document describe the general requirement, functional requirement and technical requirement of Electronic Toll Collection System to be used as a sub-system of Toll Collection System

2. Function

2.1 The ETC lanes shall provide for regular users a facility whereby tolls may be collected via deduction of Smart Card purse accurately and reliably while reducing dramatically the time taken for each transaction. This objective shall be achieved by way of the toll registration process being totally automatic and not requiring the vehicle to stop to make payment.

2.2 The Sub-Contractor shall provide robust and durable ETC lane equipment with minimal maintenance to the requirements of the Specifications. The ETC system shall be based on the principles of read / write technology.

2.3 The ETC equipment operation shall include two (2) component parts for their namely ground equipment or the antenna, installed in each lane, and the on board unit, which is a ‘tag’ or transponder with smart card insertion installed within vehicles which are entitled to use the lane. The communication between the ground equipment and the tag shall employ 5.8GHz microwave dedicated short-range communication link (DSRC) as per ISO/IEC 8802-2, ISO 15628 and ISO 14906

2.5 The ETC system shall be able to manage a complete sequence of read/write transaction with minimum of 1000 vehicle per hour. The Sub-Contractor shall, in the presence of the Turnkey Contractor or Supervising Consultant, demonstrate and provide the necessary evidence relating to the operation and completeness of the transaction performed by the ETC lane equipment under the specified requirements.

2.6 The accuracy of the system shall exceed 99.99% (9999 out of 10000 transactions) of the transactions between the OBU and the ETC lane equipment. The ETC lane equipment shall include adequate protection against cross lane transactions.

2.7 Comprehensive measure shall be taken to prevent occurrence of double deduction in all circumstance or exceptional events. It is expected that the ETC lane system shall be capable to prevent double deduction and operate continuously as normal in the following events in the lane at the minimum:-

- Violation
- Force Reset
- Two or more badge / tags in the detection lobe at the same time

2.8 The Sub-Contractor shall provide all mounting brackets, fixing and accessories necessary to complete the installation of all lane equipment.

3. Equipment Architecture and Reliability

3.1 The ETC lane equipment shall be based on multi-processor system architecture with separate processors being used to control well-defined modules. These processor controlled modules shall be connected to an executive control module which shall coordinate and schedule the activities of the individual module processors and handle all data communication with the PCS.

3.2 Each individual control shall be connected to the executive control module either by a recognized serial communication channel or by a standard network communication.

3.3 Sufficient spare capacity shall be provided in the executive control processor in terms of physical circuitry, connection points, software construction and processing power to allow the subsequent connection of at least three further modules, including implementation of the future optional facilities which may be required by the Turnkey Contractor during the life of the equipment. The Sub-Contractor shall describe, at time submitting his Tender, the architecture of the proposed ETC lane equipment and the means by which additional modules may be interfaced to the executive control processor.

3.4 The documentation provided under the Sub-Contract shall be sufficient in every respect to allow the Turnkey Contractor to implement such future expansion of the ETC lane equipment without resource to the Sub-Contractor, his Sub Sub-Contractors or agents should be so wish.

3.5 Each processor shall monitor the operation and availability of items under its direct control. Detected errors or failures shall be relayed to the executive control processor and from there to the plaza computer system. Failure of any one module shall not affect the operation of any other modules as far as is practicable, and shall not prevent the processing of transactions and recording of data in as far as they are not dependent on that module.

3.6 The equipment and its software shall be designed so that there is no noticeable delay between a transaction sequence of the antenna with the OBU or event which relates to the equipment and its confirmation being either on the TCT display and/or on signs and ancillary equipment connected to the executive control module. The equipment shall be designed to allow the continuous recording and processing of transactions as described in this Specification.

3.7 Notwithstanding the above, the following parameters shall relate to the ETC lane equipment including those options which are taken up by the Turnkey Contractor:

3.8 The various processors shall perform checks on the integrity of their associated memory on power-up, on initial connection to other processors and thereafter on a regular basis. In the event of a failure being detected, an error message shall be relayed from the relevant module to the PCS via the executive control module, if appropriate, and the particular module shall be assumed to be faulty.

3.9 The MTBF of the ETC lane equipment as an entity shall be not less than 5000 hours or the passage of 100,000 vehicles whichever is greater and the MTTR shall be not more than 60 minutes from of attendance on site with a range of replacement modules to restoration of normal shall be assumed to be faulty.

4. ETC Lane Controller

4.1 The ETC lane equipment shall comprise lane control computer complete with interface board, keyboard, lane peripherals, readers and communication modules neatly housed in a steel enclosure. The Sub-Contractor shall at the time of tender indicate the manner of maintenance of the lane controller and the requirement of maintenance facilities such as maintenance screen, keyboard and mouse.

4.2 The internal arrangement of components with regard to the division of circuitry within the lane controller shall be determined by the Sub-Contractor but shall be consistent with the requirements of the Specification with respect to modularity and access for the maintenance purposes.

4.3 Enclosure shall be of stainless steel sheet and shall be of pleasing style and appearance. The working surface of keyboards and other areas subject to frequent handling shall be brushed finish stainless steel or other resistant material to the approval of the Turnkey Contractor or the Supervising Consultant.

4.4 The following items of equipment at the minimum shall be neatly accommodated within the lane controller cabinet:-

- (i) A ‘lane open’ and ‘lane closed’ control.
- (ii) Indication to show that equipment at the minimum shall be neatly accommodated within the lane controller cabinet:-
- (iii) Terminal, keyboard and mouse for man-machine interface.
- (iv) Lane control computer with a removable media or USB storage drive.
- (v) Interface with all lane peripherals.
- (vi) Readers and communication modules associated with antenna.

4.5 All displays and indications shall be clearly visible under all ambient lighting conditions.

4.6 All necessary ventilation, cooling and dust filtering equipment shall be fitted within the lane controller cabinet to form self-contained units. It is essential that the need for filter changing shall be reduced to a minimum and therefore cooling is to be achieved by recirculation as far as practicable. The Sub-Contractor shall provide details of the necessary ventilation, cooling and the dust filtering arrangements at time of submitting his Tender. The Sub-Contractor’s attention is drawn to the environmental conditions at lane level.

4.7 All items necessary for the autonomous operation of the ETC lane equipment as required by the Specification shall be accommodated within lane controller equipment cabinet. All data relating to the jobs, transactions and alarms shall be kept in the lane controller for a minimum of thirty (30) days.

4.8 The antenna shall be used to broadcast and receive signals from OBU’s and shall have symmetrical read pattern which confine coverage to a single lane width. Vehicle with valid OBU and card shall encounter the antenna and on reading the valid OBU and card, the ALB will be opened for passage of vehicle. Information read from OBU and card shall include but not limited to the following:

- OBU ID
- Card no
- Card type
- Card Expiry
- Vehicle Class
- Last Transaction
- Card purse

The date/time of transaction, plaza/lane number shall be written onto the card during the communication process.

4.9 The Sub-contractor shall provide all mounting brackets, fixings and accessories necessary to complete the installation of the antenna.

4.10 Other than the requirements specified above the ETC Lane Controller shall:

a) Be the controller of all lane equipment.

b) Receive detection of vehicle approaching in the lane from the Lane Peripherals.

c) Read the card data in the ETC tag inside the vehicle's windscreen via the ETC Transceiver.

d) Verify that the card data by checking a blacklist. If the card number is found in the blacklist the ETC tag is not valid.

e) Calculate the fee based on the entry and exit plaza and vehicle class read from the card.

f) Verify that the card balance read from the card is sufficient to cover the fee to be charged.

g) Display the transaction result on the User Fare Display.

h) Open the Automatic Lane Barrier and turn the Lane Traffic Light to green if successful transaction.

i) Close the Automatic Lane Barrier and turn the Lane Traffic Light to red when the vehicle has passed the barrier.

j) Send an alarm to the Plaza Computer System in case a vehicle is detected in the lane and no successful transaction has been performed within 10 seconds.

k) Record and store the transaction and passage data.

l) Record and store the transaction and passage statistics

m) Send transaction and passage data and statistics to the Plaza Computer System via the local area network using TCP/IP messages.

n) Receive configuration data from the Plaza Computer System at start-up.

o) Receive blacklist and reload data from the Plaza Computer System at start-up, and the blacklist and reload list shall be updated whenever the Plaza Computer System sends data to the ETC Lane Controller.

p) Receive 'lane open' and 'lane close' commands from the Plaza Computer System and the ETC Lane Controller shall operate the Overhead Traffic Light (OTL) accordingly.

q) Have a user interface for access of operators and maintenance personnel. The access shall be protected to a sufficient level.

r) Have alarm handling and status check for its replaceable parts.

s) Receive alarms from all lane equipment and report any alarms to the PCS.

t) Regularly check the status of itself and the lane equipment, and report status to the PCS.

4.11 The ETC Lane Controller hardware shall be of Industrial PC-type with enough processing capacity to perform ETC transactions in less than 200 ms. The ETC Lane Controller operating systems shall be a commercially available real-time operating system.

5. ETC TAG

5.1 The ETC Transceiver (antenna) shall communicate with the ETC tag and card placed inside the wind screen of the passing vehicles.

5.2 The ETC Tag shall be 2 piece tags consist of tag and ISO/IEC14443A card.

5.3 The ETC Tag shall communicate with the ETC Transceiver (Antenna) using microwaves at 5.8 GHz frequency complying to the standards and specifications for dedicated short-range communication (DSRC).

5.4 The ETC Tag shall be delineated:-

No.	Descriptions	Remarks
1.	OBU Type	2 piece (Applicable to ISO/IEC14443A IC card)
2.	Communication Type	Active
3.	Frequency	5.8GHz
4.	Application Interface	ISO/IEC14906
5.	Modulation	ASK
6.	Transmission Data Rate	1,024kbps
7.	Power supply	Battery cell

5.5 A blacklist card can be either one of the single users or the fleet user type. In both cases, the lane controller shall process the transaction in the same manner as if it is a normal card except shall trigger an audible alarm at the Toll Supervisor Desk and at the plaza, like any other irregular transactions described here below. The exit barrier shall remain lowered and a message given on the User Fare Display given to instruct the driver to wait.

5.6 Whenever the local controller detects a vehicle through the entry loop detector but not the presence of a readable tag, an audible alarm shall be generated at the Toll Supervisor Console and at the plaza, the exit barrier shall remain lowered and a message given on the Toll Fare Indicator given to instruct the driver to wait.

6. ETC Transceiver (Antenna)

6.1 The ETC Transceiver shall communicate with the ETC tags placed inside the windscreen of the passing vehicles.

6.2 The ETC Transceiver shall communicate with the ETC tags using microwaves at 5.8

GHz frequency complying with the standards and specifications for dedicated short-range communication (DSRC).

6.3 The ETC Transceiver may be mounted overhead in the middle of the lane on a gantry or at other positions proposed by the Sub-Contractor and acceptable to the turnkey contractor to allow optimum performance of the ETC lane system.

6.4 The specifications of the Antenna should be as follows:

No.	Descriptions	Remarks
1.	Weight	25kg or less
2.	IP Protection Rating	IP54
3.	Power	AC100V/200V±10%, 50Hz/60Hz
4.	Power Consumption	40VA or less
5.	Communication Type	Active
6.	Frequency	5.8GHz
7.	Transmitter Power	6.3mW or less
8.	Modulation	ASK
9.	Transmission Data Rate	1,024kbps
10.	Operating Ambient Condition	-10^0 C to $+50^0$ C

7. Data Communication with Plaza Computer System

7.1 All lane controllers shall be interfaced to the PCS installed in the Supervision Building at each plaza via a Local Area Network (LAN). Data shall be transmitted from and stored by the lane controllers at various times during collection activities so as to allow compilation of audit and statistical data and monitoring of lane operation and equipment status. The following information shall be both stored by the lane controller on an individual event basis and transferred to the PCS in real time under normal operating conditions:

- System status and operational status including alarms
- daily traffic and revenue data
- job information
- hourly traffic statistics
- individual transactions
- exceptional events (violations, lane closure, ALB manual opening etc)

7.2 The data storage available within the lane equipment shall be sufficient to store the above data for a minimum period of 90 days in operation. The data shall be sufficient to allow all requirements of the Specification to be met with respect to monitoring, report generation, data transfer to the PCS. The length of time for which data is retained by elapsed time.

7.3 The lane controller and its peripherals shall include comprehensive automatic testing routines that shall be implemented on a frequent basis during all periods when power is available to the equipment. Any detected fault condition shall be reported to the

PCS within one second of it being detected.

7.4 It is recognized that there will be occasions when either the PCS system is off-line or data communication between one or more lane controller and the PCS is not possible. Under these conditions the lane controller shall continue to store data for later transmission to the PCS. During prolong data communication failure, data can be extracted from the lane equipment using removable media and subsequently transferred to the PCS.

7.5 The lane controller shall include an internal real time clock which shall receive date and time synchronization from the PCS on a regular basis in any event no less than once in every hour. The equipment shall use data from its real time clock to drive the clock display on the terminal of the lane controller and for time flagging of events and data. In the event of PCS failure, the lane controller shall continue to update its own internal clock from the last synchronization data received. The accuracy of the lane equipment clock under such conditions shall be to within + 1 minute per month. When data communication with the PCS is restored, the manual lane equipment shall assume the date and time advised by the PCS. Means shall be provided to allow authorized personnel to set up and adjust the time assumed by the lane controller in the event of data communication with the PCS not being possible.

7.6 Transaction within a job/shift shall be allocated a 4 digit serial number starting at 0001 and being incremented for each transaction during that job. The Sub-Contractor's attention is drawn to the need for various data to be identified by job/shift, day (Operational and calendar) and serial number for monitoring and recording purposes.

7.7 The lane controller shall receive operating parameters from the PCS. These shall at the minimum include:

- Fare tables with date and time of implementation
- badge list (five digit identity number and single digit to indicate personnel level)
- plaza identity code (three digits and three characters)
- payment type
- acceptable card/tag
- blacklist of card

Downloading of operating parameters shall be completed within 30 seconds under all circumstances.

7.8 Operating parameters received from the PCS shall be stored in secure read-write memory modules which allow the integrity of stored data to be maintained for a minimum of 90 days under power fail conditions. Checks shall perform on the integrity of the memory at regular intervals and, if necessary, the lane equipment shall request the PCS to retransmit these data to ensure their validity. The content of this read-write memory shall be refreshed at least once every 24 hours. The proposed method of providing this storage of operating parameters shall be stated by the Sub-Contractor at time of submitting his Tender.

7.9 Toll fare tables giving toll rates for each classification shall be held in the form of two tables, one current and one future, together with a date and time for implementation of the future table. In the event of no future rates being defined both tables shall contain the same data for security. Routines in the lane equipment shall ensure that once a change in toll rates has been implemented, data relating to previous rates is deleted from memory.

7.10 The additional fare table shall be in a matrix form and as far as applicable including all toll plazas compatible to the ETC system. The Sub-Contractor shall take into account interoperability of the ETC system and shall include toll plazas of all sections of ORR and all possible routes of the origin plaza to the next plaza in the table regardless of which section.

7.11 Each authorized member of staff will be identified by a five digit identify number. This number will be part of the data encoded on the badge cards as details elsewhere in this specification. Associated with each personnel number will be a further single digit number that identifies the authorization level of individual. The authorization level is not encoded on the identity card to facilitate rapid re-designation of staff. A minimum of nine levels of authorization are to be available, identified by digits 1 to 9. One of these levels shall be allocated to maintenance facilities as described elsewhere in this specification.

7.12 The removable media drive installed in the lane controller allows updating of operating parameters when the lane equipment is unable to communicate with the PCS.

8. Maintenance Facilities

8.1 A maintenance mode shall exist for the ETC lane equipment which will allow full operation of the equipment with the lane control signal showing closed, irrespective of the status of the various controls and interlocks. The maintenance mode shall be entered when authorized badge cards, similar to those used by collectors but with the identify number being relevant to the maintenance access level. Are used to enable the equipment.

8.2 Details of all ‘transaction’ performed in maintenance mode shall not be included in summary data files produced by the PCS but ‘end of job’ files, clearly identified as relating to maintenance mode, shall be available in respect of each period of operation. All monitoring facilities shall be available in maintenance mode.

8.3 Once maintenance mode has been entered, special test facilities shall be available via the keyboard of the console that shall assist in routine testing or fault diagnosis. The

Sub-Contractor shall submit full details of the facilities available at time of submitting his Tender.

F. SPECIFICATIONS FOR LANE LEVEL

1. Toll Lane Controller (TLC)

1.1 **General**: This specification lays down the general, functional and technical requirements of Lane Controller to be used as a sub-system in Integrated Toll Collection System at the Toll Plaza.

1.2 **Function**: The Lane Controller is used to control and monitor all the sub systems and peripheral equipment of the toll lane. The TLC controller is located in the tollbooth. It houses the Lane computer, peripheral coordination circuitry, and power protection blocks. It acquires the lane data and transmits to the server database in real time.

1.3 **System Configuration**: The system located at the toll booth consists of the following

- CPU and power supply
- Serial Data Communication ports
- Digital I/O ports
- Power distribution panel with lightning protection circuit
- Terminal blocks
- Relays
- LAN port
- IP65 enclosure with high security locking mechanism

1.4 **General Requirement**

- The system shall be modular with 8 channels Input / Output Card
- Dimensions: Not to exceed 1000mm x1000mm x300

1.5 **Technical Specifications**:

No.	Descriptions	Remarks
1.	Make	Vendor Specific
2.	Dimension	1000mm (H) x 1000mm (W) x 300mm (D)
3.	Weight	Should be less than 35 KG
4.	Installation and Fixing Details	Mounted on the floor/wall
5.	Cables	Power cable / Data cable
6.	Material	Stainless Steel Only
7.	Finishes	SS
8.	Color	Steel Finish
9.	Power Supply Requirement	240 V AC , 50 / 60 H z
10.	Access for maintenance, modularity of construction	Access through cabinet door with cables well identified and terminated
11.	Environmental Considerations	0^0C to 70^0C Operating Temperature, 240Vac, 50/60Hz

2. Lane Computer (LC-IPC)

2.1 **General**: Lane Computer is a part of the lane controller. It is fitted inside the Lane Controller. It acquires all the data from the lane peripherals and transmits them to the PCS in real time.

2.2 **Technical Specifications**:

No.	Descriptions	Remarks
1.	TYPE	Industrial Grade Computer Only
2.	Dimension	Approx 196mm (W) x 405mm (D) x 230mm (H)
3.	Weight	10.4 kg
4.	Installation	Mounted Inside the Lane Controller
5.	Cables	Power Cable UTP cable
6.	Cable routes	- Power cable and data cable are laid inside separate sub ducts in the provided manhole from the Supervision Building to the individual booth manhole. - The cables are respectively terminated from the UPS for power cable and switch for UTP cables
7.	Material and Finishes	Standard Product
8.	Color	Manufacturer's Original Color
9.	Power Supply	Operating: 230 V AC, 50 Hz. ATX
10.	Access for maintenance, modularity of construction	Minimal maintenance, off-the-shelf product
11.	Environmental Considerations	0^{0}C to 50^{0}C Operating Temperature
12.	Approvals	Included in the product
13.	Design Criteria	Pentium IV,3.0 GHz Processor 512 MB RAM Minimum 80 GB HDD Two (2) USB ports One (1) parallel port One (1) serial RS 232 port One (1) serial card (8 port RS232) model: MOXA C 168 RJ-45 network port Two (2) PS/2 ports (keyword and mouse Network Interface – PCI Ethernet 10/100 Mbps Operating System: Windows XP Embedded, Service Pack 2 Application Software: Lane Soft, Antivirus Software (Client) link to Server Overall MTBF: 30,000 hrs Overall MTTR: 0.5 hrs – 1 hrs

3. TOLL COLLECTOR DISPLAY (TCD)

3.1 **General**: This specification lays down the general, functional and technical requirements of the toll collector display to be used as a sub-system in Integrated Toll

Collection System at the Toll Plaza.

3.2 **Function**: The Toll Collector Display (TCD) is located on the toll collector's desk. It is the system's interface to the toll collector, to display the status of transactions and status of the lane peripherals.

3.3 **Technical Specifications**:

No.	Descriptions	Remarks
1.	Maker	Samsung or equivalent
2.	Display Type	TFT with Diagonal Size of 15" Minimum
3.	Installation and Fixing Details	Installed on the toll collector desk without fixing
4.	Cables	Power Cable 1 x VGA Cable (15- pin HD D – Sub)
5.	Cable routes	- Power cable is terminated to the Termination Block via booth ducting - VGA Cable is terminated to the SVGA Port at the LC via booth ducting
6.	Color	Manufacturer's Original Color
7.	Voltage Requirement	AC 230 V (50 / 60 Hz)
8.	Power Consumption	80 W
9.	Access for maintenance, modularity of construction	Standard product, minor maintenance Required
10.	Operating Temperature	10^0C to 50^0C
11.	Relative Humidity	20 % to 80 %
12.	Design Criteria	- Max. Resolution: 1024 X 768 / 60 Hz - Aspect Ratio : 4:3 - Number of Colors : 16.2M, (6bit+FRC) - Video bandwidth: 70 MHz - Viewable size: 13.8" Minimum - MTBF: 30,000 hrs - MTTR: 0.25 hrs

4. Toll Collector Keyboard (TCK)

4.1 **General**: This specification lays down the general, functional and technical requirements of the toll collector Keyboard to be used as a sub-system in Integrated Toll Collection System at the Toll Plaza.

4.2 **Function**: The keyboard on the toll terminal is a standard Industrial PC keyboard or Industrial customized keyboard for Registration of toll operations. These keys will be used to enter data of:

- Badge number
- Vehicle Classification
- Type of Transaction
- Accept/Cancel Transaction
- Method of payments etc.

5. Receipt Printer (RPR)

5.1 **General**: This specification lays down the general, functional and technical requirements of the toll collector receipt printer to be used as a sub-system in Integrated Toll Collection System at the Toll Plaza.

5.2 **Function**: The thermal receipt printer (RPR) is used to print toll receipts.

5.3 **Technical Specifications**:

No.	Descriptions	Remarks
1.	Maker/Model	EPSON TM – 88 IV
2.	Dimension	145mm (W) x 195mm (D) x 148 (H)
3.	Weight	1.8 kg
4.	Installation and Fixing Details	Installed on the toll collector desk without fixing
5.	Cables	- Power cable - Serial RS232C/ Parallel
6.	Cable routes	Power cable is terminated to the LCS Termination Block via booth ducting. RS232 cable is connected to the LCS Multi port Serial Board / Parallel Port Of LCS
7.	Color	Cool White/Dark Grey
8.	Power Supply Requirement	24 VDC $\pm$ 7%
9.	Access for maintenance, modularity of construction	The cover can be opened for maintenance. It also has paper sensors. Off-the-shelf product
10.	Operating Temperature	5 ^{0}C to 50^{0}C
11.	Relative Humidity	5 % to 90 %
12.	Design Criteria	Print Speed: 47 LPS Print font: 9x17/12x24 Print column capacity: 56/42 columns
13		Character size (mm): 0.99(W) x 2.4 (H) / 1.41 (W) x 3.4 (H) Paper dimension (mm): 79.5 $\pm$ 0.5 (W) x 83 (diameter) Paper thickness: 0.06-0.07 mm Auto cutter life: 1.5 million cuts Real-time printer status: Auto status back (ASB) messages MCBF: 52 million lines MTBF: 360,000 hours Overall MTTR: 0.25 hrs

6. Contact Less Smart Card Reader

6.1 **General**: This specification lays down the general, functional and technical requirements of Contactless Smart Card Read/ Writers to be used as a sub-system in Integrated Toll Collection System at the Toll Plaza.

6.2 **Function**: The Contactless Smart Card Read/ Writers are used for managing electronic Toll collection in conjunction with a compatible Contactless Smart Card. The Contactless Smart Card Read/ Writer is linked to a micro-controller or a PC which is typically the lane computer. It allows the vehicle to pass through after a successful financial transaction.

6.3 **System Configuration**: Card reader/writer shall be "dual-package" type, having the antenna and the electronics controller in separate housings. The antenna should be installed on the booth wall from outside of the booth for vehicle drivers to reach easily and the controller should be kept inside the booth.

6.4 **Installation Requirement**: Two Contactless Smart Card Read/ Writers shall be installed on the right side of the lane along the Toll Plaza. The Orientation of the Contactless Smart Card Reader/ Writers shall be at a suitable heights to accommodate all types of vehicles e.g. separate readers for trucks/busses and car/jeeps. This is to ensure that a successful 'Read/Write' is achieved with a Contactless Smart Card.

6.5 **General Requirements**:

a) The reader shall have the ability to read the smart card from a distance, ranging from 0cm to 10cm, with a transaction time of less than 0.5 seconds for read/write.

b) Contactless Smart Card Read/Writers shall be wall mounting type

c) All transactions shall be secured with modern and industry standard cryptographic techniques or those based on DES / 3DES mechanisms to resist fraud and to deter theft or misuse.

6.6 **Technical Specifications**:

No.	Descriptions	Remarks
1.	Type	ISO 14443 A Type Reading/Writing
2.	Installation and Fixing Details	Mounted on the toll booth panel
3.	Cables	- Power cable - RS232 cable - Antenne cable: RG174 AU, 50 ohm
4.	Cable routes	- Power cable is terminated to the LCS Termination Block via booth ducting. - RS232 cable is connected to the LCS Multi port Serial Board via booth ducting - The Reader's antenna is connected to the reader controller via shielded cable
5.	Material and finishes	PVC sheet with Epoxy painted
6.	Color	Grey/Black
7.	Power Supply Requirement	Vendor Specific
8.	Access for maintenance, modularity of construction	Modular design. Minor maintenance required
9.	Operating Temperature	-10 to 70^{0}C with heat dissipation of < 3.5W
10.	Relative Humidity	5 % to 90 %
11.	Design Criteria	- Data Transmission Between MFGPR2: 106Kbaud - Card Operating Distance: 10 cm depending on antenna and operating environment - LCD modules: 2x16 - Reading, calculating and writing operations: 200ms - Read standard MIFARE card only - Interface Protocol: According to Vendor interface - Security Feature: According to standard security implementations or DES or 3DES

		- MTBF: 30,000 hrs - MTTR: 0.25 hrs

7. Contact Less Smart Card

7.1 **General**: This specification lays down the general, functional and technical requirements of Contactless Smart Card to be used along with Contactless Smart Card Read/ Writers as a sub-system in Integrated Toll Collection System at the Toll Plaza

7.2 **Function**: The Contactless Smart Card is used for storing money value for the purpose of Toll collection in conjunction with a compatible Contactless Smart Card reader/writer. The Contactless Smart Card allows the Reader/Writers to increment/ decrement user fee from the stored money value. It allows the vehicle to pass through after a successful financial transaction.

7.3 **General Requirement**: The Smart Card shall be able to store the money value in prepaid or post paid mode

7.4 **Technical Requirements**:

a) The card shall meet the ISO 14443 A standards for contactless smart cards.

b) The memory of the smart card shall be >=1KB

c) The card shall be warranted against defects in materials and workmanship for 3 years.

d) The Operating Temperature of the Smart Card should be -10° to 60° C.

8. Toll Fare Indicator or User Fare Display

8.1 **General**: This specification lays down the general, functional and technical requirements of User’s Fare Display Unit to be used as a sub-system in Integrated Toll Collection System at the Toll Plaza.

8.2 **Function**: The Fare Display Unit is a variable message sign, controlled automatically by the lane computer. It indicates to the road user the category of the vehicle and the amount payable.

8.3 **General Requirement**s: The following information are required to be displayed:

- Class / Category of the vehicle
- Amount charged
- Balance amount (In case of Smart Cards or ETC tags)

8.4 **System Configuration**: The system is equipped with Red or Yellow LEDs. The detailed technical specifications are as per below.

8.5 **Technical Specifications**:

No.	Descriptions	Remarks
1.	Display lines	2 lines with 20 Characters each
3.	Material and finishes	Mild steel painted with high strength powder coat
4.	Character height	60 mm at least
5.	Weight	5.0 kg
6.	Type of protection	IP54
7.	Temperature	0^0C to +55^0C
8.	Power Supply Requirement	240Vac at 20W
9.	Display – Text Message	5 x 7 dot matrix Red or Amber LEDs 2 lines x 20 characters, at least 60mm character height
10.	LED type	Ultra bright AllnGaP LEDs 8000mcd at 20mA, 30^0 viewing angle Suitable for outdoor condition under bright sunlight
11.	Communication Interface	RS232 (Standard Interface Protocol)
12.	Design Criteria	MBTF: 30,000 hours MTTR: 0.25 hrs

8.6 **Installation Requirement**: The Fare Display unit shall be installed outside the booth, near the payment window so that the road user will have clear view of the category of the vehicle and the fare payable.

9. Lane Traffic Light System

9.1 **General**: This specification lays down the general, functional and technical requirements of Traffic Light System to be used as a sub-system in Integrated Toll Collection System at the Toll Plaza.

9.2 **Function**: LED based light signal, installed at the toll lane towards the exit side shall be connected to the lane controller. The traffic sign glowing red indicates that the motorist has to stop and pay the user fee. After successful transactions, the traffic sign turns green and indicates the motorists to proceed towards the exit of the lane.

9.3 **Installation Requirement**: Traffic lights shall be installed on a pole of about 2 meter above the road surface on the right side of each lane. The contractor shall decide the appropriate height taking into account other equipments to ensure clear / unobstructed visibility and control through lane controller.

9.4 **General Requirements**:

a) The Traffic light system shall work in synchronization with the boom barrier.

b) The system shall have in-built night dimming function.

9.5 **Technical Specifications**:

No.	Descriptions	Remarks
1.	Size of the traffic light	Approx 200 mm diameter with sun visor
3.	Traffic Light Color	Industry standard red & green
4.	Housing Material	Corrosion resistant material
5.	Environmental protection	IP65
6.	Intensity	9000 MCD for Red Aspect 400 MCD for Green Aspect
7.	Operating Temperature	-10^0 C to $+65^0$ C
8.	Power Supply	230 +/- 10% V AC

10. License Plate Reader System

10.1 **General**: This specification lays down the general, functional and technical requirements of License Plate Reader (LPR) system to be used as a sub-system in Integrated Toll Collection System at the Toll Plaza.

10.2 **Function**: The System Scans and stores the License Plate Numbers of the vehicles passing through the toll lane.

10.3 **System Configuration**: The License plate Recognition System comprises of specialized LPR Camera, the Video interface card and the LPR software engine.

10.4 **Installation Requirement**: The LPR Cameras shall be installed in such a manner to capture the full and clear view of the Rear or Front number plates of the vehicle approaching the toll booth.

10.5 **General Requirements**:

a) The LPR system shall be designed to read, recognize and identify the vehicle as and when the picture acquisition system is triggered.

b) The Camera and Infra Red illumination units shall be housed in a single enclosure.

10.6 **Technical Specifications:**

a) Camera shall have:

- IR 2000 W Lamp
- IR Filter
- Lens (auto iris)
- Flash unit
- Low power consumption
- Synchronizing unit

b) The Video interface card shall be capable of:

- Handling both PAL and NTSC analog video signals.
- File handling BMP and JPEG

c) The LPR software engine shall have:

(i) Able to read two row plates

(ii) Able to read white characters on black background and black characters on yellow background

(iii) Able to give back the license plate as a text and all of the characters found on the image

(iv) The recognition engine should be adaptable (trainable) to recognize special characters or for a special environment

11. Overhead Traffic Light (OTL)

11.1 **General**: This specification lays down the general, functional and technical requirements of Overhead Traffic Light System to be used as a sub-system in Integrated Toll Collection System at the Toll Plaza.

11.2 **Function**: The overhead lane signals (OTL) shall be mounted on the leading edge of the canopy covering the toll lanes above the centre of the lane. The purpose of the OTL is to indicate to the User whether the toll lane is open or closed for the processing of vehicles. A red aspect is usually used to signal that the lane is closed, whilst a green aspect is usually used to indicate that the lane is open to traffic.

11.3 **General Requirements**:

a) The LEDs shall have Luminous Intensity of at Least 8000 MCD

b) Signs shall be sufficiently bright and directed to indicate to a motorist approaching the toll plaza, at a distance of 300m on a bright cloud free day that lanes are available for use.

c) The aspects shall be at least 300mm

d) The sign shall be fitted with a sun-hood to screen the effect of the sunlight

e) The enclosure of the OHLS shall be constructed from a corrosion resistant material. The enclosure shall have an IP65 rating and be ventilated to dissipate internal heat

f) The system shall have night dimming function

11.4 **Technical Specifications**:

No.	Descriptions	Remarks
1.	Dimension	Approx 740mm x 540mm x370mm
2.	Weight	15 kg
3.	Installation and Fixing Details	Fixed mounting on toll canopy
4.	Cables	- Power cable - Data cable
5.	Cable routes	- Power cable is laid inside the duct at toll Pillars. The cable is then laid inside the booth manhole before terminating to the Termination Block. - Data cable is connected to the LCS relay Board from the termination block.
6.	Material and finishes	Polycarbonate
7.	Lens Color	Red and Green with black cover
8.	Power Supply Requirement	230/2240Vac 50/60 Hz single phase
9.	Access for maintenance, modularity of construction	Require sky master for maintenance, modular design
10.	Operating Temperature	0^0 C to 50^0 C
11.	Relative Humidity	5%-90%
13.	Power Consumption	Less than or equal to 50W
15.	Protection Against the effects of lightning	Covered under LC Surge Protection
16.	Design Criteria	- LED: ultra Bright Out door type - MTBF: 18,000 hrs - MTTR: 0.25 hrs - 0.75 hrs

12. Automatic Lane Barrier

12.1 **General**: This specification lays down the general, functional and technical requirements of Automatic Boom Barrier to be used as a sub-system in Integrated Toll Collection System at the Toll Plaza

12.2 **Function**: The barriers are used to control the traffic through the lane. The operation of Boom Barrier is linked to the lane computer. It allows the vehicle to pass through after a successful financial transaction has happened at the lane.

12.3 **System Configuration**: The system consists of a fixed housing and a movable arm with a high impact breakaway device or provision. The housing shall contain the motor and control units.

12.4 **Installation Requirement**: The housing shall be installed on the left side of the lane, on a concrete base.

12.5 **Technical Specifications**:

No.	Descriptions	Remarks
1.	Make/Model	Magnetic MIB 20
2.	Dimension	350mm (L) x 350mm (W) x 1010mm (H)
3.	Weight	50 kg (without boom)
4.	Installation and Fixing Details	Fixed mounted on the toll island
5.	Cables	- Power Cable - Data Cable
6.	Cable routes	- Power cable is terminated to the Termination Block via island ducting - Data cable is connected from the termination block to the ALB Controller.
7.	Material and finishes	Housing made from 2mm thick zinc plated steel on stainless steel base frame
	Boom Length	3000 mm for standard lanes
	Boom Profile	Round Only
	Safety Detectors	Pair of Integrated Metal Detectors
	Duty Cycle	100%
	Open & Close Time	Non ETC lane = 0.9 Sec ETC Lane = 0.6 Sec
8.	Colour	Boom: Red and white RAL 9010 Housing: RAL 2000
9.	Power Supply Requirement	240VAC 50/60Hz single phase
10.	Operating Temperature	0 - 50^{0}C
11.	Relative Humidity	5%-90%
12.	Design Criteria	- MTBF: 2 Million Cycles or 2 years - MTTR: 0.25 hrs - 0.75 hrs

12.6 **General Requirements**:

a) The motor of the Boom shall be of type Inverter, DC or Torque motor Block able with:

(i) Low motor heat, Low electric and mechanic noise design;
(ii) Instant Reversibility;
(iii) Sinusoidal Lever Drive System;

b) Logic Control with Technology to:

(i) Ensure opening & closing timings remains constant under variation of wind speed
(ii) Acceleration, deceleration and smooth landing of boom without swaying at the end positions
(iii) Optimum acceleration and deceleration based on the data from motor sensors.

12.7 The Barrier shall be such that it can be stalled & reversed at any position and programmed to avoid bouncing & swinging out at end positions

13. Lane Camera

13.1 **General**: This specification lays down the general, functional and technical requirements of Snapshot Lane Camera to be used as a sub-system in Integrated Toll Collection System at the Toll Plaza.

13.2 **Function**: The camera installed at a convenient location is used to capture images of the following vehicles from behind:

- (i) If there is a class discrepancy between the classes detected by the AVC and that entered by the toll collector
- (ii) Exempt users
- (iii) All transaction of vehicle with special events
- (iv) Offending vehicles.
- (v) When the alarm footswitch is activated by the toll collector.
- (vi) Vehicles with Smart Card or ETC payments

13.3 **Installation Requirement**: Camera would be installed inside the housing at about 2m above the surface of the lane to allow the recording of the traffic in the lane. The contractor will decide the appropriate height according the other equipment installed on the island to ensure perfect record of the vehicle and its plate number.

13.4 **General Requirements**:

a) The housing will be equipped with a hood to protect the camera under direct sunlight.

b) Protection: IP65.

c) The stand of the lane camera shall be made in steel tube that will not swing or twist under gutter speed of strong wind. The stand will be protected from corrosive environmental conditions.

d) Alternatively the camera can also be installed on the booth wall appropriately to capture the image of the vehicle from behind along with the number plate indication.

13.5 **Technical Specifications**:

No.	Descriptions	Remarks
1.	Image Sensor	1/3" CCD with Night Vision
2.	Horizontal Resolution	525 Lines
3.	Sensitivity	0.0004 Lux
4.	Shutter Speed	1/100 ~ 1/100,000 sec
5.	AGC (In full)	Automatic with manual override
6.	White Balance	Automatic with manual override
7.	Operating Temperature	-10 deg C to 60 deg C
8	Video output signal range	VBS 1.0 V p-p
9	Video output impedance	75 Ohms
10	S/N Ratio	Less than 50 db

14. Panic Alarm System

14.1 **General**: This specification lays down the general, functional and technical requirements of panic alarm system to be used as a sub-system in Integrated Toll Collection System at the Toll Plaza.

14.2 **Function**: The Emergency Footswitch is located in each Toll Booth under the Toll Collector's Desk. The foot switch is provided for use in case of emergency or accident. Pressing the footswitch causes an alarm to be given to the supervisor via the LSDU & Siren. The siren is fitted on the top of the booth.

14.3: **Technical Specifications for Foot Switch**:

No.	Descriptions	Remarks
1.	Dimension	Approx 215mm (L)x100mm(W)x120mm(H)
2.	Weight	2.5 kg
3.	Installation and Fixing Details	Mounted on the floor inside the tollbooth
4.	Cables	- Power cable - Data cable
5.	Cable routes	- The power cable is laid inside the booth manhole before terminating to the LCS Termination Block. - Data cable is connected to the LCS DI board from the termination block
6.	Material and finishes	Steel
7.	Color	Manufacturer's Original Color
8.	Power Supply Requirement	220~240 V AC 50-60Hz with 10 A
9.	Access for maintenance, modularity of construction	Modular Design, only plug and replace when failed
10.	Environmental Considerations	Operating Temperature 0 - 50^{0}C
11.	Approvals	Included with the product
12.	Design Criteria	MCBF: 100,000 operations MTTR: 0.5 hrs

14.4 Technical Specifications for Siren:

No.	Descriptions	Remarks
1.	Technology	Motor Driven
2.	Audible rating	112 dB at 1 Mtr
3.	Hearing Distance	At least 300 mtrs
4.	Environmental	Designed to meet IP65

15. Booth Communication Unit (BCU)

15.1 **General**: This specification lays down the general, functional and technical requirements of booth communication unit to be used as a sub-system in Integrated Toll Collection System at the Toll Plaza.

15.2 **Function**: The function of BCU is for communication between the toll collector at the lane and the toll supervisor at the Supervision Building.

15.3 **General Requirements**:

a) Voice communication installed in the toll booths shall provide "hands free" two-way verbal communication between the supervision staff in the toll control room and the toll collectors. The toll collector shall be able to attract the attention of the Supervisor in the control room by pressing a single button on the intercom slave unit in the toll booth.

b) The equipment shall also have the facility to allow the supervision staff to monitor communication in the toll booth between the toll collector and the user or between any tollbooths without alerting the toll collector.

c) The voice communication system shall operate independently of the Lane Computer system.

d) Voice communication shall also be implemented in various rooms of the plaza building and at building access points.

e) Two-way communications shall be possible as soon as the Supervisor responds by selecting the appropriate lane button on the Master Communication unit

f) One-way communication shall be possible from the Control Room intercom to all lanes simultaneously (broadcast)

15.4 **Technical Specifications:**

No.	Descriptions	Remarks
1.	Model	Aiphone NA-A
2.	Dimension	142mm (W) x 169mm (H) x 74mm (D)
3.	Weight	700g
4.	Installation and Fixing Details	Fixed on the toll booth. (wall mount)
5.	Speech Method	Hands-free
6.	Wiring distance	420' with 33 AWG, 1000' with 18AWG
7.	Speaker	20 ohms
8.	Power Consumption	6 W (max.)
9.	Power Supply Requirement	Power supply from Master System
10.	Wiring	2 wires, non-twisted
11.	Environmental Considerations	Operating Temperature of 10^{0}C to 50^{0}C
12.	MTBF	30,000 hrs

16. Automatic Vehicle Classification System (AVC)

16.1 **General**: This specification lays down the general, functional and technical requirements of Automatic Vehicle Counter and Classifier (AVCC) System to be used as a sub-system in Integrated Toll Collection System.

16.2 **Function**: The AVC system shall be able to distinguish between classes as defined by HGCL. This class information shall be transmitted to the Lane Computer, and simultaneously to an independent database system, on completion of the post AVC classification. The Lane Computer shall check that this information matches the classification entered by the toll collector. If there is a discrepancy between the two classifications, the Lane Camera shall be triggered to capture a digital image of the vehicle. The digital image and discrepancy information shall be communicated to the supervisory console for further processing by the toll supervision staff.

16.3 **Installation Requirement**: The classification sensors can be any of the following types:

- Fiber-optic treadles
- Piezoelectric Treadles
- Electromechanical switch treadles
- Inductive loops
- Optical height sensors

16.4 The choice of classification sensors rests with the bidder. The bidder can propose any or a combination of above mentioned classification sensors. Further the system must achieve the AVC classification performance accuracy mentioned elsewhere in this document.

16.5 **Treadle Specifications:**

No.	Descriptions	Remarks
1.	Detection Area	40mm(W) x 36mm(H) x 1900mm(L) for 5M 40mm(W) x 36mm(H) x 1600mm(L) for 3M
2.	Sensor	Strictly as per above mentioned types
3.	Rubber Type	EDPM
4.	Tensile Strength	7.47Mpa
5.	Hardness (Shore)	80 ~ 85
6.	Frame Material and finishes	Base Frame: Mild steel (Thickness-min. 5mm). Coated with 2 layer of antirust epoxy. Top Plate: Stainless Steel
7.	Rubber Color	Black
8.	Power Supply Requirement	Standard as per make
9.	Access for maintenance, modularity of construction	All cables termination are well identified and have signal received indicator Modular design with low cost maintenance
10.	Environmental Considerations	Operating Temperature of 0 ~ 70^0C
11.	Sensor Type Of Protection	IP67
12.	Design Criteria	- Detectable Vehicle Speed: 90 km/h - Tolerable Pressure: 8 kg/cm^2 - Detection Accuracy: 100% - MTBF: 3 million axle passes - MTTR: 0.25 hrs – 2 hrs

16.6 Each lane shall be equipped with an AVC controller (different from the lane controller) interface to classification sensors.

16.7 **AVC Controller Specifications:**

No.	Descriptions	Remarks
1.	Dimension	< 600mm (H) x 600mm (W) x 250mm (D)
2.	Weight	< 35 KG
3.	Installation and Fixing Details	Mounted on the floor/wall
4.	Cables	Power cable / Data cable
5.	Material	Electro-galvanized steel sheets
6.	Finishes	SS only
7.	Color	Steel Finish
8.	Power Supply Requirement	240 V AC , 50 / 60 H z
9.	Access for maintenance, modularity of construction	Access through cabinet door with cables well identified and terminated
10.	Environmental Considerations	0^{0}C to 70^{0}C Operating Temperature 240Vac, 50/60Hz
11.	Design Criteria	RISC / ARM Microprocessor - Serial RS232 port Power Supply - Overall MTBF: 30,000 hrs, Overall MTTR: 0.5 hrs Controller Module Serial IO – 16 Isolated Inputs and 16 relay output - Relay interface for OTL, LTL and ALB - Overall MTBF: 30,000 hrs - Overall MTTR: 0.5 hrs RS232 interface Protection Circuit breaker Overall MTBF: 30,000 hrs Overall MTTR: 0.25 hrs – 1 hrs

16.8 The minimum specifications for the vehicle detector and height detector sensors would be as follows,

No.	Descriptions	Remarks
1.	Sensor type	Through beam
2.	Sensor Range	Between 10m to 20m
3.	Light source wavelength	Infrared LED
4.	Full Clad Housing	Outdoor MS.
5.	Power Supply Requirement	Vendor Specific
6.	Access for maintenance, modularity of construction	All cables termination are well identified and have signal received indicator Modular design with low cost maintenance.
7.	Environmental Considerations	Operating Temperature of 0 ~ 70^{0}C
8.	Sensor Type Of Protection	IP67
9.	MTBF	30,000 hrs

16.9 **Classifications Possible & Configurable**:

Class I – Light Vehicles
Class II – Light Commercial Vehicles
Class III – Truck with 2 axels
Class IV – Bus with 2 axels
Class V – 3 Axel Vehicles
Class VI – Multiaxel Vehicles
Class VII – Extra Large Vehicles

Class VIII – Two Wheelers

16.10 In case of network failure, the AVCC system shall function independently and store all data locally on a storage device. The data shall be sent to the independent database system via a separate data communication link which is different from the Toll Lane Controller.

16.11 The system shall be able to detect a vehicle entering the toll lane and moving in wrong direction.

a) AVCC processing unit

- Shall be a real-time processing unit
- Shall be the trigger source for Lane Camera system
- Shall have a local storage device capable of storing data for a period of at least 30 days.
- Shall have a standby power supply capable of operations for a period of at least 8 hours

b) System accuracy (calculated on a base of 10000 vehicles)

- For vehicle counting : 99.9 %
- For vehicle classification : 99.5 %

16.12 For calculating vehicle classification accuracy of the system only standard size vehicles will be considered. The following definitions will be used for the purpose of identifying a particular class of vehicle

a) A heavy vehicle is defined as a motor vehicle that has an height above first axle height of >= 2.4 meters and has two axles

b) A light commercial vehicle is defined as a motor vehicle that has a height above first axle of >= 1.97 meters and < 2.4 meters. And has two axles

c) A light motor vehicle is defined as a motor vehicle that has a height above first axle of <1.97 meters and has two axles.

d) Multi axle is defined as a motor vehicle that has a height above first

e) Axle of < 2.4 meters and has more than two axles.

f) The following type of vehicle are exempt from toll tax and shall not be Considered for the purpose of measuring classification accuracy:

- Motorcycle (having 2 wheels only)
- Three wheelers

However, these vehicles shall be considered for counting accuracy.

G. SPECIFICATIONS FOR CCTV

1. Surveillance camera inside the booths & Plaza

1.1 **General**: This specification lays down the general, functional and technical requirements of Closed Circuit Television (CCTV) system to be used at the Toll Plaza

1.2 **Function**: The System monitors the activities of booth operations in the toll plaza. It shall be able to monitor activities of the operator in the booths and the supervisory staff in the plaza control room and would be recorded on the Digital Video Recorder (DVR).

1.3 **System Configuration**: The system shall comprise:

a) At the Plaza
- PTZ Video Camera with Housing

b) Inside the booths:
- Dome Video Camera with Housing

c) At the Control centres:
- Monitor
- Digital Video Recorder

1.4 **Installation Requirement**: The video camera for the plaza surveillance would be mounted at the canopy level to acquire the full view of the plaza from above. Inside the booth the dome camera would be fitted such as to capture the activities of toll collector at the time of toll collection along with the view of paying vehicle. Inside the control room the cameras would be fitted at TOD site, cash room, inside the audit room and in the reporting room.

1.5 **General Requirements**:

a) The Video Camera shall be of dome type to avoid pilferage, be resistant to vandalism and be weather-proof.

b) The mounting and equipment housing shall be able to withstand adverse weather conditions and the Video Camera shall be capable of performing as per specifications under environmental specification as defined

c) The Video Camera and associated units shall be dust-proof and protected against water ingress.

d) The Video Camera mounting shall have easy accessibility for maintenance purposes while being protected from unauthorized access.

1.6 **Technical Specifications for Booth & Control Room Cameras**:

No.	Descriptions	Remarks
1.	Image Sensor	1/3" CCD Dome with night vision
2.	Dimension	Normal Dome
3.	Weight	0.24 kg
4.	Installation and Fixing Details	The equipment shall be mounted on the ceiling or wall of the booth
5.	Cables	- Power Cable - Video Cable
6.	Cable routes	- Power cable is terminated to the Power Distribution Board. - Video cable is connected from the Camera to the DVR.
7.	Material	Back Box and Surface Mount Ring: ABS Plastic Bubble: Polycarbonate
8.	Color	Manufacturer's Original Color
9.	Power Supply Requirement	Input Voltage: 12VDC or 24VAC,autosensing Power Consumption: 3 watts or less
10.	Access for maintenance, modularity of construction	Modular design. The casing can be opened for maintenance
11.	Environmental Considerations	0^{0}C to 49^{0}C Operating Temperature Indoor

1.7 **Technical Specifications for Plaza Surveillance Camera**:

No.	Descriptions	Remarks
1.	Image Sensor	1/4" CCD with Night Vision
2.	Horizontal Resolution	420/480 TV Lines
3.	Sensitivity	0.08 Lux
4.	Lens	F3.9 – 85.8 mm
5.	AGC (In full)	Automatic with manual override
6.	White Balance	Automatic with manual override
7.	Operating Temperature	-10 deg C to 60 deg C
8	Spherical Pan tilt	Continuous rotation
9	Pan Speed	6^{0} Per Second
10	Tilt Speed	3^{0} Per Second
11	S/N Ratio	Less than 50 db

1.8 **Technical Specifications for Monitor used in the Control Room**:

No.	Descriptions	Remarks
1.	Display size	42" Diagonal
2.	Resolution	1366 x 768 or better
3.	Contrast Ratio	1000:1 or better
4.	Brightness	1000 cd/sq m or better
5.	Input Signal	PAL, NTSE, SECAM, HD, DVD,VGA, SXGA

2. Digital Video Recorder

2.1 **Description:** The digital video recorder (DVR) is used for real time display, advanced recording capacity, video storage, intelligent search and connected via network.

2.2 Technical Specifications:

No.	Descriptions	Remarks
1.	Make/Model	Pacom XR-5116 or equivalent PC Version
2.	Dimension	DVR: 482mm(W) x 177mm(H) x 450mm(D) Monitor: 17" Flat Panel Color Monitor
3.	Weight	18 kg
4.	Installation and Fixing Details	The equipment shall be installed under/inside the Toll Supervision Console
5.	Cables	- Power Cable - Video Cable
6.	Cable routes	- Power cable is terminated to the Power Distribution Board. - Video cable is connected from the camera to the DVR.
7.	Color	Manufacturer's Original Color
8.	Power Supply Requirement	20 0 -2 40 V A C, 50 / 60 Hz
10.	Access for maintenance, modularity of construction	Modular design .Off-the-shelf product
11.	Environmental Considerations	5^0C to 40^0C Operating Temperature 20-85% RH
12.	Approvals	Included in product
13.	Design Criteria	- CPU: Manufacturer's Standard RAM: 256MB or more - HDD: 120GB (max. 4HDD), 7200 RPM recommended - VGA: 32MB (ATI series)
		- OS: Windows XP, Windows 2000, complete with application software - Video/Audio Input: 16CH - Video Output: PC and Analog Monitor - Display Speed: NTSC: Max. 480 fps, PAL: Max. 400 fps - Recording Speed: 352x240, NTSC: Max. 120 fps, PAL: Max. 100 fps - 704x240, NTSC: Max. 100 fps, PAL: Max. 80 fps - 704x480, NTSC: Max. 60 fps, PAL: Max. 50 fps - Resolution: 352x240, 704x240, 704x480 - Compression: MPEG-4 - Average File Size: 352x240: 1-5 KB, 704x240: 2-10 KB, 704x480: 4-20 KB - Sensor In/Relay Out: 4CH/4CH - LAN/MODEM: 10/100 Base T Ethernet/Modem - Remote Function: Live viewing, remote playback, file backup, event alarming - CD-RW/DVD-RAM: Internal/External, USB - MTBF: 30,000 hrs

H. SPECIFICATION FOR PLAZA LEVEL

1. Plaza Computer System (PCS) Server

1.1 **General**: This specification lays down the general, functional and technical requirements of Plaza Computer System Server Hardware System to be used as a sub-system in Integrated Toll Collection System.

1.2 **Function**: The server is placed at each of the plaza at the control room. The plaza server would be connected to the Control room workstations and the lane computers through a local area network.

1.3 **Technical Specifications**:

No.	Descriptions	Remarks
1.	Installation and Fixing Details	Server chassis should be rack mountable
2.	Cables	- Power Cable - Network Cable
3.	Cable routes	- The power cable is connected to an extension after the main cable is laid inside proper trunking from Power Distribution Board - The network cable is laid inside proper trunking below the plaza raised floor and connected to the plaza hub
4.	Material and finishes	Standard product
5.	Color	Manufacturer's Original Color
6.	Power Supply	2 units of hot plug redundant power supplies and cooling fans
7.	Access for maintenance, modularity of construction	Minimal maintenance required. Off-the-shelf product
8.	Environmental Considerations	Operating Temperature: 5^0C t o 3 5^0C
9.	Design Criteria	- Dual 3.0 GHz Intel Dual-Core Xeon processor - 2GB RAM (expandable to 32GB RAM) - Six units of 73 GB SCSI drive (15K RPM) - RAID 5 Storage controller supporting 8 hot plug SCSI (SAS) Drives Two Gigabit Network Adaptor (One Internal and One Standalone) Minimum 32MB Graphic Card (Nvidia or ATI Chipset) 1 x PCI Express x4 Slot 2 x PCI-X at 133Mhz 5 x USB Ports (Two at front, two at back and one internal) 1 x 72GB DAT Drive Rack mountable pointing device and keyboard Rack mountable 17" LCD Monitor - Optical Drive: 48X IDE (ATAPI) CD ROM /DVD RW - Interface I/O:1 x Parallel 1 x Serial 1 x Pointing Device (Mouse) 1 x Graphics 1 x Keyboard 2 x External SCSI 2 x Network RJ-45 - Operating System: Windows 2007 Server, - Database: Oracle 10g

		- Application: Toll software, Antivirus - MTBF: 30,000 hrs - MTTR: 0.5 hrs – 3 hrs

2. Client Workstation

2.1 **Description:** The Client Workstation is workstation for the following systems:

i) Lane status Display Unit
ii) Auditor Workstation (PCS Client)
iii) Tour of Duty (TOD)
iv) Point of Sales (POS)
v) CCTV Monitor workstation
vi) POS Workstation

2.2 **Technical Specifications**:

No.	Descriptions	Remarks
1.	Dimension	Standard Desktop chassis with Flat Panel Color Monitor: TOD – 15” PCS – 15” POS – 15” LSDU – 17”
2.	Installation and Fixing Details	Monitor and chassis shall be installed on the Supervisor table
3.	Cables	- Power Cable - Network Cable
4.	Cable routes	- The power cable is connected to an extension after the main cable is laid inside proper trunking from Power Distribution Board - The network cable is laid inside proper trunking below the plaza raise floor and connected to the plaza hub
5.	Material and finishes	Standard product
6.	Color	Manufacturer’s Original Color
7.	Power Supply	300w, 230 V
8.	Access for maintenance, modularity of construction	Minimal maintenance required. Off-the-shelf product
9.	Environmental Considerations	Operating Temperature: 5 C to 35 C
10.	Design Criteria	- Intel® Core™2 Duo 2.33 GHz Processor - 1GB RAM (expandable to 4GB RAM) - 120GB HDD drive Minimum - Network Card: PCI Ethernet 10/100/1000 Mbps Gigabit Network Adapter Minimum 32MB Graphic Card (Nvidia or ATI Chipset) - Diskette Drive: 3.5”, 1.44MB - Optical Drive: 48X IDE (ATAPI) CD-ROM & DVD RW Combo Interface I/O:1 x Parallel 1 x Serial 1 x Pointing Device (Mouse) 1 x Graphics

		1 x Keyboard 1 x Network RJ-45 4 x USB Ports - Monitor: Flat Panel - Operating System: Windows XP, Service Pack 2 - Application: Toll software, Antivirus - MTBF: 30,000 hrs - MTTR: 0.5 hrs – 3 hrs

3. Operations Printer

3.1 **Description:** The Operations printers are operated using a high-speed laser printer. The Operations printer is connected to the:

- Auditor Workstation (PCS)
- Lane Status Display Unit (LSDU)
- Tour of Duty (TOD)

3.2 **Technical Specifications**:

No.	Descriptions	Remarks
1.	Make/Model	HP LaserJet 2015 or better
2.	Installation and Fixing Details	Installed on the TOD and supervisor table
3.	Cables	- Power Cable - Network Cable
4.	Cable routes	- The power cable is connected to an Extension after the main cable is laid inside proper trunking from Power Distribution Board. - Printer cable is connected directly from the printer to the workstation
5.	Material and finishes	Standard product
6.	Color	Manufacturer's Original Color
7.	Power Supply	220-240 VAC ± 10% (50/60 Hz)
8.	Access for maintenance, modularity of construction	The cover can be opened to change the Toner. Off-the-shelf product
9.	Environmental Considerations	10^0C t o 35^0C
10.	Approvals	Included in product
11.	Design Criteria	- Printer speed: 27 pages/min - Print Resolution Black: 1200x1200 dpi - Processor Speed: 400 MHz - Paper handling standard: 250-sheet input tray, single-sheet priority input tray - Standard connectivity: USB port, IEEE 1284-B complaint parallel port

4. Master Communication Unit (MCU)

4.1 **General**: This specification lays down the general, functional and technical requirements of master communication unit to be used as a sub-system in Integrated Toll Collection System at the Toll Plaza.

4.2 **Function**: The master communication unit MCU is a master communication system to control communication between the toll collector at the lane and the toll supervisor at the Supervision Building. The unit will be located in the Plaza Control room and controlled by supervisor.

4.3 **Technical Specifications**:

No.	Descriptions	Remarks
1.	Model	Aiphone NEM-20
2.	Dimension	346mm (W) x 260mm (H) x 110mm (D)
3.	Power Source	24V DC
4.	Current Consumption	Max. 1A, 80mA in standby
5.	Communication	Push-to-talk at master station Hands free at sub
6.	Calling	LED and intermittent ringing tone at master until answered
7.	Frequency Response	770 – 6800Hz
8.	Total Harmonic Distortion	3% @ 1000Hz at 20 ohms
9.	Mounting	Wall or desk mount
10.	Wiring	2 conductor per sub station
11.	Wiring distance	42 0 ’ w it h 22 A W G, 10 00 ’ w it h 18 AGW
12.	MTBF	30,000 hrs

5. POS System

5.1 **General**: This specification lays down the general, functional and technical requirements of Point Of Sale system to be used as a sub-system in Integrated Toll Collection System at the Toll Plaza.

5.2 **Function**: The pos system is responsible to issue the smart cards and the tags to the clients. Typically the users would have to approach the nearest POS center for buying the subscription either for the Touch and Go smart cards or the ETC tags. The POS system typically would consist of POS workstations as described in earlier section, 14443 A smart card reader writer and the ETC antenna and ETC interface required for communicating with the POS workstation.

5.3 **Technical Specifications of Touch & Go Reader:**

No.	Descriptions	Remarks
1.	Type	ISO 14443 A Type Reading
2.	Installation and Fixing Details	Mounted on the POS Table
3.	Cables	- Power cable - RS232 cable - Antenne cable: RG174 AU, 50 ohm
4.	Cable routes	Power cable is terminated to the power distribution box output at the plaza. - RS232 cable is connected to the POS Workstation Multi port Serial Board - The Reader’s antenna is connected to the reader controller via shielded cable

5.	Material and finishes	PVC sheet with Epoxy painted
6.	Color	Grey/Black
7.	Power Supply Requirement	Vendor Specific
8.	Access for maintenance, modularity of construction	Modular design. Minor maintenance required
9.	Operating Temperature	-10 to 70^{0}C with heat dissipation of < 3.5W
10.	Relative Humidity	5 % to 90 %
11.	Design Criteria	- Data Transmission Between MFGPR2: 106Kbaud - Card Operating Distance: 10 cm depending on antenna and operating environment - LCD modules: 2x16 - Reading, calculating and writing operations: 200ms - Read standard MIFARE card only - Interface Protocol: According to Vendor interface - Security Feature: According to standard security implementations or DES or 3DES - MTBF: 30,000 hrs - MTTR: 0.25 hrs

5.4 **Technical Specifications of ETC Antenna**:

No.	Descriptions	Remarks
1.	Weight	25kg or less
2.	IP Protection Rating	IP54
3.	Power	AC100V/200V±10%, 50Hz/60Hz
4.	Power Consumption	40VA or less
5.	Communication Type	Active
6.	Frequency	5.8GHz
7.	Transmitter Power	6.3mW or less
8.	Modulation	ASK
9.	Transmission Data Rate	1,024kbps
10.	Operating Ambient Condition	-10^0 C to +50^0 C

6. POS Receipt Printer

6.1 **Description:** The thermal receipt printer (RPR) is used to print POS transaction receipt.

6.2 **Technical Specifications:**

No.	Descriptions	Remarks
1.	Make/Model	EPSON U 220 Family
2.	Dimension	160mm (W) x 248mm (D) x 139mm (H)
3.	Weight	2.3 kg
4.	Installation and Fixing Details	Installed on the POS desk without fixing
5.	Cables	- Power Cable - Serial RS232C /Parallel
6.	Cable routes	- Power cable is terminated to the Plaza Distribution box - RS232 cable is connected to the POS workstation at Multi port Serial Board

7.	Color	Manufacturer's Original Color
9.	Power Consumption	24 VDC + 7%
10.	Access for maintenance, modularity of construction	The cover can be opened to change the cartridge. Off-the-shelf product
11.	Operating Temperature	5^0C to 50^0C
12.	Relative Humidity	5%-90%
13.	Design Criteria	- Print speed: 4.7 LPS - Print font: 7x9/9x9 - Print column capacity: 40/42 columns - Character size (mm): 1.2(W) x 3.1(H) / 1.6(W) x 3.1(H) - Paper dimension (mm): 57.5,69.5,76 x 83 (diameter) - Paper thickness: 0.06-0.085mm - Real-time printer status: Auto status back (ASB) messages - MCBF: 52 million lines - MTBF: 360,000 hours - Overall MTTR: 0.25 hrs

I. SPECIFICATIONS FOR TCC LEVEL

1. TCC Servers

1.1 **General:** The TCC equipments shall be provided in ORR Traffic Control Room and the sub Control room to monitor the operation of all PCS and to provide audit control and statistical data relating to all the plaza operations.

1.2 **Function:** The principle functions of the TCC shall be to:-

(i) Receive data from PCS. The data shall be from Manual, POS and ETC
(ii) Allow input of Bank-in data
(iii) Correlate data from PCS and bank-in into summary and statistical reports and files
(iv) Produce archive disks containing data files that may be further processed off-lined.
(v) Allow maintenance of operation parameters at TCC and subsequent
(vi) Download to all PCS.
(vii) Allow regeneration of traffic
(viii) Allow to update the Sub control center.

1.3 **Description:** TCC shall comprise but not limited to the followings:-

- Database server (TCC Server)
- Local Area Network (LAN)
- Financial Management Workstations
- Snapshot Image Server

- TCC Monitoring Workstation
- High speed laser printer

1.4 The TCC Server shall be configured as a two node cluster with a primary and a stand by node (where only one node will be active at any given time). The currently active node will host the toll administration processes. In the event of a serious hardware or software problem on the primary node, the clusters will failover to the secondary node, whereby the secondary node will become the active node. In this situation, the TCC processes and database will be stopped on the primary node, and will be restarted on the secondary node. Note, that failover can also happen from secondary node back to primary node (often called failback).

1.5 The shared RAID disk array is a storage device for when the TCC server reaches the limits of its internal storage capacity; it is a data storage scheme that divides and replicates data among multiple hard drives. It offers, depending on the scheme, increased data reliability and I/O performance. The RAID array device shall be used to set RAID levels 0, 1, 5, 10 and 50 and to expand storage to multiple terabytes in a variety of computing environments.

1.6 The Tape Backup servers are available for daily system backup. The servers use an Autoloader to automatically change tapes. The tape format is DAT, with a capacity of 160GB.

1.7 There is a requirement of two servers, one primary server and one stand-by server. The toll administration server shall synchronize the time of all workstations at central level and at all plazas.

1.8 Each of the two servers in the cluster shall meet or exceed the following minimum requirements

1.9 **Technical Specifications**:

No.	Descriptions	Remarks
1.	Installation and Fixing Details	Rack Mountable chassis
2.	Cables	- Power Cable - Network Cable
3.	Cable routes	- The power cable is connected to an extension after the main cable is laid inside proper trunking from Power Distribution Board. - The network cable is laid inside proper trunking below the TCC raise floor and connected to the plaza hub.
4.	Material and finishes	Standard product
5.	Color	Manufacturer's Original Color
6.	Power Supply Requirement	AC 230 V (50/60 Hz)
7.	Access for maintenance, modularity of construction	Minimal maintenance required. Off-the-shelf product
8.	Environmental Considerations	Operating Temperature: 50^0C t o 350^0C
9.	Design Criteria	- Dual 3.0 GHz Intel Dual-Core Xeon Processor DVD+R/W Drive 8GB RAM (expandable to 32GB RAM)

		Ten units of 73 GB SCSI drive (15K RPM) Two Gigabit Network Adaptor (One Internal and One Standalone) 1 x 160GB DAT Drive 2 units of hot plug redundant power supplies and cooling fans Rack mountable pointing device and keyboard Rack mountable 17" LCD Monitor Microsoft Server 2007 Database software Antivirus

1.10 **Raid Disk Array**: The Raid Disk Array must have or exceed the minimum requirements:

(i) Disk drive: Up to 10 no's of 146GB;
(ii) Back panel connectors: 68 pin shielded P type SCSI for connection to host;
(iii) Backplane board connectors: fourteen 80 pin SCA 2 connectors;
(iv) Three (3) status LED indictors for power supply status, power supply fault, and AC status and two for cooling module fault;
(v) The RAID disk array can be mounted directly into a rack.

1.11 **Tape Backup Server**: The Tape Backup Server must meet or exceed the following minimum requirements:

- Dual Intel Dual Core Processors, 2.4 GHz minimum;
- 2 GB RAM;
- 2 x 72GB Hard Drives, RAID 1, Hot swap;
- Dual Power Supplies;
- Windows Server 2007 Standard Edition;
- Ultra 160 SCSI Interface (for Autoloader); and
- Dual Gigabit NIC

1.12 **Tape Auto Loader**: It shall meet the minimum requirements:

- Autoloader with minimum 8 slots
- Interface Ultra 160 SCSI and,
- Tape format DAT minimum (160GB) compressed capacity per tape.

1.13 **Image Snapshot Server**: It shall meet or exceed the following minimum requirements:

- Dual Intel Dual Core Processors, 2.4 GHz minimum;
- 2 GB RAM;
- 2 x 240 GB Hard Drives, RAID 1, Hot swap;
- Dual Power Supplies;
- Windows Server 2007 Standard Edition;
- Dual Gigabit NIC

2. TCC Workstation

2.1 **General**: This specification lays down the general, functional and technical requirements of TCC workstations to be used as a sub-system in Integrated Toll Collection System at the Toll Plaza.

2.2 **Function**: The workstations at the TCC would be used for

- TCC Monitoring
- Financial Management
- Image Snapshot workstation

2.3 **Technical Specifications**:

No.	Descriptions	Remarks
1.	Dimension	Standard Desktop chassis with Flat Panel Color Monitor: 17" for TCC, Financial and 19" for image snapshot workstation.
2.	Installation and Fixing Details	Monitor and chassis shall be installed on the TCC operator tables
3.	Cables	Power Cable / Network Cable
4.	Cable routes	- The power cable is connected to an extension after the main cable is laid inside proper trunking from Power Distribution Board - The network cable is laid inside proper trunking below the plaza raise floor and connected to the plaza hub
5.	Material and finishes	Standard product
6.	Color	Manufacturer's Original Color
7.	Power Supply	300w, 230 V
8.	Access for maintenance, modularity of construction	Minimal maintenance required. Off-the-shelf product
9.	Environmental Considerations	Operating Temperature: 50C t o 350C
10.	Design Criteria	- Intel® Core™2 Duo 2.33 GHz Processor - 1GB RAM (expandable to 4GB RAM) - 120GB HDD drive Minimum - Network Card: PCI Ethernet 10/100/1000 Mbps Gigabit Network Adapter, Minimum 32MB Graphic Card (Nvidia or ATI Chipset) - Diskette Drive: 3.5", 1.44MB - Optical Drive: 48X IDE (ATAPI) CD-ROM & DVD RW Combo - Interface I/O:1 x Parallel 1 x Serial 1 x Pointing Device (Mouse) 1 x Graphics 1 x Keyboard 1 x Network RJ-45 4 x USB Ports - Monitor: Flat Panel - Operating System: Windows XP Pro, Service Pack 2 - Application: Toll software, Antivirus - MTBF: 30,000 hrs - MTTR: 0.5 hrs – 3 hrs

3. TCC Operations Printer

3.1 **Description**: The Operations printers are high-speed A3/A4 size black laser printer. The TCC operations printers are connected to the LAN of TCC.

3.2 **Technical Specifications**:

No.	Descriptions	Remarks
1.	Make/Model	HP LaserJet Series
2.	Dimension	19.3 x 23.6 x 15.9 in
3.	Weight	73 lb
4.	Installation and Fixing Details	Installed in the TCC operations tables
5.	Cables	Power Cable / Network Cable
6.	Cable routes	- The power cable is connected to an Extension after the main cable is laid inside proper trunking from Power Distribution Board. - Network cable is connected from the L2 switch of the TCC Lan.
7.	Material and finishes	Standard product
8.	Color	Manufacturer's Original Color
9.	Power Supply	220-240 VAC ± 10% (50/60 Hz)
10.	Access for maintenance, modularity of construction	The cover can be opened to change the toner. Off-the-shelf product
11.	Environmental Considerations	0^0C t o 45^0C
12.	Approvals	Included in product
13.	Design Criteria	- Printer speed: 35 pages/min - Print Resolution: 1200 x 1200 dpi - Processor Speed: 460 MHz - Paper handling standard: Input: 850-sheet input 3 trays, single-sheet priority input trays - Standard connectivity: 1 IEEE-1284 parallel, 1 USB, 1 EIO, 1 JDI 10/100

4. Clearing House Server

4.1 **Description**: The clearing house equipments shall be provided in ORR Traffic Control Room and the sub Control room to monitor the operation of all ETC transactions and to provide validation and blacklist control for the Touch & Go cards and OBUs. The principle functions of the POS Server shall be to:-

(i) Receive data from plaza POS systems.

(ii) Produce archive disks containing data files that may be further processed off-lined.

(iii) Allow maintenance of operation parameters of POS systems and subsequent Download to all plaza POS systems.

(iv) Allow regeneration of ETC traffic

(v) Allow to update the Sub control center.

4.2 The clearing house Server shall be configured as a two node cluster with a primary and a stand by node (where only one node will be active at any given time). The currently active node will host the toll administration processes. In the event of a serious hardware or software problem on the primary node, the clusters will failover to the secondary node, whereby the secondary node will become the active node. In this situation, the clearing house processes and database will be stopped on the primary node, and will be restarted on the secondary node. Note, that failover can also happen from secondary node back to primary node (often called failback).

4.3 The shared RAID disk array is a storage device for when the TCC server reaches the limits of its internal storage capacity; it is a data storage scheme that divides and replicates data among multiple hard drives. It offers, depending on the scheme, increased data reliability and I/O performance. The RAID array device shall be used to set RAID levels 0, 1, 5, 10 and 50 and to expand storage to multiple terabytes in a variety of computing environments.

4.4 The Tape Backup servers are available for daily system backup. The servers use an Autoloader to automatically change tapes. The tape format is DAT, with a capacity of 160GB.

4.5 There is a requirement of two servers, one primary server and one stand-by server. The toll administration server shall synchronize the time of all workstations at central level and at all plazas.

4.6 Each of the two servers in the cluster shall meet or exceed the following minimum requirements

4.7 **Technical Specifications:**

No.	Descriptions	Remarks
1.	Installation and Fixing Details	Rack Mountable chassis
2.	Cables	Power Cable / Network Cable
3.	Cable routes	- The power cable is connected to an extension after the main cable is laid inside proper trunking from Power Distribution Board - The network cable is laid inside proper trunking below the TCC raise floor and connected to the plaza hub
4.	Material and finishes	Standard product
5.	Color	Manufacturer’s Original Color
6.	Power Supply Requirement	AC 230 V (50/60 Hz)
7.	Access for maintenance, modularity of construction	Minimal maintenance required. Off-the-shelf product
8.	Environmental Considerations	Operating Temperature: 50C t o 350C
9.	Design Criteria	Dual 3.0 GHz Intel Dual-Core Xeon Processor DVD+R/W Drive 8GB RAM (expandable to 32GB RAM) Ten units of 73 GB SCSI drive (15K RPM) Two Gigabit Network Adaptor (One Internal and One Standalone) 1 x 160GB DAT Drive 2 units of hot plug redundant power supplies and cooling

		fans Rack mountable pointing device and keyboard Rack mountable 17" LCD Monitor Microsoft Server 2007 Database software Antivirus

5. Raid Disk Array

5.1 **Description:** The Raid Disk Array must have or exceed the minimum requirements:

a) Disk drive: Up to 10 no's of 146GB;

b) Back panel connectors: 68 pin shielded P type SCSI for connection to host;

c) Backplane board connectors: fourteen 80 pin SCA 2 connectors;

d) Three (3) status LED indictors for power supply status, power supply fault, and AC status and two for cooling module fault;

e) The RAID disk array can be mounted directly into a rack.

6. Tape Backup Server

6.1 **Description:** The Tape Backup Server must meet or exceed the following minimum requirements:

- Dual Intel Dual Core Processors, 2.4 GHz minimum;
- 2 GB RAM;
- 2 x 72GB Hard Drives, RAID 1, Hot swap;
- Dual Power Supplies;
- Windows Server 2007 Standard Edition;
- Ultra 160 SCSI Interface (for Autoloader); and
- Dual Gigabit NIC

7. Tape Auto Loader

7.1 **Description:** The tape autoloader shall meet the minimum requirements:

- Autoloader with minimum 8 slots
- Interface Ultra 160 SCSI and,
- Tape format DAT minimum (160GB) compressed capacity per tape.

8. Clearing House Workstations

8.1 **Description:** These workstations are used in the TCC room for performing the clearing house routine activities.

8.2 Technical Specifications:

No.	Descriptions	Remarks
1.	Dimension	Standard Desktop chassis with Flat Panel Color Monitor: 17" for TCC, Financial and 19" for image snapshot workstation.
2.	Installation and Fixing Details	Monitor and chassis shall be installed on the TCC operator tables
3.	Cables	- Power Cable - Network Cable
4.	Cable routes	- The power cable is connected to an extension after the main cable is laid inside proper trunking from Power Distribution Board - The network cable is laid inside proper trunking below the plaza raise floor and connected to the plaza hub
5.	Material and finishes	Standard product
6.	Color	Manufacturer's Original Color
7.	Power Supply	300w, 230 V
8.	Access for maintenance, modularity of construction	Minimal maintenance required. Off-the-shelf product
9.	Environmental Considerations	Operating Temperature: 50^0C t o 350^0C
10.	Design Criteria	- Intel® Core™2 Duo 2.33 GHz Processor - 1GB RAM (expandable to 4GB RAM) - 120GB HDD drive Minimum - Network Card: PCI Ethernet 10/100/1000 Mbps Gigabit Network Adapter Minimum 32MB Graphic Card (Nvidia or ATI Chipset) - Diskette Drive: 3.5", 1.44MB - Optical Drive: 48X IDE (ATAPI) CD-ROM & DVD RW Combo Interface I/O:1 x Parallel 1 x Serial 1 x Pointing Device (Mouse) 1 x Graphics 1 x Keyboard 1 x Network RJ-45 4 x USB Ports - Monitor: Flat Panel - Operating System: Windows XP Pro, Service Pack 2 - Application: Toll software, Antivirus - MTBF: 30,000 hrs - MTTR: 0.5 hrs – 3 hrs

9. Clearing House Operations Printer

9.1 **Description:** The Operations printers are operated using a high-speed laser printer. The Operations printer is connected to the workstation.

9.2 Technical Specifications:

No.	Descriptions	Remarks
1.	Make/Model	HP LaserJet Series
2.	Dimension	19.3 x 23.6 x 15.9 in
3.	Weight	73 lb
4.	Installation and Fixing Details	Installed in the TCC operations tables
5.	Cables	- Power Cable - Network Cable
6.	Cable routes	- The power cable is connected to an Extension after the main cable is laid inside proper trunking from Power Distribution Board. - Network cable is connected from the L2 switch of the TCC Lan.
7.	Material and finishes	Standard product
8.	Color	Manufacturer’s Original Color
9.	Power Supply	220-240 VAC ± 10% (50/60 Hz)
10.	Access for maintenance, modularity of construction	The cover can be opened to change the toner. Off-the-shelf product
11.	Environmental Considerations	0^0C t o 45^0C
12.	Approvals	Included in product
13.	Design Criteria	- Printer speed: 35 pages/min - Print Resolution: 1200 x 1200 dpi - Processor Speed: 460 MHz - Paper handling standard: Input: 850-sheet input 3 trays, single-sheet priority input trays -Standard connectivity: 1 IEEE-1284 parallel, 1 USB, 1 EIO, 1 JDI 10/100

ANNEX 7 CASE STUDIES FOR HIGHWAY OPERATION AND MANAGEMENT

A. National Highway Projects

INTRODUCTION

The National Highways Authority of India (NHAI) was constituted by an act of Parliament, the National Highways Authority of India Act, 1988. The Authority was operationalized in February, 1995 with the appointment of full time Chairman and other Members

It is responsible for the development, maintenance and management of National Highways entrusted to it and for matters connected or incidental thereto. The status of National Highway Development Programme (NHDP) is indicated below.

Table A7.1 Status of NHDP (as of December 2008)

	NHDP					Port connec-tivity	Others	Total by NHAI
	GQ	NS – EW Ph. I & II	NHDP Phase III	NHDP Phase V	NHDP Total			
Total Length (Km.)	5,846	7,300	12,109	6,500	31,755	380	962	33,097
Already 4-Laned (Km.)	5,704	3,083	613	63	9,463	206	737	10,406
Under Implementation (Km.)	142	3,238	1,462	967	5,809	168	205	6,182
Contracts under Implementation (No.)	15	134	31	2	182	8	15	205
Balance length for award (Km.)	-	821	10,034	5,470	16,325	6	20	16,351

Source: NHAI

The central government has introduced significant policy changes in the last two years that have acted as enablers in increasing private investment in the NHDP. These initiatives are based on the global experience which suggests that an enabling policy and institutional framework is a must for success of PPPs in the roads sector, Significant amongst these is the introduction of the standard bidding documents and the mandatory use of the MCA (Model Concession Agreement) in project awards. As a result, private investment in the union government's programme has increased by almost 60 per cent in the last two years.

At the state-level, although private investment is currently low, key initiatives have been taken to mobilize private investment in the future. These include setting up of PPP cells, introduction of enabling policies, formulation of a list of projects to be awarded in the near future, etc. Consequently, a large number of projects with high investment values are being awarded to private players by state governments.

This section provides details on the new concession award process and the MCA of the union government, legal and institutional initiatives taken by the state governments, trends in private investment at the central and state levels, and the expected private investment.

APPRAISAL/CLEARANCE OF NATIONAL HIGHWAY PROJECTS ON A PPP BASIS

The Standing Finance Committee under the chairmanship of the Secretary, Department of Road Transport and Highways appraises PPP projects with costs greater than $25 million but less than $125 million.

The PPP-AC (Public Private Partnership Appraisal Committee) under the chairmanship of the Secretary, DEA and Secretaries of the Planning Commission, Department of Expenditure, Department of Legal Affairs, and Department of Road Transport and Highways as members appraises projects with costs of $125 million and above. The PPP-AC examines the memo in a specified format, the deviations from the MCA, the feasibility study and DPRs, and the bid documents.

STANDARD BIDDING DOCUMENTS AND PROCESS

In December 2007, the union government standardized the bidding documents for road projects to be awarded on a PPP basis. The process is divided into two stages the REQ (Request for Bid) and RFP (Request for Proposal) stages. This process is based on international best practices to speed up the bidding process and to make the process transparent. Such a bidding process is followed even in contracts awarded by the World Bank and the ADB. This system is also used in the award of power projects, refinery projects, etc. in India.

The REQ document, the first stage of the bidding process, evaluates the technical and financial capability of the bidders for pre-qualification for the final stage. This stage does not require significant expenditure. The document limits the number of bidders to be pre-qualified and shortlisted for the final stage of bidding. It states that 6, 7 and 10 concessionaires are pre-qualified for 1, 2 and 3 projects respectively based on their experience score and net worth. The number is large enough to ensure that there is adequate competition as well as small enough to ensure that serious bidders are not dissuaded from investing in a competitive PPP bid as the zone of consideration is large.

A stringent eligibility criterion has been put in place at the first stage to ensure that bidders are well suited for the RFP stage and to effectively reduce the number of bidders. The criterion for short listing bidders is based on technical and financial parameters.

The technical capacity of a bidder is measured through construction work undertaken or commissioned by him and from revenues of BOT/build-operate-lease-transfer /build-operate-own/build-own-operate-transfer projects or from both, during the five years preceding the application date. The capital cost of the projects undertaken by him should be more than Rs 500 million. Eligibility conditions, as necessary, may also be stipulated in respect of O&M experience.

The financial capacity is measured by the net worth of the applicant. Applicants should have a minimum net worth equivalent to 25 per cent of the estimated capital cost of the project for which bids are to be invited. In the case of projects with an estimated cost of Rs 10 billion or more, the requirement of net worth could be reduced, but should not be less than 15 per cent.

The members of the consortium, who claim experience or net worth in the REQ, must hold at least 26 per cent of the consortium's equity. This condition is necessary for ensuring that only the experience of those members who have a substantial stake is counted for the purpose of pre-qualification, and members with small equity holdings are not added with the sole objective of improving the ranking in pre-qualification.

The project authorities can make necessary substitutions in the REQ as per the project and sector requirements. The provisions within the square brackets can be changed. Flexibility has also been extended through explanations in the footnotes. In case any further flexibility is needed for a specific sector or project, the required modifications may be made with prior approval of the PPP-AC.

The RFP is the second stage of the bidding process wherein the pre-qualified bidders of the first stage submit their financial bids. The bid is valid for a period of not less than 120 days from the bid due date. The bidder is also required to deposit a bid security equivalent to 1 per cent of the estimated project cost, along with its bid. This security is refunded not later than 60 days from the Bid Due Date except in the case of the [lowest/highest] bidder whose bid security shall be retained till it has provided a performance security under the concession agreement. This bid security can be extended in the form of a demand draft or bank guarantee.

After evaluation of the financial bids, the project is awarded to the applicant with the lowest/highest bid, as the case may be.

IMPLEMENTATION OF STANDARD BIDDING DOCUMENTS

The first batch of projects as per the standard bidding documents was awarded in February 2008. Five projects involving six-laning of 881 km of national highways under Phase V of the NHDP were awarded at a cost of $1,859 million.

Pre-qualification of a limited number of concessionaires is attracting large multinational companies which are bidding in JVs with Indian players. For instance, out of 5 projects awarded under Phase V, 4 have been awarded to JVs between foreign and Indian companies. Only one project has been awarded to an Indian company.

Table A7.2 Projects Awarded on Standard Bidding Documents under Phase V of the NHDP

Stretch	Concessionaire	Equity of Foreign Partner (%)	Nationality
Chennai-Tada (NH-5)	L&T	-	Indian
Gurgaon-Jaipur (NH-8)	Emirates Trading Agency and KMC Constructions	51	Dubai-Indian
Surat-Dahisar (NH-8)	IRB infrastructure Developers and Deutsche Bank	10	Indian-Singapore
Chilkaluripet-Vijayawada (NH-5)	IJM Malaysia and IDFC	30	Malaysian-Indian
Panipat-Jalandhar (NH-1)	Isolux Corsan and Soma Enterprise Limited	61	Spanish-Indian

Source: NHAI

As of September 15, 2008, the NHA has a plan to award 53 projects under phases III and V. Of these, RFPs for 14 projects under Phase Ill have been called for. There are another 30 projects under Phase III and 9 projects under Phase V, which are currently being evaluated. The process of award of concessions for these 53 projects is targeted to be completed by January 2009.

Implementation of the standard bidding documents has resulted in private players raising several concerns ranging from the limit on the short listing of bidders in the first stage to a large number of projects being awarded to international players.

Consequently, the MSRTH directed the NHAI to include additional eligibility conditions in the RFP document in respect of 53 project packages for four/six laning of national highway stretches under the phases Ill and V in September 2008. As per this condition, a bidder is not eligible for bidding if the bidder, its member or associate had either by itself or as member of a consortium pre-qualified and was shortlisted or the RFP stage in eight or more projects, or was selected as the bidder for undertaking four or more projects during a period of two months preceding the Bid Due Date, or was unable to achieve financial closure for two or more projects of the authority within the period specified in the respective concession agreements. In case a bidder, its member or associate has crossed any of these limits, it will have to withdraw itself from the bid process. The NHAI will then include the bidder next in line of ranking to keep the same number of shortlisted bidders.

This decision has sparked off new concerns by private players. As several PE funds/mutual funds/FIs/FlIs have invested in more than one company, private players believe that the new clause introduced by the ministry is contentious and must be reviewed and modified.

MCA FOR BOT (TOLL) PROJECTS

The implementation of the much-delayed MCA for BOT (toll) projects is, perhaps, the most significant development in the past year. It is now mandatory for the NHAI to use the new draft MCA in project bids post-January 1, 2007. The MCA addresses some long-pending demands from the industry and is a major step towards the introduction of transparency.

The MCA was drafted to ensure an appropriate balance of risks and obligations between the government and the private sector for sustaining investor interest in upgrade and maintenance of highways on a BOT basis. The framework that has been evolved in the MCA is detailed, comprehensive and based on internationally accepted principles and best practices.

This framework addresses issues which are typically important for limited recourse financing of infrastructure projects, such as mitigation and unbundling of risks, allocation of risks and rewards, symmetry of obligations between the principal parties, precision and predictability of costs and obligations, reduction of transaction costs, force majeure, and termination. It also deals with other concerns such as user protection, transparent and fair procedures, and financial support from the government.

However, although the MCA has been adopted, it is yet to receive Cabinet approval. Several issues have also been raised by the NHAl, states, developers and experts. The success of the MCA will depend on the extent to which it finds favour with these players; which only time will tell. Suggestions for testing the MCA for a longer period of time and on a larger scale to understand the implications have been put forward.

KEY FEATURES

The MCA specifies the technical parameters based on output specifications as these have a direct bearing on the level of service for users. In contrast, the earlier document specified parameters based on input procurement specifications.

A key feature of the MCA is the allocation of risks to the party best suited to manage them as against the earlier policy of the concessionaire bearing the maximum risk. While the technical and commercial risks are still assigned to the concessionaire, the direct and indirect political risks are borne by the government authority. This arrangement is likely to enhance cost and service efficiency.

Another point states that the concessionaire will be selected through open competitive bidding. The shortlisted bidder will be required to specify only the grant sought by it. In exceptional cases, instead of seeking a grant, the bidder may offer to share revenues with the NHAI. The concessionaire will be required to pay a compulsory concession fee from the tenth-year onwards on an ascending revenue-sharing basis. Further, the concession period will depend on the present and projected traffic and will cease when full capacity of the road is utilized. The construction period is included in the concession period to incentivize early completion, implying greater toll revenues.

Lender concerns have also been addressed. The MCA specifies a time limit of 180 days (extendable up to another 120 days on payment of a penalty) for financial closure; thereafter, the bid security shall be forfeited. Lenders are endowed with assignment and substitution rights to enable transfer of the concession agreement to another company in case of default by the concessionaire. The MCA also stipulates that the NHAI should provide loan assistance to lenders for supporting the debt service obligations of the concessionaire in case of a force majeure event or default by the concessionaire. All financial inflows and outflows of the project are now to be routed through an escrow account.

Land acquisition and environmental clearances have been major hurdles in project implementation. In this regard, the MCA directs NHAI to hand over at least 80 per cent of the land to the concessionaire prior to financial closure. Failing this, NHAI will be required to pay damages of 0.1 per cent of the performance security amount of the project for each day of delay, subject to a maximum of 20 per cent. Moreover, if the concessionaire is unable to complete the stretch on time due to such delays, it can begin tolling the partially-completed stretch from the date stated in the agreement.

An option of upgrading the highway from four to six lanes during the concession period has been introduced. In case of up gradation, the concession period will be reduced from 20 to 12 years. The existing operator will be given the right of first refusal at the end of the tenth year of operation. If this right is not availed of, a new operator will be appointed at the end of the twelfth year. This provision will provide the flexibility to construct the highway as per the actual traffic and make the project less capital intensive.

Tolling features have also been included in the MCA. Local residents have been exempted from paying tolls in a bid to garner local support. Discount rates for frequent users, a differential fee for peak and off-peak hours, and stricter standards for operations and maintenance (O&M) have been specified. The concessionaire has been entitled to collect user fees and liquidate damages from vehicle owners making unauthorized use of the highway.

Some other key features include detailed design studies to be undertaken by the concessionaire based on core requirements given by the NHAI, review of the project by an independent engineer, performance-based O&M, a compulsory buyout by NHAI in case of contract termination; compensatory payments to the concessionaire in case of force majeure situations or default by NHAI or in the event of an additional toll way/competing road; minimal day-to-day interaction between NHAI and the concessionaire; a 15-day time-frame to accept the change of scope notice by NHAI; and discretion of the NHAI to construct service roads after eight years from the date of appointment of the concessionaire.

KEY ISSUES AND STEPS TAKEN

Although the new draft has been widely welcomed, a few clauses have been debated time and again. These have delayed the MCA. While the Col has resolved a few concerns, some still exist.

Land Acquisition: The land acquisition clause has been a major point of contention. The NHAI considered 80 per cent land acquisition an uphill task requiring about 9-12 months and in turn, delaying award of projects. Penalties in case of failure to acquire this land rendered the clause more contentious.

Therefore, as a temporary respite, the Col has reduced the limit to 50 per cent for the initial year.

Contractors have, however, opposed this reduction. The contractors is also of opinion that the penalties NHAI will have to pay in case of non-availability of land are minuscule as compared to the toll revenue loss due to delays in completion of the project.

The Planning Commission has, however, stated that the new MCA does protect the revenue interests of the concessionaire. The earlier concession agreements did not allow the contractor to commence tolling in case the project was stalled due to non-availability of land. The concessionaire had to resort to dispute resolution mechanisms to receive compensation and bore the entire risk. As per the new MCA, the contractor can begin tolling the partially completed stretch if the completion delay is due to non-availability of land. The contractor will, however, have to complete the stretch within the time it will take, assuming good industrial practices.

Even though the Planning Commission does not believe that it is an ideal arrangement, it feels that this is the best possible compromise under the current circumstances. In due course, the Planning Commission expects the tolling of incomplete projects to cause public pressure and criticism leading to proactive policy measures to ensure land availability.

Uniform State Support Agreement: Hesitation on behalf of state governments in signing a uniform state support agreement (SSA), a bilateral agreement between the union and state government, was another major point of issue. This umbrella agreement was suggested on demands made by the NHAI, as negotiating a separate SSA for each project between the union government, state government and the concessionaire was a complex task.

The CoI has, thus, advised the NHAI to work out a bilateral SSA for whichever states it can, and use the tripartite agreement for the remaining states.

PPP Appraisal Committee: The NHAI has raised concerns on the formation of the PPP-AC. According to NHAI, the approval process of the committee delays awards by 6-8 months.

However, the Col feels that this rigorous procedure will improve project viability. In addition, delays are unlikely as tight timelines for approval will be followed.

Traffic Concerns: Contractors and experts have raised concerns on clauses related to actual traffic exceeding target traffic. These clauses state termination of the concession as an indirect political event if the actual traffic exceeds the target traffic for three consecutive years; transfer of incremental tolls to a safety fund if the actual traffic exceeds by 120 per cent of the designed capacity, and reduction or increase in the concession period if the actual traffic is 2.5 per cent more or less than NHAI estimates after a few years. These clauses are unclear about which stretch to consider in case a 100-200 km project is divided into three to four tolling sections. They may also discourage contractors from undertaking high-density projects as these run a greater risk of termination.

Experts have also stated that these target traffic clauses also result in discrepancies and cause underperformance. These clauses seem to encourage stretches which may not have high growth and where the traffic may not reach the designed capacity, instead of enabling high-density corridor projects. This is because the high traffic growth stretches run the risk of termination or reduction in the concession period or transfer of incremental tolls to the safety fund as soon as targets are exceeded.

Regarding this, the Planning Commission has affirmed that the MCA is a model contract and cannot prescribe project-related specifications. It states that the MCA document has certain features mentioned in brackets, which can be changed by NHAI and its advisors. The target traffic clause is also mentioned in brackets.

The Planning Commission suggests that in the case of long stretches, the contract must be terminated when the stretch with the lowest traffic exceeds the target traffic. Alternatively, a complex formula of averaging different sections may be formulated. The solution should, however, be project specific. Also, the Planning Commission has stated that, on a project specific basis, both the Planning Commission and the Department of Expenditure would like to clarify any issues with the state government.

Termination payments: A related concern raised by experts refers to termination payments. The formula for computing termination payments given in the MCA views the historical book value of equity and debt which has been invested in the project and gives a certain margin or mark-up over the book investment. However, if the investor has repeatedly infused equity in the project and the project gets terminated, then the contractor is at a loss as the termination payments are made only on original equity and not on the premium. Experts feel that this formula exposes the concessionaire to a peculiar kind of risk.

This issue has, however, not yet been widely discussed. But, with private equity funds coming in, this concern is likely to be raised soon.

Tolling: Some lingering concerns regarding tolling still exist. There is a difference of opinion regarding tolling rates. While the MCA states that the toll rates will be indexed to the WPI (wholesales price index) to the extent of 40 per cent, contractors are in favour of a higher level of indexation. On the other hand, the government is of the view that a higher indexation will require users to pay more for a declining (more congested) level of service, when they should be receiving the benefit of depreciated fees.

Further, contractors believe that toll rates must reflect the differences in maintenance costs that different vehicles impose on roads. There should also be a provision for accommodation of new types of vehicles introduced during the concession period. Differences over uniformity of toll rates and ambiguity over tolling of three-wheelers and tractors exists. Differential fees may cause resentment amongst users especially when they switch from off-peak to peak hours.

The tolling issues have been addressed in the new policy. This policy prescribes a uniform toll regime on all national highways. The policy has also introduced a new classification for vehicles. The tolls will be revised every year and indexed to the WPI of 2007. Till now, tolls for PPP projects and government-funded projects are revised every one year and five years respectively. The NHAI will install weigh-in motion bridges on highways to check overloading. In addition, distance-based tolling has been proposed by the government.

MCA FOR O&M OF NATIONAL HIGHWAYS ON AN OMT BASIS

With the construction of over 6,000 km of national highways complete, the focus is shifting towards maintenance. The government is of the view that it would be useful to attract private participation in O&M of national highways for better recovery of tolls and a higher quality of service.

For sustaining investor interest in O&M of national highways, a precise policy and regulatory framework has been clearly written in the MCA for O&M of national highways on an OMT basis. This MCA has been approved by the inter-ministerial group in December 2007 and by the Col in January 2008.

This framework addresses the issues that typically impact PPP projects. These include mitigation and unbundling of risks, allocation of risks and rewards, symmetry of obligations between the principal parties, precision and predictability of costs and obligations, reduction of transaction costs, force majeure and termination.

The MCA specifies the technical parameters based on output specifications as these have a direct bearing on the level of service for users. In contrast, the earlier document specified parameters based on input specifications. The core requirements of design, construction, and O&M of the project highway will be specified. The rest will be left to the discretion of the concessionaire. This is expected to provide flexibility to the concessionaire in evolving and adopting cost-effective designs without compromising on quality of service.

The risks have been allocated to the party best suited to handle them as risk alleviation and mitigation is considered to be critical for private investment. Project risks have been assigned to the private sector to the extent it is capable of managing them. The transfer of these risks is expected to result in innovations and efficiencies in costs and services. The commercial, technical and traffic risks are also assigned to the concessionaire. All direct and indirect political risks are allocated to the authority/government.

The concession period has been linked to the maintenance cycle. The current practice is of undertaking major maintenance works once in five years. Consequently, the concession period has been proposed to be determined on a project-specific basis depending on the balance period remaining before the forthcoming maintenance cycle. The government is of the view that a maximum concession period of 10 years is appropriate so that the project highway is available thereafter for augmentation of capacity.

The concessionaire will be selected through open competitive bidding. The bidder offering the highest concession fee will win the contract. In some cases, the bidder may seek O&M support from the authority/government if its operational expenditure exceeds toll revenues. The concession fee payable to the government could be increased in each subsequent year by 5 per cent to account for the increase in traffic volumes. This is also expected to result in cost effective maintenance by the concessionaire.

As far as the user fee is concerned, it will be based on the rates determined and notified by the government. These will be indexed to the WPI to the extent of 40 per cent. Also, this MCA prescribes for exemption of user fees for local traffic in case service lanes are not provided.

As per the MCA, the tolling should commence as soon as the concession agreement comes into effect. Any construction remaining (of project facilities or selected maintenance works) should not affect tolling.

The government will enforce the maintenance standards strictly. Any violations will result in stiff penalties. The MCA also provides for mechanisms to evaluate and upgrade safety requirements on a continuing basis and for traffic regulation, police assistance, emergency medical services and rescue operations.

Some of the other key features include protection against force majeure events, compulsory buy out by the government in case of termination, minimum interaction between the government and the concessionaire, monitoring vision to be done by an independent engineer, all financial flows to be routed through an escrow account to provide security to the lenders and greater stability to the project operations, stipulation of a regular traffic census and annual survey for keeping track of traffic growth, etc.

Note: This report is an extract from Road Sector in India 2008, India Infrastructure Research

B. Mumbai – Pune Expressway and NH-4

MAHARASHTRA STATE ROAD DEVELOPMENT CORPORATION LTD. (MSRDC)

MSRDC was established by the Government of Maharashtra through a resolution issued on 9th July, 1996 and incorporated as a limited company on 2nd August, 1996 under the Indian Companies Act, 1956.

Established with a view to giving it maximum operational freedom in planning, execution, raising financial resources and day-to-day administration

Maharashtra State Road Development Corporation Ltd. (MSRDC)'s mandate was to accelerate transport infrastructure development in the state by overseeing the completion of existing and new projects with the active participation of the private sector through a time bound program.

BACKGROUND OF MUMBAI-PUNE EXPRESSWAY

In 1990, the Government of Maharashtra appointed RITES and Scott Wilson Kirkpatrick of United Kingdom to carry out feasibility studies for the new expressway to be operated on toll basis. RITES submitted their report in 1994 with the estimated cost of project at Rs. 1,146 crores (11.46 billion rupees). The Government of Maharashtra entrusted the work of the construction of Mumbai-Pune expressway to MSRDC in March 1997 on Build-Operate-Transfer basis with permission to collect toll for 30 years. The environmental clearance from the Ministry of Environment and Forest, Government of India was received on October 13, 1997. The Forest Clearance was received on November 11, 1997.

The project was completed under the stewardship of the Maharashtra State Road Development Corporation (MSRDC). The expressway cost Rs. 1630,00,00,000 (approx. US$ 362 million) to construct. The first sections opened in 2000, and the entire route was completed, opened to traffic and made fully operational from April 2002.

The activity of operation and maintenance of this Expressway was entrusted to international agency M/s Elsamex Shinde IRB J/V for a period of three years upto April 2005.

SALIENT FEATURES OF MUMBAI-PUNE EXPRESSWAY

- India's first six lane access control expressway
- Length = approximately 95 km

- Starts at Kalamboli (near Panvel) and ends at Dehu Rd. (near Pune)
- Has five interchanges Kon (Shedung), Chowk, Khalapur, Kusgaon and Talegaon & two carriageways with three concrete lanes each separated by a central divider and a tarmac or concrete shoulder on either side.
- Total Project Cost including escalation is Rs. 1630 crores.
- Opened to traffic and made fully operational from April 2002

MSRDC CALLED FOR BIDS FOR O&M

According to newspaper reports, in 2004, MSRDC was deep in the red - all projections of financial viability, traffic on the expressway and of the toll that would be collected for Mumbai – Pune Expressway was gone wrong.

Mumbai – Pune Expressway project had initially been budgeted at around Rs. 1,600 crores. Finally Rs. 2,136 crores was spent on it: a cost escalation of about 30 per cent. With an average initial debt repayment interest of 13 per cent, the total liability was a whopping Rs. 3,000 crores. In a move to justify the construction when the proposal was still on the table, its proponents had projected that nearly 50,000 passenger car units (PCUs) would be using the expressway every day by 2004. But, in 2004, the actual number of vehicles using the expressway daily was only 16,000. With a majority of these being cars (one car = one PCU; one bus = 2.5 PCUs), the volume of traffic on the expressway was estimated to be only about 25,000 PCUs. The projections, it therefore turned out, were inflated by at least 100 per cent. The average annual toll collection has only been Rs. 75 crores

The main reason for low volume traffic in the Mumbai- Pune Expressway was due to a substantial portion of drivers on the Mumbai to Pune route preferred not to use the expressway in spite of the promised benefits. They continued to use the old National Highway 4 (NH4) that runs parallel to the expressway and didn't mind spending some extra time doing this, and with very valid reasons. An excellent example is the multi axle vehicles that are expected to pay Rs. 680 as toll to use the 95 km expressway. Now, for a transporter travelling the 1,000 km from Mumbai to Bangalore (the entire stretch of NH4), there could be no justification for shelling out this money for less than 10 per cent of the total journey and for less than an hour of travel time saved.

For the huge losses MSRDC incurred, the State and Central Governments decided that the public must pay. In an unprecedented move, the National Highway Authority of India (NHAI) handed over the NH4 to the MSRDC, and it became the first National Highway in the country to be privatized. Bids were invited in December 2003 for expanding a stretch of the existing NH 4 into four lanes and to make value additions to the Mumbai - Pune Expressway. The project covered a cumulative 206 kilometres of road: 111 kilometres on NH 4 and 95 kilometres on the Mumbai - Pune Expressway.

Ideal Road Builders Pvt Ltd emerged as the highest bidder for MSRDC's bid for the operation and maintenance (O&M) of Mumbai-Pune expressway and Mumbai-Pune section of NH-4 and four laning and improvements of Mumbai-Pune section NH-4. Ideal Road Builders, which is BOT operator and toll country, had quoted Rs 918 crore.

IDEAL ROAD BUILDERS PRIVATE LTD (IRBPL) AS O&M CONCESSIONAIRE

The project agreements relating to this project were entered into between Mhaiskar Infrastructure Pvt. Ltd. (MIPL), IRBPL's 100% subsidiary, IRBPL and the MSRDC. The scope of work on this project involved extending the existing NH 4 into a four-lane highway, widening major and minor bridges relating to the project, constructing bus and truck bays, constructing foot-paths, implementing lane markings, constructing toll plazas, and providing road furniture items.

With respect to the Mumbai - Pune Expressway, Ideal Road Builders Private Limited primarily undertook value additions, such as providing cattle traps, constructing crash barriers, providing landscaping and beautification services, and redoing paved shoulders. The construction completion time for this project stipulated under the relevant project agreements was 24 months, and IRBPL completed construction of this project on time. IRBPL received a completion certificate relating to their work under the project agreements on September 7, 2006.

The total cost of this project is Rs. 1,301.64 crores. This total project cost comprises an upfront fee payable to the MSRDC of Rs. 918 crores and construction costs of Rs. 383.64 crores. The aggregate value of the operation and maintenance contract for this project is approximately Rs. 754.79 crores. The project was financed by a combination of equity and debt. Approximately Rs. 105 crores of the project cost was attributable to equity and approximately Rs. 15.22 crores from internal accruals, with the remaining approximately Rs. 1,181.44 crores attributable to term loans. The term loans for the project have been provided by various banks and financial institutions.

Under the terms of the project agreements IRBPL has been granted a concession period of 15 years for each of the Mumbai - Pune Expressway and the NH 4. Tolling with respect to the Mumbai - Pune Expressway began on August 9, 2004. Pursuant to the terms of the project agreements and certain notifications received by IRBPL from the Government of Maharashtra and the Government of India, IRBPL has been authorised to collect and retain the notified toll rates upon the users of the project facilities until August 10, 2019. With respect to the Mumbai-Pune Expressway, IRBPL is permitted to collect tolls from vehicles crossing toll plazas at Shedung, Khalapur, Kusgaon and Talegaon. With respect to NH 4, IRBPL is permitted to collect tolls from vehicles crossing toll plazas at Shilpata, Shedung, Kusgaon and Dehu Road. On the expiry of the concession period, IRBPL has to hand over possession of the project assets to the Government of Maharashtra, at no cost.

The project agreements include standard provisions relating to events of default, indemnification and assignment. Under the project agreements, IRBPL would be deemed to be in default of their obligations upon the non-payment of any amounts owed by IRBPL or upon the breach of representations and warranties that IRBPL has provided. MSRDC may terminate the project agreements upon the occurrence of an event of default under the agreements, should such default remain uncured for the specified period of time. Under the terms of the project agreements, IRBPL has agreed to indemnify, defend and hold the MSRDC harmless against any and all proceedings, actions and third party claims arising out of a breach by IRBPL of any of their obligations under the project agreements, except to the extent that any such claim has arisen due to the MSRDC being in default of its obligations under the project agreements. IRBPL is not permitted to assign the project agreements without the prior written consent of the MSRDC.

During the concession period, IRBPL has also agreed to operate and maintain the facilities relating to this project. With respect to the Mumbai-Pune Expressway, the scope of IRBPL's operations and maintenance obligations include road maintenance, performing safety and security functions, asset management, and road property management. With respect to NH 4, IRBPL is primarily responsible for ensuring smooth and uninterrupted flow of traffic, charging, collecting and appropriating tolls in accordance with the project agreements, repairing potholes, cracks, joints, drains, lane marking, lighting, maintenance of illuminations and signage, safety maintenance, operations, and traffic management.

MIPL contributes around 60% to IRB's BOT revenues. The Concession Agreement allows MIPL to hike toll rates every 3 years. MIPL has hiked toll rates for Mumbai – Pune Expressway by 18% from April 2008. So MIPL would record a close to 30% growth in top line in FY 2009 (18% toll hike+10% traffic growth). The Project is characterized by higher proportion of non commercial vehicles having a contribution of around 65-70% in the total traffic density.

C. Madhya Pradesh Road Development Corporation Limited (MPRDC)

In the State Madhya Pradesh, Madhya Pradesh Public Works Department (MPPWD) is responsible for the state road network. Ministry of Shipping, Road Transport, and Highways (MOSRTH) administers national highways, but delegates development and maintenance of these roads to MPPWD. MPPWD's district administrations manage most ordinary roads and village roads.

ESTABLISHMENT OF MPRDC

MPRDC was established in line with a comprehensive reform under the ADB-funded Madhya Pradesh State Roads Sector Development Program (MPSRSDP). It is incorporated as a company under the Indian Companies Act, 1956, primarily to take over the functions of the former Madhya Pradesh Rajya Setu Nirman Nigam Limited and to promote public-private partnership projects in the road sector.

MPRDC is wholly owned by the government of Madhya Pradesh (GOMP) and has been declared and notified as the highway authority under section 4 of the Madhya Pradesh

Highway Act, 2004.

MPRDC is a lean organization using consultants for project preparation and supervision during delivery, adopting modern procurement systems guided by FIDIC conditions, and setting up computerized road asset management and financial management systems.

ORGANIZATION OF MPRDC

MPRDC is headed by a managing director, supported by a chief engineer and two deputy general managers (DGMs) for human resources and management information systems, and finance and accounting. The chief engineer is supported by two general managers for planning and maintenance, and projects; and one DGM for BOT

The general manager for planning and maintenance has two sections: (i) planning and maintenance, and (ii) road safety, which includes the environment and social management unit

The general manager for projects has four sections: (i) highway engineering, (ii) quality control, (iii) procurement, and (iv) bridge engineering.

Each section is headed by a DGM supported by an assistant general manager.

MPRDC has seven division offices, which are in charge of day-to-day project and contract management for each project. Each division office is headed by a DGM supported by five assistant general managers, 12 managers, and support staff.

FUNCTIONS OF MPRDC

MPRDC was notified as the State Highway Authority on 19 October 2005, and entrusted with the responsibility for all 8,333 km of state highways in Madhya Pradesh, including all state highways and some national highways delegated by MOSRTH and MDRs delegated by MPPWD. MPRDC has the following functions:

- To construct, reconstruct, erect, build remodel, repair, reclaim, demolish, develop, improve, operate and maintain the roads, highways, express highways, bridges, culverts embankment, sideways, subways, flyovers, tunnels, railroads, multi - modal transport systems and infrastructure, models and complexes in India.
- To carryout all types of construction, architectural or other works under the Built operate and transfer (BOT) Scheme or under any other scheme to be formulated from time to time and for the assignment of state Govt. of M.P.
- To Act as consultants in connection with infrastructure projects in India or abroad.
- To act as to modal agency of the State Govt. for executing roads and allied infrastructure projects or for objects as envisaged in above clause under public - private or joint venture basis or otherwise.
- To prepare and develop strategic plans for the state road sector and identification and selection of projects based upon economic, social for technical and commercial criteria,

and

- To invite bids from experienced firms/organizations to bid for Management and Maintenance Contracts (on Cash Contract) for the respective packages of Road Sections.

ANNEX 8 JAPAN ITS TOUR

INTRODUCTION

The study was originally supposed to propose an appropriate specifications for ITS when bidding documents were prepared, in order to select the most suitable ITS. However, it was found that it was difficult for executing agencies, HMDA and HGCL, to select appropriate ITS technologies due to lack of knowledge and information about ITS itself since it is the first time to introduce large-scale ITS in India. It is necessary to expose to the actual implementation of ITS technologies and to deepen its understanding in order to compare and examine available ITS technologies and select the most suitable one. In this context, HGCL requested JICA to conduct Japan ITS Tour study about ITS technologies in Japan, which have been proposed to be introduced in the ORR project by SAPI Team.

There is no standard for ITS prepared in India, which is necessary to expand ITS nationwide. While the ORR Project is the first to introduce ITS, it is expected to introduce the unified technology nationwide in India for sustainable and effective ITS development. In this context, the tour will be also participated by central governments which are in charge of ITS administration in India, as well as HGCL members, the main executing agencies of the ORR Project.

Purpose

The Japan ITS tour aims (i) to visit actual facilities of ITS such as interchange of expressway and Traffic Control Center and (ii) to study about ITS technologies, including ITS standard, ETC equipment, and the latest ITS, Smartway.

Participants

Participants for Japan ITS Tour include five from Hyderabad and three from Delhi. Original list include seven from Hyderabad, of which two were cancelled due to preparation for the national election in India. List of participants are shown below.

Table A8.1 List of Participants

City	Name	Agency/ Position
Hyderabad	Mr. Sri Rahul Bojja	Project Director of HGCL /Managing Director of the ORR Project
	Mr. Sri G. Jagannadha Rao	Director of HGCL / Chief General Manager (Technical) of the ORR Project
	Sri N. Surya Prakash Reddy	General Manager, HGCL
	Mrs. P. Laxmi	Deputy General Manager, HGCL
	Mr. Suresh Babu	Deputy General Manager, HGCL
Delhi	Mr. Prashant Khodaskar	Executive Engineer, Ministry of Shipping, Road Transport & Highways, Government of India
	Mr. Rakesh Kumar Singh	Executive Engineer, Ministry of Shipping, Road Transport & Highways, Government of India
	Mr. S. K. Agarwal	General Manager, National Highways Authority of India

Schedule

Overall schedule of the Tour is shown in Table A8.2

Table A8.2 Overall Schedule of Japan ITS Tour

		Activity	Accommodation
1	30 March (Mon.)	**Departure** (From Hyderabad) TG330 (From Delhi) JL 741	In flight
2	31 March (Tue.)	**Arrival** (From Hyderabad) TG676 at 15:45 (From Delhi) JL 741 at 7:00	Tokyo
3	1 April (Wed.)	11:00 Courtesy Call to JICA HQ 14:00 Internal Meeting at Nexco East 16:00 Courtesy Call to METI	Tokyo
4	2 April (Thu.)	**Field Survey (Day1)** 10:00 Tokyo Aqua Line 14:30 Iwatsuki Interchange and TCC	Tokyo
5	3 April (Fri.)	**Field Survey (Day2)** 10:00 Tokyo Metropolitan Expressway Trial Ride of “Smart-way”	Tokyo
6	4 April (Sat.)	**Field Survey (Day3)** Tohoku Expressway (Trumpet-type Interchange, rest area, etc.)	Tokyo
7	5 April (Sun.)	Free	Tokyo
8	6 April (Mon.)	10:00-16:00 HIDO (Seminar on ITS in Japan)	Tokyo
9	7 April (Tue.)	10:00 Courtesy Call to MLIT Road Bureau 10:15 Presentation of ITS in Japan 14:00 Wrap-up Meeting at JICA HQ	Tokyo
10	8 April (Wed.)	Departure (to Hyderabad) TG641 at 11:00 (to Delhi) JL 741 at 11:45	

Note: MLIT: Ministry of Land, Infrastructure, and Transport
METI: Ministry of Economy, Trade and Industry
HIDO: Highway Industry Development Organization

Tour Activities

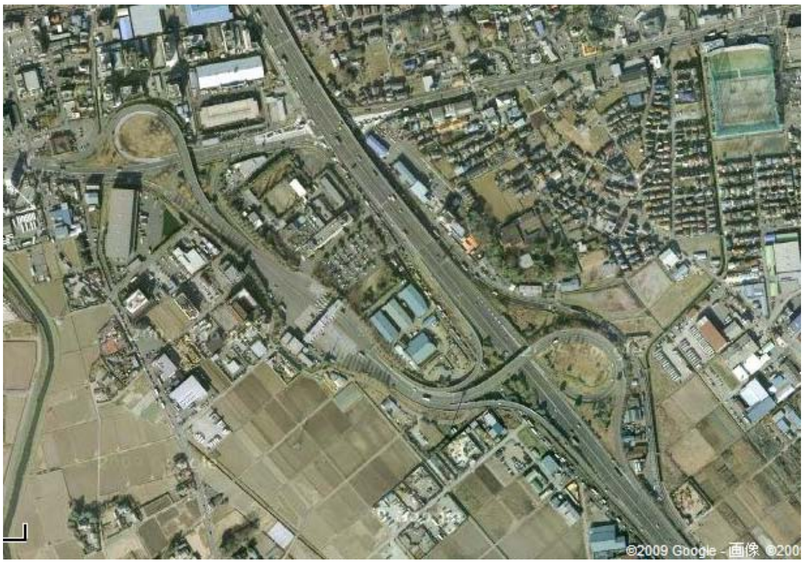
The Tour is composed of the following activities in relation to SAPI Task.

SAPI Task 1: Redesigning of ORR

1) Visit to Double Trumpet Type Interchange

Double trumpet type interchange with one toll plaza was visited, at Iwatsuki Interchange on 3rd April and other Interchange on 4th April. At Iwatsuki Interchange, locating 30 km away from Tokyo along Tohoku Expressway, overall design of the interchange was viewed from the top of traffic control center in the middle of interchange and toll gate facilities such as ETC gate were explained on ground. Overall picture of the Iwatsuki Interchange is shown in Figure A8.1.

Figure A8.1 Overall Picture of the Interchange



Source: Google

2) Rest and Commercial Service Area

Rest area and commercial services area to utilize unused land generated from interchange design modification were visited at interchange along Aqua Line, Tokyo Bay Crossing at 3rd April, and along the Nikko tourism corridor on 5th April.

SAPI Task 2: ITS Development Plan

3) Management Strategy: “Integrated Management and Operation“

Traffic Control Center of Nexco at Iwatsuki were visited on 3rd April to see the actual management of ITS. Iwatsuki TCC covers all expressways under the control of Nexco, amounting 1,200 km expressways of 20 routes. There are two control rooms in the TCC, namely traffic control room and facility control room. The former is to collect necessary information and provide right-on-time information to road users. The latter is to check the operation of various devices installed on the expressway in order to guarantee safety of road users. Both rooms were introduced by the Nexco. Another TCC at Tokyo Aqua Line was also visited. It covers facilities only along the Tokyo Aqua Line.

4) Technology Strategy “Basic and Upper Compatible”

The latest ITS and the Smartway in Japan was presented by MLIT and Tokyo Metropolitan Expressway on 4th April. After the presentation, trial driving of Smartway was conducted along Tokyo Metropolitan Expressway to see actual operation status of the Smartway.

SAPI Task 3: ITS Bidding and Procurement

5) ITS Products and Manufacturers

Various ITS products in Japan were presented in the workshop at HIDO (Highway Industry Development Organization of Japan) by industrial participants. It covered the following.

- Introduction of Japan's ITS (HIDO)
- Active DSRC and Global ETC (HIDO)
- Proposal for Tolling System for Hydrabad (Mitsubishi Heavy Industries, Ltd.)
- Effectiveness for Displaying Live Images on Road Information Board (Nagoya Electric Works Co., Ltd.)
- Expressway Traffic Information Boards (Seiwa Electric Mfg. Co., Ltd.)
- Infrared Traffic Counter for Road Operators (NEC Corporation)
- Traffic Flow Measurement Systems and Image Processing Vehicle Detector (Sumitomo Electric Industries, Ltd.)

SAPI Task 4: Assistance for New Organizational Setup

6) Policy Exchange on ITS Development

After courtesy call to Councilor, Mr. Hirose, two presentations were done, one is "Research and Development of ITS in Japan and Smartway Project" by MLIT and the other is "ITS and Radiocommunications in Japan" by MIC. After the presentations, policies on ITS development of two countries were exchanged.

7) Toward Finalization of SAPI Study

Wrap-up meeting was held to summarize the Tour and discuss necessary follow-up action toward finalization of SAPI Study.

Presentations

Presentation materials during the tour are attached.

Photos

Figure A8.2 Tour Photos

Kick-off Meeting at JICA	TCC at Aqua Line
	
Traffic Control Center at Iwatsuki (1)	Traffic Control Center at Iwatsuki (2)
	
Field Trip	Meeting at Tokyo Metropolitan Expressway