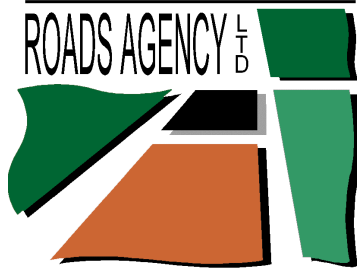


THE SOUTH AFRICAN NATIONAL



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THE SOUTH AFRICAN NATIONAL ROADS AGENCY LIMITED

STANDARD SPECIFICATIONS FOR OPERATIONS AND MAINTENANCE OF CTROM PROJECTS: TOLL SYSTEMS

OCTOBER 2010

VOLUME 2 BOOK 4a

ISSUED BY:

THE CHIEF EXECUTIVE OFFICER
SOUTH AFRICAN NATIONAL ROADS AGENCY LIMITED
P O BOX 415
PRETORIA
0001



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SECTION 1. GENERAL

1.1 GENERAL

1.1.1 SCOPE

- 1.1.1.1 This Standard Specification for the Toll System details the requirements for Toll Systems on CTROM projects.

1.1.2 OVERVIEW

- 1.1.2.1 The Contractor shall supply, install and maintain a Toll System to comply with the minimum requirements of this specification. The Toll System shall, inter alia, facilitate and manage the processing of toll transactions, control toll income and send transaction and all other data elements and information to external systems for further processing, monitoring and evaluation.

- 1.1.1.1. The Contractor shall take full responsibility for retaining any portions of Toll Systems, taken over. The Contractor shall be required to operate and maintain the Toll System, in existence at hand-over, to the same performance requirements as applicable to the previous contract.

- 1.1.2.2 The Toll Lanes at a Conventional or Hybrid Toll Plaza can include a mix of lane types, e.g. Manual Lanes, Automatic Card Lanes, Dedicated ETC Lanes, Express ETC Lanes, Mixed ETC Lanes (Manual and ETC) and Reversible Lanes. The Lanes are grouped into "Virtual Toll Plazas" according to certain rules and interface with the Contractor's Back Office System for transmission of transaction data and operational configurations. In an ORT application, Toll Lanes shall be free flow lanes.

- 1.1.2.3 It shall be noted that the use of the terms Conventional and/or Hybrid Toll Plaza in this specification also includes for the conventional and/or hybrid part of a Toll Plaza where it is combined with an ORT application. Similarly, for ORT type Toll Plazas, the use of the term ORT in this specification also includes for the ORT part of a Toll Plaza where it is combined with a Conventional and/or Hybrid Toll Plaza. The Toll System for Conventional and Hybrid Toll Plazas comprises the following major building blocks or sub-systems:

- (a) Lane Systems;
- (b) Back Office System;
- (c) VGS;
- (d) QLS;
- (e) ITIS Interface; and
- (f) Other interfaces to external systems such as the TCH System (for processing of ETC Transactions) and the National Payment System (for processing of Bank Card transactions).

1.1.2.4 The following sections in this specification shall apply to Conventional or Hybrid Toll Plaza type Toll Systems:

- (a) Section 1: System overview
- (b) Section 2: General Requirements
- (c) Section 3: General System Requirements
- (d) Section 5: Conventional and Hybrid Toll plaza Lane System Requirements
- (e) Section 6: Back Office System Requirements
- (f) Section 7: Interfaces
- (g) Section 8: TCH System Specifications
- (h) Section 9: VPC System Specifications
- (i) Section 10: Sample Sizes for Accuracy Calculations

1.1.2.5 The ORT Toll System comprises the following major building blocks or systems:

- (a) Road Side System (RSS);
- (b) Back Office System;
- (c) Interface to the Transaction Clearing House (TCH) System (for the processing of ETC Transactions); and
- (d) Interface to the Violations Processing Centre System (for Opt-in Toll Agencies) via the TCH.

1.1.2.6 The following sections in this specification shall apply to ORT type Toll Systems:

- (a) Section 1: System overview
- (b) Section 2: General Requirements
- (c) Section 3: General System Requirements
- (d) Section 4: ORT RSS Requirements
- (e) Section 6: Back Office System Requirements
- (f) Section 7: Interfaces
- (g) Section 8: TCH System Specifications
- (h) Section 9: VPC System Specifications

- (i) Section 10: Sample Sizes for Accuracy Calculations

1.1.3 CONVENTIONAL OR HYBRID TOLL PLAZA: LANE OVERVIEW

1.1.3.1 The main purpose of a Lane for a Conventional or Hybrid Toll Plaza shall be to accurately classify, detect, separate, track and count every vehicle passing through it and to generate a Transaction Record for each vehicle.

1.1.3.2 The Lane of a Conventional Toll Plaza will therefore be required to perform the following minimum functions in relation to each vehicle without an ETC Tag:

- (a) Direct a vehicle via an OHLS into an open lane;
- (b) Receive a classification of the vehicle into one of the Vehicle Classes from the Toll Collector;
- (c) Receive a method of payment from the Toll Collector;
- (d) Indicate the classification and acceptance of the method of payment to the road User;
- (e) Provide a Lane Tax Invoice / proof of passage to the road user (if requested);
- (f) Detect and classify the vehicle via the AVC into one of the specified Vehicle Classes;
- (g) Capture relevant incidents and supporting images and data to allow the operator to perform an audit on violations, unusual vehicle movements and discrepancies between the collector and the system, as applicable; and
- (h) Combine the data collected for the vehicle and road user into a Transaction Record and send it to the Back Office System.

1.1.3.3 The Lane (i.e. Dedicated Electronic Toll Collection (ETC) Lanes) of a Hybrid Toll Plaza will be required to perform the following minimum functions in relations to each vehicle with an ETC Tag:

- (a) Direct a vehicle via an OHLS into an open Dedicated ETC Lane;
- (b) Conduct a 5.8 GHz DSRC transaction with any conforming interoperable Tag present in the vehicle (also known as a Tag transaction);
- (c) Capture and read the front and rear Vehicle Licence Number (VLN) of the vehicle using an ANPR system that utilises optical character recognition (OCR) techniques;
- (d) Utilise additional optical character recognition techniques to enhance the accuracy or improve the ANPR process. This shall include comparing previously captured images to the current image to increase the accuracy and confidence level. This functionality shall be provided either at the Toll Collection Lane Equipment or at the Back Office System;

- (e) Detect and classify the vehicle via the AVC into one of the specified Vehicle Classes;
- (f) Capture a Scene Image of the vehicle which shall clearly place the vehicle at the scene. Such images may be required for enforcement, or for checking Class Discrepancies;
- (g) Utilise the details obtained from the Validation Lists received from the TCH via the Back Office System to determine and take the required action;
- (h) Combine and frame the data and images collected for the vehicle into a Transaction Record and send it to the Back Office System; and.
- (i) Provide the capability to process the number of vehicles and deliver the service levels as is specified within the Standard Specifications for Operations and Maintenance of CTROM Projects: General (Volume 2 Book 2a).

1.1.4 OPEN ROAD TOLLING (ORT) OVERVIEW

- 1.1.4.1 The Contractor is responsible for the supply, implementation and maintenance of the Road Side System (RSS) and the Back Office (BO) System. The Contractor shall also be responsible to interface to the national Transaction Clearing House (TCH) System.
- 1.1.4.2 An overview of the RSS is provided in clause 1.1.6 and the detailed specifications are contained within Section 4.
- 1.1.4.3 An overview of the Back Office (BO) System is provided in clause 1.1.7 and the detailed specifications are contained within SECTION 4.

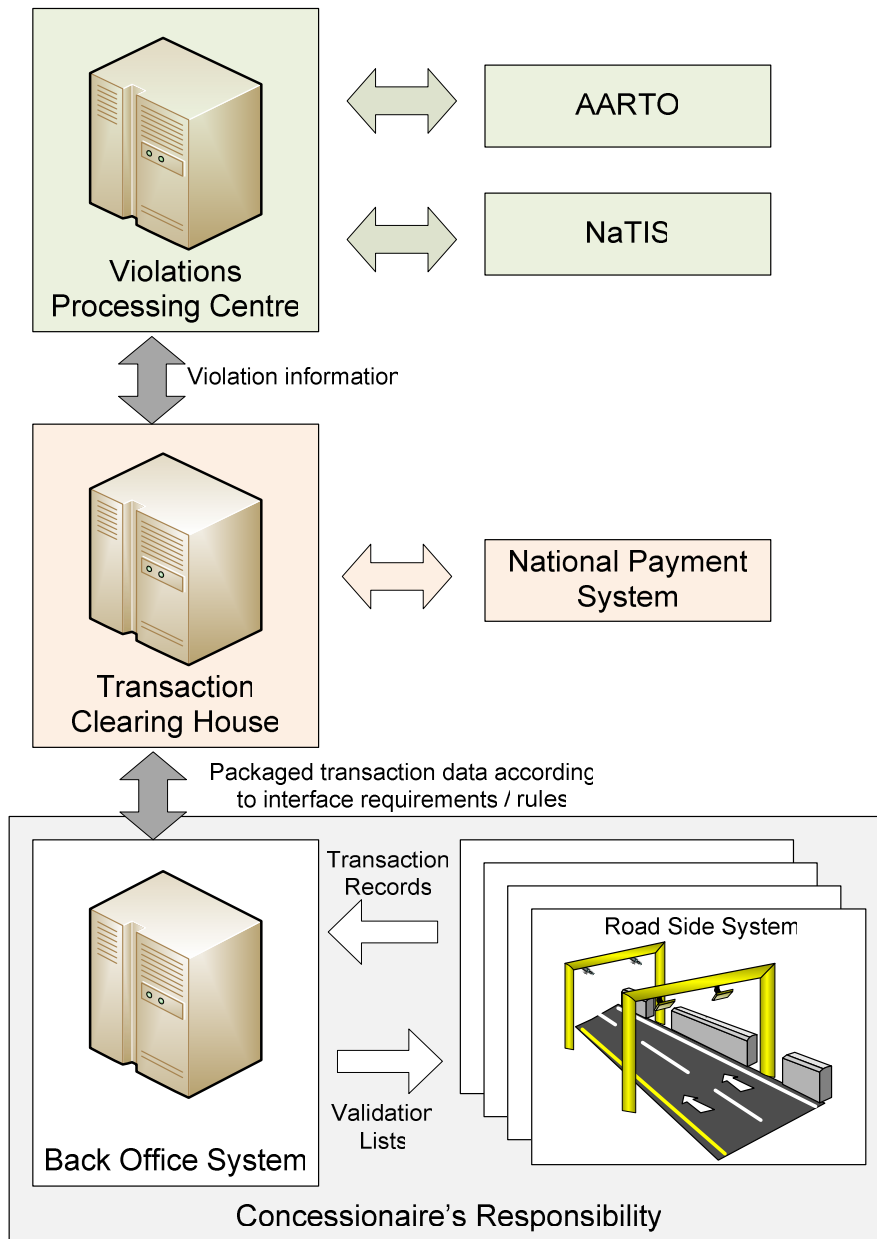


FIGURE 1-1: OPEN ROAD TOLL SYSTEM OVERVIEW

1.1.5 THE NATIONAL INTEROPERABILITY CONCEPT

1.1.5.1 Scope

This section covers the interoperability requirements that the Contractor's system shall comply with. Interoperability is aimed at achieving User convenience and cost saving by standardising aspects of the Toll Systems, allowing a single account for processing of all ETC Transactions at all Toll Plazas in South Africa and providing a single point where all the toll-related information, transaction history and Tax Invoices can be obtained by the account holder.

1.1.5.2 Electronic Toll Collection

The Contractor shall comply with the requirements as set out in the Standard Specification for Operations and Maintenance of CTROM Projects: Electronic Toll Collection (ETC) (Volume 2 Book 5).

1.1.5.3 Clearing House

The Contractor shall comply with the requirements as set out in the Standard Specification for Operations and Maintenance of CTROM Projects: Electronic Toll Collection (ETC) (2 Book 5) and Standard Specifications for Operations & Maintenance of CTROM Projects: ETC Interoperability – Business Rules (Volume 2 Book 8a).

1.1.5.4 The implementation plan for Electronic Toll Collection (ETC) in South Africa is to obtain interoperability on a national scale via a single point. The central account transaction Clearing process is facilitated by a national Transaction Clearing House (TCH).

1.1.5.5 The TCH will undertake central ETC Customer Account management and transaction Clearing services in respect of all ETC Transactions from all Toll Roads in South Africa, including those ETC Transactions generated (and to be generated in the future) on Toll Roads implementing ETC, and those ETC Transactions taking place and/or that will take place on the Toll Roads. The toll projects are administered by independent Toll Agencies obliged to transfer all ETC Transaction data to the TCH in accordance with an agreement with the Toll Agency.

1.1.5.6 Further, a Violations Processing Centre (VPC) shall provide for the processing and collection of unpaid toll fees and unpaid Customer Accounts, the managing of evidence related to exceptions, and the possible administration of prosecuting procedures as required by the AARTO process. Toll Agencies shall have the option to process their Violations through the VPC, referred to as Opt-in Toll Agencies, or to handle Violations themselves, referred to as Opt-out Toll Agencies. It is envisaged that Toll Agencies that operate in an ORT or non-barrier ETC environment will elect to use the services of the VPC. Participating Toll Agencies (Opt-in Toll Agencies) shall transmit all ETC Transactions to the TCH which shall in turn submit all Potential Violation transactions (i.e. unpaid transactions, including those not allocated to an account) to the VPC for further processing. Associated images shall be transmitted with the transactions, in accordance with the requirements of the applicable legislation and the SANS 1795 Standard (South African Standard Specification: Road Traffic Law enforcement systems). Administration fees shall be defined by the VPC for each participating Toll Agency, based on the costs incurred and the income received by the VPC in processing the respective Toll Agency's Violations. The VPC shall allow Violators the opportunity to avoid the court system process by paying the toll plus predefined fees and fines to resolve the initial toll infringement within a specified period of time.

1.1.5.7 The Employer shall maintain a list of prequalified Tag suppliers. Tags shall be procured by the TCH only from the prequalified Tag suppliers and distributed to the Toll Agencies. All the Tags procured shall be compliant to the EN 15509 standard and shall comply with the Standard

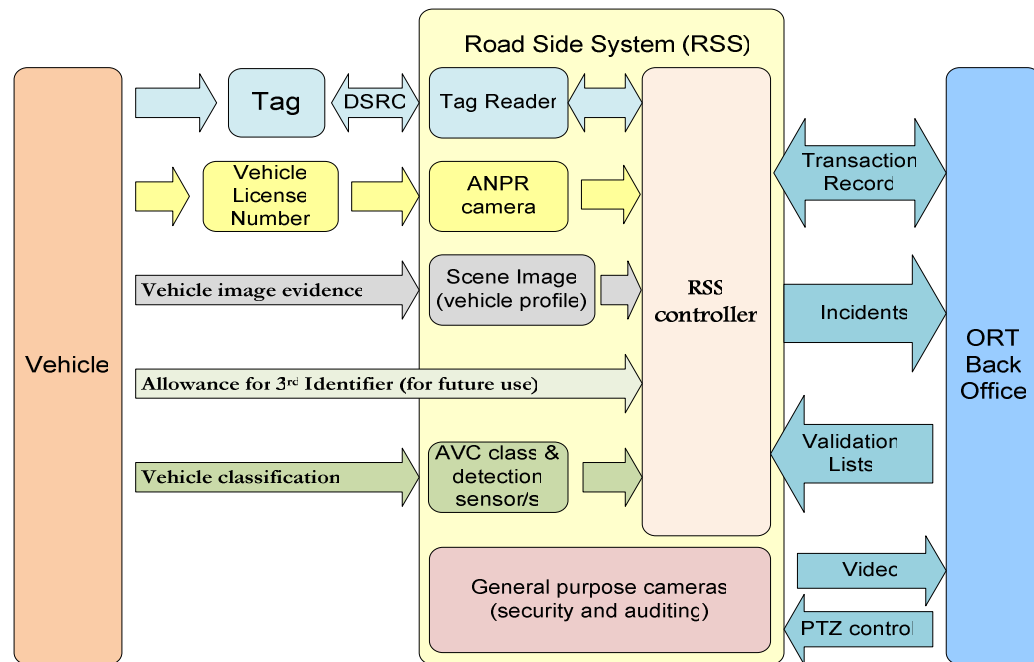
Specifications for Operations and Maintenance of CTROM Projects: Electronic Toll Collection (ETC) (Volume 2 Book 5).

1.1.6 ROAD SIDE SYSTEM (RSS) OVERVIEW

1.1.6.1 The main purpose of the RSS shall be to accurately detect and track each and every Vehicle (including motorcycles) passing through a Tolling Point and to generate a Transaction Record for each vehicle detected within any lateral position at that point, including vehicles travelling on the left and right shoulder of the Road. The RSS will therefore be required to perform the following minimum functions in relation to each vehicle (summarised in Figure 1-2: Typical RSS Functions):

- (a) Conduct a 5.8 GHz DSRC transaction with any conforming interoperable Tag present in the vehicle (also known as a Tag transaction);
- (b) Capture and read the front and rear Vehicle Licence Number (VLN) of the vehicle using an ANPR system that utilises optical character recognition (OCR) techniques;
- (c) Utilise additional optical character recognition techniques to enhance the accuracy or improve the ANPR process. This shall include comparing previously captured images to the current image to increase the accuracy and confidence level. This functionality shall be provided either at the RSS or at the Back Office System;
- (d) Detection and classification of the vehicle into one of the specified Vehicle Classes;
- (e) Capture a Scene Image of the vehicle which shall clearly place the vehicle at the scene. Such images may be required for enforcement, or for checking Class Discrepancies;
- (f) Utilise the details obtained from the Validation Lists received from the TCH via the Back Office System to determine and take the required action; and
- (g) Combine and frame the data and images collected for the vehicle into a Transaction Record and send it to the Back Office System.

1.1.6.2 The detection of each vehicle and the capturing of data and images, as indicated above, must be done accurately and in accordance with the SANS 1795 Standard (South African Standard Specification: Road Traffic Law enforcement systems) to ensure that manual checking requirements are minimised and that the data and images captured for a Potential Violation are sufficient for Evidential Records and for appropriate enforcement to be undertaken.

**FIGURE 1-2: TYPICAL RSS FUNCTIONS**

- 1.1.6.3 The RSS controller shall be required to transmit all the captured vehicle detail, relevant images and transaction information (Transaction Record) to the Back Office System in near real time, after the transaction has been processed. The RSS shall produce a single Transaction Record for each vehicle. Tag reads and images shall be associated with the correct vehicle and the correct vehicle Transaction Record.
- 1.1.6.4 The RSS controller shall receive Validation Lists from the Back Office System, which shall be utilised in the transaction processing and classification verification. The RSS controller shall also be required to store data for a predefined period in case of any communication or Back Office System failures. The stored data must be retrievable on media that can be transferred manually, if necessary, to the Back Office System for processing.
- 1.1.6.5 The RSS shall be required to transmit certain information to the Tag as specified within the Standard Specifications for Operations and Maintenance of CTROM Projects: Electronic Toll Collection (ETC) (Volume 2 Book 5).

- 1.1.6.6 The RSS shall be expected to perform self-diagnostics and generate automated alarms for Incidents in order to assist maintenance personnel with fault finding, and to minimise both the Mean Down Time (MDT) and Mean Time To Repair (MTTR). The RSS will be required to have a high system Availability and reliability (Mean Time Between Failure (MTBF)).

1.1.7 **BACK OFFICE SYSTEM OVERVIEW**

- 1.1.7.1 The main purpose of the Back Office (BO) is to collect, validate and process all Transaction Records received from the Toll Collection Lane Equipment / Road Side System. It is also required to transmit toll transactions for processing by the National Payment System and transmit the ETC Transactions to the Transaction Clearing House (TCH) for further account-related processing, as applicable.

- 1.1.7.2 The Back Office further serves as the master monitoring and system configuration manager.

- 1.1.7.3 The Back Office System shall be required, with both automatic and manual processing inputs, to:

- (a) Fully automate routine and other tolling related operational processes, management controls and operational deliverables in a secure “tamper-proof” and auditable electronic environment;
- (b) To guarantee valid and timeous system configuration and management data being ported to all Toll System peripherals and Sub-Systems;
- (c) Manage comprehensive audit control processes to guarantee data integrity and completeness.
- (d) Facilitate a comprehensive and secure data communication network infrastructure with fallback redundancy, where required, in the event of primary communications channel failure/s;
- (e) Monitor, validate and report all functional status conditions of all Toll System peripherals and Sub-System. This shall include the facilitation to accurately manage all error and fault conditions encountered on any component of the Back Office, including each peripheral and Sub-System linked to the Back-Office. This monitoring shall be performed in real time;
- (f) Manage and control Operational personnel and employees required tasks to be performed at various operational intervals, real time, hourly, operational day (if applicable), calendar day, weekly, monthly etc;
- (g) Provide electronic means of data security;
- (h) Provide electronic and automated facilities to manage live data, historic data and data archives. This shall include Toll Systems data storage, redundancy, back-up and Disaster Recovery solutions, including data communication recovery solutions;

- (i) Manage and verify the completeness and authenticity of data received from the Road Side System / Toll Collection Lane Equipment in an automated manner. This shall include automated corrective measures to guarantee the above;
- (j) Identify the vehicle through Identifiers if this was not completed by the Road Side System / Toll Collection Lane Equipment;
- (k) In case of Opt-in Toll Agencies, identify the vehicle through an ANPR process, if this was not completed by the Road Side System/ Toll Collection Lane Equipment or if the ANPR Software resides in the Back Office;
- (l) In addition to ANPR processes, the Back Office process shall include a manual process, Manual Number Plate Recognition (MNPR), in order to determine an appropriate "Identifier", e.g. Vehicle Licence Number where necessary and applicable;
- (m) Facilitate the manual resolution of vehicle Classification errors and/or discrepancies;
- (n) Allow manual resolution of Vehicle License Number Discrepancies (where applicable);
- (o) Apply Discounts correctly and determine the Toll Tariff and send the ETC Transaction Records to the TCH (where applicable) for Account processing;
- (p) Facilitate and manage the correct Toll Tariffs / Tables;
- (q) Automatically update and reconcile its database/s with information received from Validation Lists and transmit information from the Validation Lists to the RSS / Toll Collection Lane Equipment. This includes configuration, validation and other data elements required in the Toll System from third party data providers;
- (r) Store images related to transmitted ETC Transaction Records for the specified periods of time, to allow for image queries;
- (s) Store video and other image material for all other audit and verification requirements;
- (t) Perform self-diagnostics in aid fault finding and minimise both Mean Down Time (MDT) and Mean Time To Repair (MTTR);
- (u) Facilitate the remote management of specific Toll System components and/or sub-systems, such as activating an Emergency Lane and controlling un-manned tolling equipment, etc;
- (v) Facilitate Customer Account management;
- (w) Facilitate and provide automated Customer Service facilities where required. This includes real time account updating and integrated banking interfaces by means of linked bank speed-points; and
- (x) To facilitate a Road User interface to allow secure Customer Account queries via the internet.

1.1.8 SYSTEM FUNCTIONS

The typical system functions to be provided by the Back Office for the different levels of integration, is summarised in the table below.

TABLE 1-1: HIGH LEVEL SYSTEM REQUIREMENTS PER TOLL SYSTEM TYPE

No.	System Requirement	Opt-Out TA's	Opt-In TA's
1	Local Account Maintenance (for application of local Accounts, Discounts, Exempt passages and Free passages)	Y	Y
2	Discounts (Apply only Project specific Discounts. Keep counts and track Toll Tariff changes per VLN/Tag based on requirements for specific Discount.)	Y	Y
3	Data Validation		
3.1	Downloading Validation Lists	Y	Y
3.2	Perform validations against Validation Lists	Y	Y
3.2.1	Valid/Invalid Tag	Y	Y
3.2.2	Tag-VLN mismatch identification	N	Y
3.2.3	Handling of horse and trailer VLN's that differ	N	Y
3.2.4	Class Discrepancies identification	Y	Y
3.2.5	Low balance warning	Y	Y
3.2.6	Discount validation	Y	Y
3.2.7	VOSI (if required)	Y	Y
3.2.8	Exempt passage transactions	Y	Y
3.2.9	Free passage transactions	Y	Y
3.3	Downloading and validation against Hotlists from Banks	Y	N
4	VAT requirements	Y	Y
5	Reporting	Y	Y
6	Communication to TCH and VPC	Y	Y
7	General System requirements		
7.1	Encryption	Y	Y
7.2	Back-up / Archive	Y	Y
7.3	Data retention	Y	Y
7.4	System Monitoring	Y	Y

No.	System Requirement	Opt-Out TA's	Opt-In TA's
7.5	Audit control procedures	Y	Y
8	Interface requirements (as specified in the TCH interface document)	Y	Y
9	Configuration data to TCH/VPC Systems	Y	Y
10	Quality Control	Y	Y
11	Testing requirements		
11.1	RSS / Toll Collection Lane Equipment and BO changes to provide data in the required format	Y	Y
11.2	Pilot/Trial run of interface	Y	Y
12	System Certification		
12.1	Prosecution requirements w.r.t. ETC Transaction Records	N	Y
12.2	Image requirements	N	Y
12.3	Type approval (Tag Readers, OCR cameras)	Tag Readers only	Y
12.4	SANS certification (System handling of data)	Tag Readers only	Y
12.5	Continuous monitoring of certification (AVC/ANPR)	N	Y
12.6	Certification by TCH/VPC	Y	Y
13	Evidential chain		
13.1	Front, rear and Scene Images	N	Y
14	Future Upgrades		
14.1	Induced by TCH upgrades	Y	Y
14.2	Induced by VPC upgrades	N	Y
14.3	Induced by Toll System upgrades	Y	Y
15	Tag in a Bag (validation in lanes)	Y	Y
16	V-Tolls (only possible if VLN cameras are installed)	N	Y

SECTION 2. GENERAL REQUIREMENTS

2.1 SOFTWARE REQUIREMENTS

2.1.1 SOFTWARE DEVELOPMENT MANAGEMENT

2.1.1.1 Software development shall include a well-defined Software methodology, formalised development strategy with measurable milestones and clear deliverables during the execution (i.e. Functional Specifications, a Quality Assurance Plan and Risk Assessment Plan).

2.1.1.2 The Software system shall be subjected to formal reviews, tests and audits.

2.1.2 SOFTWARE DESIGN

2.1.2.1 The Software shall typically make provision for:

- (a) User friendly graphical System User interface;
- (b) Enterprise operating system and relational database; and
- (c) Access controls, which shall ensure that access to systems, data and programs is restricted to authorised users to safeguard information against unauthorised use, disclosure, modification, damage or loss.

2.1.3 MINIMUM SOFTWARE REQUIREMENTS

2.1.3.1 In general, the following minimum Software requirements shall apply:

2.1.3.2 Operating System and Data Base Management System (DBMS)

- (a) The main operating system shall be a 32-bit or better, multi tasking and multi user network operating system
- (b) The selected operating systems shall be procured from a reputable dealer and shall be selected based on stability, supportability and cost for the individual systems.
- (c) The selected AVC operating system shall be designed and proven to operate in a mission critical environment and shall not require human intervention to maintain stability. The development environment shall include the required tools to verify program stability and proper handling of system resources, especially memory.
- (d) The Toll System shall be supported by a field-proven relational Database Management System (DBMS) capable of operating in a continuously Transaction-intensive environment.
- (e) The database Software shall be compatible with the operating system and application Software, and shall support the redundant Toll System architecture. The DBMS shall

have an upgrade path and support upgrades to the operating system, application, memory, processes etc.

- (f) The latest version of the operating system and DBMS shall be used on commencement of the system. The Contractor shall obtain the life cycle road maps (or equivalent documentation) for the operating system and DBMS from the respective vendors. This must indicate the planned future upgrades and expected life cycle of the products.

2.1.3.3 Firmware

Customised and specialised firmware implementations shall be avoided as far as possible. Use of such shall be on prior approval from the Employer. Firmware implementations shall be implemented using proven technologies with a wide support base.

2.1.3.4 Application Software

- (a) The Toll System shall use specialised Software to automate the functionality.
- (b) The Software shall utilise configurable parameters to support basic Business Rule changes without requiring code changes. The parameters shall typically be updated by the System User with system administrator privileges at the front end.
- (c) The Software shall allow system operating rules and configurable parameters to be changed while the system is operating, without having to shut down the application.

2.1.3.5 Antivirus Software

- (a) All computers and workstations shall be installed with antivirus Software. An automated scheduled virus update shall be downloaded to all the computers. Firewalls shall be installed where applicable.
- (b) As a security measure, the RSS and Toll Collection Lane Equipment shall not be able to connect to the internet and shall not be able to receive any e-mail.

2.1.3.6 Language Requirements

- (a) The user interface of the Toll System shall be in English.

2.1.4 INFORMATION REQUIREMENT GUIDELINES

- 2.1.4.1 To satisfy the business objectives, the information received, produced and used by all the role players needs to conform to certain criteria. The system provided shall provide information that conforms to the following standards:

(a) Effectiveness

The information shall be relevant and pertinent to the business process as well as being delivered in a timely, correct, consistent and usable manner.

(b) Efficiency

The information shall be provided through the optimal (most productive and economical) use of Resources.

(c) Confidentiality

The information shall be protected from unauthorised disclosure.

(d) Integrity

The information shall be accurate and complete as well as valid in accordance with the business values and expectations.

(e) Availability

The information shall be available when required, by the business process. The safeguarding of necessary Resources and associated capabilities shall be included.

(f) Compliance

The information shall comply with those laws, regulations and contractual arrangements to which the business process is subject, i.e. externally imposed business criteria.

(g) Reliability

The information provided shall be appropriate to operate the entity and to exercise its financial and compliance reporting responsibilities.

2.1.5 DATA MANAGEMENT REQUIREMENT GUIDELINES

2.1.5.1 The system shall provide an effective combination of application and general controls over the system operations to ensure that data remains complete, accurate and valid during its input, update and storage. These controls shall include the following:

(a) Data preparation procedures

In this context, the system design shall provide functionality to ensure that errors and omissions are minimised. Error handling procedures during data origination should reasonably ensure that errors and irregularities are detected, reported and corrected.

(b) Source document error handling

Error handling procedures during data origination should ensure that errors and irregularities are detected, reported and corrected.

(c) Source document retention

The system should provide the functionality to ensure that original source documents are retained or are reproducible for a predefined time to facilitate retrieval or reconstruction of data as well as satisfy the legal requirements.

(d) Accuracy, completeness and authorisation checks

Transaction data entered for processing (people-generated, system-generated or interfaced inputs) shall be subject to a variety of controls to check for accuracy, completeness and validity. System procedures should also be established to ensure that input data is validated and edited as close to the point of origin as possible.

(e) Data input error handling

The system shall provide functionality for the correction and resubmission of data which was input erroneously.

(f) Data processing integrity

The system shall provide functionality for the processing of data that ensures that separation of duties is maintained and that the work to be performed is routinely verified. The procedures shall ensure that adequate controls such as run-to-run control totals and master file update controls are in place.

(g) Data processing validation and editing

The functionality provided shall establish procedures to ensure that data processing validation, authentication and editing are performed as close to the point of origin as possible.

(h) Data processing error handling

The system functionality shall include data processing error handling procedures that shall enable erroneous transactions to be identified without being processed and without undue disruption of the processing of other valid transactions.

(i) Output balancing and reconciliation

The system functionality shall include procedures for ensuring that output is routinely balanced to the relevant control totals. Audit trails should be provided to facilitate the tracing of transaction processing and the reconciliation of disrupted data.

(j) Output review and error handling

The system functionality shall include procedures for ensuring that the accuracy of output reports is reviewed by the provider and the relevant users. Procedures shall also be in place for controlling errors contained in the output.

(k) Security provision for output reports

The system functionality shall include procedures for ensuring that the security of output reports is maintained for those awaiting distribution, as well as those already distributed to users.

(l) Protection of sensitive information during transmission and transport

The system functionality shall include procedures to ensure that protection of sensitive information is provided during transmission and transport against unauthorised access, modification and misaddressing.

(m) Protection of disposed sensitive information

The system functionality shall include procedures to prevent access to sensitive information and Software from computers, disks and other Equipment or media when they are disposed of or transferred to another use. Such procedures shall guarantee that data marked as deleted or to be disposed cannot be retrieved by any internal or third party.

(n) Storage management

The system functionality shall include provision of procedures for data storage which consider retrieval requirements, and cost effectiveness and security policy.

(o) Protection of sensitive messages

Regarding data transmission over the Internet or any other public network, the system provided shall include procedures and protocols to ensure integrity, confidentiality and non-repudiation of sensitive messages.

(p) Electronic transaction integrity

Taking into consideration that the traditional boundaries of time and geography are less reliant, the Contractor shall define and implement appropriate procedures and practices for sensitive and critical electronic transactions ensuring integrity and authenticity of:

- i. Atomicity - indivisible unit of work, all of its actions succeed or they all fail;
- ii. Consistency - if the transaction cannot achieve a stable end state, it must return the system to its initial state;

- iii. Isolation - a transaction's behaviour shall not be affected by other transactions that execute concurrently; and
- iv. Durability - a transaction effects are permanent after it commits, its changes should survive system failures.

2.1.6 **SYSTEM DOCUMENTATION**

2.1.6.1 All documentation supplied shall be project specific rather than generic and should only contain standard documentation where this is completely relevant to the aspect of the system being described. The documentation suite shall also be self contained. Where there are any references to external documents, such as standards and the like, copies shall generally be included in the suite.

2.1.6.2 The level of detail and the method of presentation of each document shall be wholly appropriate for the intended user and shall assume a level of understanding of toll and computer based systems in general, that a reader with appropriate qualifications and experience to undertake roles, relevant to the manual, may be expected to have.

2.1.6.3 Overall, the level of the documentation shall be such that it could be handed to a Contractor or his employees unfamiliar with the particular system, but with appropriate general experience and qualifications. Within a reasonable length of time, the Contractor or his employees should gain sufficient understanding to be able to effectively carry out tasks appropriate to the manual. It includes system and facility operation and maintenance.

2.1.7 **SOFTWARE RECOVERY PROCEDURE**

2.1.7.1 In order to prevent the system operation from being compromised by a system failure due to Software defects, a system recovery procedure, including every component required in the process shall be developed. Refer to clause 2.1.13.

2.1.8 **CHANGE CONTROL PROCEDURES**

2.1.8.1 The Contractor shall define change control procedures to ensure that changes and system updates are introduced in a controlled and coordinated manner. The change control procedures shall be based on the ISO 12207 (Systems and Software engineering – Software life cycle processes) guidelines or similar.

2.1.9 **ESCROW AGREEMENT**

2.1.9.1 The appointment of an internationally recognized Escrow agent shall be agreed between the Contractor and Employer.

2.1.9.2 Within 90 days after the Contract award, an Escrow software agreement shall be in place.

- 2.1.9.3 All costs related to the Escrow shall be paid by the Contractor (excluding the costs of the Employer).
- 2.1.9.4 Within 30 days after the Operations Service Period has started, the Contractor shall supply the Escrow agent with the Toll System Software source code and associated design (including database dictionaries), installation, System User and support documentation and the appropriate disaster recovery pack ("the Escrow package").
- 2.1.9.5 The Escrow agent shall verify that the application Software (Including third party Software) can be successfully installed with the aid of the supporting documentation.
- 2.1.9.6 The Escrow agent shall verify that the disaster recovery pack can be successfully installed with the aid of the supporting documentation.
- 2.1.9.7 The verification of the Escrow Software shall be repeated at least annually and after major upgrades, as agreed between the Contractor and Employer.
- 2.1.9.8 On successful verification of the software within Escrow, the Escrow agent shall deposit the source code and supporting documentation in a safe and secure storage facility. Full or partial deposits shall be made after successful deployment of every new version or patch of the Toll System software within 30 (thirty) days after such new version has been approved by the Employer or the Employer's Representative. At least one full deposit shall be scheduled per year, as specified in the Project Document (Volume 3).
- 2.1.9.9 Access to such Escrow material shall be granted by the System Integrator in the event of any of the following release conditions occurring:
- (a) The bringing of any application for the dissolution and/or liquidation of the System Integrator (except for the purposes of amalgamation or reconstruction of terms approved in advance by the Employer in writing) which is not dismissed within 60 (sixty) days of its commencement;
 - (b) The bringing of any application against the System Integrator for it to be placed under judicial management or to commence liquidation proceedings or the passing of a resolution for its winding-up; or
 - (c) Abandonment by the System Integrator of any part of the Works to be performed by it whether pursuant to this Agreement, or pursuant to any subcontract concluded between the System Integrator and the Contractor;
 - (d) A material breach by the System Integrator of any of its obligations under this Agreement or if it is not a party to this Agreement, a material breach of any of its obligations under the relevant sub-contracts between the System Integrator and the Contractor.

2.1.9.10 Notification of System Integrator Default: The Contractor undertakes to notify the Employer and the Employer's Representative of the occurrence and details of any release condition contemplated in clause 2.1.9.4 and of any event or circumstances of which it is aware which would be likely to, with the passage of time or otherwise, constitute or give rise to a release condition, in either case, promptly upon the Contractor becoming aware of the occurrence thereof.

2.1.10 **SOFTWARE LICENCES AND RIGHTS**

2.1.10.1 Software licences and rights thereto shall comply with the requirements as specified in the Contract.

2.1.11 **TOLL SYSTEM SOFTWARE STANDARDS**

2.1.11.1 The Toll System Software shall be based on the applicable technical standards and legislation of South Africa.

2.1.11.2 System standards, such as the following, shall apply:

- (a) The Quality Management System (QMS) shall be based on the ISO 9001 (Quality Management Systems Standard), Capability Maturity Model (CMM) Standards or similar for a quality system as published by the International Standards Organisation.
- (b) System lifecycle Software shall be based on ISO 12207 (Systems and Software engineering – Software life cycle processes) guidelines or similar and System documentation shall be based on the IEEE, ISO/IEC 15289:2006 (Systems and Software engineering – Contents of systems and Software life cycle process information products (Documentation)) guidelines or similar.
- (c) Database security shall comply with the ECT Act of 2002.
- (d) Standards specified within the Standard Specifications for Operations and Maintenance of CTROM Projects: Electronic Toll Collection (ETC) (Volume 2 Book 5).
- (e) The image capture- and image management systems shall conform to the applicable sections of the latest version of the South African Standard Specification: Road Traffic Law enforcement systems (SANS 1795 Standard).

2.1.12 **REDUNDANCY**

2.1.12.1 Sufficient data and system redundancy shall be provided to ensure continuous operation.

2.1.12.2 Data and system redundancy includes, but are not limited to the following:

- (a) On-line data replication, to ensure business continuity;

- (b) Adequate data storage redundancy, to ensure data reliability;
- (c) Full server redundancy wherein the hot standby server can be brought into service with no disruption to operations in real time. For ORT systems a remote fail-over system at a different location is required unless otherwise agreed between the Contractor and the Employer;
- (d) Sufficient redundancy to continue operating, with at least the minimum amount of required functionality; and
- (e) Multiple levels of RAID technology in data storage.

2.1.13 SYSTEM DISASTER RECOVERY AT CONVENTIONAL OR HYBRID TOLL PLAZAS

2.1.13.1 Data should be backed-up on a daily basis. Complete back-ups should be kept at a secure location physically remote from the Back Office.

2.1.13.2 Back-up, archive and restore facilities, including all required tools, inter alia: For the performing of all Back-up and Archiving activities, all required tasks or activities shall be performed via a well-defined and user-friendly System User interface (irrespective of functional platform). All required Back-ups and archives shall be monitored and systematically managed to enforce the accurate and timeous execution of these data and system administration functions. Regarding system or component restore/rebuild activities, following any failure, such processes/facilities or tools shall be made available by the Contractor to enable any reasonably qualified person to re-commission any system or component to the required operational state. The Contractor shall accurately document detailed procedures to successfully recover and commission any component or system. The Contractor shall package all recovery packs in such a manner that any component or system can be rebuilt and re-commissioned within a maximum of 48 (forty-eight) hours after the failure occurred. The above period does not relieve the Contractor of any obligations under this Agreement, The above period does not relieve the Contractor of any penalties, including compounding penalties, which might be applicable following any system or component failure. The Contractor shall be required to have access to necessary, skills, components, parts, tools, software, operational data (back-ups, archives & accurate system/s configuration setups) and any other requirement/s, on a continuous basis, to re-commission any component or system/s to the fully required and compliant operational state.

2.1.14 OPEN ROAD TOLL SYSTEM DISASTER RECOVERY

2.1.14.1 The system disaster recovery centre and communications operations for Open Road Tolling (ORT) shall be replicated at a secure location physically remote from the current data centre, unless otherwise agreed between the Contractor and the Employer. Network connectivity shall be in place to ensure automatic fail-over and data shall be sent to both locations.

2.1.14.2 Refer to the Standard Specifications for Operations and Maintenance of CTROM Projects: General (Volume 2 Book 2a) for detail on the requirements for operational disaster recovery.

2.1.14.3 Primary Areas of Control

The following are the primary components that must be available at a safe location to form the bases for recovery of ORT operations:

- (a) Application Servers
 - i. Process servers
 - ii. Database servers
 - iii. Firewalls and other security support Hardware and Software
- (b) Network Communications (Toll Systems Communications Connectivity)
 - i. Fibre optic (Private network) (Hardware and Software)
 - ii. Virtual private networks (VPN) (Hardware and Software)
- (c) Interfaces with other networks and computers, e.g.
 - i. Banks and Credit Card companies
 - ii. Internet (Public at large)
 - iii. Wireless Telephones

2.1.14.4 Business Continuity Plan:

- (a) The Contractor shall complete and maintain a comprehensive business continuity plan, based on the SANS 17799:2005 (Security standard) guidelines and should be designed to assess risks, identify and implement appropriate security measures responsive to those risks, verify that they are effectively implemented and ensure that they are continually updated in response to new developments.
- (b) The business continuity plan shall include the procedure to successfully install a disaster recovery pack with the aid of the supporting documentation.
- (c) A Disastrous Event shall be simulated and evaluated on an annual basis.
- (d) The plan shall, as a minimum, provide for:
 - i. A business impact analysis with a sample impact matrix;
 - ii. A vulnerability assessment of risks;
 - iii. DRP Organization Responsibilities pre and post disaster (a DRP Checklist);

- iv. A back-up and archive strategy for the data recovery centre, file servers, network servers, firewalls, desktop nodes, and any authorized laptops;
 - v. Recovery strategy including approach, escalation plan process and decision points;
 - vi. Data recovery procedures in a check list format;
 - vii. An update plan for administration processes;
 - viii. A work-plan to modify and maintain the plan in an up-to-date condition;
 - ix. Appendix of job descriptions for the disaster recovery manager and team;
 - x. Technical appendix, including a definition of phone numbers and contact points for key persons; and
 - xi. Disaster recovery plan, which shall include:
 - 1. Restart capabilities for all system application processes to be operational on the servers within the specified time;
 - 2. Restore connectivity for toll operations communications to and from nodes on the current networks;
 - 3. Time synchronisation to a common primary time synchronisation source approved by the Employer;
 - 4. Firewalls and other security measures in place and functioning before processing is resumed;
 - 5. Up to date approved commercial virus protection internal security Software; and
 - 6. Restoration of the full system, after the interim measure with scaled down capacity.
- (e) Back-up, archive and restore activities shall be performed via a well-defined System User interface

2.2 HARDWARE REQUIREMENTS

2.2.1 ENVIRONMENTAL REQUIREMENTS

- 2.2.1.1 The Contractor shall ensure that the Toll System meets or exceeds the minimum environmental requirements indicated herein.

2.2.1.2 All Equipment exposed to the elements (including but not limited to the RSS cameras, Tag Readers, Automatic Vehicle Classification devices, etc.) shall successfully operate within the following ambient temperatures:

- (a) Minimum: -10 deg C
- (b) Maximum: 50 deg C external at a relative humidity of 95%

2.2.1.3 The Equipment shall successfully accommodate the high and low temperatures, the glare of the sun, excessive rain and spray on the roads.

2.2.1.4 All outside Equipment exposed to the elements (including but not limited to the RSS cameras, Tag Readers, Automatic Vehicle Classification devices, etc.) shall be housed in weatherproof enclosures that are fit for the purpose and fabricated from corrosion resistant metal. It shall be robust and suitable for long and trouble-free service in areas subject to lightning storms, occasional wind storms, periods of high condensation, high sun temperatures, vehicle induced vibration and vehicle emissions. Suitable corrosion proofing shall be employed.

2.2.1.5 The server Equipment shall be accommodated in a dedicated server room that shall conform to the standards and requirements for server rooms or Technical Shelters, such as sufficiently large, well-lit and properly ventilated area. The Contractor shall ensure that the required power outlets, server racks and other environmental/technical prerequisites as specified by the supplier have been met. The Contractor shall state the permissible environmental limits for temperature, humidity and dust for the Equipment to be supplied.

2.2.1.6 The personal computer and peripheral Equipment shall be accommodated in a standard computer environment. The Contractor shall state the permissible environmental limits for temperature, humidity and dust for the Equipment to be supplied.

2.2.1.7 The relevant standard specifications included within the Standard Specifications for Operations and Maintenance of CTROM Projects: Electrical and Mechanical Equipment (Volume 2 Book 3) shall be applicable to the supply, installation and maintenance of any Plant or Equipment as required of the Contractor.

2.2.2 **EARTHING, LIGHTNING PROTECTION AND SURGE PROTECTION**

2.2.2.1 The Contractor shall take all reasonable measures to protect all Equipment against lightning and voltage surges.

2.2.2.2 The provision of an adequate earth system is imperative, as the effectiveness of surge suppression depends directly on its adequacy.

2.2.2.3 Refer to the Standard Specifications for Operations and Maintenance: Electrical and Mechanical Specifications of CTROM Projects (Volume 2 Book 3) for earthing, lightning protection and surge protection requirements.

2.2.3 RADIO FREQUENCY INTERFERENCE

The Equipment shall be protected against radio interference so as to prevent any hampering of Equipment functionality due to such.

2.2.4 EQUIPMENT

2.2.4.1 To the extent possible, currently supported “off-the-shelf” components and Software (including the Operating System and the Database Management System) should be used.

2.2.4.2 Processors, internal memory and disk drive(s), along with planned upgrades, shall support the estimated volume of Transaction Record data anticipated over the next ten (10) years, without degradation in performance.

2.2.5 CAPACITY

2.2.5.1 The Toll System provided shall have adequate redundancy and storage capacity to appropriately and successfully manage any Transaction Record data transmission, processing or system Availability risks.

2.2.5.2 The Toll System shall be able to process Transaction Record volume loads at projected maximum loads for the next ten years. The system shall be scalable such that it can be expanded beyond the ten-year expectation. The Contractor shall commit to maintaining the Toll Systems as technically viable throughout the life of the Contract.

2.2.6 “AS-BUILT” DRAWINGS AND DOCUMENTS

2.2.6.1 Refer to the Standard Specifications for Operations and Maintenance of CTROM Projects: General (Volume 2 Book 2a) for as-built drawings and document requirements.

2.2.6.2 The submission of all relevant drawings and documents is a prerequisite for the issuing of a Commissioning Certificate.

2.2.7 DESIGN LIFE

The Contractor shall replace or upgrade the system at its own cost. The design life of the system shall be in accordance with the Operations Period and Hand-back requirements. The proposed level of spares shall be agreed between the Contractor and the Employer. Refer to the Standard Specifications for Operations and Maintenance of CTROM Projects: General (Volume 2 Book 2a).

2.3 NETWORK AND COMMUNICATION

2.3.1 COMMUNICATION INFRASTRUCTURE

- 2.3.1.1 If not already provided and maintained by the Employer and if stipulated in the Project Document (Volume 3), the Contractor shall provide a Wide Area Network (WAN) communication backbone, also referred to as the primary communications network, from the Back Office System up to each Toll Lane / Tolling Point (including the Equipment within the Technical Shelter and within suitable enclosures along the Road). The Contractor shall take full responsibility for the communications network, which shall include taking over the existing services, maintaining the service, keeping it secure, and providing all other materials, Equipment and/or services to establish a reliable Wide Area Network (WAN) between the Toll Plazas/Tolling Points and the Back Office System. The WAN shall provide sufficient bandwidth to ensure that all data from the Toll Plazas/Tolling Points can be delivered to the Back Office System in near real time.
- 2.3.1.2 The communication network between each Tolling Point/Toll Lane and the Back Office System shall be sufficient to cater for all the communication needs, including the load of the security cameras and monitoring and supervisory systems.
- 2.3.1.3 The Contractor shall provide for appropriate segmentation so that Local Area Network (LAN) traffic at each Tolling Point will not be transmitted across the WAN, unless required at the Back Office System.
- 2.3.1.4 The Contractor shall, in addition, provide for an adequate communications link from the Back Office System to the TCH, which shall cater for the volume of daily ETC Transactions' data along the entire route. This communications link shall have the potential for upgrade if required.
- 2.3.1.5 The Contractor shall provide an alternative back-up solution to the primary communication network to transmit the relevant Transaction Record data (excluding the images) to the Back Office System. This secondary communication network shall have sufficient bandwidth and Availability in order to meet the requirements for data submission as specified within this document, as well as requirements of the TCH.
- 2.3.1.6 The Contractor shall design and provide or upgrade existing networks (where applicable) to a redundant enterprise network solution that complies with the performance requirements of the Toll System. The network solution includes, but is not limited to, the following:
- (a) Provision of strict network security that allows for System User access control, firewalls for Internet and external network connections, limited Internet connectivity for System Users, restriction on the number of System Users that can receive and send mail, the use of antivirus Software on all workstations, etc.;
 - (b) Utilising managed network switches and routers which shall normally allow for continuous data traffic monitoring on the network and hence shall allow the

- (c) Contractor to change the network to alleviate congestion; and
- (d) Segmenting the network implementation (either logically or physically) to limit network traffic to the areas where it is required, and reduce network congestion.

2.3.1.7 The communication link shall carry all data transmitted (between Toll Plazas/Tolling Points and the Back Office System) and shall cater for communications to the applicable Customer Service centres, other Contractor facilities and to the TCH. Any communication link between different facilities shall typically utilise Fibre Optic cable or PSTN lines with surge protection. PSTN or public lines shall generally be configured as a VPN with a high level of data security. A typical network configuration is provided in the figure below.

2.3.1.8 The communication network provided between each Toll Plaza and the Back Office System shall be sufficient to cater for all the communication needs, including the required bandwidth of the security cameras and monitoring and supervisory systems.

2.3.1.9 The Contractor shall, in addition, provide for an adequate communications link from the Back Office System to the TCH, which shall cater for the volume of daily ETC Transactions' data along the entire route. This communications link shall have the potential for upgrade if required.

2.3.1.10 The Contractor shall provide an alternative back-up solution to the communication link to transmit the relevant Transaction Record data (excluding the images) to the Back Office System and to the Customer Service centres in case of failure of the primary link.

2.3.1.11 The communication link, services and infrastructure installed within the Road reserve shall be subject to the Employer's approval.

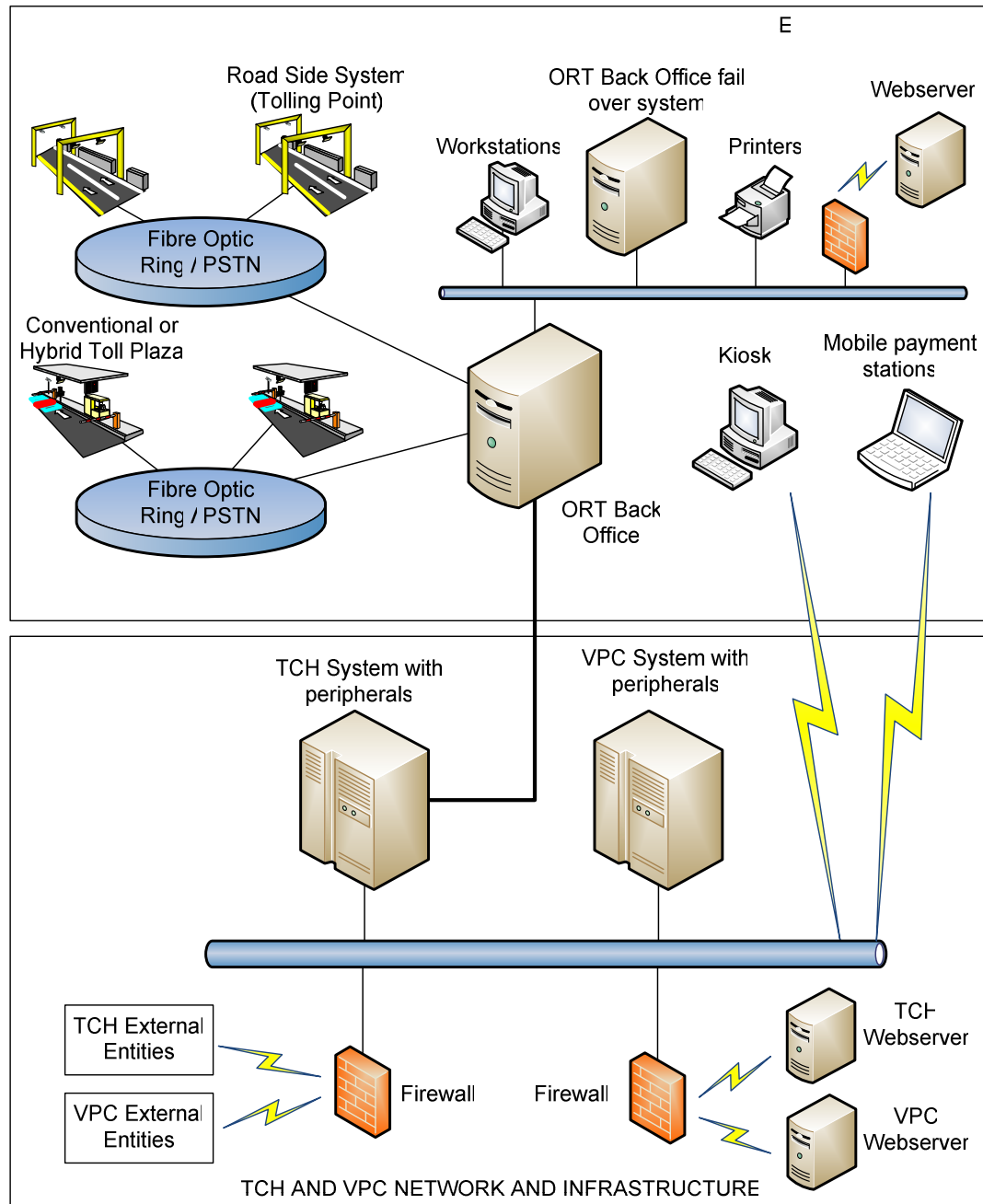


FIGURE 2-1: TYPICAL NETWORK CONFIGURATION (PURELY FOR ILLUSTRATIVE PURPOSES)

2.3.2 GENERAL NETWORK REQUIREMENTS

- 2.3.2.1 An open, guaranteed messaging communication protocol shall typically be used to ensure proper data delivery. In the event of a communications failure, the Contractor shall ensure that no loss of data shall occur.

- 2.3.2.2 The network must be operational on a 24/7 basis. To ensure this, it shall have fail over capabilities to a backup network. The network shall monitor its own performance and shall reroute traffic on the network within the network and backup network to ensure uninterrupted operation should any device or link fail. The network shall warn the maintenance team about any such failures and re-routing to ensure the problem is addressed and the redundancy is restored. The network monitoring system shall retain a complete log of failures, re-routing, performance statistics and maintenance warnings for later audit.
- 2.3.2.3 The network server and the main routers shall be backed up with spare Equipment ready in place and monitoring the ongoing communications processes and would pick-up operations in an automatic fail over.
- 2.3.2.4 A back-up strategy shall generally be arranged with the PSTN provider for events where a physical telephone line is cut or somehow disconnected.
- 2.3.2.5 The failure of any network link shall not result in the permanent loss of any data.
- 2.3.2.6 Routers, switches, Hubs, and Fibre Optic media converters shall be installed in secure, access controlled and monitored locations.

2.3.3 **COMMUNICATIONS PERFORMANCE**

All Transaction Records have to be captured by the Toll System at the Toll Plazas in real time and transmitted to the Back Office System in near real time. The network shall be monitored continuously and an alarm system is required to notify the Contractor when a network segment becomes inoperable. Refer to the Standard Specifications for Operations and Maintenance of CTROM Projects: Performance Measurement (Volume 2 Book 6a) for requirements on the submission of Transaction Records.

2.3.4 **TIME SYNCHRONISATION**

The Contractor shall introduce a central time control and synchronisation mechanism consisting of a GPS time receiver card/module that obtains its time from secure Global Positioning Satellites. Details of the GPS time receiver card/module to be used shall be submitted to the Employer's Representative for prior approval. This shall update and synchronise the time on the Toll System, including every sub-system. This system shall maintain time accuracy to within 0.25 seconds of GMT + 2 hours. The Employer's approval of time sources are required if connections are made to external time sources e.g. Internet time sources.

2.4 TESTS ON COMPLETION OF DESIGN-BUILD

2.4.1 GENERAL

- 2.4.1.1 The minimum test requirements for acceptance of the Toll System performed during the Tests on Completion of Design-Build, are listed below. Testing includes pre-commissioning testing, commissioning testing and, in case of installations at new toll facilities, Trial Operation where applicable. Some of the phases listed below are not related to a physical test but rather to the Employer's acceptance of such a phase.
- 2.4.1.2 The Contractor shall prepare a Software Functional Compliance Test Plan and detailed FAT and SAT test procedures that demonstrate a logical sequence of testing and define the aims and objectives of each section of testing. The test procedures shall be properly integrated to test all functionality of the system. The expected test results shall be supplied. Refer to Appendix A for an illustrative solution of a Test Plan.
- 2.4.1.3 The Software Compliance Test Plan shall contain a list of clause numbers in the Contract that are applicable to the systems and next to each Contract clause number reference the item in the test procedure applicable to the particular clause or whether no test is required for that clause.
- 2.4.1.4 Test plans and procedures shall be submitted to the Employer's Representative for comments one month before the Employer's Representative is required to attend the testing.
- 2.4.1.5 Testing shall be done such that Equipment performance under all environmental conditions can be verified. The Equipment shall successfully accommodate, inter alia, the high and low temperatures, the glare of the sun, excessive rain and spray on the roads.
- 2.4.1.6 No Software changes shall be allowed during the testing with the Employer's Representative, unless mutually agreed between the Parties.
- 2.4.1.7 The Employer's Representative may perform any additional tests, not included in the test procedures, which it deems necessary.
- 2.4.1.8 The Contractor shall provide a programme (Gantt chart format), complete with test milestones, indicating the Contractor's committed testing dates for all components of the Toll System. The programme shall be submitted 1 (one) month prior to the start of testing to the Employer for approval.
- 2.4.1.9 If any milestone test fails, no further tests will be conducted before the problem areas, identified by the Employer's Representative, are resolved.

2.4.1.10 The Employer shall also be directly part of the testing process to ensure that the compliance process progresses in an optimal manner. The Employer shall evaluate the findings identified at each test phase and deliver rulings on such.

2.4.1.11 At Conventional and Hybrid Toll Plazas, the VGS system shall be installed/upgraded within the first 6 (six) months after the Commencement Date for the purposes of recording all vehicle passages. Full functionality of the VGS in terms of the requirements of this specification, as described in clause 3.10, is to be provided during the functional compliance testing phase of the Toll System.

2.4.2 PRE-COMMISSIONING TESTING

2.4.2.1 Pre-commissioning testing includes the system design phase and system functional specification phase before system development is done, followed by the Factory Acceptance testing.

2.4.2.2 System Design Phase

- (a) It is the Contractor's responsibility to request clarification of any unclear areas, and areas that may be interpreted differently by different parties, in respect of the Employer's Requirements.
- (b) During the Design Build Optimisation Phase, the Employer and the Contractor shall discuss and agree on any aspect of the Toll System that requires clarification before the Functional Specifications can be completed. Toll System optimisation in terms of costs and time savings as well superior technical solutions, and any other benefit to the Toll System shall be put forth.

2.4.2.3 Functional specifications Phase:

- (a) The Contractor shall compile functional specifications for every sub-system describing how all the requirements for the Toll System shall be implemented and submit it to the Employer's Representative within 2 months after the Design Build Optimisation Phase. The functional specifications shall accommodate and refer to the clause numbers in the Standard Specifications.
- (b) The Employer's Representative will review the functional specifications and indicate areas where the specifications deviate from the requirements of the Contract or which are unacceptable for the proper functioning of the systems. Disputes shall be resolved before proceeding with the system development and implementation. The Employer's Representative shall not review the functional specification for completeness
- (c) The Contractor shall compile Software and Hardware Architecture documents for every subsystem and submit it to the Employer during the functional specifications phase.

2.4.2.4 Factory Acceptance Tests (Hardware and Software):

- (a) The purpose of the FAT is to test the functionality of the sub-systems in a factory environment to ensure that the system requirements are met.
- (b) Factory Acceptance tests shall test the Software functionality in the factory with Hardware that shall be installed at the Toll Plaza or Road Side.
- (c) The FAT testing for the Road Side System shall include testing at a test Site with actual vehicles and Equipment installed in a typical Tolling Point scenario simulating real-world traffic patterns driving through the Tolling Point.
- (d) For non-ORT Lanes, testing shall either be done with actual vehicles or with simulated vehicles.
- (e) The FAT tests shall include integrated tests between the sub-systems to verify the data flow of a Transaction Record from the Lane / RSS, to the Back Office System. The integration to the national Transaction Clearing House (TCH) System for ETC Transaction Records shall also be tested.
- (f) It is required that the Contractor complete all performance requirements before the final FAT is performed and the successful results are submitted to the Employer's Representative. The Contractor shall indicate which items were successful and which unsuccessful during testing, as well as the reason why certain items failed during the test, before inviting the Employer's Representative to the tests.
- (g) The test results shall be submitted to the Employer's Representative two weeks before the factory acceptance tests with the Employer's Representative shall take place.
- (h) If the Employer's Representative deems the number or impact of the items that were unsuccessful too large, the Contractor may be instructed to solve the unsuccessful items, perform the applicable portion of the FAT and re-submit the test results before the factory acceptance testing with the Employer's Representative takes place.
- (i) Both normal and abnormal scenarios should be demonstrated during the SFAT. Alternatively, the Contractor shall provide documentation to indicate which functional tests were done to verify exception conditions and demonstrate some of the tests.
- (j) The system shall only be deemed to have successfully completed the factory acceptance tests when the respective systems are functionally compliant to the requirements of the Contract as far as:
 - i. The functional requirements have been demonstrated to work as specified;
 - ii. No financial risk to the Employer and the Road User remains due to the loss of Revenue as a result of non-conformance of the system to the contractual requirements;

- iii. The legislative or statutory requirements such as VAT requirements have been met;
 - iv. The required interfaces and services to the System User and ITIS are provided and the tools to monitor this service is in place (as far as is practicable under factory test conditions – appropriate simulations shall be implemented); and
 - v. The system is auditable.
- (k) Following the acceptance tests, some minor snags remaining on the Software at this stage, may be allowed by the Employer's Representative. The defects shall be tracked and a retest, including some regression testing, shall be planned.

2.4.2.5 Hardware Verification:

- (a) Hardware verification shall be done to verify that the Hardware requirements of the sub-systems are met.
- (b) The Contractor shall invite the Employer's Representative to inspect one sample of each major component of the Hardware (or as agreed between the Employer and the Contractor) and to point out any non-compliant aspects or aspects that are not fit for purpose, before proceeding to order the remainder of the Hardware sets required. These inspections shall be conducted at least 1 month prior to the scheduled start of Site deployment date of the system.
- (c) Datasheets of these Hardware items shall be submitted to the Employer's Representative two weeks before these inspections, for comment, together with reports indicating how the Hardware complies with the requirements of the Contract.
- (d) As soon as the Contractor has received all the Hardware required for the project, the Contractor shall invite the Employer's Representative to verify the Equipment in order to ensure that it is available on time in accordance with the program submitted by the Contractor. The Hardware verification will only be deemed successful once this has been achieved, with only minor outstanding Hardware items. Verification shall be conducted at least 1 month prior to the scheduled start of Site deployment date of the system.

2.4.3 COMMISSIONING TESTING

Commissioning testing consists of functional compliance and site acceptance testing, and shall be performed on Site. Refer to clause 2.6 for the System installation requirements.

2.4.3.1 Functional compliance testing:

- (a) The purpose of functional compliance testing is to verify the complete Toll System, the Hardware and the installation standard in an operational environment before the system is rolled out to all Lanes / Tolling Points.

- (b) The Contractor shall perform the tests and submit test results to the Employer's Representative indicating which items were successful and which unsuccessful during testing, as well as the reason why each unsuccessful item failed the test, before inviting the Employer's Representative to the tests.
- (c) The test results shall be submitted to the Employer's Representative two weeks before the functional compliance testing with the Employer's Representative takes place.
- (d) If the Employer's Representative deems the number or impact of the items that were unsuccessful during the Contractor's test too large, the Contractor may be instructed to solve the unsuccessful items, redo the testing and re-submit the test results before the testing with the Employer's Representative takes place.
- (e) The system shall be certified as functionally compliant to the requirements of the agreement as soon as:
 - i. The functional requirements have been demonstrated to work as specified;
 - ii. No financial risk to the Employer and the Road User remains due to the loss of Revenue as a result of non-conformance of the system to the contractual requirements;
 - iii. The legislative or statutory requirements such as VAT requirements have been met;
 - iv. The required interfaces and service to the road user is provided and the tools to monitor this service is in place;
 - v. The system is auditable.
- (f) A list of minor snags might still exist at this stage. The determination of compliance to the AVC calibration free period and accuracy may also be outstanding (Conventional / Hybrid Toll Plazas).
- (g) The decision whether functional compliance is granted shall be at the sole discretion of the Employer.

2.4.3.2 Implementation in all Lanes / RSS:

As soon as functional compliance has been achieved, the new Toll System may be implemented in all Toll Lanes / RSS and Toll Plazas along the route. All new patches or versions of Software will be tested and approved in one Toll Lane or at one Toll Plaza as described above before it is installed and commissioned in the rest of the Toll Lanes.

2.4.3.3 Site acceptance testing (SAT):

- (a) The purpose of the SAT is to verify that the installation is done properly and that the system is properly configured.

- (b) Site acceptance testing shall include AVC accuracy verification (see next section).
- (c) Site acceptance testing shall take place at every plaza / Tolling Point and on every section of the Toll Road to ensure that all Site specific requirements have been achieved and to evaluate the systems after it has been operational for a while.
- (d) The Contractor shall perform the site acceptance tests and submit test results to the Employer's Representative indicating which items were successful and which unsuccessful during testing, as well as the reason why each unsuccessful item failed the test, before inviting the Employer's Representative to the tests.
- (e) The test results shall be submitted to the Employer's Representative two weeks before the site acceptance tests with the Employer's Representative takes place.
- (f) If the Employer's Representative deems the number or impact of the items that were unsuccessful during the Contractor's test too large, the Contractor may be instructed to solve the unsuccessful items, re-do the testing and re-submit the test results before the site acceptance testing with the Employer's Representative takes place.
- (g) Once the sub-systems have been individually tested, the sub-systems shall be integrated and tested to verify the data flow of a Transaction Record from the RSS and/or Toll Collection Lane Equipment, to the Back Office (BO) System. The integration of ETC Transaction Records to the national Transaction Clearing House (TCH) System shall also be tested.

2.4.3.4 Provisional compliance:

The provisional compliance milestone will be granted only after successful achievement of functional compliance, roll-out of the Toll System in all the Toll Lanes / Tolling Points and the successful site acceptance testing has been accomplished on the Toll System.

In the case of Conventional and Hybrid Toll Plazas, monitoring of the Toll Lane Equipment in order to conduct the AVC accuracy verification and calibration free period shall as a minimum require that:

- (a) Successful functional compliance testing and/or site acceptance testing has been completed; and
- (a) The AVC accuracy verification procedure was completed and certified by the Employer's Representative and ready for implementation.

2.4.3.5 Accuracy Verification

- (a) The system supplier shall prove, as part of the functional compliance testing and/or site acceptance testing, that the system is capable of achieving the specified accuracies for the applicable Equipment such as AVC, ETC, cameras and ANPR.

- (b) For the RSS, the relevant accuracy requirements are specified as follows:
 - i. AVC accuracy within clause 4.2.6;
 - ii. ETC or Tag reading accuracy within clause 4.2.3 and within the Standard Specifications for Operations and Maintenance of CTROM Projects: Electronic Toll Collection (ETC) (Volume 2 Book 5);
 - iii. ANPR accuracy within clause 4.2.8, and
 - iv. Framing accuracy within clause 4.2.10.
- (c) For the Conventional and/or Hybrid Toll Plazas, the relevant AVC accuracy requirements are specified in Section 10.
- (d) The traffic sample sizes and corresponding margins of error for each accuracy category are specified in SECTION 10.

2.4.3.6 Final Compliance Testing and Certification:

The Contractor shall compile test procedures for the testing of any outstanding items and submit it to the Employer's Representative for comment one month before the Employer's Representative is required to attend the testing.

- (a) The Contractor shall perform the final tests and submit the test results to the Employer's Representative indicating which items were successful and which unsuccessful during testing, as well as the reason why each unsuccessful item failed the test, two weeks before inviting the Employer's Representative to the tests. The requirements for the submission of test results for the AVC accuracy verification are indicated in section 10.
- (b) The Employer's Representative will not perform the final testing until the Contractor has indicated that all remaining items have been successfully resolved.
- (c) Although the Employer's Representative shall endeavour not to re-test items that have already been found successful, the Employer's Representative may perform any additional tests not included in the respective test procedures if a reason exists to do so or to re-test any item(s).

2.4.4 TRIAL OPERATION TESTING (ORT ONLY)

2.4.4.1 Trial Operation Testing shall be performed for Tolling Point installations at new toll facilities.

2.4.4.2 Trial Operation Testing is testing of the Toll System under live conditions. Trial Operation Testing shall be done in phases, per system before integrated testing is done on the complete Toll System.

- 2.4.4.3 The Contractor shall propose a Trial Operation regime strategy and submit it to the Employer's Representative for approval not less than 60 (sixty) days before the Employer's Representative is required to attend the Trial Operation testing.
- 2.4.4.4 Trial Operation testing shall contain individual test procedures for each sub-system and interface. Each test procedure shall contain a list of prerequisites as well as numbered test steps and expected results.
- 2.4.4.5 Trial Operation testing shall be conducted for each sub-system of the Toll System. Once the sub-systems have been individually tested, the integrated test shall be conducted. Integrated tests shall be done to verify the data flow of a Transaction Record from the RSS to the Back Office (BO) System and the Transaction Clearing House (TCH) System.
- 2.4.4.6 The integrated Trial Operation testing shall be sufficient to cover a month end, and shall include testing of reports as part of the month end process.
- 2.4.4.7 Test results shall be recorded and any defects shall be categorized according to severity levels, e.g. severity-1 or critical defects, severity-2 or major defects and severity-3 or minor defects.
- 2.4.4.8 The Contractor shall perform the Trial Operation test procedures and submit test results to the Employer's Representative, including the severity levels of any defects found. The Employer's Representative shall be invited to witness the formal Trial Operation testing only after all severity-1 (i.e. Critical) and severity-2 (i.e. Major) defects are resolved or a mutually acceptable workaround are identified, implemented and tested.
- 2.4.4.9 A regression test shall be conducted to verify that fixes did not introduce new defects.
- 2.4.4.10 The test results shall be submitted to the Employer's Representative 14 (fourteen) days before the Trial Operation tests with the Employer's Representative take place.
- 2.4.4.11 During the Trial Operation testing with the Employer's Representative, the Employer's Representative shall be invited to observe the full system running in pre-fee-collection mode.
- 2.4.4.12 No Software changes shall be allowed during testing with the Employer's Representative, unless mutually agreed between the Parties.
- 2.4.4.13 The Trial Operation testing shall continue for a period as proposed by the Contractor and approved by the Employer's Representative, e.g. one month, or until there are no severity-1 (i.e. Critical) defects remaining. All severity-2 (i.e. Major) defects shall be resolved or a mutually acceptable work around and a plan for resolution shall be identified. In addition, a plan for resolution of all severity-3 (i.e. Minor) defects shall be submitted for approval.
- 2.4.4.14 Once the conditions for completion of the Trial Operation testing have been met, the system can become fully operational. Any remaining defects must be resolved within a mutually agreed

schedule. Prior to introducing any fixes into the production system, the Contractor must perform a regression test using a test system configuration, and a Change Control Board must approve the Software build.

- 2.4.4.15 It is important that testing is done in all environmental conditions to verify that the Equipment is able to successfully accommodate the high and low temperatures, the glare of the sun, excessive rain and spray on the roads.

2.4.5 **STRESS TESTING**

- 2.4.5.1 The Contractor shall ensure that a comprehensive methodology for stress testing is provided. Such shall detail all system fail scenarios and corresponding recovery procedures. Such tests will be performed during the FAT and after the installation is completed.

2.4.6 **SYSTEM COMPLIANCE:**

- 2.4.6.1 Once all the requirements for the systems are met, the Employer's Representative will certify the system as compliant.

2.4.7 **RESPONSIBILITY TO COMPLY WITH ALL REQUIREMENTS:**

- 2.4.7.1 The approval of documents, inspections, testing and issuing of certificates by the Employer's Representative shall not release the Contractor of any obligation in the Contract. If it is subsequently found that the Contractor has not complied with any requirement of the Contract, the Contractor shall be liable to comply with such a requirement without delay.

2.5 **TRAINING**

2.5.1 **SYSTEM TRAINING**

- 2.5.1.1 In addition to operational training, adequate training and knowledge of the Toll System is required amongst the System Users. All training, relevant for introducing the Equipment into service, shall generally take place before using the Equipment or the Toll System.

- 2.5.1.2 The Contractor shall define, implement and update a formal training plan and programme for System Users.

- 2.5.1.3 System Users shall be trained in accordance with the defined training plan and associated Materials. Practical training exercises shall be provided where applicable.

- 2.5.1.4 The Contractor shall provide the training programme with supporting training manuals for all levels of System Users. System Users include personnel from the Employer, Back Office

System Users and any third party personnel that may be granted access to the System by the Employer.

2.5.1.5 The Contractor shall notify all role-players of details of the training for each sub-system and arrange suitable venues. Training can occur before the system installation is done.

2.5.1.6 When the Contractor is satisfied with the knowledge and competence of the System Users, the Contractor shall sign off the training.

2.5.1.7 Re-training shall be done after major System upgrades or when deemed necessary.

2.5.1.8 Training material shall be developed as part of every system development, implementation or modification. The material should be focused on the system's daily use.

2.5.1.9 The Contractor has to supply Toll System Software training manuals for the Lane System/ RSS and the Back Office System with the relevant modules for each class of System User.

2.6 INSTALLATION

2.6.1 SYSTEM INSTALLATION

2.6.1.1 The Employer shall not allow the Contractor to close a Road or carriageway for any significant period of time. It might therefore be necessary to install the RSS / Toll Collection Lane Equipment under live traffic conditions. Road closures shall be minimised and must be approved by the Employer prior to such closures.

2.6.1.2 The installation of the RSS / Toll Collection Lane Equipment shall adhere to strict traffic safety requirements of the Contract and shall be done in accordance with the Contractor approved Method Statements.

2.6.2 METHOD STATEMENTS

2.6.2.1 The Contractor shall compile Method Statements for all the major Systems and sub-systems to be constructed or installed, commissioned, tested and maintained which shall include procedures of how to construct or install the relevant item. Method Statements shall include detailed configuration drawings, relevant to all specific sub-sections of the Toll System as well as individual sections of the Site.

2.6.2.2 The Contractor shall provide Method Statements (where applicable) before commencing with work on Site.

2.6.2.3 The Method Statements shall also be included in the Maintenance Manuals as an appendix, to be utilised by maintenance personnel when configuring, repairing or replacing a particular item.

- 2.6.2.4 A register of all Method Statements, including those from Subcontractors, utilised on the Project shall be maintained on file and stored electronically.

2.7 TOLL SYSTEM UPGRADE REQUIREMENTS

2.7.1 TIME FRAMES FOR SYSTEM UPGRADES

The Contractor shall upgrade/replace the Toll System to ensure compliance with the requirements contained in this Contract within the time period/s as stated herein and in the Project Document (Volume 3). The Contractor shall not be relieved of any of its obligations under this Contract and shall ensure that the Toll System retains the functionality as at the Commencement Date until such time that the upgrades/replacements are completed.

2.7.2 SYSTEMS EXISTING AT THE COMMENCEMENT DATE

The Contractor shall maintain the existing Toll System taken over and extant at the Commencement Date, to meet, as a minimum, the performance criteria pursuant to such systems, up to the point where the Toll System is replaced or upgraded to the specifications of this Standard Specification; upon which, the performance criteria of this specification shall apply. The Contractor shall at no time allow the existing Toll System to degenerate in any way.

2.7.3 SYSTEM UPGRADES

- 2.7.3.1 The Contractor shall implement, as a minimum, the upgrades and replacements to the Toll System required meeting the requirements as set out in this specification and as indicated below. Refer to the Project Document (Volume 3) for any additional requirements:

2.7.3.2 Establishment Upgrades:

During the Site establishment and Design Build Optimisation Phase the Contractor shall replace components as specified below. Establishment upgrades shall include the following replacements and upgrades to be completed during the Site establishment and Design Build Optimisation Phase:

- (a) All inductive loops and loop cards;
- (b) All data network communications components older than 10 years and/or not capable of providing a minimum of 1GB/s communications speed. This shall include all data linking equipment connected to communications infrastructure provided by the Employer.
- (c) All swipe card reader heads older than 1 year or which has reached expected service life;
- (d) All computer workstations older than 5 years, other than those employed as Toll Lane Equipment;

- (e) All printers older than 6 years;
- (f) All Lane Receipt printers older than 4 years;
- (g) All AVC Sensors older than 4 years;
- (h) All User Fare Displays older than 10 years;
- (i) All booms (barrier) controllers and boom arms older than 10 years or not automated or not installed;;
- (j) All AVC, TCC, VGS, QLS, Network infrastructure UPSs and back-up batteries older than 3 years or not yet installed;
- (k) All motherboard and other controller batteries older than 4 years; and
- (l) All surge protection units older than 4 years or not yet installed. All replacement units shall be equipped with status indicators.

2.7.3.3 System Obsolescence Upgrades

The Contractor shall replace any Equipment during the Contract period that has become obsolete or that was identified by the Employer as obsolete in the Contract. The Contractor shall develop and maintain a strategic plan that addresses obsolescence in advance and makes plans to avoid obsolescence by being proactive in keeping the systems on currently supported platforms.

Obsolescence upgrades shall include the following:

- (a) All Operating Systems and application Software that is not supported any longer by their suppliers e.g. Microsoft Windows NT;
- (b) Operating system and application Software upgrades include but are not limited to:
 - i. All versions of Windows NT, DOS, Windows 3, Windows 95 or Windows 2000, Windows ME;
 - ii. All servers running versions of UNIX predating the year 2000;
 - iii. All database versions that predate the year 2000; and
 - iv. All other peripheral components not available or supported any longer. This shall include the data communications network infrastructure.

2.7.3.4 Routine Maintenance upgrades:

The Contractor shall during the Contract period replace certain components of the Equipment on a routine bases as required or as defined by the Contract. The following routine upgrades shall be implemented:

- (a) Replace all inductive loops older than 4 years or where the insulation impedance of the inductive loop drops below 10M Ω at 500V, measured to earth.
- (b) Loop resistance over the entire length of the loop is dependent on the specifications of the manufacturer and the length of cable used. As a guideline, the integrity of inductive loops may be compromised when the resistance level exceeds 1.3 Ω for single lanes and 2.5 Ω for extra-wide lanes. Resistance levels in excess of 25% above the manufacturers specifications for a specific cable, shall be replaced.
- (c) All other AVC detection and/or vehicle presence sensing components not capable of detecting vehicle presence at any speed up to 80km/h at Conventional and Hybrid Toll Plazas and 160 km/h for ORT.
- (d) All Servers that are older than 6 years;
- (e) All TCC and AVC computer components, inclusive of computer mother boards, RAM, hard drives, Serial cards, Computer screens, older than 6 years;
- (f) All swipe card readers heads older than 2 years;
- (g) All computer workstations older than 8 years;
- (h) All printers older than 8 years;
- (i) All Lane Receipt printers older than 6 years;
- (j) All AVC Sensors older than 6 years;
- (k) All Booms older than 10 years;
- (l) All AVC, VGS, QLS UPS and back-up batteries older than 4 years;
- (m) All motherboard batteries older than 4 years; and
- (n) All surge protection units older than 4 years. All replacement units shall be equipped with status indicators.

2.7.3.5 Performance Related Upgrades

- (a) The Contractor shall, during the Contract replace or upgrade Equipment when the Equipment does not meet its performance criteria or as specified by this Contract.

- (b) All units, components and materials used during upgrades shall be submitted to the Employer's Representative for approval.

2.7.3.6 Software related upgrades:

The Contractor shall during the Contract upgrade all operating systems, Hardware and Software once the supplier of the operating system and/or application Software has discontinued support for the operating system and application Software. In cases where the new version of the operating system and/or application Software is not compatible with the Hardware and/or application Software, the Contractor shall replace the Hardware and/or application Software with compatible Hardware and/or application Software.

2.7.4 IMPLEMENTATION OF NEW REQUIREMENTS

2.7.4.1 Need for new functionality

The Employer may from time to time need to deploy new functionality or services. In cases where these services or new functionality requires changes or additions to the Toll system, this shall follow similar installation and compliance testing processes detailed in this specification.

2.8 HAND-BACK REQUIREMENTS

2.8.1 GENERAL

2.8.1.1 At the time of Contract completion, the Contractor shall ensure that none of the Toll System components shall be obsolete. The Contractor shall ensure that the Toll System shall be able to operate without risk of obsolete Toll System components for at least one year after the Contract completion.

2.8.1.2 The Contractor shall hand over all documents, manuals and Software to the Employer in order to enable the Employer to maintain the system.

2.8.1.3 The Contractor shall be obliged, prior to the handover to the next Contractor or the Employer, to replace all missing documents.

2.8.1.4 It shall be the responsibility of the Contractor to ensure that the register of documents is accurate and up to date.

SECTION 3. CONVENTIONAL AND HYBRID TOLL PLAZA LANE SYSTEM REQUIREMENTS

3.1 DESCRIPTION OF LANE TYPES

3.1.1 GENERAL

3.1.1.1 Conventional and Hybrid Toll Plazas shall be plazas that process traffic by channelling vehicles through specific Lanes. Such channelling processes shall be managed and controlled by the use of barriers, fixed signs, variable message signs and other relevant equipment.

3.1.1.2 Traffic shall be managed by the provision of different types of lanes. These shall include:

- (a) Manual Lane;
- (b) Automatic Lane;
- (c) Mixed ETC Lane;
- (d) Dedicated ETC Lane;
- (e) Reversible Lane;
- (f) Extra Wide Lane; and
- (g) Emergency Lane.

3.1.1.3 It shall not always be required to implement all of the above lane types. The decision to implement the necessary lane types shall be made based on surveys of the traffic mix and volumes that may pass through the Toll Plaza and upon instruction by the Employer.

3.2 LANE SYSTEM REQUIREMENTS – ROAD SAFETY

3.2.1 SCOPE

This section covers Road User safety aspects that relates to Toll Collection Lane Equipment.

3.2.2 SHIFTED LOAD DETECTION

A load shift detection structure is installed at the sides of each Lane. A sensor shall be attached to the structure in such a way that only rotations of more than 15° shall activate an alarm system enabling the following actions:

- 3.2.2.1 Activate a warning signal to System Users and the Road User, which shall consist of the following:
- (a) Activate a siren, audible at a distance of 500 m as long as the load shift detector is activated;
 - (b) Flash the red Traffic Light continuously while the load shift detector is activated, overriding the standard display at the time when the load shift detector is activated; and
 - (c) Activate a flashing warning message on the UFD, showing “STOP”.
- 3.2.2.2 The siren and red flashing Traffic Light and UFD shall time-out and return to the normal state after a predetermined period (typically 15 seconds) should the load shift detector not return to its normal position;
- 3.2.2.3 Reset the warning display on the UFD, Turn the Traffic Light back to the normal state as expected during the processing of any passage transaction and turn off the siren when the load shift structure is returned to its correct/normal position before the time-out period has expired.

3.3 TOLL LANE SPECIFIC HARDWARE AND SOFTWARE REQUIREMENTS

3.3.1 TCC GRAPHICAL USER INTERFACE (GUI)

- 3.3.1.1 The system shall allow for username and password and or device (fingerprint biometric reader) controlled log in and out. System User passwords shall require regular changes.
- 3.3.1.2 Privileges shall be settable for different User group operations..
- 3.3.1.3 Remote login and logout from the Control Room to all lanes including automatic and dedicated ETC lanes shall be possible.

3.3.2 TOLL COLLECTION COMPUTER (TCC)

- 3.3.2.1 The Toll Collection Computer (TCC) shall be mounted inside the manhole of the lane or in the tunnel system of the plaza below the specific lane as approved by the Employer. The enclosure shall be manufactured from high quality stainless steel and shall be powder coated suitable for coastal as well as inland regions to an IP54 protection rating. The enclosure shall be fitted with an anti-tamper switch as well as an approved locking mechanism. The enclosure shall allow for internal air circulation to prevent hot-spots forming on specific components and shall be powder coated matt black on the inside to aid in heat absorption. Where required, a vent and fan system shall be installed to circulate outside air through the enclosure. The vents shall have dust filters that shall be easy to clean and replace and shall not affect the IP rating of the enclosure.

3.3.2.2 Latest technology entry level computer Hardware suitable for an industrial environment shall be supplied to form the TCC. This shall apply to all Equipment inside the enclosure, including the motherboard, processor and fan, memory (RAM), hard disk drive (HDD) and power supply unit (PSU).

3.3.3 TOLL COLLECTION TERMINAL (TCT)

3.3.3.1 All the manned Toll Lanes shall be equipped with a TCT located on the desk of each toll booth. The TCT shall have a rugged, spill proof housing. The TCT housing/body/casing shall be fixable to the booth desktop by means of a quick release mechanism which shall only be opened by means of a special tool or maintenance key. All the cabling into the TCT shall enter from the bottom and shall not be exposed or accessible to the collector.

3.3.3.2 The TCT shall be designed to allow for run-off of accidentally spilled liquids without affecting the performance of the keys. The TCT shall have a design and operational life of 10 years.

3.3.3.3 The toll collector shall not have any access to the operating system components.

3.3.4 RECEIPT PRINTER

3.3.4.1 A Receipt printer shall be provided for printing of Lane Receipts and Tax Invoices. The printer shall have a minimum life expectancy of 1 million printed lines and shall allow automatic partial cutting.

3.3.4.2 The Receipt printer shall be capable of printing a complete Receipt or TAX Invoice within a maximum of 2 seconds and shall be interfaced to the TCC. The design and installation of the Receipt Printer shall be done in such a manner that minimum downtime is achieved during maintenance. The Receipt Printer shall use fluff and dust free paper. The paper used for printed Tax Invoices shall be of sufficient quality to allow for archiving and storage requirements of Tax information.

3.3.4.3 The following fault statuses shall be reported to the TCC/Control Room:

- (a) Paper low;
- (b) Paper empty;
- (c) Printer communications failure; and
- (d) Other error states prohibiting the printing of receipts and Tax Invoices.

3.3.5 CARD READER DEVICE (CRD)

3.3.5.1 In-booth card readers shall, as a minimum, be required to:

- (a) Meet the ISO standard requirements;
- (b) Exceed 1 million card reads;
- (c) Provide a bad card read incident / alarm. It shall also indicate the card reader ID; and
- (d) Meet the requirements of the Employer Merchant agreements with Banks, where applicable.

3.3.5.2 External readers (out of booth), shall be of a rugged design capable of handling all ambient weather conditions. They shall be positioned to allow Users of both Heavy and Light Vehicles to swipe their cards. They shall be fitted with a clear Stainless steel back-plate with card swipe directions and pictograms approved by the Employer. They shall be fitted with twin head bi-directional card read heads.

3.3.5.3 External readers shall provide a bad card read incident / alarm and it shall also indicate the card reader ID.

3.3.5.4 Intercom / Communication Device

Communication devices shall be fitted in the Toll Lanes to allow for direct communications between the Control Room and the Lane/Toll Collector.

3.3.6 **PANIC BUTTON**

The Contractor shall install panic alarms in the Toll Booth for Toll Collector security purposes.

3.3.7 **USER FARE DISPLAY (UFD)**

The UFD shall have a minimum of 16 characters per line, two-line display which shall be visible and legible during all lighting conditions and different booth window types. It shall be positioned such that it does not obstruct the Road User's view of the swipe card reader and the Toll Collector's work space. The messaging shall be clearly visible to both Light and Heavy Vehicle Road Users.

3.3.8 **TOLL BOOTH SURVEILLANCE CAMERA**

The Contractor shall install, operate and maintain a tamper proof dome or similar camera in each toll booth for surveillance purposes. The camera shall have a wide dynamic range capability in order to accommodate the glare through the windows. The continuous recording of this camera images shall be recorded on the local TCC and kept for a rolling period of 7 days. An archive utility shall be provided to perform weekly archives. Archives shall be kept at a remote location for a minimum period of 3 months.

3.3.8.1 The local TCC video recording shall be accessible by the Contractor / Employer's Representative on an ad hoc basis remotely for post factor audit purposes.

3.3.8.2 The video quality shall be the same as specified for the continuous VGS requirements with the addition of the recording of audio in the toll booth. However, a reduced frame rate to 10 frames per second is required. The video material shall fulfil the objective to clearly identify bank notes handled by the collector in the cash tray area as well as his interaction with the Road User through the service window. The video material and audio recordings should be sufficient to evaluate customer complaints relating to incorrect change and/or Road User / collector abusive behaviour. The video angle shall also enable the viewing of the vehicle passing.

3.3.9 ETC EQUIPMENT

Refer to the Standard Specification for Operations and Maintenance of CTROM Projects: Electronic Toll Collection (ETC) (Volume 2 Book 5) for details in this regard.

The ETC equipment shall also be provided with a separate UPS power feed with a minimum 4 hour battery life.

3.4 TRAFFIC CONTROL

The Contractor shall be solely responsible for the accuracy of the traffic control signals.

3.4.1 OVERHEAD LANE SIGN (OHLS).

The OHLS shall not be allowed to reduce the clearance of passage for vehicles passing through a Lane.

3.4.1.1 Format

In the Manual Lane application, the OHLS shall display two legends, one a red cross (nominal wavelength of 630 nanometres), the other a green arrow (nominal wavelength of 525 nanometres) constructed from a matrix of high intensity LED's.

3.4.1.2 Size

The size of each legend shall not be less than 400mm by 400mm and be easily legible from a distance of 600m, with the bright sun shining in the direction of the sign.

3.4.1.3 Intensity

The minimum peak intensity of each LED shall not be less than 1000 millicandelas (mcd). The luminous intensity shall not decrease more than 50% when viewed at a minimum angle of up to

15 degrees (7.5 degrees at $\frac{1}{2}$ angle) centred about the optical axis and perpendicular to the surface of the display. In the event where the LEDs are too bright at night, it shall automatically adjust to eliminate glare and shall still be clearly visible in order to clearly identify the correct lane approach for a Road User.

3.4.1.4 Position

The OHLS shall be mounted on the approaching edge of the Toll Plaza Canopy above the centreline of each Lane facing the direction of the approaching traffic.

3.4.1.5 Interface for Automatic and ETC Lanes

The OHLS and signage to be utilised in the ETC and Automatic Lanes shall be in accordance with the Standard Specification for Operations and Maintenance: Electronic Toll Collection (ETC) (Volume 2 Book 5).

3.4.2 TOLL PLAZA CANOPY SIGNAGE

3.4.2.1 Where additional Road User directions are installed by means of signage on the Canopy, the Contractor shall ensure that sufficient lighting levels are maintained to illuminate such signage under all prevailing ambient conditions.

3.4.3 TRAFFIC LIGHTS

3.4.3.1 Format

The Traffic Light shall consist of a red and a green optical system. The red lens shall be mounted above the green lens. The optical system employed shall be of the low energy consumption types, e.g. LED technology or similar.

3.4.3.2 Size

The lenses shall have a luminous diameter of not less than 200mm.

3.4.3.3 Intensity

All signals shall be clearly visible from a distance of 20m from the Traffic Light under ambient lighting conditions ranging from direct sunlight to complete darkness.

3.4.3.4 Position

The Traffic Light shall be mounted on a pole downstream of the Toll Booth with the centre of the red lens at a height of 2.5m above the pavement (Road surface) or lower if approved by the Employer's Representative. The position of the Traffic Light pole relative to the payment point shall be such that the User views the green Traffic Light on leaving the Lane. The Traffic Light may only change to red after the User has passed the traffic pole, irrespective of Vehicle type.

3.4.3.5 Interface for Automatic and ETC Lanes

The signage to be utilised in an ETC Lane shall be in accordance with the Standard Specification for Operation and Maintenance of CTROM Projects: Electronic Toll Collection (ETC) (Volume 2 Book 5).

The Traffic Light in Automatic Lanes shall be mounted on a pole downstream of the Automatic Lane User interface at a height of 2.5m above the pavement (Road surface) or lower if approved by the Employer's Representative. The position of the traffic pole relative to the Automatic Lane User interface should be such that the User views the green Traffic Light on leaving the Lane. The Traffic Light may only change to red after the User has passed the traffic pole, irrespective of vehicle type.

3.4.4 **ABNORMAL VEHICLES**

3.4.4.1 Passage control

Each Toll Plaza will have at least one Abnormal Vehicle Lane per direction. These Lanes can be either a mainline Extra Wide Lane or a ramp Extra Wide Lane. The financial transaction for such transaction shall be captured with the correct tariff and issued with the correct and valid VAT-invoice in the Toll Lane where the passage transaction is processed. Also refer to Ramp/Mainline Swapping.

3.4.4.2 Detection

- (a) The AVC System shall accurately detect and classify any Vehicle passing through the Extra Wide section of the Extra Wide Lane.
- (b) At Toll plazas where vehicles have to be directed to another Virtual Toll Plaza, other than that Virtual Toll Plaza from where the vehicle was travelling from or where the vehicle is travelling to, will need to be directed through the barriers installed, separating the mainline from the ramp Virtual Toll Plaza. This barrier between ramp and mainline virtual plazas are referred to as "Ramp/Mainline Barriers".
- (c) The AVC System shall detect Vehicle movement passing through any Ramp/Mainline barriers, where these are installed. Movement through such barrier shall be recorded by

means of an Incident which will also activate the recording of this activity on the VGS. Appropriate cameras shall be placed to ensure proper coverage for this area.

- (d) For the avoidance of doubt – the AVC in the Extra Wide Lane shall be fitted with additional sensors to detect vehicle movement through the Ramp/Mainline barriers, the VGS shall be fitted with additional cameras to cover this area and the toll system shall provide the required incidents so that the VGS can record any passages through this area.

3.4.5 EMERGENCY VEHICLES – PASSAGE CONTROL

- 3.4.5.1 Emergency Vehicles may use any Lane in an emergency situation. The Toll System shall allow the supervisor to open any Lane in emergency mode, and any vehicle passing through shall generate a Violation with the appropriate VGS images. The Contractor shall make suitable provision to accommodate all Emergency Vehicles.

- 3.4.5.2 Any closed Lane may be selected for Emergency Vehicle passages. On selection, the OHLS in the selected Lane will flash the red cross (closed Lane indicator). The opening of booms shall be activated from the Lane where the Lane is actively manned. Where Lanes are inactive or closed, booms shall be opened remotely from the Control Room level.

3.4.6 RAMP/MAINLINE SWAPPING

- 3.4.6.1 The requirements for the specific implementation of Ramp/Mainline swapping is as indicated in the Project Document (Volume 3).

- 3.4.6.2 The Contractors shall process all passage transactions at the correct Tariff and Toll Class, which includes the generation of correct VAT-invoices and Transaction Records with the correct details, in the Toll Lane and the associated AVC registers. In the event where vehicles need to be processed through another Virtual Toll Plaza than that from where the vehicle was travelling along or where the vehicle is travelling to, such vehicles shall need to be directed through the barriers installed between the mainline and ramp Virtual Toll Plazas. This concept of processing vehicles through a different Virtual Toll Plaza with different tariffs, is known as “Ramp/Mainline Swapping”. In order to process valid toll transactions bearing the correct Lane Identity (Lane-ID), linked to the correct Toll Tariff with an associated valid TAX-Invoice, one civil Toll Lane shall have two different Toll Lane IDs. The “Primary” Lane-ID shall be that Lane-ID assigned to the lane for which it is used most commonly. Since the lane might be used as supplementary lane to another Virtual Plaza, the specific interchangeable Lane shall have a second Lane-ID, used to manage abnormal traffic conditions, which might include the processing of “Abnormal Vehicles”. This second Lane-ID shall be known as the “Pseudo” Lane-ID. The Toll System shall make provision for two types of Ramp/Mainline swapping scenarios.

- 3.4.6.3 Some Virtual Toll Plazas without extra-wide lanes will necessitate the processing of some Abnormal Vehicles, travelling along e.g. the mainline, to be processed through a ramp lane which, by civil design, does accommodate such large vehicles in an extra-wide Lane. It shall be

required that the Toll System enables the Toll Collector to process vehicle passage transactions in such extra-wide Lane at a Virtual Toll Plaza, other than that where the vehicle was originally travelling along. Such a passage transaction shall be recorded with the correct Tariff and lane-ID associated with the desired Virtual Toll Plaza traffic where the Vehicle would have travelled if that virtual plaza had an extra wide Lane.

- 3.4.6.4 Similarly, some Virtual Toll Plazas may be required to process high volumes of traffic for short durations from an adjacent Virtual Toll Plaza which does not warrant the physical civil expansion of the Toll Plaza. In this scenario it shall be possible to process vehicle passages through a Virtual Toll Plaza adjacent to the “overloaded” Virtual Toll Plaza, were the Availability of unused Toll Lanes makes this possible.
- 3.4.6.5 The affected Virtual Toll Plazas’ TCCs and AVCs shall be equipped to manage two Lane-IDs with separate sequence numbers and tariff tables for each Lane. The normal Primary Lane configuration shall always be dominant to the additional pseudo Lane.
- 3.4.6.6 Both the primary and pseudo Lane and AVC shall at all times communicate and interface with the Back Office System and DCS respectively. The Back Office System and DCS shall be configured with such pseudo lane-IDs on a permanent basis although the Lane Equipment/Hardware, including the AVC, of the primary Lane is used when triggered or activated.
- 3.4.6.7 The “dual AVC” shall record passages separately for either the ramp or the mainline traffic (primary lane-id or pseudo lane-id), each with its individual unique passage transaction sequence numbers and associated Lane transaction details.
- 3.4.6.8 The dual AVC, although using the same civil Virtual Toll Plaza, shall report traffic and Incidents continuously for each AVC, Primary and pseudo Lanes, to the DCS, like any other AVC would.
- 3.4.6.9 Any vehicle passage shall only be recorded by either the primary OR the pseudo AVC, never on both.
- 3.4.6.10 The pseudo Lane may not be activated while a Toll Collector is logged into the primary Toll Lane.
- 3.4.6.11 Pseudo Lanes shall only be activated to process passage transactions from another virtual plaza by means of an electronic trigger message from the Back Office System with an associated Lane Incident to acknowledge the swap between the primary, pseudo and back to the primary lane-ID, which shall be recorded in the Back Office System database and shall be auditable. The audit log shall include the date, time, responsible person activating the Lane swap, lane-ID being swapped from and lane - ID being swapped to.
- 3.4.6.12 The activation of the primary or pseudo AVC, to become the active AVC shall be by means of a trigger sent from the TCC.

- 3.4.6.13 For local mode application, the Lane shall, however, be “switchable” only by a Supervisor or Manager’s login in the Lane.
- 3.4.6.14 The user that activated the swapping of Lanes shall not be able to process traffic in such Lane with the same login id.
- 3.4.6.15 The VGS shall record images in the Lane approach area at maximum 2 second intervals from 1 minute preceding the activation of the pseudo Lane in order to monitor the origin of vehicles being processed through the pseudo Lane.
- 3.4.6.16 The pseudo Lane shall default back to the primary Lane should no vehicles be processed through the pseudo Lane for more than 15 minutes. This “default swap” action shall warn the Toll Collector, generate the necessary incident/s and correctly configure the Toll Lane back to the Primary lane status.
- 3.4.6.17 The vehicle classifications and counts recorded during the pseudo state may be added to the primary Lane traffic for AVC accuracy purposes only.
- 3.4.6.18 The pseudo and primary Lane (TCC/Back Office System and AVC) shall report data to ITIS on a continuous basis like any other Toll Lane.
- 3.4.6.19 Income, Revenue and traffic shall be reported and reconciled with the correct tariff and as part of the correct virtual plaza since the data is stored accordingly.

3.4.7 **EXIT BARRIER (BOOM)**

- 3.4.7.1 Exit barriers shall be installed, operated and maintained in all Toll Lanes. . Exit barriers shall be triggered to open on a validated Transaction Record and to close immediately following a single vehicle passage. A vehicle presence detection mechanism shall be installed as a safety feature to prevent closure on vehicles. The footprint area of the safety mechanism shall be below the boom arm. The following minimum requirements shall apply:
- (a) The boom arm length shall restrict passages of any vehicle type across the entire width of all Toll Lanes.
 - (b) Dedicated ETC Lanes shall use high speed barriers with a 0.9 sec opening and 0.9 sec closing time in terms of a 3 meter barrier arm .The open and close cycle of all other lane types shall not exceed 1.4 seconds.
 - (c) Automated exit barriers (boom arms) shall be fitted with a breakaway mechanism to limit vehicle damage in the event of impact.
 - (d) Exit barriers shall be configured to automatically open on power failure. Boom arms shall not automatically close down when power is restored. Booms shall be powered by the plaza UPS. The exit barrier shall not be powered from the TCC or AVC UPS.

3.4.8 AUTOMATIC NUMBER PLATE RECOGNITION (ANPR)

- 3.4.8.1 An ANPR system shall only be compulsory for Opt-in Toll Agencies. The ANPR system shall comply with all the requirements of clauses 4.2.7 and 4.2.8.

3.5 TCC USER TYPES**3.5.1 GENERAL**

- 3.5.1.1 The TCC shall allow for the following different users to operate the Lane Software associated with different access control levels as operationally required:

- (a) Toll Collector;
- (b) Supervisory Personnel;
- (c) Plaza Management; and
- (d) System Support & Maintenance Personnel.

- 3.5.1.2 Transactions processed by Maintenance Personnel shall be financial obligation of the Contractor.

3.6 LANE MODE OPERATIONS**3.6.1 GENERAL**

- 3.6.1.1 The System shall allow for different lane modes of Operation:

- (a) Normal mode of operation (all peripheral equipment and interacting communication to required linked sub-systems are operational and functional as intended);
- (b) Fault mode operation (Lane is functional but experience and/or sends peripheral warnings, i.e. low paper, printer communications failure, swipe card reader communication failure etc.). Data Communications Network/s not being able to communicate in real time with the Back Office shall also be interpreted as a Fault Mode state;
- (c) TCC stand alone mode (communication failure between TCC and AVC). The TCC remains 100% functional and operational during this mode with the only exception being that AVC data/messaging is not being communicated to and from the AVC during this mode of operation; and
- (d) TCC Local mode (TCC communication failure with Back Office).

3.6.2 LANE REPORTING/PRINTING

3.6.2.1 The lane shall have a real time reporting and printing facility. The lane printing facility shall also allow for post event printing in a readable and understandable format to the lane printer. The reporting shall provide for the following minimum reports:

- (a) VAT receipts;
- (b) Non-VAT receipts;
- (c) Sundry payment receipts

3.6.2.2 The lane shall allow the following reports on lane level on the Receipt printer, available to the supervisor group, including but not limited to:

- (a) Incidents records;
- (b) Transaction records;
- (c) Mini-shift; and
- (d) Cash-up per current collector, per shift.

3.6.2.3 The lane shall allow the following reports on lane level on the Receipt printer, available to the System Support and Maintenance Group, including but not limited to:

- (a) Incident listing set-up codes;
- (b) Set-up table settings;
- (c) Software versions;
- (d) Device configuration settings;
- (e) Tariff tables; and
- (f) Maintenance reports.

3.6.2.4 The system shall allow lane reports to be printed at the Plaza level via the Back Office Server to printer server or related printing terminal if the lane is online and the user selects to do so.

3.6.3 TOLL LANE SPECIFIC AUDIT AND FRAUD CONTROL REQUIREMENTS

3.6.3.1 Magnetic cards may be used as Method of Payment or for login purposes.

3.6.3.2 ISO Magstripe Verification Requirements:

- (a) Verify service code;
- (b) Verify Expiry Date;
- (c) Verify Luhn code;
- (d) Verify Issuer number;
- (e) Verify hot listing status; and
- (f) Verify pass-back setting for identifier (in same lane and across plaza).

3.6.4 ACCOUNT FUNCTIONALITY

3.6.4.1 The Toll System shall allow for these minimum Account functions in the toll Lane:

- (a) Verification of Identifiers against Validation Lists.
- (b) Verification of account balances and associated restrictions, where applicable.
- (c) Provision of a top-up account facility, where activated and allowed by the Employer (excluding ETC accounts).

3.6.5 LANE PASSAGE TRANSACTION RECORD INFORMATION

3.6.5.1 The Toll System shall generate a passage Transaction Record for every individual vehicle passage through each Lane of the Toll Plaza. Each passage Transaction Record shall contain at least the following data elements:

- (a) Virtual Plaza ID: the Virtual Plaza ID of the plaza where the transaction took place;
- (b) Toll Lane ID: the lane through which the vehicle passage was concluded as per the described lane layout in the Project Document (Volume 3);
- (c) Transaction conclusion date and time: the date and time on the Toll System when the transaction was concluded (hh:mm:ss,ss);
- (d) Receipt / Tax Invoice printing date and time: the date and time on the Toll System when the transaction Tax Invoice / Receipt was printed (hh:mm:ss.ss);
- (e) TCC Transaction Sequence Number: a unique incremental transaction number for all transactions occurring in the lane;
- (f) TCC System User ID: the ID of the Toll Collector operating the Toll Lane at the time of transaction. In automated Lanes this ID refers to the person responsible for activating the lane;
- (g) Payment group ID: Payment group as specified in clause 7.4.4.3

- (h) Payment mechanism ID: the payment mechanism used to conclude the transaction e.g. cash, card, credit granted, etc.;
- (i) Discount ID:
- (j) Payment type ID:
- (k) Manual Vehicle Class (MVC): the classification given to the vehicle by the Toll Collector;
- (l) Automatic Vehicle Class (AVC): the classification given to the vehicle by the AVC Equipment;
- (m) Identifier Number (where applicable);
- (n) Identifier Class: The vehicle class registered with an Identifier (if applicable);
- (o) Nominal Toll Tariff: Toll Tariff as published in the Government Gazette. The value of the Transaction, excluding discounts, in the country's local currency
- (p) Toll Concession: Toll concession Discount applied to the transaction;
- (q) Tax Invoice sequence number (where applicable);
- (r) Receipt sequence number (where applicable);
- (s) AVC Transaction sequence number; and
- (t) A special encrypted text data field should it be required. This shall cater for additional information for special transaction types, such as:
 - i. Keyed ISO bank cards: CCV number and card expiry date;
 - ii. Swiped ISO bank cards: Track two details (encrypted);
 - iii. Warrant identification numbers; and
 - iv. Scanned Bar Code.

3.6.5.2 ETC Transaction

The ETC Transaction Record shall comply with all applicable requirements contained in the Standard Specifications for Operations and Maintenance of CTROM Projects: Electronic Toll Collection (ETC) (Volume 2 Book 5).

3.6.6 LANE INCIDENT INFORMATION

3.6.6.1 The following minimum information shall be captured for Incidents:

- (a) Toll Plaza Name: the Toll Plaza at which the Incident took place
- (b) Toll Lane ID: the Lane in which the Incident took place e.g. ME01 or 01MS (as determined by the Lane numbering system of the plaza)
- (c) Incident Date and Time: the date and time on the Toll System when the Incident occurred
- (d) Incident Sequence Number: a unique incremental Incident number for all Incidents occurring in a Lane.
- (e) Transaction Sequence Number: the linked transaction sequential number if the Incident was generated together with a transaction. Alternatively the Incident shall be linked to the last transaction number in the lane. One Transaction Record shall be able to have many Incidents associated with it but one Incident shall only have one Transaction Record association.
- (f) System User ID: the Toll Collector operating the Lane at the time of Incident. If the Incident occurred when no collector was logged into the Lane, then it shall appear under "null" collector.
- (g) Manual Vehicle Class (MVC): the classification given to the vehicle by the Toll Collector if a vehicle was processed at the time of Incident. If no vehicle was being processed at the time of the Incident, no MVC shall be included
- (h) Automatic Vehicle Class (AVC): the classification given to the vehicle by the AVC Equipment. If no vehicle was being processed at the time of the Incident, no AVC shall be included

3.6.6.2 ETC Incidents:

- (a) ETC Incidents shall comply with all requirements contained within the Standard Specifications for Operations and Maintenance of CTROM Projects: Electronic Toll Collection (ETC) (Volume 2 Book 5).

3.6.7 **ERROR MANAGEMENT AND LOG**

3.6.7.1 The System shall provide for an error log facility at each level in the Toll System with a user friendly reporting tool for processed information as well as a raw data log.

3.6.7.2 The System shall provide for error management and shall generate a log of all irregular incidents that occurred at the lane level. The log shall be utilised by the support and maintenance department to assist during maintenance, repair and upgrade activities.

3.6.7.3 The error log files shall contain the following minimum information:

- (a) Date and time of error

- (b) Lane mode
- (c) Plaza and lane ID
- (d) Collector ID
- (e) Incident type and sub-type

3.6.7.4 The error logs shall be saved within the system and shall be easy to locate.

3.7 ROAD USER COMPONENTS (EXTERNAL)

3.7.1 LANE TAX INVOICES

3.7.1.1 Lane Tax Invoice or proof of passage issuing facilities shall be provided in Mixed ETC Lanes for Cash, ISO bank cards, Toll Authority cards and Credit Granted Transactions.

3.7.1.2 The Toll System shall provide the facility to print a single COPY Tax Invoice or Receipt in the Lane, if required.

3.7.1.3 The reprinted Tax Invoice or receipt shall clearly indicate "Copy Tax Invoice" or "Copy Receipt".

3.7.1.4 The Toll System shall not allow a transaction to be cancelled once a Tax Invoice is issued.

3.7.2 NATIONAL STANDARD INTERFACE

3.7.2.1 Square brackets used in this specification denote variable system parameters relating to text, for example:

- (a) Indication of the Contractor information on a Receipt will be shown as:
- (b) "Operated by [Operating Company name]".

3.7.2.2 The Receipt or Lane Tax Invoice to be issued to a User by the Contractor

Header information:

The Tax Invoice/Receipt header shall contain the following fixed header fields:

- (a) "The SA National Roads Agency Ltd";
- (b) "[Toll Route Name]", if applicable;
- (c) "[The Toll Plaza name]";

- (d) "Operated by [Operating Company name]";
- (e) "[The Customer Service Centre contact number]";
- (f) "[A variable message]";

The invoice/receipt header may be pre-printed or printed with the variable portion of the Receipt provided that the complete Receipt shall be printed in not more than 2 (two) seconds.

3.7.2.3 Transaction details to be included:

The following variable data shall be included:

- (a) [The text "TAX INVOICE" or "RECEIPT" as applicable (refer to clause 6.5 VAT REQUIREMENTS)]. The word "COPY" to be prefixed as applicable;
- (b) "VAT No:[SANRAL VAT number (refer to clause 6.5 for detail)]" e.g. 4220186250;
- (c) "[Tax Invoice number]" or "[Receipt number] format: "AA99AA-999999999999" (Toll Plaza ID-Lane ID-Date-(Tax Invoice serial number or Receipt serial number)) refer to section 3. Plaza-ID to be submitted to the Employer's Representative for approval;
- (d) "[Date]" format yyyy/mm/dd (Toll System printing date);
- (e) "[Time]" format: hh:mm:ss (24hour clock, Toll System printing time);
- (f) "[Toll Class]" e.g. "Class 1";
- (g) [Transaction value] (value reflected to be inclusive of VAT);
- (h) "[Payment mechanism]" refer to clause 7.4.4.3, "[Card details - if applicable]" it is required that only portions of the card number be printed, enough detail for the road user to identify the card number e.g. the last 4 (four) digits of any ISO card number. The blanked numbers should be marked with an asterisk ("*"). Provision shall be made for the "Non-printing" of specific VAT Invoices where Toll Fees are not exchanged in the Toll Lane, but the Contractor accepts the liability for such transactions. Examples are SANDF, SAPS, No-Payments, etc.;
- (i) [Account balance - if configured to be printed upon prior request by the Road User];
- (j) "[VAT information]" refer to clause 6.5, e.g. incl. 14% VAT

Receipts or Lane Tax Invoices shall be printed on request for the Methods of Payment as specified.

Receipt copies shall be printed as specified in section 2 and 3.

Receipts shall not contain any VAT or VAT related details.

3.7.3 VAT INFORMATION

The Contractor shall comply with the requirements as specified in clause 6.5.

3.7.4 INTERFACE FOR AUTOMATIC AND ETC LANES

3.7.4.1 The Contractor shall issue receipts or Tax Invoices for transactions taking place in Automatic Lanes and ETC Lanes at the account holder Service Centre if requested.

3.7.4.2 No receipts or Tax Invoices shall be printed in Automatic or ETC Lanes.

3.7.4.3 Signage for Automatic Lanes should clearly indicate that no receipts are available in these lanes. Road Signage and any restrictors/curtains shall be submitted to the Employer's Representative for approval.

3.7.5 TARIFF BOARD

(a) Format and Content

The Tariff board shall be a fixed display containing the different Toll Classes. The Vehicle(s) in a specific Toll Class shall be indicated by means of pictograms of the vehicle(s) and the Tariff applicable to that particular vehicle type. Clear indication regarding the inclusion of VAT in the respective Toll Classes shall be given.

(b) Position

The Contractor shall ensure that the Tariff board shall be fixed to the side of all Toll Booths or New Jersey barriers or next to the Automatic Lane User interface within clear view of the User.

3.7.6 LANE MODE BOARD

3.7.6.1 Format:

The Lane mode board shall consist of a double-sided sign – red and blue background respectively. The red side shall contain the following wording or any other wording selected by the Contractor and approved by the Employer: "EQUIPMENT ERROR. PLEASE REQUEST RECEIPT". The blue side shall contain the following wording: "THE CASHIER IS CHECKED BY ELECTRONIC EQUIPMENT. RECEIPTS ISSUED ON REQUEST ONLY". All lettering shall be in white and of an easily legible font type and size.

3.7.6.2 Position

The Contractor shall ensure that the Lane mode board shall be fixed to the side of all Toll Booths or New Jersey barriers within clear view of the User, preferably directly below the serving window of the toll booth else by moving it towards the exit side of the Virtual Toll Plaza.

3.7.7 **USER FARE DISPLAY**

The Contractor shall take full responsibility for the accuracy of the information displayed on the UFD.

3.7.7.1 The following information shall be displayed on the UFD:

- (a) [Toll Class];
- (b) [Tariff] The Tariff or Discounted Tariff (Non-ETC Transactions) corresponding to the particular Toll Class;
- (c) [Payment Mechanism or Discount description] The Method of Payment or Discount corresponding to the particular payment; and
- (d) [Variable message (optional)].

3.7.7.2 Set out hereunder is an example of the format of the text which shall be displayed on the UFD for a Class 1 Vehicle. The example uses a Class 1 Tariff of R20.00 and a Class 1 Local Discount of R 5.00:

- (a) Before classification:
 - i. Line 1 and Line 2: [Message configurable by the Contractor];
- (b) On Vehicle Classification by the Toll Collector:
 - i. Line 1: "Class1 R 20.00".
 - ii. Line 2: [Configurable by the Contractor];
- (c) Upon payment by the User and validation by the Toll Collector, the Traffic Light will change to green.
- (d) The two lines of the display shall then be utilised as follows:
 - i. Line 1: [Method of Payment or Discount description] e.g. "Cash", "Local / Regional" or "Frequent";
 - ii. Line 2: [Payment acknowledgement], [Account information] or [Regional and Local Discount Tariff] e.g. "Paid thank you", "Low balance"

- (e) For Cash, unregistered Bank cards, Exempt User, No-payment:
 - i. Line 1: "Cash", "Bank card", "Exempt User", "No-payment" as applicable.
 - ii. Line 2: If payment was received (Cash and Credit Card) the UFD shall read "Paid thank you". In the case of Exempt User or No-Payment the display shall read "Please proceed".
 - iii. Pre-Paid Account passage
- (f) Passage at the nominal or discretionary Discount Tariff (Discount Tariff only applicable to Non-ETC Transactions):
 - i. Line 1: "[Pre-paid]"
 - ii. Line 2: "Class1 R20.00"
- (g) If the User's balance is low
 - i. Line 1: "[Pre-paid]"
 - ii. Line 2: "[R20.00]" for 4 seconds and then "Low balance"
- (h) The low balance message shall be triggered by a system settable parameter.
- (i) Should the user account balance be insufficient to process the current passage transaction
 - i. Line 1: "Pre-paid"
 - ii. Line 2: "Insufficient Funds"
- (j) The insufficient funds message shall be triggered by a system settable parameter.
- (k) Local and Regional Discount passage (for Non-ETC Transactions)
 - i. Line 1: "Local / Regional"
 - ii. Line 2: "Class1 R 5.00"
- (l) If the User's balance is low:
 - i. Line 1: "Local / Regional"
 - ii. Line 2: "Class1 R 5.00" for 4 seconds and then "Low balance"
 - iii. The Low balance message shall be triggered by a system settable parameter.
- (m) Should the user account balance be insufficient to process the current passage transaction

- i. Line 1: "Local / Regional"
 - ii. Line 2: "Insufficient Funds" The insufficient funds message shall be triggered by a system settable parameter.
- (n) Frequent User Discount passage (Non-ETC Transactions)
 - i. Line 1: "Frequent"
 - ii. Line 2: "Class1 R 20.00"
 - iii. In the case of Frequent Users the Tariff displayed is the Nominal Tariff.
- (o) If the User's balance is low:
 - i. Line 1: "Frequent"
 - ii. Line 2: "Class 1 R20.00" for 4 seconds and then "Low balance"
- (p) The low balance message shall be triggered by a system settable parameter.
- (q) Should the user account balance be insufficient to process the current passage transaction
 - i. Line 1: "Frequent"
 - ii. Line 2: "Insufficient Funds" The insufficient funds message shall be triggered by a system settable parameter.

3.7.7.3 UFD Format:

- (a) The Contractor shall supply, maintain and operate the required UFDs on a continuous basis. The UFD messages shall be clearly and easy legible from the User perspective. The Contractor shall ensure that the cabling installation to the UFD is secure and tamper proof. All cable connections in the toll booth area shall be secured to avoid tampering with the functionality of the UFD. This includes the access to any configuration settings of the UFD. The minimum text display size of the UFD shall accommodate 2 lines of 16 characters each (minimum 32 characters) with a large enough font size which is legible by different User types.
- (b) The UFDs visibility shall not be compromised by the type of glass installed in the toll booth nor by any tint or security films installed on the glass.

3.7.7.4 Position:

- (a) The UFD shall consist of two display units installed behind the serving window of the Toll Booth or another suitable position on the toll booth. The one unit shall be positioned such that it is in full view and legible to the Users in Light Vehicles. The other unit shall be positioned higher to be in full view and legible to the Users in Heavy Vehicles. The

message shall be clearly visible under all ambient conditions, including artificial or bright sunlight without any reflections. The Contractor will obtain approval from the Employer's Representative for the position and mounting method of the UFD prior to installation. In the event that the Contractor decides to install only one UFD, the Contractor shall also obtain prior approval from the Employer's Representative.

- (b) The UFD shall not in any way obstruct the User's view of the swipe card reader.
- (c) The UFD shall be installed in such a manner to minimise maintenance time and cost relating to cleaning and servicing both the physical display and the immediate environment.

3.7.8 INTERFACE FOR AUTOMATIC AND ETC LANES

The UFD to be utilised in the ETC and Automatic Lanes shall be installed in such a position to ensure that it is clearly visible to the User as they travel through the Lane. The Contractor will obtain approval from the Employer's Representative for the position and mounting of the UFD before installation. In the case of an Automatic Lane the Contractor shall also ensure that the User interface clearly indicates the status of the transaction to the User.

3.8 AUTOMATIC VEHICLE CLASSIFICATION SYSTEM (AVC)

3.8.1 SCOPE

This part covers the specification of the AVC and VGS that shall be jointly used by the Contractor and the Employer in terms of this Contract. The specification aims at stating the minimum requirements to ensure that the maximum reliability and integrity is achieved with clear reporting of any malfunctioning or tampering with the systems.

3.8.2 AVC SPECIFICATION

3.8.2.1 Overview

- (a) The Toll Collection Lane Equipment shall include an Automatic Vehicle Classification system (AVC). The AVC shall be an axle and wheel type, based system.
- (b) The AVC System shall accurately detect, count, separate, track and classify all vehicles passing through a Lane continuously. It shall further be able to determine when a valid vehicle enters the vehicle identification footprint area.
- (c) The AVC System shall be able to detect abnormal conditions relating to the characteristics of the vehicle

- (d) The AVC System shall be able to detect vehicles entering the Lane from both the forward and reverse directions and shall also indicate the direction of entry in its final classification.
- (e) The AVC System shall be able to accurately differentiate between the Vehicle Classes as set out in the classification scheme as prescribed in the Government Gazette or by the Employer, under all ambient conditions.
- (f) The AVC System shall accurately detect, separate and classify motorcycles passing through any section of any toll lane area. This shall include all toll lane types.
- (g) In the event that the AVC Equipment is operating in a degraded mode (i.e. the AVC Equipment self-monitoring or built-in-test indicates that the Equipment is not fully functioning as intended), then the Lane shall flag the condition in the relevant Transaction Record.
- (h) The AVC performance accuracy shall be measured as per the requirements within SECTION 10.
- (i) The AVC shall be a stand-alone device with its own central processing unit, power supply (linked to the Toll Plaza UPS via a separate AVC circuit breaker (of the appropriate amperage and trip characteristics) on the UPS sub-distribution board and not shared with the TCC or any other device), independent power backup and battery status monitoring system (additional continuous feed power backup, over and above the Toll Plaza UPS, providing a minimum of an additional 4 hour power backup to the entire AVC System), memory and enclosure, for each Lane's AVC.
- (j) The DCS shall be equipped with the same independent backup UPS, providing an additional 4 hours of backup power above the Plaza UPS.
- (k) The additional standalone UPSs required for each AVC System and the DCS shall also serve as additional surge protection. The Contractor shall employ online UPS units. Any fluctuation in Plaza UPS power shall not affect the AVC or DCS functionality in any manner.
- (l) The AVC and DCS communications protocol shall employ sufficient data error handling in the event where any data packets or messages are missed, corrupted or otherwise affected.
- (m) The AVC controller shall be manufactured from the latest technology entry level computer Hardware suitable for an industrial environment. This shall apply to the motherboard, processor and fan, memory (RAM), hard disk drive (HDD) and power supply unit (PSU).
- (n) The AVC controller shall be installed by the Contractor in an area approved by the Employer.

- (o) The enclosure shall be fitted with an anti-tamper switch as well as an approved locking mechanism. The enclosure shall allow for internal air circulation to prevent hot-spots forming on specific components and shall be powder coated matt black on the inside to aid in heat absorption. Where required, a vent and fan system shall be installed to circulate outside air through the enclosure. The vents shall have dust filters that shall be easy to clean and replace and shall not affect the IP rating of the enclosure.
- (p) The AVC Equipment sensors shall be located in the Lane immediately beyond the point of payment and shall provide real time vehicle classification functionality.
- (q) The AVC sensors and cables shall be shielded by the Contractor to prevent unauthorised access, any physical tampering or damage.
- (r) For Ramp/Mainline Swapping the AVC shall have the ability to connect additional vehicle detection sensors to the system, to detect vehicles travelling through the barriers between ramp and mainline Virtual Toll Plazas. The AVC shall be able to generate an incident in the event when vehicles travel through these barriers, usually closed by booms or chains which are locked when not in use.
- (s) The AVC shall detect the presence of a Vehicle as it travels over / past its sensors, measure and interpret certain physical characteristics of the Vehicle and classify the Vehicle unambiguously into the correct Toll Classes as specified in the Government Gazette, as amended from time to time.
- (t) The AVC System shall detect, record and report vehicle abnormalities and vehicles of special interest as described elsewhere, to the TCC, such that this information can be passed on to the relevant authorities. The AVC System shall report the following conditions:
 - i. Load Shifted
 - ii. Abnormal height A: 4.2m
 - iii. Abnormal height B: 4.8m

3.8.2.2 AVC MINIMUM FUNCTIONALITY

The AVC System shall have the following interfaces:

- (a) AVC/DCS: This secure interface provides for the communication between each AVC and the dedicated DCS/s in order to collate all data from each AVC and to provide an independent, secure and un-tampered parallel data stream to the Employer's remote ITIS system. The AVC/DCS data network shall be a separated and secured communications network from that of the Lane (TCC), Back Office and other Tolling System's communications Network/s. A clearly defined and secure interface shall be implemented and maintained to communicate AVC data and status messages to the DCS. The required DCS which is to be supplied by the Contractor shall serve as a data repository

for all transaction and incident or event data generated by all AVCs linked to it. The communications interface between the DCS and AVC shall facilitate the DCS functionality to monitor all AVC statuses in order to maintain such status although communications between the AVC/s and DCS failed. Monitoring is therefore performed from both the AVC and DCS platforms. The contractor shall ensure and guarantee that no AVC shall be accessible via any section of the network other than the DCS or TCC. It is suggested that this interface be employed to ensure an accurate date and time stamp on the AVC from the DCS. However, the Contractor shall be required to implement robust data messaging monitoring procedures to ensure accurate and complete communication between components, including the handling and application of automated corrective actions in the event of or following communications failures. The Contractor shall provide a manual fallback procedure and tool/s, if required, to facilitate the manual porting of data in the event when the network cannot be repaired in a short period of time. Modifications to this interface protocol shall require approval by the Employers Representative.

- (b) AVC to TCC interface. The AVC and the TCC are connected sub-systems, however, it shall not be possible to access the AVC network from other system/s. No physical interface between the AVC System and other systems shall exist apart from the TCC/AVC interface and a Data Concentrator System (DCS/AVC). However, the Contractor shall be required to implement robust data messaging monitoring procedures to ensure accurate and complete communication between components, including the handling and application of automated corrective actions in the event of or following communications failures. Modifications to this interface protocol shall require approval by the Employers Representative. The operational functionality of both systems shall not be negatively affected in the event of any communications failure, partial or complete.
- (c) DCS / ITIS interface. The interface between the DCS and the ITIS shall be via a FTP server located on the Employer's data network. The AVC data shall reach the Employer's ITIS, via the DCS, by a route totally independent to the Back Office. Where applicable, an exception will be made for Lanes situated at remote ramps, in which case the communication between the AVC and DCS may be shared via fibre optic link, in which case a logical separation is still required. The Contractor shall supply the automated data interface to ITIS and shall allow for all communications mediums and associated costs, between the DCS and the FTP server. The interface protocol is described elsewhere and method and medium/s to communicate shall require approval by the Employer's Representative. During this process the DCS may also connect to a time source (to be approved by the Employer) to update its time.
- (d) DCS/Back Office interface. The DCS contains critical Tolling System management data and information which is required to support the available and sometimes incomplete data, recorded on the Back-Office. This data interface shall not facilitate real time data transfer to the Back-Office from the DCS at any time. The AVC/DCS data network shall be separated and secured from the Lane / Back Office communications network and other systems or peripherals except for the dedicated communication channel/s required to the unique Back Office application which will allow to port DCS recorded AVC transaction and incident/fault message details to the Back Office only on a "If-Needed" basis and thereby allow the Back Office Application to request any missing data elements

from the DCS and to allow the DCS to port data file management elements to and from the Employer's ITIS system. A clearly defined and secure interface shall be implemented and maintained to communicate DCS data elements to the Back-Office. This interface shall thus facilitate the porting of "missing" AVC and "missing" DCS Incidents to the Back-Office, facilitating the accurate recording of incident and alarm events by the VGS. This interface shall not be allowed to be activated until the Contractor has proven the integrity of the interface to the Employer's Representative. Failure of the Contractor to provide this secure defined interface shall be considered to be a failure under the Back-Office data integrity audit mechanisms and not a failure or non-compliance on the DCS.

- (e) DCS – Contractor – Supervisory staff interface: The Contractor or any of his representatives shall not have any access to the Operating System or secured raw DCS data. The DCS shall facilitate the reporting of status messages and/or acknowledgement files, received from the AVCs and ITIS server, to the Contractor in order to trigger corrective action where required. The Contractor shall have access to decrypted DCS Reports, generated incidents and other recorded incidents and/or alarms, critical to ensure prompt response to any AVC or ITIS related failure in real time with the exception of AVC traffic transaction details or summary counts until at least five minutes after any hour boundary or after all DCS data has been verified to be accurate and complete by means of the system integrity checks, whichever occurs the latest. The interface shall provide a user-friendly and up-to-date GUI representation of AVC and related component statuses based on a process running on the DCS that collates all required AVC and ITIS status data. This visual presentation of all component statuses shall be running as the default display on the DCS in order to facilitate the accurate and immediate corrective actions by the Contractor's personnel. The DCS software shall include intelligence to maintain accurate AVC component statuses and report it to the Contractor's personnel accordingly. This shall include the correction of previously recorded statuses which was not reported or cleared by means of AVC incidents. The DCS shall interpret transaction messaging and associated status bits to accurately maintain AVC component statuses. It shall not be possible for any of the Contractor's personnel to disable this real-time monitoring function of the DCS.
- (f) DCS – Contractor – Technical Maintenance staff interface. This interface shall facilitate the on-site technical staff to request incomplete data elements from the AVC/s via a secure systematic user interface, without allowing access to the operating system or any data element stored on the DCS. This interface shall also facilitate data and communications maintenance as required from time to time, also, without the ability to access the Operating System or AVC data related database or other data / message files.
- (g) DCS – Employers Representative interface. This interface shall allow the Employers representative complete Administrators / Root access. The interface shall also facilitate the capturing of all encryption related keys and similar security keys. Such secure access user-ID and password/s shall be handed over to the Employer's representative before granting the Provisional Compliance Milestone.

3.8.2.3 The AVC shall include the following functionality:

- (a) An interface to the Lane sensors;
- (b) Vehicle category determination.

3.8.2.4 Detection of abnormal conditions:

Wrong direction:

- (a) Vehicle passages in the Wrong Direction through the Toll Lane;
 - i. A completed passage in the reverse direction shall be handled in the same manner as a forward passage, and shall generate a transaction in the Toll System. The one exception is in the Reversible Lane, where only one of the sets of lane Equipment shall generate a Transaction Record. The other set shall be locked by the interlocking system.
 - ii. A Wrong Direction passage shall be a completed vehicle passage but in the opposite direction of the normal flow of traffic. Such a passage shall generate an incident message with an incident number in addition to the Transaction Record. This shall be reported to the Back Office as well as the DCS.
 - iii. A wrong direction incident is always associated with the recording of such a Transaction Record on both the AVC and TCC.

(b) Roll Back:

- i. Vehicles travelling into the AVC area in a forward direction (independent of the number of sensors activated but with a minimum of two types of sensors resulting in a first axle message) and then change direction and reverse back towards the payment point. The AVC and TCC shall ensure that Vehicle roll backs are catered for accurately i.e. ensure that only actual passages are reported.
- ii. A rollback incident shall be generated and reported to the TCC and DCS with a unique incident number after the vehicle has reversed out of the AVC sensor area. The AVC shall not generate a passage for this vehicle. The appropriate message shall be provided to the TCC to cancel the "First axle" message and Transaction number if this message has already been sent to the TCC (depending on the sensors activated).
- iii. The Traffic Light state shall change back to green only if this transaction was validated previously by the TCC.

(c) Vehicle Standing:

- i. A vehicle standing incident is generated in the event that a vehicle is detected and the AVC vehicle classification is not concluded within a pre-set time of 30 seconds. This incident shall be repeated on 30 second intervals with a unique AVC incident

sequence number until the vehicle clears the AVC area or a classification has been completed. The pre-set time shall be configurable and shall be set to a different value only if instructed by the Employer.

(d) Reverse Entry:

- i. The Vehicle enters into the AVC area from the Wrong Direction i.e. opposite to the normal flow of traffic. A reverse entry shall be handled in exactly the same manner as a forward entry, i.e. once a loop and one other sensor has been activated, a "First Axle" message shall be sent to the TCC, with a field identifying the direction of the entry as "Reverse".
- ii. The AVC and TCC shall ensure that Vehicle reverse entries are catered for accurately i.e. ensure that only actual passages are reported.

(e) Run Through

A run through shall be a vehicle passage in the forward direction for which there was no method of payment and /or no classification made. It shall be a complete passage over the AVC identification area. It shall have a monetary association and a transaction shall therefore be generated. Run Through passages shall have a unique incident number and shall be reported to the Back Office and DCS levels. The incident shall contain the Vehicle Class and tariff.

3.8.2.5 Tamper detection;

- (a) Continuous scanning and evaluation of sensors' signals to detect degradation or failure.
- (b) All AVC sensor inputs shall be digital inputs with optically isolated devices.

3.8.2.6 The AVC shall count axles. The axle counting process is defined below:

The axles associated with one Vehicle shall be those counted while a Vehicle presence detection sensor (e.g. light curtain and/or loop) is activated. All Vehicle classifications shall require at least two types of devices, a vehicle presence detection sensor and another type of sensor, (e.g. loop and an axle detector or light curtain and an axle height sensor) to be active before proceeding with classification.

Axle counting shall inclusively determine the following characteristics:

- (a) Direction of movement including forward and backward moving axles, based on the order of sensor activation.
- (b) Car and motorcycle wheels, based on the activation of the sensors in the same line.
- (c) All axles of a vehicle as defined in the Government Gazette.

3.8.2.7 The AVC shall distinguish between Light and Heavy Vehicles. The AVC shall include sensors and algorithms for accurately distinguishing between the Toll Classes.

3.8.2.8 The AVC shall store the following data from individual Vehicle passages:

- (a) Date of passage conclusion;
- (b) Time of day when passage is concluded;
- (c) AVC Sequential Number;
- (d) Information obtained via the AVC/TCC interface. These fields shall be blank if the information could not be obtained from the TCC due to communications or other failure:
 - i. TCC transaction number;
 - ii. Transaction Tax Invoice number;
 - iii. Collector ID;
 - iv. Toll Collector Classification;
 - v. Payment Group;
 - vi. Payment Type;
 - vii. Payment Mechanism;
 - viii. Card number (if applicable);
 - ix. Tag number (if applicable);
 - x. Receipt number (if applicable);
 - xi. Discount type (if applicable);
 - xii. Transaction value.
- (e) Classification information:
 - i. Number of forward moving axles;
 - ii. Number of backward moving axles;
 - iii. Number of motorcycle wheels;
 - iv. Number of Light Vehicle or Heavy Vehicle;
 - v. Total loop or light curtain active time. In the case of loops, this is the time from the first loop activating until the last loop is deactivated.

- (f) Abnormal conditions detected:
 - i. Wrong direction;
 - ii. Roll Back;
 - iii. Vehicle Standing;
 - iv. Reverse Entry.
- (g) Final direction of Vehicle exit:
 - i. Normal;
 - ii. Reverse.
- (h) AVC status.
- (i) AVC/TCC communication status.
- (j) AVC/DCS communication status.

3.8.2.9 Vehicle Reverse Passages

- (a) In Reversible Lanes, the Vehicle passages shall generate transactions in one active TCC and so there shall be an associated transaction number in the AVC registers of the associated active AVC. The dormant AVC in a Reversible Lane pair of AVCs, being in Shutdown Mode, shall not generate or register passage transactions. All Vehicle passages in the forward and reverse direction shall generate Vatable transactions in the active TCC and there shall be an associated vehicle classification and transaction number in the active AVC registers. Reverse Vehicle passage transactions shall be recorded by the VGS or other approved system, to allow for verification of the Vehicle Toll Class. If the VGS (or other Video Grabbing System) used for capturing these Vehicle passages for later count and Toll Class verification is incapable of accurately doing so for the purpose intended, such passages shall by default, be logged as highest financial value Toll Class passage with the corresponding Toll Tariff.
- (b) In single direction Lanes, all Vehicle passages in the forward and reverse direction shall generate Vatable transactions in the TCC and there shall be an associated vehicle classification and transaction number in the AVC registers. Reverse Vehicle passage transactions shall be recorded by the VGS or other approved system, to allow for verification of the Vehicle Toll Class. If the VGS (or other Video Grabbing System) used for capturing these Vehicle passages for later count and Toll Class verification is incapable of accurately doing so for the purpose intended, such passages shall by default, be logged as highest financial value Toll Class passage with the corresponding Toll Tariff.

3.8.2.10 The Vehicle information shall be maintained at AVC level for a minimum of 8 weeks and a maximum of 26 weeks, without influencing the speed of the AVC. Data shall automatically be copied to the DCS before being deleted at AVC level. The DCS shall include an automated daily backup process for all data from all AVCs. The AVC data maintenance requirements shall be an automated process to ensure that the AVC processing speed and performance is not compromised at any time.

3.8.2.11 The AVC shall communicate with the DCS. The AVC / DCS message format shall be as follows:

TABLE 3-1: AVC/DCS MESSAGE FORMAT

Message type ID	Message type	Message direction	Message description
0	Transaction data	AVC to DCS	Communicates all AVC transaction data per transaction to the DCS.
1	AVC Incidents/Faults	AVC to DCS	Communicates all the AVC Incident/Fault data to the DCS.
2	DCS acknowledgement	DCS to AVC	Acknowledge Receipt of messages. The DCS acknowledges/confirms Receipt of AVC data.
3	AVC audit file	AVC to DCS	Communicates a summary of all AVC passages and incidents sent to the DCS per hour. The summary shall be per hour. In the case of an AVC reset more audit files will be generated to cover the hour period. This includes a file from the start of the hour to the restart, files for the period between restarts if more than one restart occurred in an hour, and a file from the last AVC restart in the hour until the end of the hour. Under normal conditions the audit file periods will not overlap.

- (a) For data transmission from the AVC to the DCS, the DCS/AVC communication process shall monitor the success of the transmission. If the data transfer/communication from the AVC to the DCS failed, the data transfer shall be repeated. After resending the data ten times, within one minute, the communications shall be considered to be in a DCS communication failed state.
- (b) During a DCS communication failed state, the AVC shall continue to classify Vehicles and attempt to send data to the DCS. Once the communication is restored, the AVC shall upload all the data that could not be transmitted during the communication failed state.

3.8.2.12 The DCS acknowledge message (AVC/DCS message type ID 2) shall contain the follows data:

- (a) Message source - DCS;
- (b) Date (Message date);
- (c) Time of day (Message time);

- (d) Message type being acknowledged;
- (e) AVC sequence number and AVC message number, uniquely generated for each message, for message being acknowledged.

3.8.2.13 The AVC to DCS transaction message (AVC/DCS message type ID 0) shall:

- (a) Include all the data contained in the AVC transaction message. Refer to clause 3.8.2.8.
- (b) Toll Collector ID;

3.8.2.14 The format of the DCS audit file message (AVC/DCS message type ID 3) shall be as follows:

- (a) Message source - AVC;
- (b) Date (Message date);
- (c) Time of day (Message time);
- (d) AVC transaction start sequential number;
- (e) AVC transaction end sequential number;
- (f) Number of AVC transactions (sequence number check): The difference between AVC transaction end sequential number and the AVC transaction start sequential number;
- (g) Number of AVC transactions (individual transaction record check): Count of individual AVC transaction records;
- (h) TCC transaction start sequential number;
- (i) TCC transaction end sequential number;
- (j) Number of TCC transactions (sequence number check): The difference between TCC transaction end sequential number and the TCC transaction start sequential number;
- (k) Number of TCC transactions (individual transaction record check): Count of individual TCC transaction records;
- (l) AVC Incident start sequential number;
- (m) AVC Incident end sequential number;
- (n) Number of AVC Incidents (sequence number check): The difference between AVC end sequence number and the AVC start sequential number;
- (o) Number of AVC Incidents (individual transaction record): Count of individual AVC Incident transaction records;

- (p) VAT start number;
- (q) VAT end number;
- (r) Number of VAT transactions (sequence number check): The difference between last VAT number and the first VAT number;
- (s) Number of VAT transactions (individual Transaction Record): Count of individual VAT Transaction Records;
- (t) AVC to TCC message start sequential number;
- (u) AVC to TCC message end sequential number;
- (v) Number of AVC to TCC messages (sequence number): The difference between AVC to TCC message end sequential number and the AVC to TCC message start sequential number;
- (w) Number of AVC to TCC messages (individual message records): Count of individual message records;

3.8.2.15 The AVC shall communicate on a continuous basis with the TCC. The AVC / TCC Message format shall be as follows:

- (a) Various message types shall be communicated between the AVC and TCC. The Contractor shall not deviate from the prescribed AVC/TCC interface message structure and format without the approval of the Employer's Representative. This includes sending additional types of messages or additional AVC Incidents/faults. The Employer's Representative will consider additional AVC Incidents/faults proposed by the Contractor if these additions comply with the specified message structure and contributes to the improved operations of the Toll System. The message types are:

TABLE 3-2: AVC / TCC MESSAGE FORMAT

Message Type ID	Message type	Message direction	Message description
0	First axle	AVC to TCC	Communicated from the AVC to the TCC on detection of the Vehicle first axle in a forward or reverse direction.
1	AVC Incidents/Faults	AVC to TCC	AVC Incidents/faults inter alia, vehicle standing, AVC reboot and AVC/DCS communication fail.
2	Vehicle data	AVC to TCC	Vehicle data and classification.
3	AVC alive message	AVC to TCC	Message sent continually to confirm that the AVC is available.
4	TCC acknowledge	TCC to AVC	Acknowledge Receipt of message. This message can be populated or unpopulated

- (b) The serial connection shall be as described below:

- i. The serial cable shall be a 0.22mm Mylar Screen 2 Pair Twisted or similarly approved. The cable shall be fitted with 9 Way Sub D Type connectors. Pin 2, 3 and 5 shall be used with pin 2 and 3 reversed.
- ii. Cable Connection: AVC = Com Port 1, 2, 3, or 4. (Selectable)
- iii. TCC = Com Port 1, 2, 3, or 4. (Selectable)
- iv. Protocol
 - RS232
 - Minimum baud rate of 19 200 bits per second
 - Stop Bit 1
 - Parity None
 - Data Bits 8
 - No Delay
 - 16 bit checksum shall be implemented
 - The messages flow during a classification take place in two forms:
 - Normal transaction with no Incidents
 - Abnormal transaction with Incidents
 - During a normal transaction with no Incidents
 - Vehicle is processed in the Lane by the TCC
 - Vehicle proceeds through the AVC area
 - First axle forward message is sent
 - TCC responds with transaction details
 - Car exits the AVC area completely
 - AVC sends the classification data to the TCC
 - TCC responds with an ack. (un-populated)
 - During an abnormal transaction with an Incident
 - Vehicle is processed in the Lane by the TCC

- Vehicle proceeds through the AVC
- First axle forward message is sent
- TCC responds with transaction details
- Car exits the AVC area completely
- AVC sends the Incident to the TCC
- TCC responds with an ack. (un-populated)
- AVC sends the classification data to the TCC
- TCC responds with an ack. (un-populated)

The Contractor shall implement a 16 bit checksum as specified above. The following Pascal code explains the methodology used to calculate the checksum.

```

function DoAVCCheckSum(AVCMessage: String): String;
var
  iCRC, iTemp: LongInt;                                     // CODESC: local variables to function, used
                                                           // to store temp values
  iCharValue, i, j: Integer;

begin
  iCRC := $FFFF;                                           // CODESC: initialise local checksum with max
                                                           // 16 bit hex value
  for i := 1 to Length(AVCMessage) do                     // CODESC: Loop through each and every
                                                           // character in the received message and
                                                           // process inside of loop starting at character
                                                           // position 1 up to length of data
  begin
    I_iCharValue := Ord(p_stAVCMessage[i]); // CODESC: Get the ascii value of the
                                                           // character of which we are currently working
                                                           // with inside the loop

    I_iTemp := I_iCharValue AND $FF; // CODESC: Do a logical AND with the ascii
                                                           // calculated above and HEX FF

    I_iCRC := I_iCRC XOR I_iTemp; // CODESC: Do an exclusive OR of the value
                                                           // from above step

    for j := 1 to 8 do                                     // CODESC: Perform another loop operation
                                                           // stepping from 1 to 8
    begin
      if (I_iCRC AND $1) = $1 then // CODESC: if checksum and HEX 1 is equal
                                                           // to 1
      then
        begin
          I_iCRC := I_iCRC div 2; // CODESC: integer divide the checksum with
                                                           // 2

          I_iCRC := I_iCRC XOR $A001; // CODESC: logical XOR the result from
                                                           // above with HEX A001

        end else
          I_iCRC := I_iCRC div 2; // CODESC: integer divide the checksum with
                                                           // 2
        end;
      end;
    end;

    Result := IntToHex(I_iCRC, 4); // CODESC: Return the string representation
                                                           // of integer Checksum up to 4 String characters
  end;
end;

```

(c) Symbol Definitions

TABLE 3-3: SYMBOL DEFINITIONS

Symbol	HEX Value	Description
C		Checksum.
AVC		Automatic Vehicle Classification System
DDMMYYYY		Date Format
HHmmss		Time Format
,		Comma, used to separate fields
TCC		Toll Collection Computer
ASCII(2)ASCII(16) STX DLE		Message Start De-Limiter
ASCII(3)ASCII(16) ETX STX DLE	28H	End Of Message Start De-Limiter
ASCII(3)ASCII(16) ETX DLE	28H	End Of Message De-Limiter
!	21H	First Axle

(d) First axle message (AVC to TCC message, type 0)

- i. On detection of the first axle, a First Axle Forward Message is sent to the TCC. The TCC will acknowledge this message with a Populated Message Type 4 containing the Vehicle Transaction Data. If the AVC does not receive a Message Type 4 from the TCC, the following sequence of events will occur:
 - The First Axle Forward Message will be stored in the AVC buffer.
 - The First Axle Forward Message will be transmitted a total of 10 times at intervals of 2 seconds.
 - After sending the message for the tenth time the message will be cleared from the buffer and will be lost.
- ii. If the vehicle has proceeded through the AVC the next message (AVC Classification or Incident Message) will be sent. This message will also be resent 10 times if no ACK is received from the TCC. Whether the TCC Acknowledged the First Axle Forward Message or not will have no relevance to the AVC.
- iii. The AVC Software will fill the missing data in the acknowledge message with blanks.

iv. Example first axle message:

v. STXDLEU,AVC,DDMMYYYY,HHmmss,0,20346,766789,!F,1D78ETXDLE

TABLE 3-4: FIRST AXLE MESSAGE

Item	Description	Format
	Message Start delimiter. This is a ASCII(2) with a ASCII(16)	STX DLE
	Message length, from start (including STX DLE) of message to end (including ETX DLE) of message, ASCII value to character e.g. for a 85 byte message this will be U.	U
	Message Source - This is a three Character Message in Alpha format.	AVC
	Message Date – This is the actual Date of when the Message is generated.	DDMMYYYY
	Time Of Day – This is the actual Time of when the Message is generated. This is a 24-hour format.	HHmmss
	Message Type – This is the Message ID. This is a one-Character Message in Numeric format.	0
	AVC message ID – This is a Numeric value ranging from 1 to max integer (2 147 483 647). This counter is incremented for every new message (same number is used for resend), all types, sent by the AVC. The TCC uses the counter to track communications with the AVC.	766789
	AVC transaction number (current transaction in process) - Sequentially incremented for every new transaction – This is a Numeric value ranging from 1 to max integer (2 147 483 647).	20346
	First Axle Message. – This is a HEX symbol of 21H.	!
	First Axle Direction. – This is a one Character Message in an Alpha format. F in capitals denotes the Forward Direction. R in capitals denotes the Reverse Direction.	F (or) R
	Checksum – 4 Character String	1D78
	Message End delimiter. This is a ASCII(3) with a ASCII(16)	ETX DLE

3.8.2.16 AVC Incident/fault message (AVC to TCC message, type 1)

- (a) The AVC Incident/Fault message (AVC/TCC message type ID 1 and AVC/DCS message type ID 1) shall have the format as indicated below. On detection of any AVC Incident/Fault (refer to AVC Incidents and faults included under clause 3.8.2.8, the AVC shall communicate the following information to the TCC and DCS:
- (b) Example message:
- (c) STXDLEU,DDMMYYYY,HHmmss,3456,1,20346,789654,001,87865443CCD,1D78ETXDLE

TABLE 3-5: AVC INCIDENT/FAULT MESSAGE

Item	Description	Format
1.	Message Start delimiter. This is a ASCII(2) with a ASCII(16)	STXDLE
2.	Message length, from start (including STX DLE) of message to end (including ETX DLE) of message, ASCII value to character e.g. for a 85 byte message this will be U.	U
3.	Message Source – This is a three Character Message in Alpha format.	AVC
4.	Message Date – This is the actual Date of when the Message is sent.	DDMMYYYY
5.	Time Of Day – This is the actual Time of when the Message is sent. This is a 24-hour format.	HHmmss
6.	AVC message ID – This is a Numeric value ranging from 1 to max integer (2 147 483 647). This counter is incremented for every new message (same number is used for resend) send by the AVC. The TCC uses the counter to track communications with the AVC.	3456
7.	Message Type – This is the Message ID. This is a one-Character Message in Numeric format.	1
8.	Previous (if no AVC transaction is in progress) or current AVC transaction number – A sequentially incremented for every new transaction – This is a Numeric value ranging from 1 to max integer (2 147 483 647)	20346
9.	AVC Incident sequence number – This is a Numeric value ranging from 1 to max integer (2 147 483 647). This number is incremented with each Incident generated by the AVC.	789654
10.	Incident/Fault code - This is a 3 Character Message in Numeric Format.	001
11.	Incident data field – This is a string that contains any additional data to be used by the TCC e.g. vehicle speed.	Varchar
12.	Checksum – 4 Character String	1D78
13.	Message End delimiter. This is a ASCII(3) with a ASCII(16)	ETXDLE

3.8.2.17 The Vehicle data message (AVC/TCC message type ID 2) format:

- (a) Each time a Vehicle completes its passage over the sensors, the AVC will send the correlated data to the TCC.
- (b) The TCC will acknowledge this message with an Unpopulated Message Type 4. If the AVC does not receive an ACK from the TCC, it will resend the message 10 times at 2 second intervals. If a vehicle has proceeded through the AVC, the next message will be sent and the previous message will be lost.
- (c) The TCC must be aware that if a Classification Message is received with no preceding First Axle Message, the TCC must not respond with a "Green Light". The TCC should scan the AVC Sequential Number to ascertain whether the message is a new classification.
- (d) Similarly if the TCC has received a First Axle Forward Message with a new sequential number, but has not received a Classification message, it should conclude the associated TCC transaction. In such cases the TCC Transaction will have "UK" as the AVC class.
- (e) Example message:
- (f) STXDLEU,AVC,22122006,
111245,23477,2,23,45,F,01,S11|DO|DCS,13MN,121,1D78ETXDLE

TABLE 3-6: VEHICLE DATA MESSAGE

Item	Description	Format
1.	Message Start delimiter. This is a ASCII(2) with a ASCII(16)	STX DLE
2.	Message length, from start (including STX DLE) of message to end (including ETX DLE) of message, ASCII value to character e.g. for a 85 byte message this will be U.	U
3.	Message Source - This is a three Character Message in Alpha format.	AVC
4.	Message Date – Classification Date	DDMMYYYY
5.	Time Of Day – 24-hour format. I.e.: Classification Time	HHmmss
6.	AVC message ID – This is a Numeric value ranging from 1 to max integer (2 147 483 647). This counter is incremented for every new message (same number is used for resend) send by the AVC. The TCC uses the counter to track communications with the AVC.	23477
7.	Message Type – This is the Message ID. This is a one-Character Message in Numeric format.	2
8.	Current AVC transaction Number. – This is a Numeric value ranging from 1 to max integer (2 147 483 647). This counter is incremented for every new transaction generated by the AVC transaction.	23
9.	AVC Current Incident Number – This is a Numeric value ranging from 1 to max integer (2 147 483 647) This is the Current Incident Sequential Number of the First Incident during the last completed AVC transaction i.e. the one associated with this message.	45

Item	Description	Format
10.	Direction - This is a one Character Message in an Alpha format. F in capitals denotes the Forward Direction or R in capitals denotes the reverse direction.	F (or) R
11.	Toll Class – This is a two Character Message in Alphanumeric format.	01
12.	<p>AVC Status field – String. This message includes all the warning states detected by the AVC during the processing of the transaction. The message will be build up as follows:</p> <p>Only abnormal statuses will be communicated. A “ ” will be used to delimit the various status messages.</p> <p>Message mapping:</p> <ul style="list-style-type: none"> • Sensor type 1 (Loop) faulty: S11 to S19 • Sensor type 2 (Axle counter status) faulty: S21 to S29 • Sensor type 3 (Double wheel detector) faulty: S31 to S39 • Sensor type 4 (Height sensor) faulty: S41 to S49 • For future Sensor type 5 (Wheel base detector) faulty: S51 to S59 • For future Sensor type 6 (Light curtain) faulty: S61 to S69 • Senor type 7,8 and 9 (Future use): S71 to S79, S81 to S89, S91 to S99 • Door Open sensor open: DO1 • Battery low: BL1 • Extra wide passage: EW • DCS communication fail: DCS • AVC/TCC communication fail: TCC • Vehicle with more than 10 axles : AX10> • AVC in critical error mode: CM • AVC in serious error mode: SM • User login to the AVC: UL • AVC rebooted: RB • AVC disk full Incident generated: DF • This list may be extended to report the status of new devices or to add some Contractors specific Incidents/messages. Such additions shall be submitted to the Employer's Representative for approval. 	<p>675</p> <p>S11 IS21</p>
13.	Lane ID - This is a four Character Message in Alpha Numeric Format.	13MN
14.	Plaza ID - This is a three Character Message in Numeric Format.	121
15.	Checksum – 4 Character String	1D78
16.	Message End delimiter. This is a ASCII(3) with a ASCII(16)	ETX DLE

3.8.2.18 The AVC alive message (AVC/TCC message type ID 3) format:

- (a) If there is no other information to communicate, the AVC shall generate a "communication test message" to be sure that the communication process is working and to let the TCC know that the AVC is "alive".

- (b) If there is no other information to communicate, the AVC will generate a Communication Test Message commonly known as the Alive Message.
- (c) The TCC will acknowledge this message with an Unpopulated Message Type 4. If the AVC does not receive a Message Type 4 from the TCC, it will resend the message 10 times. After the 10th resend with no ACK from the TCC, the AVC will deem the communication as failed. From that point all messages will only be sent once until an ACK is received is received from the TCC.
- (d) Message example:
- (e) STXDLEU,AVC,22122006, 111245,23477,3, 1D78ETXDLE

TABLE 3-7: AVC ALICE MESSAGE

Item	Description	Format
1.	Message Start delimiter. This is a ASCII(2) with a ASCII(16)	STX DLE
2.	Message length, from start (including STX DLE) of message to end (including ETX DLE) of message, ASCII value to character e.g. for a 85 byte message this will be U.	U
3.	Message Source - This is a three Character Message in Alpha format.	AVC
4.	Message Date – This is the Date of when the Message is sent.	DDMMYYYY
5.	Time Of Day – This is the Time of when the Message is sent. This is a 24-hour format.	HHmmss
6.	AVC message ID – This is a Numeric value ranging from 1 to max integer (2 147 483 647). This counter is incremented for every new message (same number is used for resend) send by the AVC. The TCC uses the counter to track communications with the AVC.	23477
7.	Message Type – This is the Message Type ID. This is a one-Character Message in Numeric format.	3
8.	Checksum – 4 Character String	1D78
9.	Message End delimiter. This is a ASCII(3) with a ASCII(16)	ETX DLE

3.8.2.19 Blank TCC to AVC acknowledgement message (AVC/TCC message type ID 4) format:

- (a) When the AVC sends a Communication Test Message to the TCC, the TCC will respond with an Un-Populated Message Type 4 but including the TCC System Time and Date. The AVC will use this message to synchronise its own System Time and Date once in every 5 minutes.
- (b) This Message is sent by the TCC after it has received a message type 0, 1, or 3 from the AVC. This Message will contain blank items, which are populated only when this Message is sent together with the Vehicle Transaction details, which is typically after the First Axle Forward Message has been sent to the TCC.
- (c) Example message:

(d) STXDLEU,TCC,29122006,121145,3,,,,,,,,,,,,,1D78ETXDLE

TABLE 3-8: BLANK TCC TO AVC ACKNOWLEDGEMENT MESSAGE

Item	Description	Format
1.	Message Start delimiter. This is a ASCII(2) with a ASCII(16)	STX DLE
2.	Message length, from start (including STX DLE) of message to end (including ETX DLE) of message, ASCII value to character e.g. for a 85 byte message this will be U.	U
3.	Message Source – This is a three Character Message in Alpha Format in capital letters.	TCC
4.	Message Date – This is the TCC System Date of when the Message is sent.	DDMMYYYY
5.	Time Of Day – This is the TCC System Time of when the Message is sent. This is a 24-hour format.	HHmmss
6.	Message Type being Acknowledged – This is a one-Character Message in Numeric format which ranges from 0, 1, 2 or 3.	3
7.	AVC Last Sequence Number - This is a Numeric value ranging from 1 to max integer (2 147 483 647). THIS FIELD IS BLANK	
8.	TCC Current Sequence Number - This is a Numeric value ranging from 1 to max integer (2 147 483 647). THIS FIELD IS BLANK	
9.	Toll Collector ID – a string. THIS FIELD IS BLANK	
10.	Toll Collector Current Classification - This is a two Character Message in Alpha Numeric Format. THIS FIELD IS BLANK	
11.	Current Payment Type - This is a two Character Message in Numeric Format. THIS FIELD IS BLANK	
12.	Current Payment Mechanism - This is a two Character Message in Numeric Format. THIS FIELD IS BLANK	
13.	Current Discount Type - This is a two Character Message in Numeric Format. THIS FIELD IS BLANK	
14.	Current Transaction Value. – Integer depicts the tariff in cents. THIS FIELD IS BLANK	
15.	Current Tax Invoice Number - String. THIS FIELD IS BLANK	
16.	Plaza ID - This is a three Character Message in Numeric Format.	

Item	Description	Format
	THIS FIELD IS BLANK	
17.	Lane ID - This is a four Character Message in Alpha Numeric Format. THIS FIELD IS BLANK	
18.	Transaction Date – This is the actual Date of the Transaction. (DDMMYYYY) THIS FIELD IS BLANK	
19.	Checksum – 4 Character String	1D78
20.	Message End delimiter. This is a ASCII(3) with a ASCII(16)	ETX DLE

3.8.2.20 Populated TCC to AVC acknowledgement message (AVC/TCC message type ID 4) format:

- (a) This Message is sent by the TCC after it has received a message type 0
- (b) Example message:
- (c) STXDLEU,TCC,29122006,121145,0,20346,1212,01,C001,01,04,01,2000,01MN12345,2
12,01MN,2922006,1D78ETXDLE

TABLE 3-9: TCC TO AVC ACKNOWLEDGEMENT MESSAGE

Item	Description	Format
1.	Message Start delimiter. This is a ASCII(2) with a ASCII(16)	STX DLE
2.	Message length, from start (including STX DLE) of message to end (including ETX DLE) of message, ASCII value to character e.g. for a 85 byte message this will be U.	U
3.	Message Source – This is a three Character Message in Alpha Format in capital letters.	TCC
4.	Message Date – This is the TCC System Date of when the Message is sent.	DDMMYYYY
5.	Time Of Day – This is the TCC System Time of when the Message is sent. This is a 24-hour format.	HHmmss
6.	Message Type being Acknowledged – This is a one-Character Message in Numeric format which ranges from 0, 1 2 or 3.	0
7.	AVC Last Sequence Number - This is a Numeric value ranging from 1 to max integer (2 147 483 647).	20346
8.	TCC Current Sequence Number - This is a Numeric value ranging from 1 to max integer (2 147 483 647).	1212
9.	Toll Collector ID – a string.	01
10.	Toll Collector Current Classification - This is a two Character Message in Alpha Numeric Format.	C001
11.	Current Payment Type - This is a two Character Message in Numeric Format.	01

Item	Description	Format
12.	Current Payment Mechanism - This is a two Character Message in Numeric Format.	04
13.	Current Discount Type - This is a two Character Message in Numeric Format.	01
14.	Current Transaction Value. – Integer depicts the tariff in cents.	2000
15.	Current Tax Invoice Number - String.	01MN12345
16.	Plaza ID - This is a three Character Message in Numeric Format.	212
17.	Lane ID - This is a four Character Message in Alpha Numeric Format.	01MN
18.	Transaction Date – This is the actual Date of the Transaction. (DDMMYYYY)	29122006
19.	Checksum – 4 Character String	1D78
20.	Message End delimiter. This is a ASCII(3) with a ASCII(16)	ETX DLE

3.8.2.21 The AVC shall incorporate the following features to ensure AVC redundancy and error tolerance:

- (a) The AVC shall wait for a response for each message sent to the TCC. If no response is received, the message shall be resent every 2 seconds. After re-sending the same message 10 times, within a maximum of one minute, the communication shall be considered to be in a failed state. The AVC shall send an instant alarm message to the DCS to indicate any TCC/AVC communication failures. Neither the AVC nor TCC functionality shall be impaired in such a way that the TCC or AVC terminates or halts its required minimum processing when a different or no message is received by either the TCC or AVC.
- (b) Under all conditions, even during a communications failed state, the AVC shall continue to detect & classify each vehicle individually, store the vehicle passage and any abnormal status (Incident) in the AVC database and communicate via the parallel data stream to the DCS.
- (c) The AVC shall store data for each Vehicle locally and inform the DCS accordingly. This shall include reporting the TCC communication status and data on each Vehicle detected.
- (d) TCC Stand alone mode refers to a state when the AVC has no communication with the TCC. AVC Stand alone mode refers to a state when the AVC has no communication with the DCS. In the event of a communications failure between the AVC, the TCC and/or the DCS, the AVC shall continue to detect & classify each individual Vehicle in AVC Stand-alone Mode or TCC standalone mode. The AVC shall synchronise all messages and data with the DCS and report all vehicle passages recorded to the DCS while in TCC stand-alone mode.
- (e) The Contractor shall install the necessary sensors and implement AVC Software algorithms to ensure AVC Sensor redundancy with the required level of fault detection.

AVC Sensor redundancy means that the AVC shall continue to operate accurately if any one sensor fails. If a sensor is faulty, disconnected, blocked, fail high or fail low, the system shall have algorithms in place to detect such problems and report it to the TCC and DCS. A sensor fault Incident (alarm) shall be reported for a sensor which failed to be activated or did not respond during a vehicle passages. The AVC shall also report fail "open" and fail "closed" situations of each sensor. Faults shall be reported to the DCS within 10 seconds of the fault occurring. The AVC shall scan the sensors every 10 seconds. If on the next scan the sensor indicated no error, the AVC shall report the status change to the DCS (status "Fail" and "OK"). This ("OK") message shall reset the alarm condition and will also be logged. The AVC/DCS shall report an audible alarm to the Contractor who shall close such Lane, immediately, which is operated in AVC Fault Mode.

- (f) In cases where more than one sensor is faulty the AVC shall report a Critical error mode start (sensor fail) Incident to the TCC and DCS.
- (g) The VGS shall record all Lane activities by at least a camera in the affected lane where the AVC is in Critical Error mode. Images of the Lane shall be recorded continuously with a frame rate of no less than 10 frames per second.

3.8.2.22 The following diagnostics and fault reporting shall be implemented.

- (a) The AVC shall report fault conditions to the TCC and DCS. This reporting shall be achieved in real-time.
- (b) The AVC Incidents and faults listed in the Employer's Interface section, shall be reported to the TCC and DCS.

3.8.2.23 The AVC shall have serial or network communication interfaces. There shall be a 100 Base T (or higher) network interface to the TCC and DCS.

3.8.2.24 The AVC shall also have the ability to export its data to an external electronic device. The Contractor shall ensure that this data is protected against any alteration or tamper. The data export shall be via:

- (a) USB removable disk or CD/DVD;
- (b) Serial communication link; and
- (c) Local Area Network (dedicate AVC/DCS link).

3.8.2.25 Data Volumes, Timing and Output Data Flows:

The AVC shall have storage capacity on its local drive/battery backed memory to store information for 60 000 passages.

- 3.8.2.26 The AVC shall be capable of operating in Stand-alone mode, in the case of other Toll System components or network communication failure. During Stand-alone mode operation, the AVC shall continue detecting, counting, classifying and registering Vehicle passages. When communication is restored, the AVC shall synchronise its message files with DCS.

3.9 INSTALLATION AND CABINET DETAILS

The AVC cabinet/enclosure/s, sensors, sensor cabling, power cabling and any related cabling and the installation thereof shall be of such standard that it eliminates unauthorised access to the AVC System. Only authorised maintenance personnel shall be able to access any component of the AVC System.

3.9.1 AVC CABINET AND PERIPHERAL INSTALLATION

- 3.9.1.1 The regional and environmental application of the AVCs shall be indicated by the Employer Representative in order to specify the minimum quality grading of the AVC enclosures. The installation position of the cabinet shall be approved by the Employer. All AVC enclosures shall be guaranteed by the Contractor to be maintenance-free, visibly oxidation/rust-free and maintain the quality finishes for 10 years from the day of acceptance by the Employer's Representative.

- (a) Coastal application: - enclosures exposed to elements (i.e. on toll islands and damp manholes):
- (b) The enclosure shall be made of grade 316 austenitic, polished, stainless steel, which is at least 1.6mm thick.
- (c) Coastal application: - enclosures installed in ventilated tunnels:
- (d) The enclosure shall be made of grade 304 austenitic, polished, stainless steel, which is at least 1.6mm thick.
- (e) Inland application: - enclosures exposed to elements (i.e. on toll islands and damp manholes):
- (f) The enclosures shall be made of grade 3CR12[®] ferritic stainless steel, which is at least 1.6mm thick.
- (g) Inland application: - enclosures installed in ventilated tunnels:
- (h) The enclosures shall as a minimum be made of mild steel which is at least 1.6mm thick.

- 3.9.1.2 All enclosures shall be fitted with a high-security door lock with a door open sensor. Exposed enclosures (like toll island installations) shall include additional security measures to ensure that doors cannot be prised open and thereby compromising the IP65 rating or the integrity of the hardware and Software in the enclosure. Enclosures shall include conduits, sprague, draw boxes,

connector/connection boxes and terminations between peripheral sensors/instruments and the control Equipment.

3.9.1.3 All cabling shall be routed through conduits (or sprague tubes for final connection only), as applicable, of the same or higher grade material as for an AVC enclosure in the same environment. AVC sensor and -cabling protection plates of at least 3 mm thick shall be used in the Lane area to protect against sabotage/accidental damage where applicable. The use of other types of conduits, other than the above for the routing of cables in certain locations such as secure service tunnels, may be allowed if so approved by the Employer's Representative. Only approved glands, connections and connector housings shall be used. At no point shall any cabling (processing, power, communication and sensor etc) be accessible to non-maintenance staff. All AVC enclosures (for processing, power, communication, sensor etc) and all connections shall at least comply with IP65 standard.

3.9.1.4 All 3CR12® and mild steel enclosures shall be chemically cleaned, treated to prevent oxidation before powder coated, to a minimum of 70 microns, baked and cured.

3.9.2 **AVC SERIOUS ERROR MODE**

3.9.2.1 The AVC shall be classified to be in Serious Error Mode if any of the following errors or conditions exists:

3.9.2.2 AVC communication failure to the TCC and/or DCS. In cases where the AVC communication failure is due to critical errors it remains the Contractors responsibility to take appropriate corrective actions.

3.9.3 **AVC CRITICAL ERROR MODE**

3.9.3.1 The AVC shall be classified to be in Critical Error mode if any of the following Critical Errors or conditions exists:

- (a) Any error that renders the AVC unable to classify accurately.
- (b) Multiple AVC Sensor failures. Due to sensor redundancy and fault detection implementation on the AVC, the AVC shall be required to continue to operate accurately if any one sensor fails. In cases where any two or more sensors are faulty, the AVC may still be capable of operating effectively (due to the algorithms implemented by the AVC supplier). This notwithstanding, any and all cases where two or more sensor failed, the AVC shall be considered to be in AVC Critical Error mode;
- (c) CPU, processor or storage device failure. This type of failure cannot be effectively monitored due to the fact that other errors have the similar symptoms. Critical errors will be separated by the rest of the errors by the DCS. The DCS will check data continuity and completeness and report missing/incomplete data to ITIS as a critical error;

- (d) Power failure. Reporting under total power loss conditions is not possible; the AVC UPS battery low will therefore be used to indicate that the AVC is in serious error mode. The Contractor shall implement adequate control measures on the AVC to alert of AVC UPS, low battery backup power levels. An AVC Incident shall be generated to indicate low battery backup power levels (Voltage) that could compromise the correct functioning of the AVC. The AVC backup UPS Battery low Incident shall be generated at a minimum voltage level not lower than the nominal voltage rating of the batteries used less 20%. (e.g. 12V less 20% = 9,6V). The AVC battery low Incident shall be generated at a voltage level, high enough, to ensure that the AVC UPS will not cut out before this Incident is generated and transmitted to the rest of the Toll System. Any loss of power or inadequate power levels from the AVC UPS, as described above, to the AVC that terminates/compromises its operation is a critical failure.

- 3.9.3.2 AVC tamper conditions: If a Person has access to the AVC box, it is technically possible to disable the AVC, without triggering any of the critical error related Incidents. The AVC will therefore be deemed to be in Critical Error Mode while the AVC box is open.

3.10 VIDEO GRABBING SYSTEM (VGS) (WHICH INCLUDE CAMERAS, VGS NETWORK AND/OR CABLING AND POWER SUPPLY)

3.10.1 GENERAL

- 3.10.1.1 The Contractor shall supply, install and maintain a VGS that equals or surpasses the minimum requirements set in this specification. The objective of this system is to serve as the primary, independent and stand-alone control and audit tool for the Employer and Contractor to ensure that video audits are possible on a continuous basis in order to record and verify all events and abnormal conditions, i.e. class discrepancies, violations and system failures. The VGS DVR shall continuously record images (video stream), at a frame rate of at least 25frames per second and a minimum resolution of SXGA+, for the cameras connected to it to ensure that all passages through the Lane is detected.
- 3.10.1.2 The VGS shall be required to interface to the Employer's Intelligent Transport Systems (ITS) platform, where applicable.
- 3.10.1.3 The VGS continuous recording shall not be affected by failures of other sub systems including the primary toll system network.
- 3.10.1.4 The VGS shall consist of a primary Digital Video Recorder (DVR) to collect continuous video. The VGS server shall incorporate an interface system to accept triggers and extract sequences of images from the DVR according to the triggers received and an interface to supply the captured image sequences and data to the Back Office System Incident control module. The Back Office System Incident control module shall have the capability to play back the captured image sequences. The triggers mentioned shall be based on the incidents generated by the various sources of the system as defined in Table 3-10: VGS Actions.

- 3.10.1.5 The Contractor shall as a minimum install one camera per Lane and ensure that images have sufficient detail to enable the accurate detection and verification of the Vehicle Class under all ambient conditions including the impact of area lightning or vehicle lights.
- 3.10.1.6 The recorded image shall include the following embedded details on the overlay:
- (a) Lane ID and/or camera specific ID (depending on application)
 - (b) Date/time of the camera
- 3.10.1.7 The following overlay inserts shall be optional for specific lane camera applications to reflect lane status changes:
- (a) Traffic light status
 - (b) OHLS status
 - (c) Boom status
 - (d) Collector ID
 - (e) Collector vehicle classification
 - (f) AVC Classification
 - (g) Payment Mechanism
- 3.10.1.8 Each VGS installation shall require the Employer's Representative's approval including a proposed layout plan for each individual site which will be followed by an on-site operational verification. The Contractor shall adjust and reposition cameras to meet the specified requirements to the satisfaction of the Employer's Representative.
- 3.10.1.9 The Contractor may add additional cameras to improve the usability of the VGS.
- 3.10.1.10 Cameras from other systems may be shared by the VGS if approved by the Employer's Representative..
- 3.10.1.11 The VGS shall have the ability, upon receiving an external or an internal trigger, to access the image data from one or more cameras and to capture several images digitally.
- 3.10.1.12 The VGS shall record images for all triggers generated by external or internal sources, for a window period at set intervals, as listed in clause 3.10.1.13.
- 3.10.1.13 The VGS clock shall be synchronised with the central time source on site within a time difference of less than 10 milliseconds of the Lane time.

- 3.10.1.14 Toll Lane related Incidents such as Violations and Toll Class discrepancies and other Incidents, as listed in the table below in this chapter, shall be reported by the TCC or other components to the Video Grabbing System. At least the following information shall be sent with the data and shall be stored with the image:
- (a) Lane Number;
 - (b) Toll Collector ID;
 - (c) Date (Incident generation date);
 - (d) Time (Incident generation time);
 - (e) Latest transaction sequence number;
 - (f) Type of Incident;
 - (g) Toll Collector Toll Class;
 - (h) AVC Toll Class;
 - (i) Source of the incident (AVC, VGS, DCS etc); and
 - (j) Last sequence number used by the source of the incident.
- 3.10.1.15 The Contractor shall ensure that the cameras are installed in such a way that the Video Grabbing System is capable of capturing images to enable the accurate classification and detection of a Vehicle in accordance with the Video Grabbing System and to identify which Lane the Vehicle is exiting from.
- 3.10.1.16 The continuous recording shall be made accessible to the Employer via remote browser facility, this shall include the VGS recorded images and the continuous recording from individual cameras for a specific time period.
- 3.10.1.17 The VGS shall utilise a database with a query facility to be able to access any previously recorded images while the system is capturing new images in real time. It shall further have the facility for the Contractor to update the database to reflect the actual Toll Class. The Back Office System shall also be updated with the actual Toll Class.
- 3.10.1.18 The VGS shall have security on the system and database level and should cater for at least the following categories:
- (a) Plaza Manager;
 - (b) Supervisor; and
 - (c) System Administrator.

Any raw data shall not be available to any Toll Plaza personnel other than the System Administrator

- 3.10.1.19 The VGS primary recording device shall be installed in a secure tamper-proof enclosure to ensure that the recorder is tamper proof. The VGS primary recording device internal UPS shall also be housed in this enclosure.
- 3.10.1.20 The VGS primary recording device shall have a storage capacity of at least 21 days continuous recording and the VGS shall have an online storage capacity of 6 months of triggered Incidents and linked images. These triggered Incidents and linked images shall be stored in a database. In addition to the above the VGS DVR shall have the functionality to do motion based recording when motion is detected in a pre-selected area of a camera view. The Contractor shall allow additional capacity on the VGS storage device to store images for up to 5 cameras utilizing motion based recording for a 3 month period. This additional capacity shall be used by the Employer's Representative and Contractor to verify the AVC accuracy requirements as specified in Section 10.2.
- 3.10.1.21 Following the direct recording required as noted above, all triggered incidents and linked images shall be permanently stored on a back-up device for auditing purposes. An archive and backup utility shall be provided by the Contractor on CD, DVD or external hard-disk drive to store triggered Incidents and linked images, approved by the Employer's Representative. The Contractor shall facilitate access to such archived images when requested by the Employer's Representative for audit purposes.
- 3.10.1.22 The Back Office System shall be provided with the statuses of the all VGS components, including primary recording device, cameras and VGS application to ensure continuous operations.

3.11 VGS POWER SUPPLY

3.11.1 GENERAL

- 3.11.1.1 The VGS shall be a stand-alone device with its own Uninterrupted Power Supply (one or more UPS), capable of supplying uninterrupted power supply to all components of the VGS, including cameras, network, DVR and switches for at least 4 (four) hours. The changeover, if any, between the normal supply of power and the inverter power shall not affect the functionality, continuity or quality of images in any way. The Contractor shall ensure that electrical power supplied to the VGS components is clean and does not affect the image quality and data continuity in any way.
- 3.11.1.2 Any restrictions relating to Power over Ethernet (POE) need to be considered where long cable lengths and the specifications of the switch may impact the proper working of the system.

3.11.1.3 The Contractor is to take special care to ensure that the VGS is protected against lightning, electrical surges and other irregularities.

3.11.1.4 VGS actions following the reporting of AVC, DCS, Back Office System, DVSS and other Incidents, Fault messages or Alarms:

- (a) As a minimum the Contractor shall configure the VGS to the following parameters in order to verify events from a point in time prior to any Incident till a point after the Incident was reported or until the relevant fault status changed (ended). The table below contains the Toll System Incidents as defined by the Employer and the criteria for the recording of properly referenced image material/video clips to verify the surrounding circumstances in the event of a reportable Incident or fault message was received. The rules, under which the Incidents below are generated, are described elsewhere. Image records shall not be duplicated on the database in the event where the same or another Incident requires the same image material for verification purposes. Where applicable, should the “fail” Incident not be followed up by an “OK” Incident to terminate the storage window of images, the VGS may cut off the window period after the “Default termination period” in order to eliminate the possibility of open-ended window periods.

TABLE 3-10: VGS ACTIONS

ID	Name	Before seconds -	After seconds +	Frames per second	Default termination period (seconds)	Area to be monitored	Required / Optional for recording and auditing
1.	AVC reboot/restart	-240	+240	0.5	-	Lane/AVC	Required
2.	Serious start - AVC Communication fail	-120	End #3	1	7200	Lane/AVC	Required
3.	Serious end - AVC Communication OK	Strt #2	+120	1	-	Lane/AVC	Required
4.	Roll-back	-60	+120	1	-	Lane/AVC	Optional
5.	Reverse entry	-60	+120	1	-	Lane/AVC	Optional
6.	Vehicle standing	-120	+60	1	-	Lane/AVC	Required
7.	Vehicle with more than 10 axles	-120	+15	2	-	Lane/AVC	Required
8.	AVC sensor type 1 – fail	-30	End #9	0.5	7200	Lane/AVC	Required
9.	AVC sensor type 1 – OK	Strt #8	+30	0.5	-	Lane/AVC	Required
10.	AVC sensor type 2 – fail	-30	End #11	0.5	7200	Lane/AVC	Required
11.	AVC sensor type 2 – OK	Strt #10	+30	0.5	-	Lane/AVC	Required
12.	AVC sensor type 3 – fail	-30	End #13	0.5	7200	Lane/AVC	Required

ID	Name	Before seconds -	After seconds +	Frames per second	Default termination period (seconds)	Area to be monitored	Required / Optional for recording and auditing
13.	AVC sensor type 3 – OK	Strt #12	+30	0.5	-	Lane/AVC	Required
14.	AVC sensor type 4 – fail	-30	End #15	0.5	7200	Lane/AVC	Required if used
15.	AVC sensor type 4 – OK	Strt #14	+30	0.5	-	Lane/AVC	Required if used
16.	Critical start - AVC panel door open	-240	End #17	0.5	14400	Lane/AVC	Required
17.	Critical end - AVC panel door close	Strt #16	+240	0.5	-	Lane/AVC	Required
18.	Serious start - AVC Stand-alone Data	-300	End #19	1	21600	Lane/AVC	Required
19.	Serious end - AVC Stand-alone Data	Strt #18	+120	1	-	Lane/AVC	Required
20.	Critical– AVC Memory 90% full	-	-	-	-		
21.	Critical start - AVC-UPS Backup battery voltage low	0	End #22	0.25	21600	Lane/AVC	Required
22.	Critical end - AVC-UPS Backup battery voltage OK	Strt # 21	+120	0.25	-	Lane/AVC	Required
23.	Serious start - TCC Communication fail	-120	End # 24	1	14400	Lane/AVC	Required
24.	Serious end - TCC Communication OK	Strt #23	+300	1	-	Lane/AVC	Required
25.	Un-transmitted data deleted	-	-	-	-	-	
26.	Plaza UPS power failed	-30	End #27	0.5	28800	Lane/AVC	Required
27.	Plaza UPS power OK	Strt #26	+120	0.5	-	Lane/AVC	Required
28.	AVC User access – login	-	-	-	-	-	
29.	AVC User access – logout	-	-	-	-	-	
30.	Critical start - Sensor failure	-30	End #45	2		-	Required
31.	AVC time update	-	-	-	-	-	
32.	Lane IP address change	-	-	-	-	-	

ID	Name	Before seconds -	After seconds +	Frames per second	Default termination period (seconds)	Area to be monitored	Required / Optional for recording and auditing
33.	Plaza IP address change	-	-	-	-	-	
34.	AVC IP address change	-	-	-	-	-	
35.	Lane ID change	-	-	-	-	-	
36.	-	-	-	-	-	-	
37.	AVC License expired	-	-	-	-	-	
38.	AVC License updated	-	-	-	-	-	
39.	AVC Data Storage Device reset	-	-	-	-	-	
40.	AVC Data Storage Device error	-	-	-	-	-	
41.	Wrong Direction	-30	+30	1	-	Lane/AVC	Required
42.	AVC Mode change.	-30	+60	0.5	-	Lane/AVC	Required if applicable.
43.	Ramp/Mainline barrier	-120	+120	0.5	-	Ramp/Mainline barrier opening	Required
44.	Run-Through violation	-60	+10	2	-	Lane/AVC	Required
45.	Critical end – Sensor failure	Strt # 30	+30	2	-	-	Required
46.	Serious start – DCS comms fail	-5	End #47	0.25	28800	Lane/AVC	Required
47.	Serious End – DCS comms fail	Strt # 46	+10	0.25		Lane/AVC	Required
48.	Critical error mode time exceeded	-	-	-	-	-	Required as per other incidents
49.	Critical error mode traffic exceeded	-	-	-	-	-	Required as per other incidents
50.	Serious error mode time exceeded	-	-	-	-	-	Required as per other incidents
51.	AVC data missing – Critical error mode	-	-	-	-	-	
52.	DCS reboot	-	-	-	-	-	

ID	Name	Before seconds -	After seconds +	Frames per second	Default termination period (seconds)	Area to be monitored	Required / Optional for recording and auditing
53.	ITIS data submission failure	-	-	-	-	-	
54.	Positive discrepancy (PD)	-30	+5	2	-	Lane/AVC	Required
55.	Negative discrepancy (ND)	-30	+5	2	-	Lane/AVC	Required
56.	Reversible Lane AVC pair – Active AVC	-120	+120	0.5	-	-	Required if applicable
57.	Reversible Lane AVC pair – Dormant AVC	-120	+120	0.5	-	-	Required if applicable
58.	Critical End AVC Memory 90% Full						
59.							
60.							
N	AVC Incident n						

3.12 DIGITAL VIDEO SURVEILLANCE SYSTEM (DVSS)

3.12.1 GENERAL

- 3.12.1.1 The Employer may supply and install a third party digital video surveillance system (DVSS) for its own use to monitor the Contractor's compliance to performance KPI's. The DVSS will also be used to report vehicle queuing situations to the Employer or his Representative and for general surveillance at the Toll Plaza.
- 3.12.1.2 The Contractor shall make provision for the installation of the DVSS by providing clean Plaza UPS power.
- 3.12.1.3 The Contractor shall allow the Employer's contractor to install the DVSS system at the plaza without any restriction after arrangements have agreed between the affected parties.

3.13 QUEUE LENGTH MONITORING SYSTEM (QLS)

3.13.1 General

- 3.13.1.1 The Contractor shall supply, install and maintain a QLS that equal or surpass the minimum requirements set out in this specification. The objective of this system is to serve as an independent stand-alone monitoring and management tool for the Employer and Contractor to ensure that the minimum traffic (vehicle) processing specifications are continuously adhered to. The system shall record images of all approaches to each Virtual Toll Plaza which will include coverage of the area in front of each toll booth where vehicles are being attended to. The queue length requirements are described in more detail in the Standard Specifications for Operations and Maintenance of CTROM Projects: General (Volume 2 Book 2a).
- 3.13.1.2 The QLS shall be required to interface to the Employer's Intelligent Transport Systems (ITS) platform, where applicable.
- 3.13.1.3 Since the physical layout of each Toll Plaza is unique, the Contractor shall table a proposal of the intended QLS indicating sufficient details depicting position of Equipment, video image coverage, communication, Digital Video Recording (DVR), power supply, etc as part of the Tender document for evaluation. The conceptual acceptance of the Contractor's Proposal during Tender stage does not relieve the Contractor in any way to comply with the requirements set in this Contract. The proposed QLS installation shall again be submitted to the Employer's Representative during the Contract Execution stage, for comments and conceptual approval, before the Contractor continues with the QLS installation.
- 3.13.1.4 The Contractor shall install a DVR fed by a sufficient number of cameras, of appropriate quality, positioned in such a manner so as to cover the entire approach area of vehicle at the Toll Plaza. As a minimum the Contractor shall implement at least one camera to provide coverage of three adjacent Virtual Toll Plazas, providing a clear view of the approaching traffic including the vehicle being attended to at the toll booth. The Contractor shall also implement a rear- and/or side view camera combinations, pointing towards the Toll Plaza which will include a view of the OHLSS (camera/s pointing in the same direction as the traffic). Cameras shall be installed in such a manner that it is not affected by wind, vibration and passing of large vehicles. Refer to the Project Document (Volume 3) for further plaza specific details.
- 3.13.1.5 The Contractor may share cameras with the VGS and/or security and surveillance systems, if approved by the Employer.
- 3.13.1.6 At smaller remote Toll Plazas the Contractor shall install independent DVR Equipment for queue length monitoring purposes to ensure data completeness for these plazas. The Contractor may share the QLS Equipment at these remote sites with the requirements of the VGS, if approved by the Employer's Representative. This approval will not be unreasonably withheld. If approved, the Contractor shall not allow any interference from one system to the other.

- 3.13.1.7 Cameras shall be installed in the Toll Plaza area to face the oncoming traffic in such a position that the queue length of any Lane can be captured. The view provided by these cameras shall enable the viewer to identify the Lane(s) in which Vehicles are queuing. The Contractor is to ensure that the QLS functions in such a manner that the queue length monitoring specification can be audited at any time under any weather conditions taking into consideration the glare from oncoming traffic at night, reflections under wet conditions as well as sunlight.
- 3.13.1.8 The system shall have the ability to automatically capture the images every 10 seconds, for each queue length monitoring camera.
- 3.13.1.9 The QLS shall synchronise its time with the main standard time source of all other electronic Equipment at the Toll Plaza.
- 3.13.1.10 The capturing and storage of queue length images on the QLS shall be performed in the following manner:
- 3.13.1.11 The system is to allow the verification / auditing of queue length images via a browser type interface.
- 3.13.1.12 The QLS images shall be easily accessible from a user menu for a specific Control Centre, Toll Plaza, Virtual Toll Plaza, date and time reference point.
- 3.13.1.13 The Contractor shall supply a permanent communications link to each QLS. The functionality must be maintained till the end of the Contract during which it needs to be transferred and handed over to the next Contractor. The frame and resolution requirements shall be similar as for VGS. The Contractor shall be responsible for the installation and configuration of any Software required to access the QLS. Any other communication protocol proposed by the Contractor may only be implemented if approved by the Employer's Representative. The Contractor shall implement sufficient access control to prevent un-authorised access to the QLS, other than the Employer's Representative and Contractor.
- 3.13.1.14 The communications link shall enable the Employer to view QLS video material from a remote access point via the internet without bandwidth restriction. In the event where communication services is not available to provide the required bandwidth, the Contractor shall enable the Employer to access the video material at reduced video streaming resolution rates without losing the functional requirement of the system. Downloading of historic video material shall be provided based on the original recording resolutions. The Contractor shall provide a continuous communication link with a minimum upload data transmission speed of 4096 kbps,
- 3.13.1.15 The Contractor shall ensure that the QLS operates continuously. The Contractor shall apply for permission from the Employer's Representative to conduct Routine Maintenance that may result in the QLS failing to record images as specified.

- 3.13.1.16 The Contractor shall store and maintain all data captured by the QLS on the QLS server or DVR for a period of not less than 4 (four) months after such capture date.
- 3.13.1.17 The Contractor shall ensure that the Employer's Representative will have full access to this data if so required by it.
- 3.13.1.18 The Contractor shall provide means to ensure that the video images are archived, at least on a weekly basis. Archived data shall be available for at least a four month window period. The archived data shall be stored in such format that it could be restored on the QLS DVR or audited directly from the storage device.
- 3.13.1.19 Selecting and downloading of images for viewing shall be limited to 15 minutes window periods per virtual plaza selection.
- 3.13.1.20 As a minimum the following reference data shall be recorded as a text overlay with each image:
- (a) Virtual Plaza ID
 - (b) Date
 - (c) Time
 - (d) Lane Number (Camera position/direction)
- 3.13.1.21 The QLS shall be a stand-alone device with its own Uninterrupted Power Supply (one or more UPS units), capable of supplying uninterrupted power supply to the QLS, including cameras, for at least 4 (four) hours. The changeover, if any, between the normal supply of power and the inverter power shall not affect the functionality, continuity or quality of images in any way.
- 3.13.1.22 The Contractor is to take special care to ensure that all components of the QLS are protected against lightning, electrical surges and other irregularities.

SECTION 4. ORT RSS REQUIREMENTS

4.1 FUNCTIONALITY AND REQUIREMENTS

4.1.1 INTRODUCTION

4.1.1.1 The RSS shall provide for a complete and integrated system that functions accurately and to the specified requirements. It shall accurately detect and track each and every vehicle (including motorcycles) passing through a Tolling Point and generate a Transaction Record for each vehicle detected within any lateral position at that point, including vehicles travelling on the left and right shoulder of the Road.

4.1.1.2 In addition, it shall accurately classify each and every vehicle according to the classification scheme for ORT applications as specified in clause 3.1 as well as the Government Gazette, as well as capture supporting images of the specific vehicle which shall include front and rear Vehicle License Number images which the system shall utilise to automatically determine the VLN by means of Optical Character Recognition (OCR).

4.1.1.3 The RSS shall interface with the Back Office System utilising a guaranteed messaging communication protocol that will ensure that each transaction is delivered once, without duplication. In the event of a communication failure, no loss of data will occur.

4.1.2 TECHNICAL SPECIFICATIONS

4.1.2.1 The technical requirements of the Toll System specified within this document as well as the following documents shall be complied with:

- (a) The Standard Specifications for Operations and Maintenance of CTROM Projects: Electronic Toll Collection (ETC) (Volume 2 Book 5);
- (b) SANS 1795-0: Road traffic law enforcement systems – Part 0: General Requirements;
- (c) SANS 1795-5: Road traffic law enforcement systems – Part 5: Data capturing and recording devices for Road traffic law enforcement; and
- (d) Other specified standards including those contained within this specification.

4.1.3 TRAFFIC CAPACITY

4.1.3.1 The RSS, excluding storage requirements, shall cater for traffic up to the maximum capacity of the highway, which shall not be less than 2,500 vehicles per hour per traffic lane.

4.1.4 TECHNICAL SHELTERS AND GANTRY STRUCTURES

4.1.4.1 The Technical Shelter and gantry structures will be provided by means of a nominated sub-contractor. The Technical Shelter will include an air-conditioner, utility power connections, back-up generator and an uninterruptible power supply (UPS). The gantries will be provided to a generic design and will include the necessary sub-surface cable, cable ducts between the Technical Shelter and gantry and the requisite civil works (i.e., access roads, etc). Further details may be obtained within project specifications.

4.1.4.2 The Contractor shall take full responsibility for maintaining the structures and Equipment provided, keeping it secure, fitting Equipment to it, and providing all other materials and/or tasks which will be required to ensure that the Contractor meets the project specifications as specified in the Standard Specifications for Operations and Maintenance of CTROM Projects: General (Volume 2 Book 2a).

4.1.4.3 It shall be the responsibility of the Contractor to ensure the safety of all personnel and motorists in proximity to a Tolling Point during, but not limited to, fitment of Equipment, maintenance activities etc. associated with both the gantry and Technical Shelter structures, and do so in accordance with any and all applicable legislation (see clause 4.2.14 for additional details on installation of RSS Equipment).

4.1.5 TOLL SYSTEM LIGHTING

4.1.5.1 The Contractor shall provide and maintain all lighting required for the ORT Toll System (transaction capturing and maintenance), including lighting required for cameras (excluding security cameras).

4.1.5.2 The median lighting infrastructure shall be supplied as part of a nominated sub-contract.. The power supply to the median lighting shall be supplied from a separate utility supply and will not require emergency power back-up supply.

4.1.5.3 The Tolling Point lighting infrastructure shall be provided as part of a nominated sub-contract. The Tolling Point lighting infrastructure will be supplied with emergency power (when normal power is disrupted) from the back-up generator (located within the Technical Shelter). Under this condition only some parts of the Tolling Point area will be illuminated. Note that this lighting shall also be utilised as general lighting for security (including security cameras) and maintenance purposes.

4.1.5.4 The Contractor shall be responsible for the maintenance of the entire lighting infrastructure which includes Toll System lighting, median lighting, Tolling Point lighting, as well as any additional lighting supplied by the Contractor.

4.1.6 SECURITY AND ANCILLARY SYSTEMS

4.1.6.1 Access Control:

- (a) The Technical Shelters and gantry structures shall be fitted with suitable access control and intrusion detection systems by the Contractor, to help prevent the unauthorised entry into the Technical Shelters and onto the gantries. All such access control systems shall be approved by the Employer's Representative.
- (b) All Equipment placed on the gantry structures shall be secured by means of quick fit brackets and stay wires which will facilitate maintenance activities, however shall have enclosures with a suitable level of access control. This shall mean that Equipment housed within enclosures shall not, without the use of specialist Equipment, be accessible to any Person having gained access to the gantry structure.
- (c) Similarly, all Distribution Boards (DBs) mounted on the gantry structure and in the Technical Shelters shall be adequately protected from unauthorised access, and shall be kept locked at all times. Only authorised maintenance personnel may be granted access to such DBs.
- (d) The Contractor shall provide enclosures for all Equipment located within the Technical Shelter. The enclosures shall be similar to 19" racks with see-through lockable front and rear doors, removable side panels, cable trunking and power outlets. These racks shall be kept locked at all times, and access shall only be granted to authorised personnel.
- (e) In addition to the physical access control measures detailed, the Contractor shall ensure that no unauthorised personnel may gain access to any stored data or Software interfaces at the RSS. This shall be accomplished by means of user authentication using a username and password. Different users shall have different assigned access rights to the system, depending on their authorised level of access. Any failed attempts to access the RSS, as well as any valid log-ins to the system shall be logged, including all changes made during each session.

4.1.6.2 Security Camera System:

- (a) A security camera system shall be provided by the Contractor at each Tolling Point to monitor access to the Technical Shelter, gantry structure, and surrounding area. The system shall utilise one fixed camera for a view of the Technical Shelter as well as one for gantry access, and an additional PTZ camera for the surrounding area. These shall be high definition colour IP cameras of which the live video feeds shall be recorded by a network video recorder (NVR) system, housed at the RSS within the Technical Shelter, once triggered by unauthorised access to either the Technical Shelter or gantry structure.
- (b) The NVR shall have the capability of recording video automatically from four cameras at a time. The NVR shall allow the recorded video to be exported to a DVD disk, viewed on a portable computer (laptop) or viewed at the Back Office System over the primary

communication link. The system shall also allow the Employer or the Employer's Representative to switch to, and watch, either recorded video footage, or a live video stream, in real time, on a computer or laptop from a remote location through a secure network connection. The Contractor shall make allowance for a minimum of five (5) computers on which the required Software shall be installed.

- (c) Cameras used shall have the capability to provide images of sufficient quality during day and night and under all ambient conditions. This includes the capability to handle high glare levels.
- (d) The Contractor shall ensure that the security cameras do not overload the network with video data, and that the security cameras are capable of switching to a lower frame rate if required under network congestion.
- (e) The Contractor shall provide other external parties with access to the cameras and video if so requested by the Employer.
- (f) Access to the security cameras shall be restricted by appropriate means and access shall only be allowed to certain authorised individuals.

4.1.6.3 The Contractor shall fit all Technical Shelters with an adequate and automatic means of fire detection and suppression systems. Any such system shall be approved by the Employer's Representative, with the main aim of early detection and prevention of fires causing damage within the Technical Shelter(s).

4.1.6.4 Any additional security and ancillary support system, including SCADA systems shall be provided at the discretion of the Contractor.

4.1.6.5 The security cameras, access control, SCADA, fire detection and alarm system shall be monitored from a central location, e.g. a Control Room.

4.1.7 **CRITERIA FOR CAPTURING OF DATA**

4.1.7.1 The RSS shall, apart from the requirements within this specification, measure and capture data in accordance with the performance requirements specified within the Standard Specifications for Operations and Maintenance of CTROM Projects: Performance Measurement (Volume 2 Book 6a) and in accordance with the Business Rules as specified within the Standard Specifications for Operations and Maintenance of CTROM Projects: ETC Interoperability – Business Rules (Volume 2 Book 8a). The following rules provide an indication of the minimum requirements:

- (a) The RSS shall capture the Tag Identifier as the primary Identifier;

- (b) The RSS shall capture and store the Vehicle Licence Number images and Scene Image/s of every Tag transaction as specified within 4.1.10. The Contractor shall allow for such a storage capability up to the end of the Contract, in case the Tag reading process could not be certified;
- (c) The RSS shall automatically capture and populate all the Transaction Records with the Vehicle Licence Numbers obtained through the ANPR process where available (if the OCR engine is located at the RSS), which could include the use of a 3rd Identifier;
- (d) The RSS shall automatically capture Scene Images and front and rear Vehicle Licence Number images, even if the Vehicle Licence Number is not present or visible, and forward images to the Back Office System, at least for:
 - i. Vehicles without valid Tags (including lost or stolen Tags, which information shall be obtained from the Validation Lists);
 - ii. Vehicles where the Tag was not successfully read;
 - iii. Vehicles of which the registered Vehicle Licence Numbers (obtained from the Validation Lists) for the specific Tag Identifier do not match the ANPR processed Vehicle Licence Numbers;
 - iv. Vehicles of which the front and rear Vehicle Licence Numbers differ;
 - v. Vehicles where more than one Tag Identifier was determined;
 - vi. Vehicles of which the Registered Vehicle Class (obtained from the Validation Lists) differs from the measured Vehicle Class;
 - vii. Vehicles of Special Interest (VOSI) (obtained from the VOSI List);
 - viii. Vehicles exceeding the legal vehicle height (as measured by the AVC);
 - ix. Vehicles receiving special Discount, such as public transport Discount (obtained from the Validation Lists);
 - x. Free passage vehicles (obtained from the Validation Lists);
 - xi. Exempt Vehicles (obtained from the Validation Lists); and
 - xii. Any vehicle of which the Vehicle Licence Numbers and Scene Images must be captured (obtained from the Validation Lists).
- (e) In addition, the RSS shall automatically capture vehicle details and forward these to the appropriate entity in the case of:
 - i. Vehicles of Special Interest (VOSI): When an Identifier which is on the VOSI list is detected during a transaction, the RSS shall send a high priority message, which

shall include the VLN, location, and time of such an even to the Mobile Police and/or relevant authority in near real-time. Such functionality may be accomplished within the Back Office System provided that the message can be delivered to the Mobile Police and/or relevant authority without delay.

- ii. Vehicles exceeding 4.2 meters in height: When a vehicle is detected that exceeds 4.2 meters in height the RSS shall generate an alarm and forward all the vehicle details, including VLN, location, and time of the event on to the Back Office System.
- iii. Vehicles exceeding 4.8 meters in height: When a vehicle is detected that exceeds 4.8 meters in height, the RSS shall send a high priority message, which shall include the VLN, location, and time of such an even to the Mobile Police and/or relevant authority near real-time. Such functionality may be accomplished within the Back Office System provided that the message can be delivered to the Mobile Police and/or relevant authority without delay.

4.1.8 **VLN AND SCENE IMAGE REQUIREMENTS**

4.1.8.1 Vehicle Licence Number Images

- (a) Vehicle Licence Numbers images may be captured as monochrome images but should be of sufficient image quality and clarity so as to identify the Vehicle Licence Numbers through a manual (performed by a System User) process. The minimum image resolution from these cameras shall be 1280 × 1024 pixels. Images shall at all times comply with the SANS 1795 Standard as specified in clause 4.1.2 and 4.2.12 Images may be compressed, provided that such compression techniques will satisfy the legal requirements.
- (b) Cameras used shall have the capability, and shall be installed in such a manner as to provide images of sufficient quality during day and night and under all ambient lighting conditions. This includes the capability to handle high glare levels during sunrise, sunset, from oncoming traffic at night and wet pavement surfaces.
- (c) Cameras shall also be equipped with adequate protection (such as hoods and waterproof enclosures etc.) from environmental Elements so as to ensure the camera's ability to function in the presence of, but not limited to, rain, sleet, hail, or fog given that there is a level of visibility adequate for reading VLN's manually.
- (d) In the event of a single ANPR camera failure (front or rear), images from both (if applicable) adjacent ANPR cameras (to the camera that has failed) shall be captured, stored (at the RSS), and linked to each specific transaction occurring within that specific traffic lane. Such images shall be available to the Back Office System on request, or transmitted to the Back Office System if the Business Rules so require.

4.1.8.2 Scene Images

- (a) The Contractor shall supply a camera system that can be used to verify the make, model, and type of a vehicle utilising a specific lane at a Tolling Point during a toll transaction. This camera system shall be able to provide colour images during day time when adequate ambient light is available, and monochrome images otherwise. These images shall be used by the Contractor to verify or provide evidence of characteristics such as the Vehicle Class, the presence of the particular vehicle as well as compatibility with the scene (as might be required for the legal process), and other vehicle characteristics for comparison with those captured on eNaTIS. These images shall be captured by the RSS and will be transmitted with the Transaction Record, if so required by the Business Rules. The Scene Image shall include a unique Tolling Point identification number, as well as a code representing the traffic lane in which the transaction took place. Images shall at all times comply with the SANS 1795 Standard as specified in clause 4.1.2 and 4.2.12.
- (b) Cameras shall also be equipped with adequate protection (such as hoods and waterproof enclosures etc.) from environmental Elements so as to ensure the camera's ability to function in the presence of, but not limited to, rain, sleet, hail, or fog given that there is a level of visibility adequate for verifying vehicle characteristics manually.
- (c) In the event of a Scene Camera failure, images from all other Scene cameras at the affected Tolling Point shall be captured, stored (at the RSS), and linked to each specific transaction occurring within such a period. Such images shall be available to the Back Office System on request, or transmitted to the Back Office System if the Business Rules so require.

4.1.9 RSS DATA STORAGE AND BACKUP TRANSFER CAPABILITY

- 4.1.9.1 The RSS is required to store all transaction data and images generated for vehicles passing a Tolling Point (including the Transaction Record, Vehicle Licence Number images, Scene Images and AVC measurements) for a minimum period of ten (10) days. The Contractor shall calculate the above storage requirement based on an average traffic volume of 25,000 vehicles per traffic lane per day of which 30% will require storage. The conditions for capturing and storing images are specified in clause 4.1.8.
- 4.1.9.2 The storage requirement above excludes the Tag transaction image storage requirement, which requires the RSS to store Vehicle Licence Number images and Scene Image/s of every Tag transaction for a minimum period of 3 months. The Contractor shall calculate the storage requirement for Tag transactions based on the highest expected three month traffic volume at the Tolling Point's location and assuming all passages were conducted by means of a Tag. The calculation of available Tag transaction storage shall also include for the effects of average traffic growth over the Contract period." These images must be accessible should any Tag transaction be queried.

- 4.1.9.3 At no stage should any data be discarded before the period stated above has expired. The Contractor shall therefore ensure that adequate storage space is provided. The RSS shall be allowed to overwrite stored transaction data if the storage space is exhausted, on condition that the applicable period above has expired. In the event that the available storage space at a Tolling Point drops below 5% and there is no old data which may be overwritten an alarm condition shall be generated and sent to the Back Office System to request urgent attention.
- 4.1.9.4 In the event of a primary communication link failure between the RSS and the Back Office System, there must be a secondary means of uploading the critical transaction data and Incidents (or alarm conditions), as well as synchronising the RSS time to the Back Office System. This shall be accomplished via a backup communication link (e.g. GPRS or wireless), or any other approved communication medium as specified in clause 2.3.
- 4.1.9.5 The RSS shall also make provision for a facility to physically download data and/or images on Site to a mobile storage medium, for example flash memory, portable hard drives, CD, DVD, etc. and physically transport and upload it to the Back Office System.
- 4.1.9.6 When the primary communication link between the RSS and Back Office System has been restored, the system shall ensure that any un-transmitted data be automatically transmitted to the Back Office System. The system shall not create duplicate transactions of the same Transaction Record or lose any data due to a communication link failure.
- 4.1.10 **DATA SECURITY AND INTEGRITY**
- 4.1.10.1 The RSS shall not have direct access to the internet nor will it have e-mail functionality. If the Contractor requires internet access or e-mail functionality, a separate workstation/s shall be supplied, to ensure that the network security is not compromised. This workstation shall be equipped with an up to date operating system, firewall, anti-virus, anti-spyware Software, and configured to protect itself against internet threats.
- 4.1.10.2 Viruses shall not be introduced into the system when external media are connected to the RSS. The Contractor shall ensure that operating systems and application Software are updated with the latest security updates.
- 4.1.10.3 The RSS shall utilise techniques for protecting data files and their integrity in any database structure or operating system. These shall include controls which will ensure that access to systems, data and programs is restricted to authorized users to safeguard information against unauthorized use, disclosure, modification, damage or loss. Data security shall include protection against unauthorised users gaining access to data storage disks and files. This shall be accomplished by access security individually assigned and allocated on an “as-needed” basis to personnel, allowing or denying access to specific areas of the system depending on job function.

- 4.1.10.4 The Contractor shall ensure the safe keeping of all privileged or confidential information collected and/or stored at the RSS, as per the Electronic Communications and Transactions (ECT) Act.
- 4.1.10.5 All images (Scene and VLN Images) captured by the Toll System shall be protected by appropriate measures, including but not limited to watermarks, encryption, digital signatures etc. in order to assure the security and integrity of image data in accordance with the SANS 1795 Standard.
- 4.1.10.6 All Security Keys stored at a Tolling Point and used for the encryption/digital signing of images, Transaction Records, during a Tag transaction (Authenticators), and information interchange within the RSS and to the Back Office System etc. shall be protected in such a way that any attempt to retrieve such sensitive data will result in the deletion of all such Security Keys. This may be linked to the intrusion detection system or may only occur once an attempt is made to obtain the keys.
- 4.1.10.7 Transaction Records and images stored at a Tolling Point shall be flagged in the event of any attempt to gain access to such data, as specified in clause 4.1.8.1.
- 4.1.10.8 All Transaction Records shall be encrypted and/or digitally signed immediately after generation, in accordance with requirements of the TCH.
- 4.1.10.9 The RSS and Back Office System shall not allow any operator/System User to modify or alter any field in the original Transaction Record. Corrections made to any measured/captured value shall be a separate entry and a clear audit trail shall be available as to whom and why corrections were made.
- 4.1.10.10 All data communicated between components of the Toll System (between the RSS and the Back Office System), shall be encrypted and/or digitally signed; all data transmitted shall have adequate security measures to ensure protection against data modification and/or data privacy as applicable. Encryption shall provide protection against external and to some degree, unauthorized internal access attempts, whereas digital signatures shall provide authentication and data modification protection (when computed over a hash of the data). Details of the proposed scheme shall be submitted to the Employer's Representative for approval.

4.1.11 **DATA EXCHANGE**

- 4.1.11.1 In addition to network and communication requirements specified in clause 2.3, the RSS shall provide the following:
- (a) The RSS shall utilise near real-time data communication with the Back Office System;
 - (b) The RSS controller shall receive the most current Validation Lists from the Back Office System each time it re-connects to the Back Office System (after a primary

communication link failure), and at a prescribed frequency (which shall be configurable) during normal operating conditions;

- (c) Should the primary communication link between the RSS and the Back Office System be interrupted for any reason, the RSS will function without interruption or intervention of any kind by utilizing the most recent Validation List(s); and
- (d) The RSS shall transmit the transaction data and associated images to the Back Office System in near real time, but in any case not later than five (5) minutes from the transaction having occurred when the primary communication network is up and running.

4.1.12 **TRANSACTION RECORD**

The Transaction Record shall comply with all applicable requirements contained within The Standard Specifications for Operations and Maintenance of Toll Projects: Electronic Toll Collection (ETC) (Volume 2 Book 5) as well as any additional criteria required by the TCH.

4.1.13 **TOLL SYSTEM**

- 4.1.13.1 The system shall capture vehicles (including motorcycles) accurately at any lateral position within the Tolling Point measuring area, including the left or right shoulders of the Road.
- 4.1.13.2 The system shall not create more than one Transaction Record for any vehicle passage. If the system is inclined to generate more than one Transaction Record per vehicle passage, such as a vehicle straddling two lanes or a paid transaction and Violation transaction for the same vehicle, then the duplication must be automatically resolved at the RSS, or alternatively, at the Back Office System, before the transaction is forwarded to the TCH.
- 4.1.13.3 The Toll System shall select only one Tag Identifier if more than one Tag is detected within a vehicle. The system shall not assign an additional Tag located within any one vehicle to another vehicle. This functionality may be performed at either the RSS or the Back Office System.
- 4.1.13.4 The Toll System shall provide sufficient redundancy to continue operating when any individual unit(s) or subsystem (such as AVC -, ANPR -, or Tag reading subsystem) of the Toll System fails. The system will continue operating in a failure or degraded operational mode after a critical failure has occurred and will automatically notify the Contractor of such failure modes. No single failure of any kind may affect the operation of another subsystem, even if such a failure is one that renders the affected subsystem inoperable.
- 4.1.13.5 The Toll System shall have adequate redundancy to ensure data reliability in accordance with the specified accuracies for all scenarios, including the case of a break in the Wide Area Network communication.

4.1.13.6 The Contractor shall provide sufficient spare parts, in accordance with the Availability, reliability and performance requirements specified within the Standard Specifications for Operations and Maintenance of CTROM Projects: Performance Measurement (Volume 2 Book 6a), so that the Contractor can repair critical subsystems within the required timeframe.

4.1.14 **RSS CONTROLLER**

4.1.14.1 The RSS controller, as referred to here, is a generic “logical” entity that encompasses all the processing functionality of the RSS. It shall receive raw data from Equipment mounted on the gantry structure and process and combine/frame such data to create a Transaction Record for each vehicle passing the Tolling Point.

4.1.14.2 To the extent possible, the RSS controller shall utilise currently supported “off-the shelf” components and Software (including the operating system and database management system). The technical proposal shall indicate all “off-the-shelf” components and Software.

4.1.14.3 The RSS controller Hardware shall be industrial-grade, rugged, modular, scalable and easily maintained. It shall be equipped with all the necessary cooling and heating elements for continued operation within the required environment.

4.1.14.4 The RSS controller internal memory and disk drive(s) shall support the volume of data and images anticipated in the next ten (10) years including (but not limited to) transaction data, images and Validation Lists.

4.1.14.5 The RSS controller and components shall be capable of processing the initial and projected future volume of vehicles, images and Tags (including anticipated growth in both the transaction volume and size of the Validation Lists) without degradation in performance.

4.1.14.6 The RSS controller Software shall utilise configurable parameters to support basic Business Rule changes without requiring Software changes. These changes shall be configurable at a front end workstation.

4.1.14.7 The RSS controller Software shall allow system operating rules and configurable parameters to be changed while the system is operating, without requiring shutdown or recompilation of the application. Examples of such parameters would be time synchronisation, incorporation of Validation Lists, Business Rule changes, changes in information communicated to and from Tags, changes to the classification scheme parameters, changes in the format of Vehicle Licence Number plates, etc.

4.1.14.8 The RSS controller shall communicate with its peripheral devices utilizing standard networking diagnostics and other automated methods to detect operational status. All failures shall be logged, and alerts and alarms shall be generated for critical conditions or Incidents that require immediate Contractor intervention. Refer to 3.7 for more detail.

4.1.14.9 In the event that the RSS controller, or any part thereof fails, the Tag Reader, Automatic Vehicle Classifier and Vehicle Licence Number capturing shall be capable of operating in stand-alone mode and store data that shall be used to recreate ETC Transactions that would otherwise be lost

4.1.14.10 The RSS controller and all connected peripheral devices (if required), at each Tolling Point, shall be synchronised to a single time source located at the Back Office System. Such a time source shall have a real time accuracy of within 0.1 seconds of the national time standard. Once an RSS sub-system becomes available on the network, it shall synchronise the time before resuming its general function. However, failure to synchronise the time with the time source at the Back Office System shall not render the system ineffective, in which case it shall synchronise to a particular (pre-specified, and configurable) Tolling Point or other approved time source after several failed synchronisation attempts.

4.2 TOLL SYSTEM REQUIREMENTS

4.2.1 TAGS AND TAG INTEROPERABILITY

4.2.1.1 All the Tags to be procured and utilised for this Project shall comply with the provisions of the Standard Specifications for Operations and Maintenance of Toll Projects: Electronic Toll Collection (ETC) (Volume 2 Book 5).

4.2.1.2 Tags will be procured by the TCH on behalf of the Contractor. The TCH will only procure Tags from Pre-qualified Tag suppliers. The Contractor shall distribute the Tags to the Customers. The Contractor will have to inform the TCH, in a timely fashion, of the required quantities.

4.2.1.3 The Toll System must be certified to be interoperable with all Tags in use within South Africa at the time of implementation. Such certification process shall be undertaken by the Employer's Representative once the Contractor has performed his own certification of the system.

4.2.2 TAG READERS

4.2.2.1 The specifications within the Standard Specifications for Operations and Maintenance of Toll Projects: Electronic Toll Collection (ETC) (Volume 2 Book 5), are a minimum requirement for the Tag Readers.

4.2.2.2 The Contractor shall be required to demonstrate that they have integrated their RSS to a compliant Tag Reader and that they can communicate with Tags which comply with the requirements as specified within the Standard Specifications for Operations and Maintenance of Toll Projects: Electronic Toll Collection (ETC) (Volume 2 Book 5).

4.2.2.3 The RSS shall therefore be able to successfully communicate with the Tags from all the prequalified Tag suppliers and all ETC Toll Roads in South Africa. The Contractor shall test, integrate and certify the Tags as follows:

- (a) Up to ten (10) sample Tags from every one of the prequalified Tag suppliers as well as from all the Toll Agencies in South Africa, shall be tested and made to function according to the specifications by the Contractor, first through a validation and certification process undertaken by the Contractor, and then through a certification process witnessed by the Employer's Representative, at any designated test location where the Tag Reader has been installed. Should such witnessed test fail, the Contractor will be required to retest the sample Tags within one month from the initial tests, and shall carry all the retesting costs;
- (b) If the Tags do not function according to the requirements, then the Contractor shall be responsible to rectify the problem and to liaise with the Tag supplier and/or relevant Toll Agency;
- (c) If the Contractor cannot read or communicate with a specific Tag due to a Tag error, then the Contractor shall provide reasons why the Tag could not be read and what solutions can be implemented to correct this. In this case, the Contractor shall still liaise with the Tag supplier and/or relevant Toll Agency in order to find solutions for the problem. The Contractor will not be held responsible for Tags that fail certification due to their non-compliance with the Standard Specification for Operations and Maintenance: Electronic Toll Collection (ETC) (Volume 2 Book 5);
- (d) The Tag testing and certification process witnessed by the Employer's Representative will occur within one (1) month after the sample Tags are made available to the Contractor.

4.2.2.4 In addition to the requirements of the Standard Specification for Operations and Maintenance: Electronic Toll Collection (ETC) (Volume 2 Book 5), the RSS shall have the capability to indicate to the Road User, by means of the Tag, that he/she must contact the Contractor or the Call Centre, when indicated in the Validation Lists. This shall include for the scenario where a Tag low battery is anticipated (based on the expected battery life of the Tag).

4.2.3 TAG READING ACCURACY AND MONITORING

4.2.3.1 The RSS shall maintain a Tag read accuracy, which shall be defined as the number of Tags read successfully out of the total number of Tags mounted on the windscreens of the vehicles which passed the Tolling Point, under all conditions as specified in the table below:

TABLE 4-1: TAG READ ACCURACY

	Description	Accuracy
1	Tag read accuracy (for speeds greater than 0 up to 160km/h)	99.5%

- 4.2.3.2 The RSS shall have the capability to automatically and continuously monitor and report on the overall Tag Reader accuracy and Availability performance, as measured by the RSS. If at any stage an error or degradation in performance is detected, it shall generate an automated alarm for the attention of the maintenance personnel, to ensure the best level of service to the Road User.
- 4.2.3.3 If the system encounters an error during a Tag read/transaction, the system shall not produce inaccurate data. It shall however flag the transaction during which the error occurred to be validated by the Back Office System before transmission to the TCH.
- 4.2.3.4 The system shall be subjected to extensive testing and audits throughout the course of the Project. The Contractor shall conduct his own component-level, integration and Functional Testing before the final certification test with the Employer's Representative, as is specified within the Standard Specifications for Operations and Maintenance of Toll Projects: Electronic Toll Collection (ETC) (Volume 2 Book 5). The Contractor shall be able to demonstrate to the Employer's Representative that the system is capable of achieving the requirements, including the specified accuracies, in accordance with SECTION 10.
- 4.2.3.5 The Contractor shall provide vehicles (representing all classes and including motorcycles) and personnel to continuously drive at varying speeds and driver behaviour through every completed Tolling Point to create the required number of transactions as part of the testing process during the site acceptance testing (SAT), in accordance with SECTION 10. The Contractor shall retest the Tag Reader system with sample Tags every time a new or different Tag Reader and/or Tag Reader controller is utilised. The tests of different subsystems may be combined into one, as long as the different tests or the outcome thereof do not influence another test.
- 4.2.3.6 The Contractor shall be obliged to test the Toll System in the presence of the Employer's Representative, if so requested, should there be Customer complaints about the accuracy of the transactions captured on the TCH or if there are problems with the capturing of Tag information accurately.
- 4.2.3.7 The burden of proof shall be upon the Contractor to adduce and establish conclusively that the Tag communication process meets the accuracy requirements as specified. As part of this process, the Contractor shall develop a comprehensive Tag communication certification procedure to be utilised during testing, which procedure shall be available no later than one month before the start of the accuracy certification.
- 4.2.3.8 Periodic audits shall be performed by the Contractor and shall be made available to the Employer and/or the Employer's Representative. The periodic audits shall include the review of the video captured by the camera audit system as well as the data read from Tags (refer to clause 4.2.13).
- 4.2.3.9 Customer complaints about the system not reading the Tags shall be monitored and investigated immediately and any problems resolved as soon as possible.
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4.2.4 AUTOMATIC VEHICLE CLASSIFIER (AVC) AND SCHEME

4.2.4.1 The RSS shall detect, count, separate, track and classify all vehicles continuously at each Tolling Point, including vehicles on the left and right shoulders, by utilising a gantry mounted Automatic Vehicle Classifier (AVC). The RSS shall associate the correct class with the appropriate vehicle (as a function of accurate vehicle framing) under all traffic conditions including severely congested (stop-and-go) traffic as well as high-speed traffic situations in accordance with the parameters specified in the classification scheme.

4.2.4.2 The AVC shall be able to accurately detect, trigger all appropriate image capturing systems and separate vehicles travelling in close proximity for all driving conditions, vehicle speeds and environmental conditions.

4.2.4.3 The system shall be able to accurately differentiate between the Vehicle Classes as set out in the classification scheme under all conditions.

4.2.4.4 The system shall allow for the three (3) different sources within the Transaction Record. The AVC class shall be the class as measured by the AVC, the Registered Vehicle Class shall be obtained from the Validation Lists and the Actual Class shall be the class determined by the System User at the Back Office System. Only the AVC class and Registered Vehicle Class (obtained from the Validation Lists) shall be populated by the RSS.

4.2.4.5 The AVC System shall have the capability of measuring a vehicle's average speed while travelling through a Tolling Point. If such functionality cannot be accomplished by the AVC System directly, the following parameters may be used to determine an estimate of the vehicle's average speed:

- (a) Trigger times for both front and rear ANPR cameras;
- (b) The length of the vehicle; and
- (c) The separation of the front and rear ANPR trigger points.

The calculation of the average speed from the parameters above may be performed at the RSS or the Back Office System, but must be available at the Back Office System for verification purposes. Any RSS accuracy reports shall be supplemented with a file containing the average speed and/or speed measurement parameters for every transaction recorded as part of the accuracy report. Note that vehicles exceeding the defined speed threshold value for specified RSS accuracies shall not be included in determining system accuracies, but that all such instances shall be verified by the Employer's Representative using the supplied speed measurements and/or parameters.

4.2.4.6 The system shall capture, store (as specified in clause 4.1.10), as well as transmit all measurements taken during a transaction to the Back Office System, which shall include the

measured height, width, length, average speed and/or the speed calculation parameters (as outlined above) of each vehicle.

4.2.4.7 The Contractor may verify the measured AVC class at the Back Office System by comparing Scene Images and measurements from the AVC with the Registered Vehicle Class (RVC) or, in the absence of a Registered Vehicle Class (RVC), may only validate the AVC class.

4.2.4.8 In the event that the AVC Equipment is operating in a degraded mode (i.e. the AVC Equipment self-monitoring or Built in Test (BIT) indicates that the Equipment is not functioning properly), then the RSS shall flag the condition in the Transaction Record.

4.2.4.9 The AVC shall be capable of detecting the following abnormal conditions:

- (a) Vehicles travelling in the Wrong Direction;
- (b) Vehicles travelling on the shoulders (left or right shoulder of the Road);
- (c) Vehicles exceeding the clearance height (refer to clause 3.3.4); and
- (d) Vehicles standing in the measurement area.

4.2.4.10 The system shall have the capability to reconfigure the length, width and height parameters that determine the differentiation characteristics of the Vehicle Classes.

4.2.5 **AVC CLASS DISCREPANCIES**

4.2.5.1 In the case where there is a difference in the Registered Vehicle Class (RVC) obtained from the Validation Lists and the measured AVC class, then the RSS shall capture and utilise the Scene Image of such a vehicle (which clearly identifies the vehicle in question), provide images of the Vehicle Licence Numbers for the ANPR process and provide the supporting measurements taken by the AVC to the Back Office System. The Back Office System User can then add an Actual Class to the transaction, based on the Contractor's assessment of the supporting images, AVC measurements and if available, the typical volumetric details of the type of vehicle.

4.2.5.2 Business Rules, as is specified, will be used to determine which class will be used and the RSS or Back Office System shall provide the facility to use either the Registered Vehicle Class or AVC class as the default class. This default class may differ for the different Vehicle Classes.

4.2.6 **AVC COUNT AND CLASSIFICATION ACCURACY AND MONITORING**

4.2.6.1 The system shall classify vehicles according to the classification scheme with a minimum accuracy as per the table below, or if such accuracies are specified within the Standard Specifications for Operations and Maintenance of CTROM Projects: Performance Measurement (Volume 2 Book 6a), then according to those accuracies:

TABLE 4-2: AVC COUNT AND CLASSIFICATION ACCURACY

	Description	Accuracy
1	Total vehicle count (for speeds greater than 0 up to 160km/h)	99.5%
2	Vehicle Classification for all classes (for speeds greater than 0 up to 160km/h)	98.5%

- 4.2.6.2 The system shall be subjected to extensive testing and audits throughout the course of the Project. The Contractor shall conduct his own component-level, integration and Functional Testing before the final certification test with the Employer's Representative. The Contractor shall be able to demonstrate to the Employer's Representative that the system is capable of achieving the specified accuracies.
- 4.2.6.3 The Contractor shall provide vehicles (representing all classes and including motorcycles) and personnel to continuously drive at varying speeds and driver behaviour through every completed Tolling Point to create the required number of transactions as part of the testing process during the site acceptance testing (SAT), in accordance with SECTION 10. The Contractor shall retest the AVC every time a new or different AVC is utilised. The different tests may be combined into one, as long as the different tests or the outcome thereof do not influence another test.
- 4.2.6.4 Customer complaints about the system not classifying vehicles correctly shall be monitored and investigated immediately and any problems resolved as soon as possible.
- 4.2.6.5 The Contractor shall be obliged to test the Toll System in the presence of the Employer's Representative, if so requested, should there be Customer complaints about the accuracy of the transactions captured on the TCH or if there are problems with the AVC accuracy.
- 4.2.6.6 The burden of proof shall be upon the Contractor to adduce and establish conclusively that the AVCs meet the accuracy requirements as specified. As part of this process, the Contractor shall develop a comprehensive AVC accuracy certification procedure to be utilised during testing, which procedure shall be available no later than one month before the start of the AVC accuracy certification.
- 4.2.6.7 Periodic audits shall be performed by the Contractor and shall be made available to the Employer and/or the Employer's Representative. The periodic audits shall include the review of the video captured by the camera audit system as well as the supporting measurements taken by the AVC (refer to clause 4.2.13).
- 4.2.6.8 If at any time any AVC is found to be defective or measuring outside the accuracy limits specified, the Contractor shall immediately repair or replace such Equipment in accordance with the safety requirements.

4.2.7 AUTOMATIC NUMBER PLATE RECOGNITION (ANPR)

- 4.2.7.1 An ANPR system shall be utilised whereby front and rear Vehicle Licence Numbers images will be captured for each vehicle, in addition to the requirement for Scene Image/s. The ANPR or OCR engine/s can reside in the RSS, within the Back Office System or within both.
- 4.2.7.2 The ANPR system shall utilise advanced image processing techniques to enhance the ANPR process and that will minimise operator intervention. The Vehicle Licence Numbers images collected shall also meet the SANS 1795 Standard as specified in clause 4.2.12.
- 4.2.7.3 The ANPR system shall capture Vehicle Licence Numbers images for every transaction (this includes both valid Tag transactions and any Potential Violation i.e. no valid Tag read for the specific transaction due to whatever reason). The rules specified within clause 4.1.8 will be used to determine which images must be processed, which should be saved, and for what duration.
- 4.2.7.4 If the ANPR or OCR engine resides at the RSS, then the system shall automatically populate the front and rear ANPR processed Vehicle Licence Number field of the Transaction Record (it is envisaged that the association of the Transaction Record will be performed at the RSS) for all the transactions, including the ANPR confidence level.
- 4.2.7.5 The criteria for correctly mounted and designed South African Vehicle License Number (VLN) plates shall be in accordance with South African legislation. Legislation on the construction and use of VLN plates can inter alia be found in the National Road Traffic Act 1996 (Act No. 93 of 1996) and the National Road Traffic Regulations (1999). Applicable specifications include SANS 1116-1 (SABS 1116-1) Parts 1 to 4 (Retro-reflective number plates for motor vehicles).
- 4.2.7.6 A VLN plate is classified as 'readable' for the purposes of performance measurement if it is readable to a human enumerator. The following are examples of plates that would not be classified as readable;
- (a) One or more characters obscured by a towing hitch;
 - (b) One or more characters obscured by dirt or mud;
 - (c) A plate that is damaged such one or more characters cannot be enumerated,
 - (d) A plate that is missing, etc.
- 4.2.7.7 Consequently, cameras that are not in focus, tend to over-expose images, are misaligned, not triggered at the right moment, suffer from headlamp glare or the effects of weather or direct sunlight, not catering for vehicles in between traffic lanes or vehicles driving on shoulders, are not of sufficient quality and resolution, would not be sufficient grounds for a plate to be considered unreadable at the time of performance measurement.

4.2.7.8 The ANPR processes shall have the capability to interpret all existing and future VLN plate alphanumeric character sets and VLN plate formats for vehicles registered in South Africa.

4.2.7.9 The ANPR processes shall have the capability to interpret all existing VLN plate alphanumeric character sets for foreign vehicles, including vehicles registered in Zimbabwe, Swaziland, Mozambique, Botswana, Namibia and Lesotho. The ANPR process shall report a confidence level and whether the plate is national or foreign.

4.2.8 **ANPR ACCURACY AND MONITORING**

4.2.8.1 The ANPR system must facilitate, along with the image quality and OCR Software or OCR engine, an overall accuracy rate as per the table below under all operating conditions, or if such accuracies are specified within the Standard Specifications for Operations and Maintenance of CTROM Projects: Performance Measurement (Volume 2 Book 6a), then according to those accuracies.

4.2.8.2 For the purpose of this specification, the following terms shall be defined as follows:

- (a) “Trigger rate” is the proportion of vehicles (whether or not the Vehicle Licence Number is readable) that pass through the ANPR capture zone that result in a Vehicle Licence Number image i.e. the OCR result may be wrong but at least the Vehicle Licence Number is completely visible and the camera was not triggered falsely.
- (b) “Capture rate” is the proportion of vehicles with a readable Vehicle Licence Number that pass through the ANPR capture zone that result in a usable image i.e. the OCR result may be wrong but at least the Vehicle Licence Number is completely visible, the camera was not triggered falsely and a human operator can read the Vehicle Licence Number.
- (c) “Correct read rate” is the proportion of vehicles that pass through the ANPR capture zone with a readable Vehicle Licence Number that is visible to a human operator and which was interpreted correctly by the OCR engine or ANPR process(es).

4.2.8.3 In addition, the ANPR system must indicate the confidence level for every transaction processed via the OCR engine(s), and if this is below a minimum configurable threshold, then the Toll System shall allow an operator/System User to manually review and enter such a Vehicle Licence Number. Multiple OCR engines may be required to improve OCR confidence and reduce the number of images requiring manual review and/or verification.

TABLE 4-3: VLN SYSTEM ACCURACY

	Description	Accuracy
1	Trigger rate for front cameras and rear cameras (for speeds greater than 0 up to 160km/h)	95%
2	Capture rate for front cameras and rear cameras (for speeds greater than 0 up to 160km/h)	92.5%
3	Correct read rate for front cameras and rear cameras (for speeds greater than 0 up to 160km/h)	90%

- 4.2.8.4 The above accuracies shall be automatically monitored for each camera location where applicable, and whenever the accuracy of any camera drops below the specified accuracy for a certain configurable period of time, maintenance personnel shall be notified immediately and corrective action shall be taken.
- 4.2.8.5 The ANPR system shall be subjected to extensive testing and audits throughout the course of the Project. The Contractor shall conduct his own component-level, integration and Functional Testing before the final certification test with the Employer's Representative. The Contractor shall be able to demonstrate to the Employer's Representative that the system is capable of achieving the specified accuracies.
- 4.2.8.6 The Contractor shall provide vehicles (representing all classes and including motorcycles) and personnel to continuously drive at varying speeds and driver behaviour through every completed Tolling Point to create the required number of transactions as part of the testing process during the site acceptance testing (SAT), in accordance with SECTION 10. The Contractor shall retest the Vehicle Licence Number triggering, capturing and correct read rates every time a new or different camera or OCR engine is utilised. The different tests may be combined into one, as long as the different tests or the outcome thereof do not influence another test.
- 4.2.8.7 The burden of proof shall be upon the Contractor to adduce and establish conclusively that the ANPR process, including triggering, capturing and correct read rates meet the accuracy requirements as specified. As part of this process, the Contractor shall develop a comprehensive ANPR certification procedure to be utilised during testing, which procedure shall be available no later than one month before the start of the ANPR accuracy certification.
- 4.2.8.8 The Contractor shall be obliged to test the Toll System in the presence of the Employer's Representative, if so requested, should there be Customer complaints about the accuracy of the transactions captured on the TCH or if there are problems with the ANPR or VLN capturing accuracy.

4.2.8.9 Periodic audits shall be performed by the Contractor and shall be made available to the Employer and/or the Employer's Representative. The periodic audits shall include the review of the video, captured by the camera audit system, and the supporting output from the ANPR process, together with an analysis of the ANPR system accuracy levels. This process is specified in clause 4.2.13.

4.2.8.10 The ANPR system accuracy shall automatically be measured and reported for all images that are retained in accordance with Business Rules.

4.2.8.11 If at any time any ANPR camera or OCR engine is found to be defective or measuring outside the accuracy limits specified, the Contractor shall immediately repair or replace such Equipment in accordance with the safety requirements.

4.2.9 TRANSACTION FRAMING

All data captured and generated during a transaction (including but not limited to Tag read information, Vehicle Classification data, Scene and Vehicle Licence Number images) shall be combined to accurately identify a single vehicle, also known as framing. This data shall all be linked to a unique and sequential transaction number. The system shall ensure that all the source data can be traced to the originating sub-system and time of measurement.

4.2.10 TRANSACTION FRAMING ACCURACY AND MONITORING

4.2.10.1 The system must correctly frame all the relevant data, including the inputs from the Tag Readers, AVC, Scene and ANPR cameras, accurately to a single vehicle given that all the data to be framed is available, as per the table below, or if such accuracies are specified within the Standard Specifications for Operations and Maintenance of CTROM Projects: Performance Measurement (Volume 2 Book 6a) then according to those accuracies:

TABLE 4-4: FRAMING ACCURACY

	Description	Accuracy
1	Framing accuracy, given that all the data to be framed are available	99.5%

4.2.10.2 The accuracy shall be monitored where applicable (at both the RSS and Back Office System), and whenever the accuracy of the system drops below the specified accuracy for any period, maintenance personnel shall be notified immediately and corrective action shall be taken.

4.2.10.3 The framing process shall be subjected to extensive testing and audits throughout the course of the Project. The Contractor shall conduct his own component-level, integration and Functional Testing before the final certification test with the Employer's Representative. The Contractor shall be able to demonstrate to the Employer's Representative that the system is capable of achieving the specified accuracies.

4.2.10.4 The Contractor shall provide vehicles (representing all classes and including motorcycles) and personnel to continuously drive at varying speeds and driver behaviour through every completed Tolling Point to create the required number of transactions as part of the testing process during the site acceptance testing (SAT), in accordance with SECTION 10. The Contractor shall retest the framing accuracy every time a new or different subsystem is utilised. The different tests may be combined into one, as long as the different tests or the outcome thereof do not influence another test.

4.2.10.5 The burden of proof shall be upon the Contractor to adduce and establish conclusively that the framing accuracy meet the requirements as specified. As part of this process, the Contractor shall develop a comprehensive framing certification procedure to be utilised during testing, which procedure shall be available no later than one month before the start of the accuracy certification.

4.2.10.6 The Contractor shall be obliged to test the Toll System in the presence of the Employer's Representative, if so requested, should there be Customer complaints about the accuracy of the transactions captured on the TCH or if there are problems with the framing accuracy.

4.2.10.7 Periodic audits shall be performed by the Contractor and shall be made available to the Employer and/or the Employer's Representative. The framing accuracy audit shall include the review of the video captured by the camera audit system. This process is specified in clause 4.2.13.

4.2.11 **ACCURACY PERFORMANCE**

4.2.11.1 Failure to meet the performance and accuracy requirements specified within this specification and/or within the Standard Specifications for Operations and Maintenance of CTROM Projects: Performance Measurement (Volume 2 Book 6a), shall allow the Employer's Representative to apply the penalty conditions within the Standard Specifications for Operations and Maintenance of CTROM Projects: Performance Measurement (Volume 2 Book 6a).

4.2.12 **LEGAL AND OTHER REQUIREMENTS**

4.2.12.1 The Contractor shall as part of his system supply, undertake a process to ensure that Vehicle Licence Number and Scene Image capturing is legally compliant and certified, so that the cameras and images taken by the cameras, and subsequently processed using OCR and/or manual methods to determine the Vehicle Licence Number can be successfully utilised in court as per the requirements and approval of the South African Bureau of Standards (specified in the SANS 1795 Standard). As a minimum requirement the information captured shall provide sufficient content and quality that unambiguously associates a specific vehicle to a specific place at a specific date and time. In order to satisfy this and the SANS 1795 Standard, the Contractor shall implement all necessary measures such as the use of encryption to protect images, the need for timely storage of images following capture, watermarking/digital signatures to detect tampering, RSS intrusion detection mechanisms (and system response), RSS access control, image storage media types, image key distribution methods, infrared illumination, etc.

The Contractor shall ensure that the system is calibrated periodically as necessary and that the personnel keep to the set procedures developed by the Contractor, to ensure compliance with the SANS 1795 Standard.

4.2.12.2 The Contractor shall as part of his system supply, get the Tag Readers (including the communication with Tags) legally compliant and certified or type approved with the SANS 1795 Standard and ICASA requirements.

4.2.12.3 The Contractor shall ensure that Tags read by the system, and subsequently processed, can be successfully utilised in court as per the requirements and approval of the South African Bureau of Standards. The Contractor shall further ensure that the system is calibrated and type approved accordingly, and that the personnel keep to the set procedures developed by the Contractor, to ensure compliance with the SANS 1795 Standard and to provide an Evidential Pack meeting the requirements of the prosecuting authority.

4.2.13 **AUDIT CAMERA SYSTEM**

4.2.13.1 The Contractor shall supply a video based camera audit system to verify and analyse the ANPR system, the AVC System and the framing performance levels as well as the number, type and make of vehicles that pass a Tolling Point, and compare this with information obtained from the RSS. The Contractor shall preferably provide front view ANPR cameras with the means to capture live video of all vehicles passing through the ANPR capture zone, which video feed can be utilised and compared with the RSS Transaction Record data.

4.2.13.2 Should it not be possible to provide live video from the front view ANPR cameras, the Contractor shall provide separate cameras with a comparable field of view of the ANPR capture zone as the front view ANPR cameras. These cameras shall have a similar resolution to that of the ANPR cameras (at least 1280x1024 pixels), and capture video at a minimum rate of 25 frames per second which will ensure video quality of the same standard as ANPR images. The Contractor shall provide cameras with a field of view that can be adjusted to suit the ANPR capture zone for a specific Tolling Point. The cameras shall make use of quick release brackets and suitable installation methods. The Contractor shall ensure that the cameras are aligned as intended before the video is recorded.

4.2.13.3 The system shall provide for DVR recorders that can record the live video of all the cameras at that Tolling Point. The DVR recording shall be non-interlaced and shall allow for the playback of the video one field at a time, which field shall be compatible to the ANPR image quality so that an operator can compare the particular field with the ANPR image. It shall be possible to export the video to a DVD disk to be viewed on a portable computer (laptop) and to print an image of the vehicle in question. The system shall be synchronised to the time utilised by the RSS, which time shall be displayed or overlaid onto the video, so that comparisons can be made between the information on the video and the data measured and recorded by the RSS.

4.2.13.4 A minimum two-hour long continuous video stream, containing the required traffic sample size as specified in SECTION 10, shall be captured for each front view camera at that Tolling Point,

which will be utilised by the Contractor, and subsequently verified by the Employer's Representative, to audit the RSS Tolling Point. The audit shall analyse and account for every vehicle in the recorded video stream, and shall indicate at least the following for every vehicle travelling in that lane:

- (a) Whether a vehicle (visible in the video) was not captured by the RSS;
- (b) Whether a Tag was visible to the operator or System User (in the windscreen of the vehicle) for which no Tag read by the RSS;
- (c) Whether a particular vehicle had been issued with a Tag, based on the Vehicle Licence Number;
- (d) Whether the vehicle was detected by the AVC;
- (e) Whether the Vehicle Classification did not match the typical volumetric details of that type of vehicle, which will be available to the Back Office System operator through the TCH interface;
- (f) Whether the Vehicle Licence Number did not match the Vehicle Licence Number processed by the OCR engine (even if the OCR engine is located at the Back Office System);
- (g) Whether the Vehicle Licence Number images were triggered correctly;
- (h) Whether the Vehicle Licence Number images were captured correctly;
- (i) Whether the Vehicle Licence Number images were read correctly by the ANPR engine;
- (j) Whether the Vehicle Licence Number could not be read due to Equipment error;
- (k) Whether the Vehicle Licence Number could not be read, but not due to Equipment error; and
- (l) Whether all the relevant data for the particular vehicle were captured by the RSS.

4.2.13.5 The above audit shall be summarised into a report which will indicate all the required ANPR system triggering, capturing, and correct read rates, for each ANPR camera as well as the ANPR system as a whole, including the results from the Back Office System. This report, together with the log files and source data shall be submitted to the Employer's Representative.

4.2.13.6 The audit report shall also provide the AVC count and classification accuracy, the Tag transaction and the framing accuracy.

4.2.13.7 The Contractor shall, for the duration of the Contract, audit two (2) Tolling Points (as described here) per month, and shall repeat the process once all the Tolling Points have been audited. The Employer/Employer's Representative may request the Contractor to audit different Tolling Points.

4.2.13.8 The audit report, specified in (e) and (f) above, shall provide conclusive evidence to support the respective performance requirements specified in the Standard Specifications for Operations and Maintenance of CTROM Projects: Performance Measurement (Volume 2 Book 6a), and may be used to apply penalty conditions as contained in the Standard Specifications for Operations and Maintenance of CTROM Projects: Performance Measurement (Volume 2 Book 6a) if the required performance figures are not met.

4.2.14 **RSS INSTALLATION**

4.2.14.1 The aspects related to lane closures are specified within clause 2.6.

4.2.14.2 The installation of the RSS will adhere to all applicable road traffic safety requirements as dictated by South African legislation and any additional safety requirements as deemed necessary by the Employer, which will include the following:

- (a) All tools to be utilised and Equipment to be installed onto the gantry shall be secured by stay wires, safety nets and safety mechanisms;
- (b) All personnel shall comply with the procedures and Method Statements that will be developed by the Contractor and approved by the Employer's Representative; and
- (c) Any other requirements specified within clause 2.6.

4.2.15 **VEHICLE SPEED**

4.2.15.1 The system shall suffer no degradation in performance (with regard to requirements within this specification) for vehicle speeds greater than 0 up to 160 km/h.

4.2.16 **INDEPENDANT TRAFFIC AUDIT SYSTEM (ITAS)**

4.2.16.1 The Employer will provide an Independent Traffic Audit System which will be utilised by the Employer's Representative to validate the total traffic through a Tolling Point. The RSS will not be required to interface to ITAS.

4.2.16.2 In addition, the ITAS may be used by the Employer's Representative to determine additional Tolling Points to be audited (in addition to the requirements of clause 4.2.13.7). In the event of the RSS traffic count and ITAS traffic count exceeding a variance of 2%, the Employer's Representative may request that such Tolling Point be audited. The Contractor shall then be obliged to submit such audit to the Employer's Representative within no longer than a week after such request has been made.

4.2.17 **POSSIBLE SYSTEM MODIFICATIONS**

4.2.17.1 The RSS shall be flexible to allow for a 3rd Identifier.

SECTION 5. GENERAL SYSTEM REQUIREMENTS

5.1 VEHICLE CLASSES

5.1.1 GENERAL

- 5.1.1.1 The Vehicle Classification scheme is as published in the Government Gazette.
- 5.1.1.2 Due to the difference in Vehicle Classification Schemes for ORT and Conventional or Hybrid Toll Plaza applications, the TCH System provides a generic Vehicle Classification System that allows the System User or Customer to choose his vehicle from a defined Vehicle List instead of matching his vehicle to a specific Vehicle Class.
- 5.1.1.3 The AVC System shall be able to classify motorcycles as a separate Class.
- 5.1.1.4 In the event of a Heavy Vehicle that can pull a trailer, the Vehicle Class of the Heavy Vehicle must be registered, but it shall be indicated on the system that the Heavy Vehicle can pull a trailer and thus belong to multiple classes.
- 5.1.1.5 The TCH System automatically maps the generic Vehicle Class to the Vehicle Classification of the Contractor.
- 5.1.1.6 The generic Vehicle Class shall appear in the Validation Lists.

5.2 ETC TRANSACTION RECORD COMPLIANCY STATUS

5.2.1 GENERAL

- 5.2.1.1 ETC Transaction compliancy has an impact on the risk to manage and recover the transaction Toll Tariff.
- 5.2.1.2 A Transaction Record can be 'Compliant and Complete', 'Compliant and Incomplete' or 'Non-Compliant'. Payment to the Tolling Agency is guaranteed for a Compliant Transaction Record (complete or incomplete), irrespective whether the toll fee could be recovered or not. The toll fee of both Compliant and Non-Compliant Transaction Records are recoverable or not recoverable. The VPC shall take the risk for unrecoverable Compliant Transaction Records in case of Opt-In Toll Agencies while the Toll Agency or TCH will take the risk for unrecoverable, Non-Compliant Transaction Records.
- 5.2.1.3 A Transaction Record has one of the following compliancy statuses:
 - (a) A Compliant Transaction Record is a Transaction Record for which all the available information has been captured accurately and was successfully encrypted and framed

as required by technical requirements. A Compliant Transaction Record may either be complete or incomplete.

- (b) A Compliant and Complete Transaction Record is a Transaction Record that:
 - i. Has been accurately captured and framed; and
 - ii. Contains the required minimum information and images (if relevant) as specified in clause 3.2.1.5; and
 - iii. Is appropriately encrypted.
- (c) A Compliant and Incomplete Transaction Record is a Transaction Record where some required Transaction Record information is not available, and is not due to any negligence by the Contractor, i.e. where:
 - i. The Identifier(s) could not be determined through Tag read, ANPR process or other means, although the Transaction Record has been accurately captured and framed; and
 - ii. The Transaction Record is accompanied by the required images, e.g. for vehicle discrepancies (as specified in clause 3.2.1.5);
 - iii. The Transaction Record contains the minimum data fields captured (as specified in clause 3.2.1.5); and
 - iv. Is appropriately encrypted.
- (d) A Non-Compliant Transaction Record is a Transaction Record where Transaction Record information is not available due to the Contractor's negligence, i.e.:
 - i. The Identifier number(s) for the Transaction Record could not be determined; and/or
 - ii. The Transaction Records has not been accurately captured and framed; and/or
 - iii. The Transaction Records does not contain the required minimum information and/or relevant images (as specified in clause 3.2.1.5); and/or
 - iv. The Transaction Record is not appropriately encrypted.

5.2.1.4 Requirements for a Compliant Transaction Record:

- (a) Images shall be captured of all vehicle passages for ORT applications. However, only the Transaction Records, with potential financial and operational risk, as defined in clause 5.2.1.14(a) (ORT only) shall be accompanied with the required images.
- (b) For ETC Transactions at Conventional or Hybrid Toll Plazas, images shall be captured according to the VGS requirements as specified in clause 5.2.1.4 (a).

- (c) The requirements for the minimum information in the Transaction Record are specified in clause 3.4.3 and the Standard Specifications for Operations and Maintenance of Toll Projects: Electronic Toll Collection (ETC) (Volume 2 Book 5).

5.2.2 IMAGE REQUIREMENTS FOR AN EVIDENTIAL RECORD (OPT-IN TOLL AGENCIES ONLY)

5.2.2.1 At least three image files are required:

- (a) The image of the rear Vehicle Licence Number;
- (b) Image of the front Vehicle Licence Number; and
- (c) A Scene Image, with a view sufficient to ensure that the vehicle and the location where the image was taken can be identified.

5.2.2.2 The following minimum information shall be stored with an image:

- (a) Transaction Record number;
- (b) Transaction Record date and time;
- (c) Tolling Point where the Transaction Record occurred; and
- (d) Camera ID number of the camera that captured the image.

5.2.2.3 The image files shall comply with the SANS 1795 Standard (South African Standard Specification: Road Traffic Law enforcement systems) specifications and TCSP (Technical Committee for Standards and Specifications) guidelines.

5.2.3 MANUAL CAPTURING OF TRANSACTION RECORD

5.2.3.1 The Toll System shall allow the manual capturing of missing Transaction Record data, as is required for within the Transaction Record.

5.2.3.2 The Toll System shall provide a complete audit trail on all Transaction Records captured including the date and time of capture and the identification of the user who captured the information.

5.3 SYSTEM MONITORING

5.3.1 GENERAL

5.3.1.1 The Back Office System shall supply a status monitoring function, which will provide an accurate status assessment of the Lane / RSS and Back Office System in near real time. The status monitoring function may include digital dashboard Software applications, but shall at least display the traffic per Lane / Tolling Point for a configurable period, e.g. the last rolling hour.

5.3.1.2 Footage of the security camera system may be used to assist the Contractor in monitoring the system performance.

5.3.1.3 During the system design phase, the Contractor shall provide a complete list of items that can be monitored in real time, which shall be submitted for approval to the Employer's Representative.

5.3.2 DATA MAINTENANCE

The system shall allow for a 'system health monitoring' tool whereby the overall system health is monitored. This shall include but not be limited to the monitoring of, applications, processes, databases and back end systems. All anomalies shall be reported. The system shall also allow for a comprehensive reporting structure regarding the system health where repairs can be tracked and/or managed.

5.3.3 VEHICLES OF SPECIAL INTEREST (VOSI)

5.3.3.1 When a vehicle on the Vehicle of Special Interest (VOSI) list is detected, the RSS / Toll Lane Equipment shall send a high priority message, which message shall include the Vehicle Licence Number, location and time of such an event, to the Mobile Police Unit or other Authority approved by the Employer in near real time. The Contractor may provide an alternative solution to implement this functionality within the Back Office System, provided that the message can be delivered to the Toll Collector, the Mobile Police Unit or other Authority approved by the Employer in near real time. The RSS / Toll Lane Equipment shall also capture and forward the relevant Vehicle License Numbers and images of such a vehicle to the Back Office in near real time.

5.3.3.2 The Back Office System shall identify Transaction Records flagged as VOSI Transaction Records. The System User shall be able to view the images of such a vehicle.

5.3.4 VEHICLES EXCEEDING THE LEGAL VEHICLE HEIGHT

5.3.4.1 The RSS / Toll Lane Equipment shall monitor the overall height of vehicles by means of the AVC and shall capture the vehicle details of all vehicles that exceed the maximum height and

which may cause damage to the gantries and/or structures. The RSS / Toll Lane Equipment shall provide an alarm and forward all the vehicle details (all the relevant Identifiers, images and height measurements) to the Back Office System should any vehicle or its trailer/cargo exceed 4.2 metres in height.

5.3.4.2 If a vehicle or its trailer/cargo exceeds 4.8 metres, the RSS / Toll Lane Equipment shall send a high priority message, which message includes the Vehicle Licence Number, location and time of such an event, on to the Toll Collector, the Mobile Police Unit/s, or other Authority approved by the Employer, without any delays. The Contractor may provide an alternative solution to implement this functionality within the Back Office System, provided that the message can be delivered to the relevant authority without delay. The RSS / Toll Lane Equipment shall also capture and forward the relevant Vehicle License Numbers and images of such a vehicle to the Back Office in near real time.

5.3.4.3 The Transaction Record that has to be transferred to the TCH shall be flagged as an abnormal high vehicle Transaction Record to indicate to the TCH System that further action is required, such as to inform the Road User. In a Conventional Toll Lane the Toll Collector will be notified in order to inform the Road User.

5.4 AUDITABILITY

5.4.1 SCOPE

This section covers the system properties necessary to comply with the Employer and the Auditor General's requirements, and deals with system attributes to enable routine and special audits which may be required pursuant to this Contract.

5.4.2 SYSTEM AUDITABILITY

The Toll System shall comply with the industry best practice for auditing and must be auditable.

The following general auditability requirements will apply for Non-ORT Toll Systems:

5.4.2.1 Toll System Auditability

The Contractor shall comply with the following:

- (a) Each and every transaction shall be a uniquely identifiable and traceable unit, stored by the Toll System. This requirement shall include the Tax Invoice information as stated. The same shall also apply to Receipts generated by the Toll System where Tax Invoices are not generated or where Tax Invoices are generated but not allowed to be printed in any Toll Lane and the Receipt printed to serve as proof of passage and handed to the Road User.

- (b) The Transaction Record (or transaction) shall contain all data relating to the passage of a single vehicle through the Lane, inter alia:
 - i. the Lane-id at the relevant Toll Plaza where the transaction occurred;
 - ii. the date and time of the Lane financial transaction for Receipt and VAT Invoice purposes;
 - iii. the date and time when the transaction was concluded by the AVC (AVC/TCC message type 2 data) or abnormally concluded by the TCC under acceptable fault conditions;
 - iv. the Payment Mechanism;
 - v. the Lane transaction sequence number,
 - vi. the Toll charged in the Lane;
 - vii. ETC Tag number or card number and input origin in the case of a Bank Issued Card or Contractor Card transaction;
 - viii. AVC sequence number
 - ix. Toll Collector vehicle classification
 - x. AVC Classification (AVC/TCC message type 2 data)
 - xi. Tax Invoice number if applicable
- (c) The Toll System shall ensure that all data stored by the Back Office, and data supplied to the Employer, the AVC and DCS can be traced back and reconciled to the Lane and AVC transaction data. Each and every vehicle passage over the AVC shall be a uniquely identifiable and traceable unit, stored by the AVC System. The lane (TCC) and AVC transactions shall use the same date and time stamp so that these transactions can be compared exactly in the Back Office System and AVC data streams.
- (d) For reference purposes and data allocation within the system logs as well as the grouping of data in hourly summaries a passage transaction is only concluded once the vehicle has passed over or through the AVC Sensors. Under normal conditions the AVC transaction conclusion time, as recorded in the vehicle data message (AVC/TCC message type ID2) sent to the TCC after the vehicle has passed through or over the AVC Sensors, shall be used to conclude the AVC and TCC transaction.
- (e) The date and time stamp in the AVC/TCC message type ID2 shall be used to sort, group and audit TCC and AVC transactions. Other time stamps may be stored in both the TCC and AVC Transaction Records for auditing purposes. The AVC Transaction Record shall contain all data relating to the passage of a single vehicle passage over the AVC area, inter alia:

- i. the specific Lane-id at the specific Toll Plaza where the transaction occurred;
- ii. the date of the AVC passage transaction;
- iii. the time when the transaction was concluded (AVC/TCC message type 2 data);
- iv. a unique AVC sequence number;
- v. information obtained via the AVC/TCC link, including:
 - 1. the tariff;
 - 2. the Payment Mechanism (received from the TCC);
 - 3. TCC transaction sequence number (received from the TCC);
 - 4. Tax Invoice number if applicable (received from the TCC).
 - 5. Toll Collector ID
- (f) The Back Office System shall incorporate automated verification procedures to verify that all the Toll System peripherals have successfully communicated all the required data elements from one sub-system to the other. Data integrity verification and collating of missing data shall be performed at least at the following intervals:
- (g) The TCC or Back Office System shall verify that all Lane related data, at minimum 1 (one) hour intervals, is transmitted to the Back Office. The hour period shall start at ("00:00") zero minutes and zero seconds and end at ("59:59") fifty nine minutes and fifty nine seconds of each hour. The TCC audit file may be an hour long or less and shall never overlap the above hour boundaries as described above. Each Virtual Toll Plaza (TCC) shall employ such audit record file and transmit it to the Back Office System containing audit references for the Back Office System to use in verifying whether all data have been successfully received and recorded. On maximum hour intervals, these files shall include:
 - i. Lane-ID
 - ii. Start Date of data verified
 - iii. End Date of data verified
 - iv. Start Time of data verified
 - v. End Time of data verified
 - vi. Unique audit file sequence number
 - vii. Start Lane transaction sequence number
 - viii. End Lane transaction sequence number
 - ix. Start VAT Invoice number

- x. End VAT Invoice number
 - xi. Start AVC sequence number
 - xii. End AVC sequence number
 - xiii. Start Lane Incident sequence number
 - xiv. End Lane Incident sequence number
 - xv. Count of VGS triggers generated
 - xvi. TCC Incident count
 - xvii. TCC passage transaction count
- (h) The Back Office System shall incorporate automated verification procedures to validate and verify whether all data from each TCC has been received within 5 minutes of the end of the expected end of the TCC audit file e.g. by 10:05 the Back Office System will have checked to confirm if the TCC audit file and its associated data has been received.
- (i) In the event where data is corrupted, missing or the TCC audit file have not been received, the Back Office System shall automatically request such incomplete data from the relevant TCC in order to update the Back Office System database.
- (j) The Back Office System shall at minimum hourly intervals perform data integrity checks on the data received from each Virtual Toll Plaza. The database shall be interrogated to check whether complete TCC audit files have been received from each TCC and that the relevant associated data records have been recorded by the Back Office System and stored in the database. The results of the data completeness check must be displayed in a user friendly manner that enables the Contractor to effectively establish which Lanes are experiencing data transmission problems.
- (k) At least the following data integrity checks need to be performed by the Back Office System:
- i. The Back Office System shall frequently, at a minimum of once every six hours, verify that the user account balances and other required configuration files, like bank card hotlists, have been successfully transmitted to each Virtual Toll Plaza and as required by the Business Rules. The Back Office System shall on at least a daily basis, not later than 60 (sixty) hours after each calendar day, verify that all data for each calendar day is complete in terms of operational functions and stored in the database. This shall include:
 - TCC audit files and associated data;
 - All VGS transaction verifications have been done and stored on the Back Office System database;

- All the required financial transaction reconciliations and operational functions have been performed/completed (where applicable). These include Collector cash-ups, bank deposits and bank file reconciliation, capturing of all AVC Stand-alone and Manual Mode transaction data, etc.
 - The results of the data completeness check must be displayed in a user friendly manner that enables the Contractor to effectively establish which Lanes are experiencing data transmission problems.
- ii. The Back Office System shall on a monthly basis, not later than 5 (five) days after the last calendar day of the month, perform similar verification functions as those described for the daily verification, but for the entire calendar month. The month-end verification shall also include functionality to lock all data for the previous calendar month in order to eliminate any possibility to tamper or modify Back Office System data after the day when this complete calendar month have been “closed” or “locked”. The results of the data completeness check must be displayed or reported in a user friendly manner that enables the Contractor to effectively establish which Lanes are experiencing data transmission problems
- (l) The ITIS data files transmitted to the Employer shall reflect the data integrity of the data presented in any of these files. The “Validated Complete” identifier shall only be used in these files once the above data verification and completeness checks have been done and the associated results logged in log files.
- (m) All reports submitted to the Employer in electronic or any other format shall reflect the data integrity status of the data or statistics reflected in any such report, based on the integrity checks described above.
- (n) The Toll System shall as least comply with the generally accepted practices for auditing as specified herein.

5.4.3 TOLL SYSTEM AUDITABILITY FOR ORT TOLL SYSTEMS

- 5.4.3.1 Each and every Transaction Record shall be a uniquely identifiable and traceable unit, stored by the Toll System. The Transaction Record shall contain all data relating to the passage of a single vehicle through a Tolling Point/Lane, as set out below.
- 5.4.3.2 The Toll System shall ensure that all data stored on the Back Office System and data supplied to the Employer can be traced back and reconciled to the RSS / Lane Transaction Record data.
- 5.4.3.3 The Transaction Record format and data structure will be available from the TCH Interface document.
- 5.4.3.4 At least the following Transaction Record information shall be captured by the RSS / Toll Lane for ORT Transaction Records:

Table 5-1: ETC Transaction Record Information created by the RSS / Toll lane

Information Required:	
a)	Unique Transaction Record number.
b)	Transaction Record date and time when Transaction Record is concluded.
c)	Unique identifier number of the Toll Agency, as assigned by the Employer.
d)	Unique identifier number of the Tolling Point, as assigned by the Employer.
e)	The identifier number of the Lane as assigned by the Employer in the case of Conventional Toll Plazas.
f)	Tag Reader Used (for ETC Transaction Records only).
g)	Unique Identifier number of ETC Tag, for ETC Transaction Records only.
h)	Classification of the vehicle associated with the Identifier, as available from the Validation Lists.
i)	AVC Equipment used for classification.
j)	Class of vehicle as determined by the AVC. The classification should be in accordance with the Employer classification scheme.
k)	Equipment in Certification Status indicator, as required by the VPC System
l)	VLN Image status indicator, e.g.: <ul style="list-style-type: none"> i. Front image captured ii. Rear image captured iii. Side view captured (Scene) iv. Different front and rear image v. No image captured
m)	Vehicle Licence Number from ANPR, if ANPR is done by the Road Side System. The RSS shall be able to accommodate foreign Vehicle Licence Number plates. Indicate if no number plate is available, e.g. 'No ID'.
n)	ANPR confidence level, if ANPR is done by the Road Side System.
o)	3 rd Identifier Equipment ID number*, for 3 rd Identifier Transaction Record Records only.
p)	3 rd Identifier number*, for 3 rd Identifier Transaction Record Records only.
q)	Validation List(s) used to process the Transaction Record.
r)	Active Tag status on the Validation List(s) used.
s)	VOSI and abnormal high vehicle indicators.

* If required in future

Information Required:	
t)	Relevant image files.
u)	Tag transaction counter
v)	Reserved for future use

5.4.3.5 Requirements for additional information linked to the Transaction Record at Back Office System level:

Table 5-2: Transaction Record Information appended by BO System

Information Required:	
a)	Actual Class of the vehicle as determined by the system or System User. The Actual Class shall either default to the AVC class, or the Registered Vehicle Class, as specified in the Business Rules.
b)	Vehicle Class Discrepancy detected indicator.
c)	Identifier of the System User who determined the Vehicle Class in case of discrepancy.
d)	Tariff Table Identifier number.
e)	Nominal Tariff of the Transaction Record.
f)	Discount types applied by the Toll Agency, if any.
g)	Discount amounts applied by the Toll Agency, if any.
h)	Exempt / free passage Transaction Record indicator.
i)	Net Transaction Record Value charged for the Transaction Record.
j)	Vehicle Licence Number(s) from ANPR, if ANPR is done by the Back Office System. The ORT Back Office System shall be able to accommodate foreign Vehicle Licence Number plates. Indicate if no number plate is available, e.g. 'No ID'.
k)	ANPR Confidence level, if ANPR is done by the Back Office System.
l)	MNPR Vehicle Licence Number, if MNPR was performed.
m)	Identifier of the System User who performed the MNPR, if MNPR was performed.
n)	Vehicle Licence Number from Validation List(s).
o)	Vehicle Licence Number discrepancy detected indicator.
p)	Transaction Record Identifier Type, e.g. ETC, VLN, None.
w)	Initial Transaction Record compliancy indicator (Compliant and Complete, Compliant and Incomplete, Non-Compliant).
x)	Potential unrecoverable Transaction Record / Potential Violation indicator.
q)	Manually Imported Transaction Record indicator.

Information Required:

- | | |
|----|--------------------------------------|
| y) | Retransmitted Transaction indicator. |
|----|--------------------------------------|

5.4.3.6 The Back Office System shall have the capability to store and retrieve information to accommodate:

- (a) TCH and VPC queries, e.g. where an image is not available at the national TCH or VPC (Opt-in Agencies only); and
- (b) User queries on a particular Transaction Record (post event) via a Call Centre, which could not be resolved by the national TCH.

5.4.3.7 Audit trails will be required for all updates or modifications of data in the system.

5.4.4 DATA INTEGRITY VERIFICATION

5.4.4.1 The Toll System shall incorporate automated verification procedures to verify that all the required data elements were successfully communicated from one system to the other. Data integrity verification and request of missing data shall be performed at pre-defined intervals.

5.4.4.2 All reports submitted to the Employer in electronic or any other format shall reflect the data integrity status, e.g. whether the day/month is closed, of the data or statistics reflected in any such report.

5.4.4.3 At least the following data integrity checks need to be performed by the Back Office System:

- (a) The Back Office System shall verify that the relevant Validation and VOSI Lists (where required) were retrieved from the TCH System and transmitted to each Tolling Point/Lane frequently and at intervals as agreed upon. Refer to the Standard Specifications for Operations and Maintenance of CTROM Projects: ETC Interoperability – Business Rules (Volume 2 Book 8a).
- (b) The Back Office System shall verify that processed ETC Transaction Records are available for transfer to the TCH System within a predefined time, as specified in the Standard Specifications for Operations and Maintenance of CTROM Projects: ETC Interoperability – Business Rules (Volume 2 Book 8a).

5.4.5 PROTECTION OF THE TOLL SYSTEMS

5.4.5.1 System security and data privacy policies shall be compiled and implemented to eliminate internal and external security breaches and concurrently provide for the protection of Customer privacy in compliance with acceptable legislation.

5.4.5.2 Privileged or confidential information shall include all information that is:

- (a) Determined by the Employer to be privileged or confidential (such as Bank Issued Card information and other Road User information);
- (b) Of a personal nature about a third party;
- (c) Disclosure of which would violate a Person's right to privacy if disclosed; or
- (d) Declared to be privileged, confidential or secret in terms of Law.

5.4.5.3 Any aspect of the system that relates to bank card transactions or has access to the system's bank card related functionality has to be PCI DSS compliant.

5.4.5.4 The Contractor shall implement all procedures, Equipment and Software, or a combination thereof necessary to ensure that the Toll System is adequately protected against any 3rd party obtaining unauthorised access to any part of the Toll System. This shall include the safeguarding of all data communication lines and dial-up facilities. The Contractor shall ensure that all functions within the Toll System, including those functions of the LAN and functions within the application Software, shall require protection against use by unauthorised Persons.

5.4.5.5 If the Toll System is linked to the Internet or any other public network, sufficient procedures have to be defined and implemented to safeguard the Toll System against Internet threats and ensure confidentiality and non-repudiation of sensitive messages.

5.4.6 **ACCESS CONTROL**

5.4.6.1 Procedures shall be in place to keep authentication and access mechanisms effective (e.g. regular password changes).

5.4.6.2 Access Control shall be based upon the ISO/IEC 17799 (Information security policy) standards.

5.4.6.3 Logical access controls, which ensure that access to systems, data and programs is restricted to authorized users to safeguard information against unauthorized use, disclosure or modification, damage or loss shall be implemented.

5.4.6.4 Unauthorised system users shall not be able to have access to the Toll System.

5.4.6.5 Authorised system users shall typically enter a username and password to sign into the system.

5.4.6.6 The Toll System shall prohibit the use of common System User identifiers and passwords that are not subject to change.

5.4.6.7 The system shall be auditable in terms of System User access to the system.

5.4.7 PROTECTION OF DATA WITHIN THE TOLL SYSTEM

- 5.4.7.1 The Contractor shall utilise techniques for protecting data files and their integrity for any database structure or operating system within the Toll System. This shall include techniques for providing data integrity, encryption, overwrite protection and data security.
- 5.4.7.2 Data security shall include protection against unauthorised users gaining access to data storage disks and files of the Toll System. This shall be accomplished through the use of access security, individually assigned by the Contractor and allocated on an “as-needed” basis to personnel, with access to specific areas of the system provided or denied, depending on job function.
- 5.4.7.3 In case of a security breach to image capturing devices, the applicable Transaction Record shall be flagged in accordance with the certification rules applicable to ORT transactions. For Conventional toll plaza and toll lanes, the VGS shall generate an appropriate incident and record such incident as required.
- 5.4.7.4 All data communicated between components of the Toll system, except the AVC/TCC communication, shall be encrypted; no data or passwords shall be communicated in plain text format. Details of the encryption utilised shall be submitted to the Employer’s Representative for approval. The Contractor shall also keep in place a firewall, virus protection Software and spy ware protection Software (regularly updated) on all relevant parts of the Toll System. The Contractor shall also ensure that operating systems and application Software are updated with the latest security updates.
- 5.4.7.5 Viruses shall not be introduced into the system when external media are connected to the Toll System.
- 5.4.7.6 The Contractor shall ensure the safekeeping of all privileged or confidential information as per the Electronic Communications and Transactions (ECT) Act. Similarly the Contractor shall implement measures to safeguard and only record data elements allowed in terms of all applicable Merchant Agreements and other similar requirements i.e. Master/Visa, Fleet Card Association of South Africa, etc. The Contractor shall refuse a request for access to privileged or confidential information, unless:
- (a) Written approval has been obtained for such disclosure from the Employer;
 - (b) The individual whose rights might be affected, has consented in writing to its disclosure to the requester concerned; or
 - (c) So ordered by law or a South African court.

5.4.8 INDEMNIFICATION AND LIABILITIES

5.4.8.1 The Contractor shall keep the Employer indemnified against any claim of whatsoever nature, which may be instituted by:

- (a) Any 3rd party pursuant to the Contractor's failure to safeguard privileged or confidential information or any other information in the Toll System; or
- (b) Any party, for failure to protect any function within the Toll System against use by unauthorised Persons.

5.4.8.2 The Contractor shall accept all liability with regard to Software products used in the Toll System, including procurement rights, intellectual property rights and copyrights of such products.

5.4.9 PROTECTION OF TRANSMITTED DATA

5.4.9.1 Protected data shall comply with the contractual requirements of the Toll System.

5.4.9.2 Data transfers shall be secured from one sub-system to another to prevent eavesdropping, spoofing, replay and undetected tampering.

5.4.9.3 All security related Hardware and Software shall at all times be protected against tampering to maintain their integrity and against disclosure of secret keys.

5.4.10 AUDITABILITY

5.4.10.1 All data from the Commencement Date of this Contract must be available at all times for audit purposes. On expiration of this Contract, archived data must be made available on request. This data must be exportable to an ODBC compliant database or structured ASCII files. It remains the Contractor's responsibility to ensure that this data is accessible and readable.

5.4.11 AVC SYSTEM QUALITY CONTROL SYSTEM:

5.4.11.1 The Contractor shall introduce a quality control system that will ensure the integrity and accuracy of the AVC data. This procedure shall be submitted to the Employer for approval during the Establishment Period, and shall be updated to comply with the Employer's Requirements before implementation. The Quality system shall comply with ISO 9000 guidelines for a quality system and shall cover the following items:

- (a) Factory acceptance and testing. Procedures shall be drafted and implemented to ensure that each component and the integrated unit complies with the specification;
- (b) Installation. A complete installation procedure including a Site acceptance test;

- (c) An installation compliance test procedure shall be documented and performed to verify that the unit complies with the accessibility and Equipment installation requirements, required accuracy and reliability. The aim shall be to detect any problems with the Hardware, installation and functionality before the Employer's Representative certifies his acceptance of the AVC System. The installation verification process shall include an initial AVC accuracy certification process (see clause 10.2) for all newly installed or upgraded AVCs.
- (d) Maintenance and calibration. A procedure for the calibration and maintenance of the AVC shall be documented;
- (e) AVC accuracy verification: The Contractor shall supply a standard document test procedure/process to establish the accuracy of the AVCs. Details of this shall be supplied during the Establishment Period. This shall include but not be limited to:
 - i. All sensor signal strengths and frequencies per AVC. This includes values associated with the optimum alignment of optical sensors (if installed);
 - ii. Standard readings for the detection and classification of standard Vehicles;
 - iii. Jigs to verify the accuracy of installation and orientation of detectors. This shall include:
 - 1. Height measurement (if applicable);
 - 2. Width and spacing
 - 3. Angle of sensor placement;
- (f) Signal strength with standard impact if applicable (weight sensors);
- (g) AVC System access control. The Contractor shall introduce physical restrictions and procedures to control the access to the AVC System, including:
 - i. Physical access to the;
 - 1. AVC box: Install high security lock and implement key control procedure;
 - 2. Data Concentrator System (DCS): Place in control access area and implement access control to the DCS;
 - 3. AVC/TCC interface: Serial cable to be placed inside galvanised conduits (as specified elsewhere);
 - 4. Physical interface between AVC computer and AVC Sensors and other detectors secured as specified elsewhere;
 - 5. Physical interface between AVC connectors and the DCS including the power supply to any network hubs on the above interface. Network hubs to be installed in lockable cabinets and key control procedures implemented;

6. Power supply to the AVC System: Plaza UPS and UPS distribution boxes to be securely locked and key control procedures implemented. The AVC shall be supplied directly from a dedicated circuit breaker in the closest or most appropriate plaza UPS sub-distribution box and not via a circuit breaker inside the TCC box;
 7. DCS and the Employer's interface: Place in control access area and implement access control to the DCS and ITIS interface;
- (h) System access control levels shall be introduced that limit the control to the AVC System:
- (i) AVC System administrator access will be granted to and controlled by the Employer's Representative. System administrator functionality include data manipulation, Software updating, system updates;
- i. System configuration access – Configuring/updating the system settings and access;
 - ii. Calibration;
 - iii. Data maintenance – backup, archive, delete and re-store activities will be performed via a well defined User interface that will ensure that:
 1. Data is backed-up, archived and communicated to the Employer before allowing deleting of data;
 2. Removal of data from AVC level once it is backed-up, archived and communicated to the Employer's interface from the data concentrator PC and backed up on the system;
 3. Data maintenance shall at no time disable the AVC System functionality;
- (j) Fault reporting and fault response procedures to ensure minimum AVC Downtime. The following Downtime and Availability criteria shall be met by the Contractor:
- i. Downtime related to AVC Critical Error mode: No AVC shall remain in the critical error mode for more than 4 hours, or the value defined in the Project Document (Volume 3), per event.
 - ii. Downtime related to AVC Serious Error mode: No AVC shall remain in the serious error mode for more than 24 hours, or the value defined in the Project Document (Volume 3), per event.
 - iii. Availability per AVC calculated as a 3 month average shall be better than 98%.
 - iv. The Contractor shall apply to the Employer's Representative for approval for planned AVC Downtime due to maintenance which will exceed the above periods.

- v. Downtime due to loop failure or other failures which will exceed the above periods shall not attract any penalties if the AVC Downtime was pre-approved by the Employer's Representative.

5.4.12 **AVC SYSTEM AUDITABILITY:**

- 5.4.12.1 The AVC System shall consist of various AVCs installed in the Lanes as indicated and the Data Concentrator System (DCS) that will automatically collect, store, compress data and also transmit data to the Employer.
- 5.4.12.2 The DCS shall monitor the communications status of the AVCs. The Back Office System shall monitor the communication status of the TCCs and the AVCs (via the TCCs). If it is confirmed that the AVC communications is not functional, the video grabbing system shall be triggered to continuously capture and store images, at maximum 5 second intervals, in the appropriate direction until the AVC communications is restored.
- 5.4.12.3 The AVC System is a critical component of the Toll System and Contractor's fraud control. Therefore the system shall comply with strict quality control and auditability requirements.
- 5.4.12.4 The AVC System shall comply with the following auditability criteria:
 - (a) Each Transaction Recorded by the system shall be time-stamped and uniquely and sequentially numbered. The time stamp shall be the time when the AVC concluded the classification of the AVC passage transaction (AVC/TCC message type 2 data);
 - (b) All status messages shall be uniquely linked to the Toll transaction in progress. Each status message shall be uniquely and sequentially numbered;
 - (c) DCS hourly summaries shall indicate the range of transaction and status messages contained in the hourly summary;
 - (d) No changes to source data shall be possible on the AVC System without the Employer's Representatives approval.
 - (e) All AVC transactions shall be grouped into hourly summaries (for auditing and ITIS) based on AVC transaction conclusion time. The same conclusion time shall be used to conclude normal Lane transactions (AVC/TCC message type 2 data). AVC and Lane transactions shall be auditable and have the same conclusion time and grouped into the same hour summaries for the same passage transaction. Only under abnormal conditions shall the Lane and AVC have different conclusion times. AVC/TCC communications failure shall be such abnormal condition. The AVC shall build an hourly summary file (audit files) and transmit it to the DCS at the end of each hour. The file shall contain the start and end sequence numbers for transactions and Incidents, as well as audit counts of the individual traffic transactions and AVC incident transactions per hour, and audit counts per Vehicle Class. Each AVC hourly audit file shall be uniquely and sequentially numbered. The DCS shall use the AVC hourly audit file and the

individual transaction and Incident files to determine if any data is missing. The AVC data missing Incident will be generated if the DCS did not receive an AVC hourly audit file from an AVC.

5.4.13 **REPORTING**

- 5.4.13.1 The Toll System shall ensure that a breach in security are logged, reported and appropriately escalated on a regular basis to identify and resolve Incidents involving unauthorized activity.

5.4.14 **CONFIGURATION CONTROL**

- 5.4.14.1 Controls and systems (similar to the Asset Management System: item 3.4.17 of this section) shall be implemented that identify and record the revision / version history and current status of all System Software, Hardware and documentation and their physical location, and a regular verification programme which confirms their existence to account for all Software, prevent unauthorized alterations, verify physical existence and provide a basis for sound change management.

- 5.4.14.2 The Toll System shall provide the functionality and visibility to enable the Contractor to implement configuration and Software version control.

- 5.4.14.3 The system shall include an audit trail to indicate the origin of configuration modifications including the user, system level, date and time; to download the tables to the lanes; and to record the transaction history of all actions/movements regarding the system configuration tables.

5.4.15 **CORRECTIONS**

- 5.4.15.1 The system shall allow the user to verify and update or correct user (operational) input in a controlled and auditable manner.

- 5.4.15.2 The system shall record all corrections and/or changes to the data. A comprehensive audit trail shall be implemented to log such events to enable adequate control and audit functions on the original data and the changed/corrected data.

5.4.16 **ALLOCATION OF RESPONSIBILITY**

- 5.4.16.1 The system shall allocate and log function actions to the user responsible for performing the actions to allow the transfer of responsibility as required by the operations.

5.4.17 **ASSET MANAGEMENT SYSTEM**

- 5.4.17.1 The Contractor shall supply and maintain an Equipment record and stock control system.

5.4.17.2 During the course of the Contract the Equipment record and stock control system shall be used to track Equipment movement and manage minimum spare levels. The output of this system shall be used for control and audit purposes and at the end of the Contract, for the handover of the Equipment to the Next Contractor. The system shall:

- (a) Be computerised. Include all the functionality of an off-the-shelf stock and asset management control system;
- (b) Shall be updated on at least a weekly basis;
- (c) Track the location of all major units and major sub-assemblies;
- (d) Keep record of the serial numbers of major units and major sub-assemblies;
- (e) Be able to provide printouts of the above to aid in Asset management; and
- (f) Allow the audit of Assets including the replacements of Assets.

5.4.17.3 The Contractor shall implement and maintain an Asset Management System for the capturing, control and tracking of Assets in an electronic database as discussed in Standard Specifications for Operations and Maintenance of CTROM Projects: General (Volume 2 Book 2a). The Asset Management System shall include a fully integrated Equipment Record System (ERS) for the management of Toll System Equipment components and spares.

5.5 GENERAL REPORTING REQUIREMENTS

5.5.1 GENERAL

5.5.1.1 The reporting system shall be efficient, flexible and configurable and consistent with the overall system's operating environment. It shall support a wide spectrum of System User configuration parameters to allow for managed reporting, ad-hoc queries and predefined exception condition reporting.

5.5.1.2 The reporting system shall supply the Contractor and system users with the relevant information to make informed decisions, monitor operations and verify that specific requirements are addressed on time.

5.5.1.3 All reports supplied to the Employer will be according to calendar days. The reports and their applicable file formats shall be agreed upon between the Contractor and the Employer.

5.5.1.4 It shall be possible to export the contents of the reports to multiple formats including, but not limited to, Excel, PDF and XML.

5.5.1.5 The Toll System shall generate all reports to enable accurate monitoring and measurement of the Service Levels and requirements specified in the Standard Specifications for Operations and Maintenance of CTROM Projects: Performance Measurement (Volume 2, Book 6a).

5.5.1.6 The Toll System shall provide appropriate reports according to the information requirements specified in the Standard Specifications for Operations and Maintenance of CTROM Projects: General (Volume 2, Book 2a).

5.5.1.7 The Back Office System shall be able to provide reports on all the data received from every Toll Plaza.

5.5.1.8 The Back Office System shall provide adequate reporting to validate and reconcile the data transmitted from a Toll Plaza to the Back Office System.

5.6 DATA RETENTION

5.6.1 DATA STORAGE

5.6.1.1 It is good practice that all data should be retained for a minimum of hundred and eighty (180) days to enable the Contractor to perform reconciliation, reporting and auditing functions.

5.6.2 CONVENTIONAL AND HYBRID TOLL PLAZA SYSTEM STORAGE AND STABILITY MONITORING

5.6.2.1 All components of the Toll System shall individually be able to store the data generated by it as well as data transferred to it from a separate subsystem. These facilities shall allow for the following:

- (a) Auto archiving of data to a higher level or locally if the higher level is not available;
- (b) Monitoring and reporting on storage space Availability;
- (c) Management of an automatic deletion process and report. Data shall not be deleted until such time as it is confirmed to properly archived;
- (d) Provision of a system time synchronisation facility and status report;
- (e) Provision of a lane watchdog facility and auto start-up after “hang-up” conditions. These occurrences shall be logged in the relevant log file to allow trending and monitoring to resolve recurring problems: and
- (f) Provision for receiving and validating of data from subsystem and backing up and restoration of data.

5.6.3 BACK-UP, RECOVERY AND DATA DELETION

- 5.6.3.1 The Back Office System shall have a proper archive, back-up and restore strategy. The configuration of the systems shall include back-up Equipment such as a high capacity tape or disk drive system. Back-up, archive, delete and restore activities shall be performed via a well-defined System User interface.
- 5.6.3.2 The data shall be backed up on a daily, weekly and monthly basis. The back-up storage media must be stored both on-site and offsite in a secure (locked) fire and damp proof container.
- 5.6.3.3 The systems shall have additional capacity to cater for archiving without impacting on the normal processing speed and storage space.
- 5.6.3.4 The systems shall have a level of security adequate to protect the back-up Resources from unauthorized access, theft or damage.
- 5.6.3.5 The last twelve months of back-up data must be available at all times, unless otherwise specified.
- 5.6.3.6 The archived data shall be stored in such format that it could be successfully restored for auditing purposes. Archived data shall be available within a predefined time after the request. Refer to the Standard Specifications for Operations & Maintenance of CTROM Projects: ETC Interoperability – Business Rules (Volume 2 Book 8a).
- 5.6.3.7 A platform shall be supplied on which the system can be restored for audit and query purposes. This platform shall provide the Contractor with a mechanism to validate backup integrity on a monthly basis.
- 5.6.3.8 Data shall be deleted from time to time. However, data shall be retained long term when required by legal statute. The system shall not allow data to be deleted before the data are summarized, archived and/or backed-up.
- 5.6.3.9 All data from the Commencement Date of this Contract shall be available for auditing purposes in accordance with contractual requirements. On Expiration of this Contract, archived data shall be made available on request. This data shall be exportable to an ODBC compliant database or structured ASCII files. It remains the Contractor's responsibility to ensure that these data are accessible and readable.

5.7 MAINTENANCE AND SUPPORT REQUIREMENTS

5.7.1 OVERVIEW

5.7.1.1 The Contractor shall maintain all systems to surpass the minimum requirements of this Contract. The Contractor shall replace obsolete Equipment and parts before the end of its life cycle as required by this agreement.

5.7.1.2 The operations, maintenance and support of the Toll System shall be performed in accordance with the requirements of the Standard Specifications for Operations and Maintenance of CTROM Projects: General (Volume 2 Book 2a).

5.7.2 SUPPORT REQUIREMENTS

5.7.2.1 The system supplier should provide an electronic internal support Help Desk system. As a minimum requirement the support Help Desk must typically be able to:

- (a) Enable the Contractor to log internal requests that needs to be attended to;
- (b) Link the request to a fault category, e.g. 'Contractor Error', 'Latent Defect' etc;
- (c) Link the request to the sub-system in which error occurred, e.g. Accounts or Reporting module etc;
- (d) Apply a criticality rating that corresponds to a performance requirement, e.g. Category A (Needs to be fixed within 2 hours) or Category B (Needs to be fixed within 8 hours) etc;
- (e) Keep record if the Person who logged the request;
- (f) Keep record of the Person who attended to the request;
- (g) Log the date and time the request was received; and
- (h) Log the date and time the requests was resolved.

5.7.2.2 The Help Desk system must also provide detailed reports that can be used for performance monitoring purposes. The system shall allow for, but not be limited to the generation of the following reports:

- (a) Fault summary (by date, by Equipment type)
- (b) Mean time between failure (MTBF)
- (c) Meant time to Repair (MTTR)
- (d) Availability

5.7.3 SPARES CONTROL

- 5.7.3.1 The system shall provide the functionality to control spares by recording and tracking the use of the spares and reporting on the low stock levels.
- 5.7.3.2 The output of this system shall be used at the end of the Contract, for the hand-back of the Equipment and spares. The system shall:
- (a) Track the location of all major units and major sub-assemblies;
 - (b) Keep record of the serial numbers of major units and major sub-assemblies;
 - (c) Keep record of all lane Equipment and support requests.
 - (d) Be capable of sending automated alerts via SMS and/or email of faults logged on the system to the maintenance personnel.
 - (e) Be able to provide reports to aid in Asset management and audits.

5.7.4 RSS / TOLL COLLECTION LANE EQUIPMENT MAINTENANCE AND TERMINAL

- 5.7.4.1 The RSS / Toll Collection Lane Equipment shall provide, at least, the following functionality:
- 5.7.4.2 The system shall perform self-diagnostics and shall utilise built in tests to generate automated alarms for Incidents whenever a critical error is detected, including but not limited to, any Tag Reader, AVC sensor, ANPR camera, Scene Camera and any other controller failures. All such faults or errors shall be reported to the maintenance personnel without delay.
- 5.7.4.3 The system shall include diagnostic utilities that allow maintenance personnel to activate the devices and subsystems in order to evaluate their status through built in tests (BIT), either through remote diagnostic devices or through the maintenance terminal. Access to the diagnostic utilities shall be limited to authorised personnel using a secure access capability.
- 5.7.4.4 The system shall include a maintenance terminal that will provide access to the system and which can be used to monitor the application and the execution thereof.
- 5.7.4.5 All Equipment (intelligent peripheral devices) shall utilise built in tests to determine the device status or the reason for any error or fault that might have occurred.
- 5.7.4.6 All Equipment shall be regularly tested, cleaned and calibrated by the Contractor to ensure accurate and correct operation.
- 5.7.4.7 The Contractor shall keep record of when maintenance is done and shall ensure that all the cameras are maintained, cleaned and type approved periodically in accordance with the SANS 1795 Standard.

5.7.4.8 The maintenance of Equipment on gantries shall typically be done without requiring lane closures, but if lane closures are required, approval shall be obtained from the Employer.

5.7.4.9 The system shall record and monitor, inter alia, the following:

- (a) Controller restarts or reboots;
- (b) Software versions;
- (c) Tag Reader failures;
- (d) ANPR camera failures;
- (e) Scene Camera failures;
- (f) Failures of any other controller;
- (g) Back Office System and Toll Collection Lane Equipment / RSS communication failures;
- (h) Transaction Record transmission failures;
- (i) Equipment performance degradation;
- (j) Equipment failures (graded into severity or impact level);
- (k) Intrusion attempts and security breaches;
- (l) Technical Shelter, toll booth and/or toll enclosure door openings;
- (m) Gantry structure, gate, manhole or trap door openings;
- (n) Power failures; and
- (o) UPS and backup generator failures.

5.8 DATA STRUCTURES – CONVENTIONAL/HYBRID TOLL PLAZAS

The Toll System, including all sub-systems and peripherals shall be operational on a continuous basis for 24 hours a day, 7 days a week. The system shall allow operational management and control capability of staff members employed/contracted by the Contractor. The Toll System shall allow for operational shifts to be configured so that data for a shift shall be grouped together to correspond with the responsibility of the System User.

5.8.1 SUNDRY TRANSACTIONS AT TOLL PLAZA

- 5.8.1.1 All Sundry Payments, e.g. collector debts, account recharges or top-up, fines/penalties, excess charges, etc., shall be recorded on the Toll System.
- 5.8.1.2 Sundry Payments at the Toll Plaza excludes Top-Ups of ETC Accounts.
- 5.8.1.3 It shall be possible to switch to a Sundry Payment screen on the lane TCT to receive money other than toll transaction money.
- 5.8.1.4 Money received shall be included in the cashup for the collector but shall be consolidated separately as a Sundry Payment
- 5.8.1.5 The following data shall be displayed for the Lane Sundry Payments:
- (a) Plaza ID
 - (b) Lane ID e.g. ME01
 - (c) Lane Sundry Payment Sequence Number
 - (d) Date and Time when the lane sundry payment was concluded
 - (e) Collector User ID
 - (f) Sundry Payment amount
 - (g) Amount tendered

5.9 PAYMENT MECHANISMS AND SETTLEMENT OPTIONS – CONVENTIONAL/HYBRID TOLL PLAZA

The method of payment registered on the Lane System will have a “one to many” relationship with regards to the settlement options available to pay for the transaction and the identifying mechanism used in the lane.

5.9.1 PAYMENT MECHANISM (LANE PAYMENT METHOD IDENTIFICATION)

5.9.1.1 Method of Payment

- (a) As a minimum, the Toll System shall accept the Methods of Payment as stated in the Standard Specification for Operations and Maintenance of CTROM Projects: General (Volume 2 Book 2a).

- (b) The use of Smart Cards for pre-paid applications is the prerogative of the Contractor, provided that it is in accordance with ISO 14443A and B and Mifare.
- (c) The implementation of ETC shall be in accordance with that specified in the Contract.

5.9.1.2 Validation

- (a) The Contractor shall take full responsibility for the validation of all card and ETC Transactions.
- (b) All Bank Issued Cards, Smart Cards, Bank Debit Cards, Operator Cards or any other Payment Mechanism shall be checked against the latest bank or card merchant hotlist (if applicable) as issued by the bank or card merchant and in accordance with the bank or card merchant agreement.

5.9.1.3 Magnetically encoded cards complying with ISO

- (a) Card validation shall be carried out according to ISO7811, ISO7812 and ISO7813 and shall include inter alia: validating the issuer number (1st 6 digits), Expiry Date and Luhn code, card number length (16 to 19 digits), anti-pass-back as well as the service code or any other validation method as specified by the bank or card merchant.
- (b) A valid issuers list shall be obtained from the bank or card merchant. The issuer number shall be used to clearly distinguish cards for acceptance and bank or card merchant allocation purposes.
- (c) If an ISO card issuer number is not available for a route the Contractor shall apply for an ISO card issuer number in the name of the Employer for the specific route.

5.9.1.4 Magnetically encoded Cards not complying with ISO

Magnetically encoded Cards not complying with ISO shall be validated according to the rules specified by the card issuers, which must make the card clearly distinguishable from other standard ISO cards.

5.9.1.5 ETC Tags

Validation of ETC Tags shall be in accordance with the Standard Specification for Operations and Maintenance of CTROM Projects: Electronic Toll Collection (ETC) (Volume 2 Book 5).

5.9.1.6 Bank Debit Cards

Validation shall be in accordance with the general card validation requirements specified in clause 3.4.5.3.

5.9.1.7 The payment mechanism refers to any device that can be used to identify an account holder or a valid payment method.

5.9.1.8 Pre-Payment

It shall be possible to register an electronic identification mechanism on the system as Identifier of a registered Pre-Paid Account.

- (a) Registered ISO Bank Card;
- (b) Registered ISO magnetic stripe off-card Balance (Issued by the Contractor);
- (c) Registered ETC off-card Balance Tag (Issued by the Transaction Clearing House);
- (d) Other registered Operator's Payment Mechanism (Issued by the Contractor);
- (e) Registered Smart Card on-card Balance (Touch and Go - Bank and Contractor issued);
and
- (f) Registered Smart Card off-card Balance (Touch and Go - Bank and Contractor issued).

5.9.1.9 Post-Payment

It shall be possible to register any electronic identification mechanism on the system as system Identifier to a registered Post-Paid Account.

- (a) Unregistered ISO Bank Card (Issued by Banking institution);
- (b) Registered ISO Bank Card (Issued by Banking institution);
- (c) Registered ISO Magnetic Stripe off-card Balance (Issued by the Contractor);
- (d) Registered ETC off-card Balance Tag (Issued by the Transaction Clearing House);
- (e) Other registered Operator's Payment Mechanism (Issued by the Contractor).
- (f) Registered Smart Card on-card Balance (Touch and Go - Bank and Contractor issued)
and
- (g) Registered Smart Card off-card Balance (Touch and Go - Bank and Contractor issued)

5.9.1.10 Non-Payment

The system shall generate a transaction and an incident record in the lane to assist the Toll Collector in recording the Non-Payment event.

(a) Exempt Voucher

The system shall be able to recognise a registered Exempt account holder or allow the Toll Collector to allocate a transaction to the Exempt method of payment and shall provide a function to control these transactions, e.g. transaction needs to be updated with a voucher number and the system needs to validate the voucher number.

(b) Free Passage Voucher

The system shall be able to recognise a registered free passage account holder or allow the Toll Collector to allocate a transaction to the Free Passage method of payment and shall provide a function to control these transactions, e.g. transaction needs to be updated with a voucher number and the system needs to validate the voucher number.

(c) Operator's Payment Mechanism

It shall be possible to register any electronic identification mechanism (issued by the Contractor) on the system as system Identifier to a registered Non-payment account.

(d) ETC off-card Balance Tag - (Issued by Transaction Clearing House)

It shall be possible to register any electronic identification mechanism on the system as system Identifier to a registered Non-payment account.

5.9.1.11 No-Payment

The system shall provide a function to control No-Payment transactions. The system shall provide a function to link two No-Payment transactions processed for the same vehicle and will include the verification of the validity of the event. The system shall force the conversion of an invalid No-Payment to a Violation transaction. The system shall generate a transaction and an incident record in the lane to assist the Toll Collector in recording the No-Payment event.

5.9.1.12 Lane Violation

The system shall provide a function to control Violation transactions. The system shall provide a function to allow the identification and processing of a Violation transaction to a Paid Violation, Technical Violation or Road user error. The system shall add the Revenue for a paid Violation to the Toll Collector's cash expected. The system shall provide a function to control and follow-up on actual run-through Violations. The system shall generate a transaction and an incident record in the lane to assist the Toll Collector in recording the Violation event.

5.9.2 **ISSUERS OF PAYMENT MECHANISMS**

5.9.2.1 Payment mechanisms are issued by different issuing authorities including banks, the Transaction Clearing House and the Contractor. The system shall provide a function to

configure the linking of the payment mechanism to a payment mechanism issuer. This link will be used during processing of the transactions to determine where the transaction should be sent for further processing and settlement.

5.9.3 SETTLEMENT OPTIONS

5.9.3.1 The system shall at least provide for the following settlement options.

- (a) Cash;
- (b) ISO Bank Credit Card;
- (c) ISO Bank Debit Card;
- (d) ISO Bank Fleet Card;
- (e) Bank Debit Order; and
- (f) Internet Payment.

5.9.4 SUNDRY PAYMENTS

5.9.4.1 The additional payments registered on the system via manual input (at lane or plaza level) or via an interface to the National Payment system.

5.9.4.2 The system shall allow the classification of sundry payments into different types. The number of sundry Payment Types shall be unlimited.

5.9.4.3 The system shall allow for the type of sundry payments to be configurable.

5.9.4.4 The system shall include a VAT indicator for every sundry payment transaction to indicate whether VAT is or is not applicable on the transaction.

5.9.4.5 Examples of types of sundry payments are listed below:

- (a) Payment of Toll Collector debt;
- (b) Payment of a Pre-Paid Account deposit on an account;
- (c) Settlement on a Post-Paid Account;
- (d) Account payments such as administration fee; and
- (e) Payment received from a Violator.

SECTION 6. BACK OFFICE SYSTEM REQUIREMENTS

6.1 OVERVIEW

6.1.1 GENERAL

6.1.1.1 In this section the Back Office System requirements for both Open Road Tolling and Conventional Plazas are specified.

6.1.2 ROUTE BACK OFFICE

6.1.2.1 Transaction Record management is one of the primary functions of the Road Side and Back Office Systems. The Back Office System has to verify the Transaction Records received from the Road Side System (RSS) against the Validation List(s).

6.1.2.2 Vehicle Licence Numbers have to be identified with the aid of ANPR and MNPR functionality where applicable. Discrepancies shall be resolved. Transaction Toll Tariffs and route specific Discounts shall be determined and applied to the Transaction Record before the Transaction Records are sent to the TCH System.

6.1.2.3 In addition, the Back Office shall be responsible for the monitoring of and reporting on the Road Side and Back Office System.

6.1.3 BACK OFFICE FOR CONVENTIONAL AND HYBRID TOLL PLAZAS

6.1.3.1 The purpose of the Back Office System at Conventional Toll Plazas is to:

- (a) Receive data from all the lanes, validate data to ensure correctness and completeness, and provide system tools to the plaza supervisory personnel to assist with the efficient management of the data and the plaza.
- (b) Allow manual input of additional data required for accurate transaction processing, including adding an Actual Class for transactions with class discrepancies and adding transaction information not captured in the lane, e.g. transactions processed during Manual Mode operations.
- (c) Verify and consolidate complete data received from each Toll Lane and RSS linked to each virtual plaza linked to the Back Office to process all data including additional payments received, or made at the Back Office level, allow for the employee cash-up and provide employee and period reconciliations (calendar day, operational day and or other shift periods).
- (d) Allow for local account maintenance, allocate Discounts, perform account maintenance functions, transfer data files to external systems, provide consolidated reconciliations, allow controlled system configuration and provide comprehensive reports on all activities. The Back Office System is also to facilitate the automated interaction with

account holders. The system shall also manage the integrated verification interface to the approved financial institution providing Bank Card verification and transaction processing employing a Point-of-Sale (POS) unit.

6.1.3.2 The Back Office System shall provide the functionality to:

- (a) Verify the completeness and authenticity of data received from the lanes;
- (b) Add information required for data completeness;
- (c) Automatically transmit consistent data;
- (d) Provide visibility of all the background processes and system configurations to allow the supervisory staff to manage the system and identify system problems;
- (e) Report and manage Incidents that occur at the plaza level or the lane level. This includes amongst others the VGS application, VGS cameras and primary recording devices,;
- (f) Receive operational lists and configurations and send the information to the lanes;
- (g) Allow for adequate redundancy and storage capacity, back-up and housekeeping facilities;
- (h) Manage Toll Revenue, e.g. Control cash Revenue via the cash-up, consolidated cash-up and cash banked functions;
- (i) Allow account registration and maintenance functions for local account holders;
- (j) Allocate Discount;
- (k) Create data files for transmission to external systems for further processing of electronic transactions;
- (l) Receive and compile operational lists and configurations and send the information to the lower levels; and
- (m) Report on traffic, financial information, audit trails, data status and maintenance.

6.2 TRANSACTION RECORD MANAGEMENT

6.2.1 RECEIPT OF DATA FROM THE RSS OR TOLL COLLECTION LANE EQUIPMENT

6.2.1.1 Automatic Data Transfer

- (a) The Back Office System shall receive Transaction Records with the relevant images from the Road Side System or Toll Collection Lane Equipment through an automated process.
- (b) The Back Office System shall automatically verify and check the Transaction Records received from the RSS / Toll Collection Lane Equipment (Refer to the next section).
- (c) For legal purposes, the contents of the ETC Transaction Records, including the front, rear and Scene Images, may under no circumstances be modified prior to transmission to the TCH System. Additional transaction information, linked to the Transaction Record from the RSS, shall be supplied by the Back Office System, e.g. Discounts, Toll Tariffs and the Actual Class related to the Transaction Record. In this document any reference to the 'Transaction Record' shall therefore include this additional information generated by the Back Office System.

6.2.1.2 Data Import

- (a) The Back Office System shall provide a function to import the Transaction Records and relevant images from acceptable electronic media, should the communication between the Back Office System and RSS/Toll Collection Lane Equipment be interrupted.
- (b) The system shall flag Transaction Records that were manually imported.

6.2.2 VERIFY DATA COMPLETENESS AND AUTHENTICITY

6.2.2.1 The Back Office System shall verify that all the data is received from the RSS / Toll Collection Lane Equipment and that the data is complete, i.e. whether the Transaction Records consists of all required minimum information. Each Transaction Record shall be delivered once and only once.

- (a) Sequence checking has to be done to ensure that all data was received from the RSS / Toll Collection Lane Equipment and that no duplications have occurred.
- (b) In the event of missing, incomplete or corrupted data, the Back Office System shall request the data from the relevant Tolling Point / Toll Collection Lane Equipment, typically through an automated process. If the automatic request of incomplete data is not successful, data shall be retrieved from the RSS / Lane controller using a manual process. All data entered manually shall be flagged as such.

- (c) Duplicate data shall be identified and resolved.
- (d) The incomplete Transaction Records shall be flagged as such.
- (e) The results of the data integrity verification checks shall be displayed in a user-friendly way. Invalid data shall also raise an alarm to enable the System User to focus on the invalid data and determine effectively which Tolling Points / Lanes are experiencing data transmission problems.
- (f) The Back Office needs to store the en/decryption key in a secure manner.
- (h) Refer to clause 3.4 for Auditability requirements.

6.2.2.2 The Back Office System shall process the Transaction Records; the Nominal Tariff and relevant Discounts shall be added to the Transaction Record and discrepancies shall be handled (as specified in the next sections). The Back Office System shall provide adequate functionality to optimise Compliant and Complete ETC Transaction Records.

6.2.2.3 The Back Office System should have the capability to log into a Tolling Point / Lane to verify a Transaction Record. This shall be a read only capability and the System User shall not be allowed to modify or change any data at that Tolling Point / Lane.

6.2.3 **DATA MODIFICATION**

6.2.3.1 ETC Transactions

The Back Office System shall prevent any changes to the ETC Transactions. Only the addition of the Actual Class will be allowed. ETC Transactions will be transferred to the higher levels in near real time or immediately after the Actual Class has been added.

6.2.4 **AUTOMATIC NUMBER PLATE RECOGNITION (ANPR) FOR OPT-IN TOLL AGENCIES**

6.2.4.1 The ANPR function shall be performed on the RSS / Toll Collection Lane Equipment or on the Back Office System or both (Opt-In Toll Agencies). If ANPR is performed on the RSS / Toll Collection Lane Equipment, it is an option to include some ANPR functions on the Back Office System in addition to those provided by the RSS for improved accuracy.

6.2.4.2 ANPR is required to identify the Vehicle Licence Number of Transaction Records where images are required, such as Transaction Records without a Tag Number (Refer to clause 4.1.8). However, the system shall be configurable to do ANPR on all Transaction Records.

6.2.4.3 The ANPR function shall convert an image into a valid Vehicle Licence Number according to a confidence level as determined by the Employer in order to meet his obligations. Successfully converted Vehicle Licence Numbers as well as the ANPR confidence level shall be added to the Transaction Record. Refer to the ANPR specification in clause 4.2.7 for more detail.

6.2.4.4 If the Transaction Record cannot be associated with an ANPR image at the point of capture, the MNPR process shall be used to identify the Vehicle Licence Number.

6.2.5 MANUAL NUMBER PLATE RECOGNITION (MNPR) FOR OPT-IN TOLL AGENCIES

6.2.5.1 If the ANPR process is unsuccessful or below the required ANPR confidence parameters, whether performed by the RSS or Back Office System, the Back Office System shall have a manual function for determining an appropriate Vehicle Licence Number, referred to as MNPR. Advanced image processing Software shall be provided to enhance images when required.

6.2.5.2 Vehicle Licence Numbers which are successfully identified by the MNPR process will be added to the Transaction Record.

6.2.5.3 If the Vehicle Licence Number could not be successfully identified and there is no valid Tag associated with the Transaction Record, the Transaction Record will be flagged as a potential unrecoverable Transaction Record.

6.2.5.4 The system shall flag all Transaction Records that went through the MNPR process, whether the Vehicle Licence Number could be successfully identified or not.

6.2.6 ETC TRANSACTION RECORD VERIFICATION

6.2.6.1 The Transaction Records shall be verified to determine whether the Transaction Records have been accurately captured and framed by the RSS. Transaction Records not accurately captured and framed shall be flagged as 'Non-Compliant'.

6.2.6.2 Transaction Records shall be verified against the Validation List(s) from the TCH System.

6.2.6.3 The system shall be able to utilise and validate a possible 3rd Identifier.

6.2.7 V-TOLL TRANSACTIONS (OPT-IN TOLL AGENCIES)

6.2.7.1 If the Tag read cannot be successfully identified, the Back Office System shall compare the Vehicle Licence Number of the Transaction Record to the registered Vehicle Licence Number.

(a) If the Vehicle Licence Number (as recorded by the ANPR or MNPR process) successfully matched the registered Vehicle Licence Number associated with a registered Tag Identifier, the Transaction Record Identifier type shall be changed to a V-Toll Transaction Record and processed accordingly; and

(b) The Transaction Record shall be accompanied by the required images.

6.2.7.2 Should the Back Office System not succeed in identifying the V-Toll Transaction Record, the Transaction Record shall be flagged as a potential unrecoverable Transaction Record.

6.2.7.3 Should the VPC however succeed in linking the Transaction Record to a registered Identifier, the VPC System will inform the Back Office System via the TCH System. The Back Office System will add the Transaction Record to the appropriate account record.

6.2.8 DISCREPANCIES

6.2.8.1 Vehicle Class Discrepancies

- (a) The Back Office System shall provide a function to perform Class Discrepancy management should there be a discrepancy between the Registered Vehicle Class from the Validation List(s) and the AVC class (ETC Transactions) or between the Manual Vehicle Class and the AVC class (Non-ETC Transactions). The Vehicle Class as determined by the System User within the Back Office is referred to as the Actual Class of the vehicle.
 - i. The Vehicle Class will be identified and allocated with the aid of images through a manual process and/or automated process. Information from the Vehicle Lists, such as the make, Vehicle type and corresponding Vehicle Class, may be used to assist the System User in determining the Vehicle Class. The Actual Class will be added to the Transaction Record. For audit purposes the system shall keep record of the System User who performed the function.
 - ii. The Actual Class shall default either to the AVC class, the Registered Vehicle Class (ETC Transactions) or Manual Vehicle Class, according to the configuration of the system. The Back Office System shall be able to apply different Business Rules for different Vehicle Classes. In principle, the default class can only be overruled if it can be verified through the corresponding image.
 - iii. The ETC Transaction Record shall be flagged as a record with a Vehicle Class Discrepancy and the discrepancy information shall be transferred to the TCH System for further action. The Transaction Records shall include images to accommodate road user queries.
- (b) The Back Office System shall use the Actual Class in determining the applicable Toll Tariff for the Transaction Record.
- (c) The Back Office System shall allow for the updating of the Actual Class. An audit trail on all updates shall be available.

6.2.8.2 Vehicle Licence Number Discrepancies (Opt-in Toll Agencies)

- (a) A Tag shall be dedicated to a specific vehicle with a unique vehicle Licence Number. A Tag is not transferable between vehicles.

- (b) The Back Office System shall provide a function to identify Vehicle Licence Number discrepancies. (If a particular Tag is not eligible for Discount, the Vehicle Licence Number need not be verified, unless these transactions are queried by the road user).
- (c) If the Vehicle Licence Number of the front licence plate differs from the rear licence plate number, the Vehicle Licence Number of the front licence plate shall be used (if available).
- (d) The Vehicle Licence Number derived from the ANPR or MNPR process will be compared with the Vehicle Licence Number in the Validation List(s), also known as the registered Vehicle Licence Number.
- (e) The Back Office System shall keep track of the number of mismatches between the registered VLN and the VLN determined through the ANPR process through an automated or manual process.
- (f) If there is a continuous mismatch between the registered VLN and the VLN determined through the ANPR process and the mismatches can be verified, the Transaction Records shall be flagged as Vehicle Licence Number discrepancies to inform the TCH System that the road user is possibly abusing the Discount rules, so that the TCH System can take further action, such as to inform the road user about the mismatches.
- (g) If a road user continues to misuse the system, the Discount of a road user may be terminated. The Back Office System shall no longer apply the Discount to Transaction Records linked to the Tag Identifier.

6.2.9 **DISCOUNTED, EXEMPTED AND FREE PASSAGE TRANSACTION RECORDS**

- 6.2.9.1 The Toll System shall enable the **Contractor** to implement User Discount as specified in the Standard Specification for Operations and Maintenance of CTROM Projects: General (Volume 2 Book 2a).
- 6.2.9.2 For ETC Transactions, a Transaction Record will include a Nominal Tariff as well as the Discounted Toll Tariff applied to the Transaction Record before it is send to the TCH.
- 6.2.9.3 For ETC Transactions, the Back Office System shall create non-revenue tracking accounts. Relevant account information may be retrieved from the TCH System in order to perform the required functionality.
- 6.2.9.4 The Back Office System shall track the usage of an individual Identifier associated with Frequent User Discount. Discounts shall be reset every month.
- 6.2.9.5 Exempt Vehicles
 - (a) Some vehicles are by Law exempted from paying toll, for example, the South African Police Force (SAPS) and the South African National Defence Force (SANDF).

- (b) Depending on the Business Rules, either the Nominal Toll Tariff or a zero Tariff shall be applied to Exempt Transactions.
- (c) Exempt Vehicles on ORT roads:
 - i. These vehicles will not necessarily require a Tag and can only be categorised as such through the Vehicle Licence Number or viewing of the image.
 - ii. The Transaction Record shall be flagged as an Exempt Vehicle, utilising the Exempt and Validation Lists. Transaction Records shall be accompanied with the required images. The Back Office System shall verify the legality of the Exempt Transaction Record, i.e. verify that the Vehicle Licence Number corresponds to the registered Vehicle Licence Number contained within the Validation List(s) (Refer to clause 6.2.8.2). Exceptions shall be flagged as Potential Violations.

6.2.9.6 Exempt Vehicles in Conventional lanes:

An Exempt User will Tender a valid official and original warrant or valid Contractor Card. The Transaction Record shall be classified / flagged as an Exempt transaction.

6.2.9.7 Free Passage Road Users

- (a) Free Passage Transaction Records on ORT roads:
- (b) Vehicles qualifying for free passage Discount shall have a Tag/3rd Identifier. The free passage Transaction Records shall be flagged as such, utilising the indicator on the Validation List(s) and accompanied with the required images.
- (c) It is the function of the Back Office System to verify the legality of the free passage Transaction Record, i.e. that the Tag/3rd Identifier corresponds with the registered Vehicle Licence Number contained within the Validation List(s).
- (i) Free Passage Transaction Records in Conventional Lanes:

The system shall be able to recognise a free passage account holder and shall provide a function to control these transactions.

6.2.9.8 Discounts

- (a) Discounts are applied to Transaction Records by the Back Office System. Discount structures shall be based on, but not necessarily be limited to, a combination of the following rules:
 - i. The system shall allow for multiple Discounts per Transaction Record;
 - ii. Discounts can either be calculated per Identifier or per account;

iii. Discount can be applicable on specific route only.

(b) The system shall support Discount structures such as the following:

- i. Frequent User Discount: Frequent User Discount is based on the frequency of use of a specified route during a month. The Discount is calculated on predetermined thresholds based on the number of trips, according to the step scheme philosophy (Refer to the example below) and will generally be applied per Identifier.
- ii. Discount per Identifier: Discount based on the Identifier type used, i.e. Tag users may receive Discount.
- iii. Public transport Discount: Identifiers linked to a registered public transport vehicle (as per permit). Road users with public transport vehicles may qualify for public transport Discount on specific zones (predefined set of Tolling Points) only. When a Transaction Record of an Identifier linked to a public transport vehicle is received, the system shall verify whether the Transaction Record is eligible for Discount on the specific zone.
- iv. Time and traffic density Discount: Discount linked to the time and traffic density period, based on the current or historical congestion levels for the network. Discount shall be applied to Transaction Records of vehicles passages during low congestion period. The system shall allow for various Toll Tariff periods per day. The Discount is applicable to all road users.

6.2.9.9 'Tag in a Bag' road users

- (a) 'Tag in a Bag' transactions are identified on TCH level.
- (b) 'Tag in a Bag' identifier numbers shall be allocated to the Green list as soon as the Tag leaves the TCH warehouse.
- (c) As a minimum, a 'Tag in a Bag' Road User shall be recognized in a boom-down lane by means of the Issuer Identifier number of the Tag and the boom should open.
- (d) 'Tag in a Bag' road users shall not receive any Tag or frequent user Discount until the road user has registered as a **Customer** on the system. (The Green List shall indicate that the **Nominal Tariff** should be used).

6.2.9.10 Illustrative Example of step scheme Frequent User Discount:

- (a) Discount is based on the number of Tolling Point passages that occurred during a month; and
- (b) It shall be possible to specify any number of thresholds for a Discount scheme, e.g. between 1 and 5 passages the road user receives no Discount; between 6 and 10

passages the road user receives 10% Discount; between 11 and 20 passages the road user receives 20% Discount, and on more than 20 passages the road user receives 40% Discount.

Discount Structure

Trips 1-5	0% discount
Trips 6-10	10% discount
Trips 11-20	20% discount
Trips 21+	40% discount

Assume a nominal tariff of R10.00 for a transaction

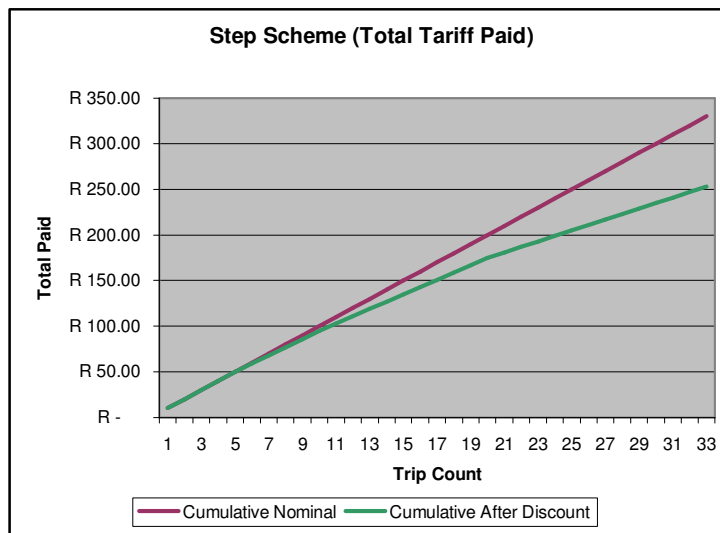
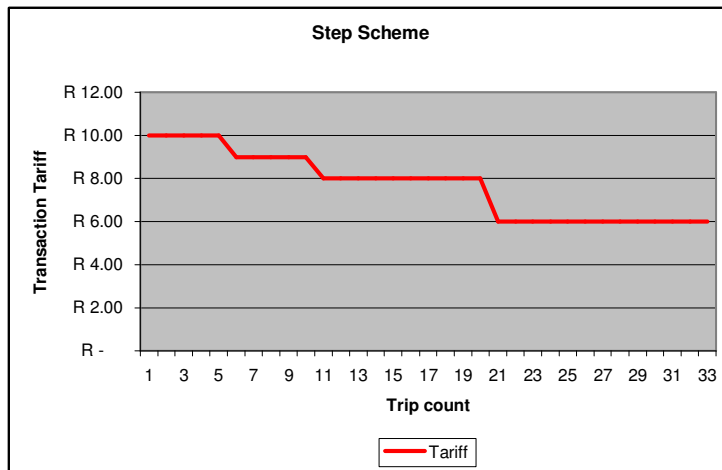


FIGURE 6-1: STEP SCHEME PHILOSOPHY

6.2.10 TOLL TARIFF

6.2.10.1 A Nominal Tariff is the Toll Tariff applicable to a Transaction Record at a Toll Plaza before any Discount is applied. On ETC Transaction Records, Toll Tariffs may be allocated to the Transaction Record by the Back Office System, in accordance with the Toll Tariff Table and Discount structures. Every Transaction Record will include a Nominal Tariff as well as the Discounted Toll Tariff applied to the Transaction Record.

6.2.10.2 Toll Tariff Tables and Discount structures are configured on the Back Office System from where it is implemented and transferred to the TCH System and Conventional Lanes.

6.2.10.3 The system shall make provision for different Toll Tariffs and Discount structures per Vehicle Class at the different Toll Plazas and they shall be configurable.

6.2.10.4 The Toll Tariff shall, amongst others, be determined by:

The Actual Class used for payment purposes;

- (a) The road user type, e.g. Exempt Vehicles;
- (b) Discount e.g. per Identifier type, for frequent usage of the Road or other special Discounts; and
- (c) Applicable Toll Tariff Tables as stored on the Back Office System.

6.2.10.5 Toll Tariff and Discount Updates

- (a) The system shall make provision for the update of the Toll Tariffs and Discount structures by the System User with the required access levels via a user friendly wizard.
- (b) Whenever new Tariffs are published in the Government Gazette these must be downloadable from the Contractors Back Office System to all Lanes in advance of the gazetted date and time and must automatically become active. The Contractor shall also update all Tariff boards and notices accordingly. The Tariffs do not need to be downloaded to the RSS since the Tariff are typically determined at Back Office level.
- (c) The system shall activate a new Toll Tariff and Discount structure automatically when the activation date and time are reached. Toll Tariff and Discount corrections (due to changes on historic trips) shall automatically be done with the applicable Toll Tariff and Discount structure.
- (d) All Toll Tariff changes shall be tracked and recorded in the audit log.
- (e) As a minimum requirement, the current, previous and future (if available) shall be saved on the Back Office System. Old Toll Tariffs shall be accessible on the Back Office System as long as they are relevant.

6.2.11 TRANSFER DATA TO THE HIGHER SYSTEM LEVEL

- 6.2.11.1 The system shall transfer data to higher levels for processing in near real time or, if additional processing is required at plaza level, as soon as data is processed and verified as correct and complete.
- 6.2.11.2 The system shall allow the manual export of data in the format required for manual transfer and import to the other levels.

6.2.12 ETC TRANSACTION RECORD TRANSFER

- 6.2.12.1 When the ETC Transaction Records are processed, they are available to be transferred to the TCH. For Opted-in Toll Agencies, both Compliant and Non-Compliant Transaction Records shall be transferred to the TCH unless otherwise specified for the specific Project. Transaction Records shall either be flagged as a recoverable Transaction Record or as a potential unrecoverable Transaction Record.
- 6.2.12.2 Potential Unrecoverable Transaction Records
 - (a) If the ETC Transaction Record is incomplete, the Transaction Record shall be flagged as a potential unrecoverable Transaction Record. The Transaction Record of Opted-in Toll Agencies shall be sent to the VPC System via the TCH System for recording and audit purposes, even if debt collection is not possible.
 - (b) Should the VPC succeed in linking the Transaction Record to a registered Identifier, the VPC System will inform the Back Office System via the TCH System. The Back Office System will add the Transaction Record to the appropriate account record.
 - (c) The Vehicle Class of the potential unrecoverable Transaction Record will be based on the AVC class unless there is an Actual Class added during the Class Discrepancy process.

6.3 TOLL REVENUE MANAGEMENT

6.3.1 OVERVIEW

- 6.3.1.1 It is a function of the Back Office System to reconcile the Transaction Records and associated transaction value. Reconciliation shall be done per calendar day and month and shall be based on the date and time sent to the TCH System (unless stated differently). Differences in reconciliations shall be reported by and resolved on the Back Office System.

6.3.2 Minimum reconciliation requirements

- 6.3.2.1 Reconciliation includes, but is not limited to the following:

- (a) Transaction Records received from the RSS, to those that are still in process at the Back Office System, those sent to the TCH System for the calendar day and for previous days.
- (b) Transaction Records sent to the TCH System and the associated transaction value for the calendar day to the transaction value of Transaction Records received by the TCH System for the calendar day.
- (c) Transaction Record processing fees owed to the TCH, to Transaction Records sent to the TCH System and the associated processing fees.
- (d) The value of Transaction Records of special Road Users (i.e. Exempt Vehicle or free passage Transaction Records), Discounted Transaction Records and nominal Transaction Records, to the associated nominal transaction value less Discount, for the calendar day.

6.3.3 Toll Transaction Payment

- 6.3.3.1 The Guaranteed Payment for Compliant Transaction Records is made once the Transaction Record status is confirmed by the TCH and VPC Systems respectively. Refer to the Standard Specifications for Operations and Maintenance of CTROM Projects: ETC Interoperability – Business Rules (Volume 2 Book 8a) for more detail in this regard.

6.4 SYSTEM INCIDENTS

6.4.1 GENERAL

- 6.4.1.1 Incidents that occur on the RSS / Toll Collection Lane Equipment and Back Office System shall be reported in near real time. Refer to clause 3.7.4 for more information in this regard. When required, an incident shall be generated for vehicles of special interest (VOSI) and vehicles exceeding the maximum legal height defined for the Toll Road.

6.5 TAX AND VAT REQUIREMENTS

6.5.1 SCOPE

- 6.5.1.1 This part covers the Toll System requirements to meet the TAX and VAT obligations in such a way that a user-friendly service is maintained.
- 6.5.1.2 It shall be the Contractors responsibility to ensure that the Toll System complies with all Applicable Laws including the current and future TAX and VAT legislation (currently VAT Act 89 of 1991 as amended).

6.5.1.3 The content of this section shall not be construed in any way as limiting, amending or changing in any way the requirements of any Applicable Law and are set out merely for the purpose of convenience of the Contractor. It shall be the responsibility of the Contractor however, to comply fully with the requirements of the Employer as set out below. The Contractor shall bear and pay all Taxes payable in connection with the execution of this Contract levied on the Contractor, its sub-contractors or their respective agents, employees or workmen by the relevant authorities and all local, State or national governmental authorities in connection with the Works in the Republic of South Africa, in so far as the same apply or relate to the performance by the Contractor of its obligations under this Contract.

6.5.1.4 The Employer will submit the VAT Return and pay the VAT.

6.5.1.5 Without detracting from the generality of any of the provisions relating to the Contractor's responsibility in respect of compliance with Applicable Laws, the payment of Taxes and duties, the Contractor shall indemnify the Employer against all loss or claims arising out of the default of or failure by the Contractor to comply fully with its obligations under this section, its compliance with all laws in respect of taxation and all Applicable Laws generally.

6.5.1.6 For the purposes of this specification all documents produced by the Toll System shall be classified as indicated below:

- a) Tax Invoices;
- b) Tax Credit notes; and
- c) Receipts.

6.5.1.7 Tax Invoices and Tax credit notes shall comply with the VAT requirements as stipulated in the specification. Tax Invoices will be issued at plaza level on VAT-able Sundry payments such as Card Fee and Admin Fee. Receipts will be issued for transactions where VAT is not applicable. Receipts in the lanes are used to indicate Receipt of money for Pre-Paid Account deposits and are in the format of a Transaction Record, no VAT is applicable to such payments. Receipts at plaza level will be issued for payment of a transaction where a Tax Invoice has been issued, such as Violation transactions and other post payment transactions.

6.5.2 **VAT REQUIREMENTS**

6.5.2.1 General requirements

The Toll Equipment shall comply with all VAT requirements as may be stipulated by Applicable Law and the requirements of the South African Revenue Services from time to time. In addition the system shall automate the issuing and retention of all TAX documents (invoices and credit notes) for audit purposes. The system shall provide the User with the necessary TAX documents in a format that will make the claiming of VAT on Toll transactions and associated fees possible. This shall include the functionality to register identifiers (Bank and Contractor

Cards and ETC Tags) to a User account and issue a consolidated Tax Invoice reflecting the summarised Toll Transaction records and detailed Statement reflecting all individual Toll Transaction Records per Tolling Point per Identifier for a period.

The implementation of the TAX requirements listed in this section shall be subject to the approval of the Employer at the Contractors cost.

6.5.2.2 VAT Act Requirements

In order for a system to comply with the SARS VAT requirements it needs to comply with the following basic concepts (amongst other requirements):

- (a) A uniquely numbered Tax Invoice shall be issued for all VAT-able transactions on request. All VAT-able transactions performed by a VAT registered company must be reflected in its VAT return.
- (b) The Tax Invoice shall contain the information of the purchaser when the Tax Invoice value exceeds the limit as specified in the VAT legislation.
- (c) All Tax Invoices and credit notes shall be retained in an electronic format for a period as defined by Applicable Law for VAT inspection purposes. Applicable Law regarding the storage of VAT information shall dictate whether summary information would be acceptable. The system shall be able to reproduce any TAX document on request from VAT Inspectors.
- (d) Tax documents generated may not be changed. Any changes to Tax Invoice values shall be performed according to the prescribed VAT procedure. This involves retracting the original Tax Invoice by issuing a TAX credit note and then issuing the correct Tax Invoice. TAX Credit notes shall be linked to the month in which the Tax Transaction occurred.
- (e) An original TAX document shall not be duplicated. It shall be possible to print a copy of a Tax document. A copy of any TAX document shall clearly State "Copy Tax Invoice" or "Copy TAX credit note".
- (f) Any Tax Invoice printed before month-end closure shall clearly indicate "Pro-forma Tax Invoice".

6.5.2.3 The Employer's Implementation of the VAT Business Rules

In order to comply with the VAT requirements in the Toll environment, the following application of the VAT rules shall apply:

- (a) User-friendly systems shall be in place to enable road users to claim VAT on Toll. This includes:
- (b) Obtaining Tax Invoices for certain transactions in the Lanes;

- (c) Consolidated monthly Tax Invoices shall be made available at Back Office level for registered Users for non-ETC Transactions.
- (d) Consolidated monthly Tax Invoices shall be made available at TCH level for registered Users for ETC Transactions.

Registered for Tax Invoice shall mean the registration of a User for the purpose of receiving a monthly account Statement/ statements and a consolidated monthly VAT/Tax Invoice/Invoices, for all Toll passages through all Toll Plazas using an approved Payment Mechanism inter alia a Bank Issued Card, Operator Card, Pre-Paid Account or Post-Paid Account.

- 6.5.2.4 The Back Office System shall automatically transfer the taxable ETC Transaction Records to the TCH System. The TCH will act as an agent for the Toll Agency and the TCH System will generate Consolidated Tax Invoices and TAX credit notes (where applicable) for ETC Toll Transaction Records on behalf of the Toll Agency.
- 6.5.2.5 The consolidated ETC Tax Invoices for Transaction Records shall be summarized as agreed with the TCH. However, the Customer shall be able to obtain a detailed list of Transaction Records on request.
- 6.5.2.6 The TCH System shall either link the Transaction Records received from the Toll Agency to a Customer Account, or will not be able to link the Transaction Record to a Customer Account.
- 6.5.2.7 ETC Transaction Records not linked to a Customer Account shall be linked to a "Potential Violator" account.
- 6.5.2.8 The system shall allocate a unique id number (transaction serial number) to each transaction.
- 6.5.2.9 VAT documentation numbers shall be sequential to ensure audit-ability. The format of this number is defined in the National Standard Interface (clause 3.7.2). The unique number sequence shall be:
 - (a) Per Lane for Lane-generated Tax Invoices ,
 - (b) A single sequence shall be used for Back Office System-generated Tax Invoices. for local accounts (non-ETC Transactions) and a separate sequence per pay station for Sundry Payments.
 - (c) Per Toll Agency for Tax Invoices generated by the TCH on behalf of the Toll Agency (ETC Transactions).
 - (d) Per Toll Agency for TAX credit notes generated by the TCH on behalf of the Toll Agency (ETC Transactions).

- (e) A single sequence shall be used for cancellation of Tax Invoices issued by the Back Office system (non-ETC Transactions) and a separate sequence per pay station for Sundry Payments.

6.5.2.10 A clear distinction exists between the generation and printing of Tax Invoices. This is clearly illustrated by the table contained in clause 6.5.3.

6.5.2.11 Generation of a Tax Invoice: This is the process whereby a unique Tax Invoice number is assigned to the VAT-able transaction. Generation of Tax Invoices occur on Lane, TCH and Back Office System levels (but never on more than one for the same transaction) as follows:

The Lane Tax Invoice number shall be unique and sequential per Lane per Toll Plaza. Lane Tax Invoices shall be generated for the following transaction types (all transactions except registered identifiers):

- (a) Cash;
- (b) Bank Issued Cards not registered with the Contractor;
- (c) Exempted User;
- (d) Violation; and
- (e) Non-payment

The Back Office System Tax Invoice number shall be unique and sequential per Toll Plaza. Original Tax Invoices shall only be generated once a month has been financially closed off. Tax Invoices generated may not be changed.

6.5.2.12 VAT rules for ETC Transaction Records linked to an account:

- (a) Transaction Record
 - i. The TCH System shall allocate the ETC Transaction Records received from the Toll Agency Systems to the Customer Accounts.
 - ii. The TCH System shall generate a consolidated Toll Agency (TA) Tax Invoice for Toll Transaction Records on behalf of the Toll Agent.
 - iii. The Consolidated TA Tax Invoices shall be generated for a Customer, per account, per Toll Agent, once or twice a month, according to the TCH invoice generation rules for the account.

6.5.2.13 VAT rules for Compliant ETC Transaction Records not linked to a Customer Account:

- (a) Compliant Transaction Records settled within the Grace Period

- i. The TCH System shall allocate ETC Transaction Records from the Toll Agencies to a "Potential Violator" account.
- ii. The TCH System shall generate a consolidated TA Tax Invoice to the Road User for Toll Transactions on behalf of the Toll Agencies.
- iii. Consolidated TA Tax Invoices are generated per Road User per Toll Agency when settled by the Road User.

(b) Compliant Transaction Records not settled within Grace Period

- i. If Compliant Transaction Records of Opted-in Toll Agencies are not settled within the Grace Period, the Transaction Records are "Sold On" to the VPC.

6.5.2.14 Any changes to Tax Invoice information shall be performed according to the prescribed VAT procedure. This involves retracting the original Tax Invoice by issuing a credit note and then issuing the correct Tax Invoice. Back Office System Tax Invoices shall be generated for all registered account Users. This includes the following transactions:

- (c) Bank Issued Cards linked to an Contractor account
- (d) Identifier (Smart Cards and Operator Cards) linked to a Contractor account.

6.5.2.15 Printing of Tax Invoices: This is the process whereby a Tax Invoice is printed for a User on request. Two types of Lane documents are printed, a Tax Invoice and a Receipt.

6.5.2.16 Printing of original Tax Invoices:

- (a) Lane: The following transaction types shall be issued with an original Tax Invoice at Lane level on request. The Lane Tax Invoice shall only be issued during the transaction, after the transaction has been validated and before the first axle message has been received by the TCC from the AVC. A transaction where a Tax Invoice has been generated and issued, may not be cancelled;
 - i. Cash;
 - ii. Bank Issued Cards not registered with the Contractor;
- (b) Back Office System Level: The following transaction types shall be issued with an original consolidated monthly Tax Invoice at account User Service Centres on request. Any Tax Invoice printed before month-end closure will clearly indicate proforma Tax Invoice.
 - i. Bank Issued Cards linked to an account where the account was specifically registered to generate Tax Invoices on Back Office level;
 - ii. Smart Cards and Operator Cards linked to an account; where the account was specifically registered to generate Tax Invoices on Back Office level;

- iii. Account charges e.g. card, query and Statement fees as a part of the monthly account Tax Invoice.

6.5.2.17 The Contractor shall ensure that it is possible to print a copy Tax Invoice. The following shall apply.

- (a) The following transaction types shall be issued with copy Tax Invoices at Lane level on request. A Copy Lane Tax Invoice shall only be issued during the transaction, after the transaction has been validated and before the first axle message has been received from the AVC:
 - i. Cash;
 - ii. Unregistered Bank Issued Cards;
- (b) The following transaction types shall be issued with a COPY consolidated monthly Tax Invoice, generated at Back Office System level from any toll Service Centre, on request:
 - i. Bank Issued Cards linked to an account;
 - ii. Exempt User transaction;
 - iii. Account charges e.g. card, query and Statement fees, as a part of the monthly account Tax Invoice.
- (c) The following transaction type shall be issued with a consolidated monthly transaction STATEMENT. This Statement would reflect all the individual Tax Invoices and credit notes for the specified period. This Statement would be clearly marked as a "STATEMENT":
 - i. Bank Issued Cards not registered or linked with a Contractor account;
 - ii. Bank Issued Cards linked to an account;
 - iii. Exempt User transaction;
 - iv. Account charges e.g. card, query and Statement fees, as a part of the monthly account Tax Invoice.

6.5.2.18 The following transaction types shall be issued with a Transaction Record at Lane level on request:

- (d) Exempt User transactions;
- (e) Bank Issued Cards linked to an account; and
- (f) No-Payment (Optional).

6.5.2.19 A Receipt shall be issued for Lane settlement/deposit of accounts. This shall not be a Tax Invoice.

6.5.2.20 Sundry payments including Local account settlement and account deposits shall be issued with a Receipt at Back Office System level

6.5.2.21 The following transaction types shall be issued with a Tax Invoice at Back Office System level

- (a) Sundry payments including:
 - i. Card/ETC Tag fee payment
 - ii. Any other Contractor charges

6.5.2.22 Printing of Tax Invoices at Back Office System level for unregistered Users.

- (b) This is the prerogative of the Contractor. However, should this service be provided, the Contractor shall ensure that the word “COPY” shall appear.
- (c) Set out below is an example based on Mtunzini Lane 02ME (ZM = Mtunzini Mainline Plaza and ZP = Mtunzini Plaza or Control/Service Centre):

6.5.3 The Employer's Implementation of the VAT Act Requirements

Item	Method of Payment / transaction type (in random order)	LANE At time of transaction			BO SYSTEM Monthly Tax Invoice		Comment
		TRX #	Tax Invoice # see format under national user interface	Receipt or Lane Tax Invoice printed (Y/N)	Printed	Tax Invoice # see format under national user interface	
1.	Cash	1234	ZM-02ME-2002/10/25-00024	Possible tax inv	Copy	Lane inv #	Original only printed in the Lane
2.	Bank Issued Cards not registered with the Contractor	1235	ZM-02ME-2002/10/25-00025	Possible tax inv	Copy	Lane inv #	Original only printed in the Lane
3.	Cash	1236	ZM-02ME-20021025-00026	Possible tax inv	Copy	Lane inv #	Original only printed in the Lane
4.	Exempt User transaction	1237	ZM-02ME-2002/10/25-00027	Possible Transaction Record Null value to road user	Copy	Lane inv #	Statement
5.	Violation	1238	ZM-02ME-2002/10/25-00028	No Printing	Copy	Lane inv #	Statement from debtors account or Issue on payment for Collector error.

Item	Method of Payment / transaction type (in random order)	LANE At time of transaction			BO SYSTEM Monthly Tax Invoice		Comment
		TRX #	Tax Invoice # see format under national user interface	Receipt or Lane Tax Invoice printed (Y/N)	Printed	Tax Invoice # see format under national user interface	
6.	Operator Card or ETC Tag – Acc001	1239		Possible Transaction Record	Copy	BO System inv # ZP-07CC-- YYYY/MM/DD- #####	Month-end TAX inv or proforma Tax inv.
7.	Registered Bank Issued Cards – Acc444	1240		Possible Transaction Record	Copy	BO System inv # ZP-07CC-- YYYY/MM/DD- #####	Month-end TAX inv or Proforma Tax inv
8.	Operator Card – Acc001	1241		Possible Transaction Record	Copy	BO System inv # ZP-07CC-- YYYY/MM/DD- #####	Month-end TAX inv Proforma Tax inv
9.	Violation	1242	ZM-02ME-2002/10/25- 01242	No Printing	Copy	Lane inv #	Statement from debtor account or Issue on payment for Collector error.
10.	No-Payment	1243	ZM-02ME-2002/10/25- 01243	None	Copy	Lane inv #	Issue on payment for Collector error
11.	Lane deposit	12122		Print receipt	Orig/ Copy	Origin dependant Lane or BO SYSTEM receipt #	Not a VAT-able transaction. Recharges have their own sequence number. Force the printing of a receipt at point of transaction
12.	BO System sundry payment			None	Orig/ Copy	BO System Receipt # or Tax inv #. Dependant on transaction type	Recharges are not VAT- able transactions. Card and account fees are VAT-able.

6.5.3.1 The application of the VAT rules on ETC Transactions in the toll environment is illustrated in Figure 6.2: VAT Overview for ETC Transactions.

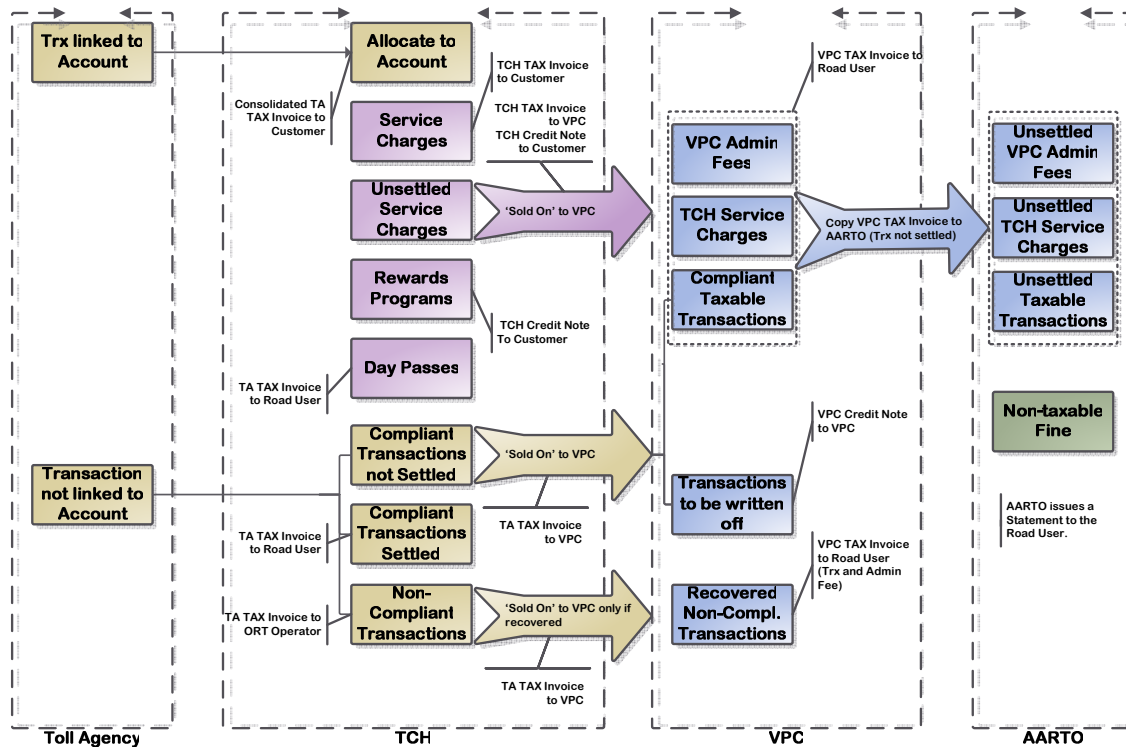


FIGURE 6-2: VAT OVERVIEW FOR ETC ACCOUNTS

6.5.4 TAX AUDIT REPORT

A TAX audit report shall be introduced by the Contractor to allow VAT or other auditors to trace VAT-able income to the various sources, including the Lane, Back Office System, sundry payments and credit notes. The TAX audit report shall comply with the following:

6.5.5 SUMMARY REPORT

The format shall include the following per sources (Lane, Back Office System, sundry payment, credit note):

- Total (b + c + d + e) VAT-able income showing: Total, VAT and Total inclusive of VAT;
- Total Account holder Service Centre VAT invoice value : Total, VAT and Total inclusive of VAT;
- Total Lane VAT invoices total and item per Lane: Total, VAT and Total inclusive of VAT;
- Total VAT invoices issued by the TCH on behalf of the Toll Agency; and
- Total Account adjustments: Total, VAT and Total inclusive of VAT.

6.5.6 DETAILED ACCOUNT HOLDER SERVICE CENTRE TAX INVOICE REPORT:

Detailed listing of a selected month's account holder Service Centre invoices (Tax Invoice number, account number, total, VAT and Total inclusive of VAT);

6.5.7 LANE TAX INVOICE HOURLY SUMMARY REPORT

Hourly summary listing of Lane Tax Invoices per Lane per hour (Tax Invoice number range, total, VAT and Total inclusive of VAT);

6.5.7.1 Detail Lane Tax Invoice report:

- (a) Detailed listing of Lane Tax Invoices per Lane per day (Tax Invoice number, total, VAT and Total inclusive of VAT);
- (b) Detailed listing of Lane Tax Invoices per Lane per hour (Tax Invoice number, total, VAT and Total inclusive of VAT);

6.5.8 DETAIL ACCOUNT CORRECTION REPORT:

Detailed listing of local account corrections per month (Tax Invoice number, total, VAT and Total inclusive of VAT).

6.5.9 TAX INVOICE INFORMATION

6.5.9.1 The information to be printed on a Lane Tax Invoice or Receipt is set out in clause 3.7.2.

6.5.9.2 Account Holder Service Centre Tax Invoices

A registered User shall have the option to receive a consolidated monthly Tax Invoice for all the transactions against such an account. Such shall also be provided on request by the User

6.5.9.3 Account holder Service Centre Tax Invoice information for registered users

6.5.9.4 The following information shall be printed on the Tax Invoice:

- (a) The text "TAX INVOICE";
- (b) Unique identifier (Tax Invoice number) format as per clause 3.7.2.2. This shall be a unique serial number. This may consist of a sequential number per account;
- (c) The Employer's information:
 - i. [Logo];

- ii. [Name], "The SA National Roads Agency";
- (d) [The Employer's VAT registration number], "4220186250";
- (e) User information:
 - i. [Company or individual's name];
 - ii. [Postal address];
 - iii. [Account number];
- (f) [Toll Plaza name];
- (g) "Operated by [Contractor Company name]";
- (h) "[Contractor postal address and contact details]" e.g. " For account queries please contact the Contractor at (011) 555 5555"
- (i) [Tax Invoice period], e.g. "From 1st to 31st of January 2002";
- (j) [Transaction listing] One consolidated line with a single value per identifier per Toll Plaza;
- (k) [Gross (nominal) value of transactions] This is a non VAT-able amount;
- (l) [Discount detail] if any post transaction Discounts apply;
- (m) [Total transaction value excluding VAT];
- (n) [VAT amount contained and the percentage], i.e. "VAT at 14%: R 1.00".
- (o) [Transaction value including VAT]. Text that state "Total including VAT at 14%;

6.5.9.5 Alternatively to items (m), (n) and (o) above, the invoice may show the total amount inclusive of VAT and the percentage of VAT included;

6.5.9.6 Example Tax Invoice, Pro-forma Invoice or Copy Tax Invoice format:

N17 TOLL ROUTE PLAZA**OPERATOR**

Logo

Operator's Details

**PROFORMA INVOICE OR
TAX INVOICE OR
COPY TAX INVOICE**

THE SOUTH AFRICAN
NATIONAL ROADS AGENCY
LIMITED Reg No 1998/009384/06

VAT REG. No: 4220xxxx

TO:

BANANA TRANSPORT CC

P.O.BOX 1173

MALELANE

1749

ACCOUNT NUMBER	0001
INVOICE NUMBER	GP-07CC-2002/11/03-00123
INVOICE DATE	2002/11/03

Your ref: MR SLIPPERY JOE

Transaction period: FROM: 01/10/2010 TO: 31/10/2010

CARD NO.	REGISTRATION NO.	Passage count	Plaza ID	Description	Tariff	TOTAL	
243681	XNF 899 GP	5	GM	Gosforth mainline		50	00
243681	XNF 899 GP	9	GW	Gosforth W/ramps		747	50
243685	TSM 746 NC	21	DM	Dalpark mainline		750	00
243685	TSM 746 NC	16	DR	Denne road		82	50
243791	LSR 176 GP	45	GM	Gosforth mainline		950	00
243791	LSR 176 GP	13	GM	Freq user discount		-	
254321	ABD 007 MP		DM	Dalpark mainline		50	00
254321	ABD 007 MP					600	00
						10	00
TOTAL including VAT @ 14%						3167	00

For account queries please contact the Operator at

6.5.10 COPY TAX INVOICE

6.5.10.1 The system shall offer the facility at an account holder Customer Service Centre level to provide Copy Tax Invoices, of any previously generated original or copy Tax Invoices, to any user on request. This shall apply to Lane, Back Office and Service Centre TAX Invoices. All Copy TAX Invoices shall reflect shall reflect the original Tax Invoice details. All Copy Tax Invoices shall indicate "COPY TAX INVOICE".

6.5.10.2 Copy Tax Invoices shall not be available for Lane cash transactions on Back Office level.

6.5.11 TAX DOCUMENT CONTROL

6.5.11.1 The Contractor shall:

Retain an electronic copy of each TAX document generated. It shall retain all the information specified above. A User-friendly interface shall enable the Contractor (or VAT inspector) to extract any TAX document copy on request. This shall include Lane and monthly Tax Invoices even if the Lane invoice was not printed.

6.5.11.2 Issuing of Tax Invoices

- (a) The Contractor shall have the capability of generating batches of Tax Invoices, at month-end, for mailing purposes.
- (b) The Contractor shall have the capability to produce TAX credit notes for incorrectly issued Tax Invoices.

6.5.12 TAX REQUIREMENTS

6.5.12.1 In addition to the requirements of Applicable Law, the system shall comply with the following TAX requirements:

6.5.12.2 Tax documents shall be retained for a period as defined by the Applicable Law. The Contractors system shall export electronic TAX documents to CD ROM format. The extraction tools for viewing, searching and printing the documents shall reside on the same CD. The CD shall be clearly marked to indicate the period contained on the CD. Tax Invoice CDs shall be generated on a monthly basis adding the latest month, to the maximum allowed by the storage medium.

6.6 TRAFFIC ANALYSIS SYSTEM (TAS) – ETC, VLN OR 3RD IDENTIFIER TRANSACTION RECORDS ONLY

6.6.1 GENERAL

- 6.6.1.1 Should an interface to a Traffic Analysis System (TAS) be required, the Contractor shall develop an interface from the Back Office System to the Traffic Analysis System (TAS). The Contractor shall also be required to supply and maintain a server and associated Software for the TAS to accommodate the requirements as defined below.

6.6.2 SYSTEM REQUIREMENTS

- 6.6.2.1 The TAS System shall comply with the following requirements:

The Operating System shall be compatible with the Operating System of the Back Office.

- (a) The Database Management System of the server shall be compatible with the Back Office System.
- (b) A database must be provided that will cater for the storing of the Abbreviated Transaction Records. The Abbreviated Transaction Records has to be stored in the database and no additional Software development is required.
- (c) The TAS system shall accommodate 5 days worth of Abbreviated Transaction Records.
- (d) When the database is fully populated with 5 days of Abbreviated Transaction Records, the database should not be more than 40% full.
- (e) While populating the database with the Abbreviated Transaction Records, the load on the system Resources must not exceed 40% of the system resource's capacity.

6.6.3 INTERFACE REQUIREMENT

- 6.6.3.1 The Contractor shall develop an interface from the Back Office System to the TAS, should it be required. The interface must copy the Abbreviated Transaction Record information from the Back Office System and insert it into the database.
- 6.6.3.2 At least 40% of all Transaction Records which contains a valid Identifier (ETC Tag, VLN or 3rd Identifier) shall be inserted into the TAS database within five (5) minutes after the Transaction Record was captured at the Tolling Point/Plaza. A further 50% of the Transaction Records shall be inserted into the TAS database within twenty four (24) hours after the Transaction Record was captured and the remaining 10% of Transaction Records within forty eight (48) hours after the Transaction Record was captured.

6.6.4 ABBREVIATED TRANSACTION RECORD

6.6.4.1 The Transaction Record shall not contain any financial and personal road user information. However, at least the following Transaction Record information shall be contained in the Abbreviated Transaction Record:

- (a) Unique Transaction Record number;
- (b) Transaction Record date and time when Transaction Record is concluded;
- (c) Unique identifier number of the Tolling Point, as assigned by the Employer;
- (d) Unique identifier number of ETC Tag, for ETC Transaction Records only;
- (e) Class of vehicle, as determined by the AVC. The classification should be in accordance with the Employer classification scheme;
- (f) Vehicle Licence Number from ANPR, for vehicles without an ETC Tag; and
- (g) 3rd Identifier number, for 3rd Identifier Transaction Record Records only (where applicable).

6.6.4.2 In addition to the above, the traffic per Tolling Point/Plaza, summarized for a configurable period, shall be transferred to the TAS.

6.7 TOLL SYSTEM ACCOUNT FUNCTIONALITY

6.7.1 OVERVIEW

6.7.1.1 All Road Users, using the interoperable ETC accounts, will be registered on the TCH System and will be administered by the TCH but the Toll Agency might opt to use accounts to identify, control and report on specified groups of users who would not be using interoperable ETC as payment mechanism. This section describes the functionality required for this type of Road User. An account will be registered locally with the Toll Agency and administered by the Toll Agency.

6.7.1.2 An account provides a means to link Transaction Records and payments received to a specific single Road User's vehicle or multiple Road Users and vehicles. The account must provide a means to the System User and account holder to centrally manage personal information, payment mechanisms (payment types) and a means to initiate and accept payments against the account. It shall also allow the System User to link Discount profiles to the account and/or Lane Identifiers and provides a function for generation of Statements and consolidated Tax Invoices and an interface to the System User to handle enquiries.

6.7.1.3 The Toll System shall facilitate the setup and configuration of accounts of various Road User requirement combinations as described in clause 7.4.4. The account shall consist of, at the least, the following components:

- (a) Contact details, preferred methods of communication and address details.
- (b) Account settlement method and financial institution details including validation codes and expiry dates of Identifiers used as Payment Types.
- (c) Account statuses and other indicators required for the complete management of such account.
- (d) Single Identifier or multiple Identifiers linked to the account in order to consolidate all toll transactions into one single monthly consolidated TAX-Invoice.
- (e) Single or multiple, unique vehicle details associated Identifier

6.7.2 ACCOUNT FUNCTIONALITY & PROCESSING

6.7.2.1 The system shall allow for the following automated account functionality:

- (a) Real time updating of account balances with payments received, transactions processed, Discounts realized and account corrections processed.
- (b) Download of balances and account status.
- (c) Provide pro forma and actual VAT Statement.
- (d) Provide secure internet site for the Road User to perform account related enquiries and actions such as account applications, limited modifications to Road User information, financial transactions, extract of SARS documents, Transaction detail reports, lodging queries and complaints.
- (e) Allow credit notes to be processed on termination or for corrections.
- (f) Allow debit notes to be processed on termination or for corrections.
- (g) Allow function for transfer of money between accounts.
- (h) Allow for the Receipt, banking and control of sundry account related fees.
- (i) Allow for management of pre paid float.
- (j) Low balance flag.
- (k) Allow automatic top-up from banking institution.

- (l) The Back Office shall incorporate financial reconciliation and porting facilities to import bank statements from the Joint Account in order to detect all EFT payments and to reconcile all movement of funds.
- (m) The Back Office shall allow for unique privacy conditions to be set on each account and Identifier, linked to such account. This shall be applicable in an environment where the User is informed of financial statuses via printed media or the UFD in Conventional or Hybrid Toll Plazas.

6.8 PROCESSING OF BANK RELATED TRANSACTIONS

6.8.1 CREDIT, DEBIT AND FLEET CARD PAYMENTS – EMPLOYER MERCHANT AGREEMENT

- 6.8.1.1 The Back Office shall interface in real time via an integrated speedpoint or similar to the Merchant Bank during any account application in seeking immediate payment for application and related fees. This bank verification of payment shall be used to accept the presented Card as a valid Payment Method (Payment Type) for settlement purposes of the account in future.
- 6.8.1.2 In terms of the Merchant Agreement, the term “Transaction” shall be associated with valid VAT-Invoices (in accordance with the requirements of SARS).
- 6.8.1.3 The system shall use the applicable lists received from the bank to validate transactions before allowing the card to be used as payment for a transaction.
- 6.8.1.4 The system shall generate an electronic file to transfer bank card transaction data to the banking institution according to the banking institution's specified format.
- 6.8.1.5 The system shall receive an electronic file with processing status from the bank to indicate the status of transactions processed or rejected by the bank. This file shall enable the automated reconciliation of bank transactions. Only un-recognised transaction references shall be processed by means of Contractor intervention.
- 6.8.1.6 The system shall reconcile transactions sent to the bank to transactions processed and paid by the bank and report on transactions not processed by the bank. The Back Office shall employ an automated credit control and account follow-up management system.

6.8.2 DEBIT ORDER PAYMENTS

- 6.8.2.1 The system shall allow for the electronic transfer of debit order transactions to the chosen banking institution.
- 6.8.2.2 The system shall allow for the automatic processing of the acknowledgment file for the debit orders processed.

- 6.8.2.3 The system shall reconcile debit order requests sent to the bank to debit order transactions processed and paid by the bank and allocate the valid payments to the road users' accounts.

6.8.3 CONSOLIDATION, CONFIGURATION & CONTROL LISTS USED FOR VALIDATION

- (a) The system shall receive hotlists and other operational card lists from the various banks and other card issuing authorities.
- (b) The system shall provide an efficient and effective facility to automatically download the applicable lists to all lower levels including the Toll Lanes.
- (c) The system shall report on the success of the download of the various lists to the lanes
- (d) The system shall maintain an audit trail of changes made to the lists.

6.8.4 CALCULATION OF MERCHANT COMMISSION AND BANK COST PAYABLE

The system shall provide a facility to automatically calculate the merchant commission and bank cost payable on the processing of the electronic transactions.

6.9 DATABASE MAINTENANCE

- 6.9.1.1 The system will provide the most efficient reporting tool to allow adequate control and monitoring of the database maintenance and will include the following information:

- (a) Data consistency status (correctness and completeness) of the data received from the Lanes and Tolling Points.
- (b) Data transmission status: The report will include transmission status (success and failures) between the toll sub-system levels, e.g. hot card lists and account balance updates.
- (c) Data retention and maintenance status, including:
 - i. Oldest data available on the system.
 - ii. Last day archived.
 - iii. Last date of back-up.
 - iv. Disc space available on the system.

6.10 TOLL INCOME, REVENUE AND TRAFFIC MANAGEMENT

6.10.1 GENERAL

6.10.1.1 The system will provide the reports necessary to manage and control the further processing of Toll Income and Toll Revenue.

6.10.1.2 The system will provide reports to assist the audit and verification of the Toll Income, Toll Revenue and Toll Traffic.

6.10.1.3 Reports will include listings of the detail information used in the calculation of the summarised information.

6.10.2 TOLL TRANSACTION PAYMENT FOR ETC TRANSACTIONS

The Guaranteed Payment for Compliant Transaction Records is made once the Transaction Record status is confirmed by the TCH and VPC Systems (for Opt-in Toll Agencies) respectively. Refer to the Standard Specifications for Operations and Maintenance of CTROM Projects: ETC Interoperability – Business Rules (Volume 2 Book 8a) for more detail in this regard.

6.11 REPORTING

6.11.1 GENERAL

6.11.1.1 The general reporting requirements are addressed in clause 3.5.1.

6.11.1.2 The Toll System shall be capable of generating a report providing the actual Toll Class versus the AVC Toll Class and the Toll Collector Toll Class versus the actual Toll Class. All necessary corroboratory information and detail shall be made available by the Contractor, upon request by the Employer's Representative.

6.11.1.3 In addition, the reporting system shall supply the Contractor and System Users with the relevant reports with regards to the following:

- (a) Traffic Reports
- (b) Transaction Processing Reports
- (c) Incident Management Reports
- (d) Financial Reports

(e) Audit Reports

(f) System Maintenance Reports

6.11.1.4 Refer to the Standard Specifications for Operations and Maintenance of CTROM Projects: General (Volume 2 Book 2a) for more details.

SECTION 7. INTERFACES

7.1 OVERVIEW

7.1.1 INTRODUCTION

7.1.1.1 The Back Office and Road Side System / Toll Collection Lane Equipment are expected to interact with a number of systems, and as such will have to manage and participate in various interfaces and interactions. The interfaces, file format, protocol and frequency shall be agreed upon by the interfacing parties. Interfaces shall be well defined in an interface document.

7.1.1.2 Large volumes of data need to be exchanged in a fast and reliable way, according to accepted best practices. Data shall be transferred securely from one subsystem to another to prevent eavesdropping, spoofing, replay and undetected tampering.

7.1.1.3 The Toll System shall cater for additional interfaces should these be required.

7.2 RSS / TOLL COLLECTION LANE EQUIPMENT AND BACK OFFICE SYSTEM INTERFACES

7.2.1 OVERVIEW

The RSS / Toll Collection Lane Equipment shall interface with the Back Office to exchange the following information:

7.2.1.1 Raw Data

7.2.1.2 Validation List(s) (ETC Transactions only)

7.2.1.3 VOSI Lists (If required)

7.2.1.4 Card Hot Lists (Conventional /Hybrid Plazas only)

7.2.1.5 Registered Local Accounts (Conventional /Hybrid Plazas only)

7.2.2 RAW DATA INTERFACE

7.2.2.1 System-related Incidents and Transaction Records, with the relevant images, shall be transferred from the RSS/ Toll Lane to the Back Office in near real time.

7.2.2.2 The Back Office System shall be able to automatically or manually request missing data from the RSS/Toll Lane during the validation process, e.g. when Transaction Record sequence numbers are missing.

7.2.3 VALIDATION LIST(S)

- 7.2.3.1 The Back Office System shall check and validate Validation List(s) retrieved from the TCH System and transfer the Validation List(s) to the RSS/Toll Lane in near real time or as agreed between the Contractor and Employer. The RSS/Toll Lane shall acknowledge receipt of the Validation List(s).

7.2.4 VOSI LISTS (IF REQUIRED)

- 7.2.4.1 The Back Office System shall check and validate VOSI Lists retrieved from the TCH System and transfer them to the RSS/Toll Lane in near real time, should the system make provision for VOSI. The RSS/Toll Lane shall acknowledge receipt of the VOSI Lists.

7.2.5 CARD HOT LISTS (CONVENTIONAL /HYBRID PLAZAS)

- 7.2.5.1 The Back Office System shall transfer the card hot lists received from the Banks to the Toll Lanes in predefined intervals.

7.2.6 REGISTERED LOCAL ACCOUNTS (CONVENTIONAL /HYBRID PLAZAS)

- 7.2.6.1 The Back Office System shall and transfer the relevant details of local account holders to the Toll Lanes in near real time.

7.3 BACK OFFICE TO NATIONAL PAYMENT SYSTEM INTERFACES**7.3.1 OVERVIEW**

The Contractor shall comply with the requirements of the various Merchant Agreements between the Employer and the banks.

- 7.3.1.1 The Contractor will accept Bank Issued Credit Cards and Bank Issued Debit Cards for:

- (a) Lane payment – only Credit Cards where a PIN is not required (including Fleet Cards);
- (b) POS payment - Credit Card transactions (including a card where a PIN is required); and
- (j) POS payment - Debit Card transactions where a PIN is required.

- 7.3.1.2 The Contractor might decide to allow debit order payments for top-up or settlement of account balances.

- 7.3.1.3 The required system interfaces between the Contractor and the banks shall be specified and agreed with the merchant agreements between the Employer and the banks.

7.4 THE EMPLOYER'S INTERFACE

7.4.1 SCOPE

7.4.1.1 This section covers the data interface between the Employer and the Contractor and/or the Toll System. The interface contained in this section defines the structure of the Contractors/the Employer interface, otherwise referred to as the ITIS Interface. Detailed field values will be supplied during the Establishment Period.

7.4.1.2 The ITIS interface for Conventional Plazas and Conventional portions of Conventional/Hybrid Toll Plazas has the following objectives:

- (a) To report hourly summary passage transaction data from the AVCs in each Lane (including pseudo Lanes), from each Virtual Toll Plaza, via the DCS to the Employer.
- (b) To report hourly summary passage transaction data from the Back Office System for each Lane per virtual plaza to the Employer.
- (c) To report the required Revenue to be deposited by the Contractor into the joint bank account on a daily basis to the Employer.
- (d) To report hourly summary Incident data from each AVC per Virtual Plaza via the DCS to the Employer.
- (e) To report monthly reconciled financial data to the Employer.
- (f) To facilitate continuous video image feed from the Queue Length Monitoring System and associated critical Incident monitoring to the Employer Operations Monitoring Centre.

7.4.1.3 The ITIS interface for any ORT type applications has the following objectives:

- (a) To report hourly summary passage transaction data from the DCS (collected by the RSS) at each Tolling Point to the Employer.
- (b) To report hourly passage transaction data from the Back Office System for each Tolling Point to the Employer.
- (c) To report the required Income generated from vehicles passing through all Tolling Points on a daily and monthly basis to the Employer.
- (d) To report hourly summary Incident data for the RSS per Control Centre via the DCS to the Employer.
- (e) To report the monthly reconciled transaction data to the Employer.

7.4.1.4 These interfaces will be revised from time to time within the guidelines defined herein. Revisions will be limited to file format changes. The Contractor shall modify the Toll System to comply with such updates. The Contractor shall allow for modification or addition of any one of the following:

- (a) Toll Class;
- (b) Payment Mechanism;
- (c) Payment Type;
- (d) Payment Group;
- (e) Discount group.

7.4.2 **THE EMPLOYER'S DATA INTERFACE (ITIS)**

7.4.2.1 All data shall be reported to ITIS daily, or as agreed between the Contractor and the Employer. ITIS requires the following data for Conventional and Conventional portions of Conventional/Hybrid Toll Plazas:

- (a) Back Office System traffic information: This is based on the complete and updated integrated Lane and AVC Transaction Records, primarily as recorded by the TCC and Back Office System, summarised hourly information per Toll Lane per Toll Class. The passage transactions shall be grouped in hourly summaries based on the passage transaction conclusion time when the vehicle completed its passage over or through the entire AVC area and its sensors. In cases where the AVC class is not available, the TCC shall use a timer to conclude the transaction. In such cases the transaction time shall be the time when the timer reached completion. The Back Office System traffic shall reflect all vehicle passages including all manual transactions although not recorded by the TCC and/or AVC. This shall include transactions captured to reflect Manual Mode transaction processing and those not successfully recorded by the TCC for actual vehicle passages. The Back Office System traffic and revenue reporting shall be based on corrected or actual vehicle classifications as verified by the Contractor and is auditable by means of the VGS.
- (b) Back Office System Income and Discount information: per Toll Plaza Control Centre per day and month as applicable. Frequent user Discounts may only be available at month-end.
- (c) AVC traffic/passage information: This is based on hourly information per AVC per Toll Class.
- (d) AVC Incidents / faults information per AVC.
- (e) DCS Incidents / faults.
- (f) All additional income other than income from passage transactions.

7.4.2.2 ITIS requires the following data for any ORT type applications:

- (a) Back Office System traffic information: This is based on data collected and/or combined at the Back Office System, and summarised as hourly information per Tolling Point per Vehicle Class. The ETC transactions shall be grouped in hourly summaries based on the transaction conclusion time once the vehicle has concluded its passage through the Tolling Point (as measured by the RSS). The Back Office System traffic shall reflect all vehicle passages including all passages for which no valid Identifier could be ascertained. The Back Office System traffic report shall be based on the corrected Actual Class as verified by the Contractor and is auditable by means of ANPR and Scene images.
- (b) Back Office System Income and Discount information: per Tolling Point per day and month as applicable.
- (c) RSS traffic/passage information: This is based on hourly information per Tolling Point per Vehicle Class as collected by the RSS.
- (d) RSS Incidents / faults information per Tolling Point.

7.4.2.3 All calendar days refer to days starting at 00:00:00 and ending at 23:59:59

7.4.2.4 All hour referencing to hours in any data file shall be in terms of hour 00 to 23, i.e.:

- (a) hour 00 represent all data from 00:00:00 to 00:59:59;
- (b) hour 01 represent all data from 01:00:00 to 01:59:59;
- (c) hour 02 represent all data from 02:00:00 to 02:59:59;
- (d) hour 03 represent all data from 03:00:00 to 03:59:59;
- (e) hour 21 represent all data from 21:00:00 to 21:59:59;
- (f) hour 22 represent all data from 22:00:00 to 22:59:59; and
- (g) hour 23 represent all data from 23:00:00 to 23:59:59.

7.4.3 Statistical Information Requirements

7.4.3.1 The Contractor shall supply data to the Employer in the format indicated to enable the Employer to generate the following reports for Conventional and Conventional portions of Conventional/Hybrid Toll Plazas:

- (a) AVC traffic per Toll Class, per Lane, per hour;
- (b) Back Office System traffic, per Toll Class, per Lane, per hour (based on the AVC transaction conclusion time);

- (c) Back Office System Income per Virtual Toll Plaza, per Method of Payment, per month;
- (d) Back Office System Revenue detailing each individual source, per day, per month;
- (e) Frequent User Discount, per Control Centre, per month;
- (f) Bank roll-up file variations report indicating the discrepancy details of Credit Card transactions, transaction rejections, commissions and other bank charges;
- (g) Local and Regional Discount, per Virtual Toll Plaza, per month, per Method of Payment, where no Frequent User Discount was granted;
- (h) Local and Regional Discount, per Toll Plaza (or per Control Centre if approved by Employer's Representative), per month, where Frequent User Discount was granted;
- (i) Heavy Vehicle Discount per Virtual Toll Plaza, per month, per Method of Payment, where Heavy Vehicle Discount was granted;
- (j) Contractor Discount granted per Virtual Toll Plaza per month, per Discount group, per Method of Payment where Contractor Discount was granted (depending on Discount structure). Reporting to be approved by Employer's Representative;
- (k) Exempt User transaction values per Virtual Toll Plaza per month for the following categories:
 - (l) South African Police Services;
 - (m) South African National Defence Force;
 - (n) Other;
- (o) Value of unpaid Violations, including No-Payment Violations per Virtual Toll Plaza, per day.
- (p) AVC Incidents / Faults.

7.4.3.2 The Contractor shall supply data to the Employer in the format indicated to enable the Employer to generate the following reports for any ORT type applications:

- (a) RSS traffic per Vehicle Class, per Tolling Point, per hour;
- (b) Back Office System traffic, per Vehicle Class, per Tolling Point, per hour;
- (c) Back Office System Income per Control Centre, per month;
- (d) Discount type per Control Centre, per month;
- (e) Exempt User transaction values per Control Centre, per month for the following categories:

- i. South African Police Services (SAPS);
 - ii. South African National Defence Force (SANDF);
 - iii. Other;
- (f) Value of transactions with an Identifier not linked to a Customer Account, or no determinable Identifier, per Tolling Point, per day; and
- (g) RSS Incidents/Faults.

7.4.4 Interface Definition: Predefined Data

Predefined data is that data, which will be fixed, and can only be changed with the approval of the Employer.

7.4.4.1 Control Centre names, Toll Plaza names, Virtual Toll Plaza names and Lane names (or Lane ID's) for Conventional and Conventional portions of Conventional/Hybrid Toll Plazas:

- (a) The Employer shall, at its sole discretion, allocate Lane ID's, Virtual Toll Plaza ID's, Toll Plaza ID's and Control Centre ID's. Toll Plaza ID's and Virtual Toll Plaza ID's shall be unique and shall consist of three numeric characters (999).
- (b) Control Centre ID's shall be unique and shall consist of three numeric characters (999) - Refer to the Project Document (Volume 3). Where reporting is done on Control Centre level, "Virtual Plaza" ID is replaced with "Control Centre" ID.
- (c) Virtual Toll Plaza ID's shall be unique and shall consist of three numeric characters (999) - Refer to the Project Document (Volume 3).
- (d) Lane ID's for each traffic Lane per Virtual Toll Plaza Lane-group shall consist of a unique, four (4) digit alpha-numeric ID (99AA). In the case of reversible Lanes each direction would have its unique lane ID indicating the difference in direction (12MS and 12MN). The appropriate table containing the ID's will be supplied to the Contractor by the Employer's Representative.
- (e) The following is an example of the format of the Toll Plaza table. Only the Virtual Toll Plaza ID is used in the interface:

TABLE 7-1: VIRTUAL TOLL PLAZA TABLE

CONTROL CENTRE ID	VIRTUAL TOLL PLAZA ID	DIRECTION	VIRTUAL PLAZA NAME
003	036	N	Huguenot
003	035	S	Huguenot
021	116	N	Kranskop mainline

CONTROL CENTRE ID	VIRTUAL TOLL PLAZA ID	DIRECTION	VIRTUAL PLAZA NAME
021	117	S	Kranskop mainline
021	118	N	Kranskop ramp
021	119	S	Kranskop ramp

- (f) Lane ID Table for Conventional and Conventional portions of Conventional/Hybrid Toll Plazas: The following list is an example of the Lane ID's. The ID's and description required by the Contractor will be issued to the Contractor by the Employer's Representative. The Virtual Toll Plaza ID is used in the interface.

TABLE 7-2: LANE ID TABLE

VIRTUAL TOLL PLAZA ID	LANE ID	DESCRIPTION
098	85RN	Lane 85 of Virtual Plaza "098" - Ramp North
035	06MS	Lane 06 of Virtual Plaza "035" Mainline South
035	07MS	Lane 07 of Virtual Plaza "035" Mainline South
036	18MN	Lane 18 of Virtual Plaza "036" Mainline North

7.4.4.2 Tolling Point names and ID's for any ORT type applications:

- The Employer shall, at its sole discretion, allocate Tolling Point ID's. Tolling Point ID's shall be unique and shall consist of four numeric characters (9999).
- The appropriate table containing the ID's will be supplied to the Contractor by the Employer's Representative.
- The following is an example of the format of the Tolling Point table. Only the Tolling Point ID is used in the interface:

TABLE 7-3: TOLLING POINT TABLE

TOLLING POINT ID	TOLLING POINT NAME
1001	Scienta
1002	Waterkloof
1044	Griffiths
1045	Isando

7.4.4.3 Methods of Transaction logging linking the transaction source to the final payment or account settlement protocol for Conventional and Conventional portions of Conventional/Hybrid Toll Plazas:

- (a) A list of Payment Groups, Payment Mechanisms, Discount Types and Payment Types with the allocated numeric ID's are included below. This list may be amended from time to time depending on unique conditions or the requirements of the Employer. Amendments will be made at the sole discretion of the Employer. In the event that such list is amended it will be distributed by the Employer to the Contractor. The relationship between Payment Group, Payment Mechanism, Discount Type and Payment Type is illustrated below:

TABLE 7-4: METHODS OF PAYMENT (CONVENTIONAL /HYBRID TOLL PLAZAS)

Payment Group	Possible Payment Mechanism applicable to the Payment Group (identified by)	Possible Discounts applicable to the Payment Type/group	Payment Type
Cash	Cash Operator Card (Magnetic Stripe)	Nominal Tariff Local and Regional Discount	Cash
TCH Account: (Pre- and Post Paid Account Identifiers on the Green List but EXCLUDING any Exempt Vehicle Identifiers)	ETC Tag issued by the TCH VLN 3 rd Identifier	Nominal Tariff Frequent User Discount Local and Regional Discount Payment Mechanism Discount Time of day Discount Public Transport Discount	N/A
Pre Payment	Credit Cards Fleet Cards Charge Cards Operator Card (Mag striped) Operator Card (smart card) Smart card issued by a Bank Bank Debit Cards	Nominal Tariff Frequent User Discount Local and Regional Discount Discretionary Discounts Heavy Vehicle Discounts	Cash (Including debit orders, cheques, direct transfers, bank deposits etc.) Clearing of Bank Issued Card payments Other

Payment Group	Possible Payment Mechanism applicable to the Payment Group (identified by)	Possible Discounts applicable to the Payment Type/group	Payment Type
Post Payment	Credit Cards (Registered and Un-registered Users) Fleet Cards Charge Cards Operator card (Magnetic stripe) Operator Card (smart card) Smart card issued by a Bank Bank Debit Cards	Nominal Tariff Frequent User Discount Local and Regional Discount Discretionary Discounts Heavy Vehicle discounts	Cash (Including debit orders, cheques, direct transfers, bank deposits etc.) Clearing of Bank Issued Card payments Other
Run-through Violation	Run Through Identifier	Nominal Tariff	Cash (Including debit orders, cheques, direct transfers, bank deposits etc.) Clearing of Bank Issued Card payments Other
Exempt Vehicles (SANDF) (SAPS) (Other) (For ETC Tags this shall be determined by the account type as indicated by means of the Validation List(s))	Credit Cards Fleet Cards Charge Cards Operator Card (Magnetic stripe) Operator Card (smart card) Smart card issued by a Bank ETC Tag issued by the TCH (only Exempt Identifiers) Bank Debit Cards Official Warrant	100 % discount (Taxable Nominal Tariff Transaction in Toll Lane written off in Back Office with Credit Note).	Cash (Including debit orders, cheques, direct transfers, bank deposits etc.) Clearing of Bank Issued Card payments Credit Notes Other
No-Payment	No-Payment identifier	Nominal Tariff	Cash (Including debit orders, cheques, direct transfers, bank deposits etc.) Clearing of Bank Issued Card payments Other
Sundry items: (Pre-paid User			Cash (Including debit orders, cheques, direct transfers, bank

Payment Group	Possible Payment Mechanism applicable to the Payment Group (identified by)	Possible Discounts applicable to the Payment Type/group	Payment Type
account deposits) (Surplus Revenue) (Over collections, Negative discrepancies etc) (Paid passage transactions for Violations, Exempts, No-Payments) (Other income for the Employer's account) (Other income for Contractor account including Contractor user account charges)			deposits etc.) Clearing of Bank Issued Card payments Other

- (b) The Contractor shall ensure that the Toll System can accept a minimum of 15 (fifteen) different Payment Groups. The current approved list of Payment Groups is as follows for Conventional and Conventional portions of Conventional/Hybrid Toll Plazas.

TABLE 7-5: PAYMENT GROUPS

Payment Group ID	Payment Group
01	Cash
02	Pre paid
03	Post paid
04	Run-through Violation
05	Exempt Vehicle
06	No Payment
07	Sundry: Pre-paid User account deposits
08	Sundry: Surplus Revenue (Over collections, Negative discrepancies etc)
09	Sundry: Paid passage transactions – Violations, Exempts, No-Payments
10	Sundry: Other income for the Employer's account
11	Sundry: Other income for Contractor account including Contractor user account charges

Payment Group ID	Payment Group
12	TCH Account (excl. Exempt Vehicle accounts)
....	
n	Payment Group _n

- (c) The Contractor shall ensure that the Toll System can accept a minimum of 15 (fifteen) different Payment Types. The current approved list of Payment Types for Conventional and Conventional portions of Conventional/Hybrid Toll Plazas: is as follows:

TABLE 7-6: PAYMENT TYPES

Payment Type ID	Payment Type
01	Cash
02	Bank Issued ISO Credit Card
03	Fleet Card
04	Charge Card
05	Contractor Account
06	Credit Notes
07	
08	
....	
N	Payment Type _n

- (d) The Contractor shall ensure that the Toll System can manage a minimum of 31 (thirty one) different Payment Mechanisms. The current approved list of Payment Mechanisms for Conventional and Conventional portions of Conventional/Hybrid Toll Plazas: is as follows:

TABLE 7-7: PAYMENT MECHANISMS

Payment Mechanism ID	Payment Mechanism name
00	Cash
01	ISO Credit Card
02	Fleet Card
03	Charge Card
04	ETC Tag

Payment Mechanism ID	Payment Mechanism name
05	Operator Card
06	Smart Card
07	Operator Smart Card
08	Official Warrant
09	Run Through
10	No-Payment
....
N	Payment Mechanism _n

7.4.4.4 Methods of Payment for ORT type applications

- (a) A list of Payment Groups and Payment Mechanisms with the allocated numeric ID's applicable for ORT type applications are included below. This list may be amended depending on requests from the Contractor or the requirements of the Employer. Amendments will be made at the sole discretion of the Employer. In the event that such list is amended it will be distributed by the Employer to the Contractor. The relationship between Payment Group, Payment Mechanism and Discount is illustrated below:

TABLE 7-8: METHODS OF PAYMENTS (ORT)

Payment Group	Possible Payment Mechanism applicable to the payment group (identified by)	Possible discounts applicable to the payment group
TCH ACCOUNT (Pre- and Post Paid Account Identifiers on the Green List but EXCLUDING any Exempt Vehicle Identifiers)	ETC Tag issued by the TCH VLN 3 rd Identifier	Nominal Tariff Frequent User Discount Local and Regional Discount Discretionary Discounts Payment Mechanism Discount Time of day Discount Public Transport Discount
RUN-THROUGH VIOLATION (Identifiers on the Red List) (Vehicles with no valid Identifier)	Run Through Identifier	Nominal Tariff

Payment Group	Possible Payment Mechanism applicable to the payment group (identified by)	Possible discounts applicable to the payment group
EXEMPT VEHICLES (SANDF) (SAPS) (Other)	Exempt Identifier	Free User Passage 100% discount

- (b) In addition to the requirements of the Toll System for Conventional type applications, the following Payment Groups, relevant for ORT type applications, shall be applicable/supported:

TABLE 7-9: PAYMENT GROUPS (ORT)

Payment Group ID	Payment Group
04	Run-through Violation
05	Exempt Vehicles
12	TCH Account (excl. Exempt Vehicle accounts)

- (c) In addition to the requirements of the Toll System for Conventional type applications, the following Payment Mechanism, relevant for ORT type applications, shall be supported:

TABLE 7-10: PAYMENT MECHANISMS (ORT)

Payment Mechanism ID	Payment Mechanism name
04	ETC Tag
08	Exempt Identifier (Tag / VLN / 3 rd Identifier)
09	Run Through
11	VLN
12	3 rd Identifier

7.4.4.5 Discount Types for Conventional and Conventional portions of Conventional/Hybrid Toll Plazas:

- (a) A list of Discount types with the allocated numeric ID's is provided below. This list may be amended depending on requests from the Contractor or the requirements of the Employer at the sole discretion of the Employer. In the event that such list is amended it will be distributed by the Employer to all relevant Contractors.
- (b) The Contractor shall ensure that the Toll System can manage a minimum of 31 (thirty-one) different Discount types.

- (c) The current approved list of Discounts is as follows:

TABLE 7-11: DISCOUNT TYPES

Discount ID	Discount Name
00	Nominal
01	Heavy Vehicle Discount
02	Frequent User Discount
03	Local and Regional Discount
04	Contractor account
05	Official SANDF warrants
06	Official SAPS warrants
07	Discretionary Discount
N	Discount _n

7.4.4.6 Discount Types for ORT type applications:

- (a) In addition to the requirements of the Toll System for Conventional type applications, the following Discount types and associated numeric ID's, relevant for ORT type applications, shall be supported by the Toll System:

TABLE 7-12: DISCOUNT TYPES (ORT)

Discount ID	Discount Name
00	Nominal
02	Frequent User Discount
03	Local and Regional Discount
05	Official SANDF Identifiers
06	Official SAPS Identifiers
07	Discretionary Discount
08	Payment Mechanism Discount
09	Time of day Discount
10	Public Transport Discount

7.4.4.7 Vehicle Class for Conventional and Conventional portions of Conventional/Hybrid Toll Plazas

The Contractor shall ensure that the Toll System shall classify vehicles in accordance with the vehicle classes as published in the latest Government Gazette. The Contractor shall ensure that the design of the Toll System can manage a minimum of 15 (fifteen) different Vehicle Classes.

TABLE 7-13: VEHICLE CLASSES - AXLE BASED (ILLUSTRATIVE INFORMATION – REFER TO GOVERNMENT GAZETTE FOR VEHICLE CLASS INFORMATION)

ID	Name	Mapped Vehicle Classes
01	Toll Class 1	2 or more axle Light Vehicle
02	Toll Class 2	2 axle Heavy Vehicle
03	Toll Class 3	3 axle and 4 axle Heavy Vehicle
04	Toll Class 4	5 and more axle Heavy Vehicle

7.4.4.8 Vehicle Class for ORT type applications

The Contractor shall ensure that the Toll System shall classify vehicles in accordance with the vehicle classes as published in the latest Government Gazette. The Contractor shall ensure that the design of the Toll System can manage, as an extension of the requirements for Conventional type applications, the following designated Vehicle Classes.

TABLE 7-14: VEHICLE CLASSES – VOLUMETRIC (ILLUSTRATIVE INFORMATION – REFER TO GOVERNMENT GAZETTE FOR VEHICLE CLASS INFORMATION)

ID	Name	Mapped Vehicle Classes
05	Vehicle Class A1	Motorcycle
06	Vehicle Class A2	Light Vehicle
07	Vehicle Class B	Heavy Vehicle
08	Vehicle Class C	Heavy Vehicle

7.4.5 **Interface Definition: AVC/DCS and other Toll System Incidents/Fault messages**

7.4.5.1 Conventional and Conventional portions of Conventional/Hybrid Toll Plazas

- (a) The Contractor shall ensure that the Toll System can manage up to 1000 (one thousand) different Toll System Incident/fault/alarm and other status messages. The table below contains the various Incidents as defined by the Employer. The rules under which these Incidents are generated are described below and elsewhere in the Contract. Certain incidents may be generated by “substitute” platforms like the DCS and

the Back Office in the event where the typical source system did not generate the incident.

- (b) Examples of substitution incident generation, amongst other, are:
- i. The Manual and AVC Vehicle Classification are both incorrect and the Contractor corrects the Vehicle Classification. The Back Office shall log the status change and generate a positive or negative discrepancy on that level with the same Lane ID as if it was generated by the TCC. The Incident sequence number will, however, be that of the Back-Office and not the TCC.
 - ii. Where any transactions are recorded manually and captured on the Back Office, such transactions shall be verified by the Contractor in a similar manner as required for Violation or Run-Through passage transactions/passages.

The Toll system shall monitor fault statuses and end or close such fault state if the originating sub-system was not in the position to perform the end or closed state as would have been by the originating sub-system.

The Contractor may add additional Incidents that enable the management of critical operational functionality. Such incidents may be added to the critical incident lists upon acceptance by the Employer.

TABLE 7-15: INCIDENT MESSAGES (CONVENTIONAL / HYBRID TOLL PLAZAS)

ID	Name	Source/Comment	Reported to	Required /Optional
1.	AVC reboot/restart	AVC/Recorded by AVC on during boot cycle and AVC application restart.	DCS/TCC/VGS/ITIS	Required
2.	Serious start – AVC/DCS Communication fail	AVC/Detected by AVC when communication is lost with DCS	DCS/TCC/VGS/ITIS	Required
3.	Serious end – AVC/DCS Communication OK	AVC/Detected by AVC when communication is restored with DCS	DCS/TCC/VGS/ITIS	Required
4.	Roll-back	AVC/Defined elsewhere in the document	DCS/TCC/VGS/ITIS	Optional
5.	Reverse entry	AVC/Defined elsewhere in the document	DCS/TCC/VGS/ITIS	Optional
6.	Vehicle standing	AVC/Defined elsewhere in the document	DCS/TCC/VGS/ITIS	Required
7.	Vehicle with more than 10 axles	AVC/Maximum number of axles detected by any of the axle counters	DCS/TCC/VGS/ITIS	Required
8.	AVC sensor type 1 - fail	AVC/Loop failure, detected after three passages	DCS/TCC/VGS/ITIS	Required
9.	AVC sensor type 1 - OK	AVC/Loop reset, detected after three passages	DCS/TCC/VGS/ITIS	Required
10.	AVC sensor type 2 - fail	AVC/Axle counter failure, detected after three passages	DCS/TCC/VGS/ITIS	Required

ID	Name	Source/Comment	Reported to	Required /Optional
11.	AVC sensor type 2 - OK	AVC/Axle counter reset, detected after three passages	DCS/TCC/VGS/ITIS	Required
12.	AVC sensor type 3 - fail	AVC/Light/Heavy detector failure, detected after three passages	DCS/TCC/VGS/ITIS	Required
13.	AVC sensor type 3 - OK	AVC/Light/Heavy detector reset, detected after three passages	DCS/TCC/VGS/ITIS	Required
14.	AVC sensor type 4 - fail	AVC/Height detector failure, detected after three passages	DCS/TCC/VGS/ITIS	Required if used
15.	AVC sensor type 4 - OK	AVC/Height detector reset, detected after three passages	DCS/TCC/VGS/ITIS	Required if used
16.	Critical start - AVC panel door open	AVC/Detected by AVC on opening of door	DCS/TCC/VGS/ITIS	Required
17.	Critical end - AVC panel door close	AVC/Detected by AVC on closing of door	DCS/TCC/VGS/ITIS	Required
18.	Serious start - AVC Stand-alone Data	AVC/Reported by AVC if vehicle passage/s were recorded while AVC was in stand-alone mode	DCS/ITIS/TCC/VGS	Required
19.	Serious end - AVC Stand-alone Data	AVC/Reported by the AVC at the time when the AVC Stand-alone status is restored. The Incident is only reported if vehicles were recorded by the AVC during the AVC Stand-alone period. Incidents 18 & 19 are, therefore, always paired.	DCS/TCC/VGS	Required
20.	Critical start – AVC Storage 90% full	AVC/AVC Data storage device (e.g. Hard drive or flash) disk 90% full. This status is to be checked at least, once every hour and reported when valid.	DCS/TCC/ITIS	Required
21.	Critical start – AVC-UPS Backup battery voltage low	AVC/AVC UPS battery voltage low. Minimum voltage before Incident is generated is described elsewhere.	DCS/TCC/VGS/ITIS	Required
22.	Critical end – AVC-UPS Backup battery voltage OK	AVC/AVC UPS battery voltage recovered above the voltage low threshold described above.	DCS/TCC/VGS/ITIS	Required
23.	Serious start – TCC Communication fail	AVC/AVC/TCC communication failure detected and reported by the AVC and TCC	DCS/VGS/TCC/ITIS	Required
24.	Serious end – TCC Communication OK	AVC/Communication restoration detected by AVC	DCS/TCC/VGS/ITIS	Required
25.	Un-transmitted data deleted	AVC/AVC Data deleted by user or system before successfully transmitted to the DCS.	DCS/TCC/ITIS	Required

ID	Name	Source/Comment	Reported to	Required /Optional
26.	Plaza UPS power failed	AVC/Power to AVC fail (plaza UPS power)	DCS/TCC/VGS/ITIS	Required
27.	Plaza UPS power OK	AVC/Power to AVC restored (plaza UPS power)	DCS/TCC/VGS/ITIS	Required
28.	AVC User access – login	AVC/User accessed AVC (Software login)	DCS/TCC/ITIS	Required
29.	AVC User access – logout	AVC/User access to AVC terminated (Software log-out)	DCS/TCC/ITIS	Required
30.	Critical start – Sensor failure	AVC/Generated by the AVC when any two or more sensors fail during a vehicle passage	DCS/TCC/ITIS	Required
31.	AVC time update	AVC/AVC time updated by User or time server via the TCC	DCS/TCC/ITIS	Required
32.	Lane IP address change	TCC/IP address changed by user	DCS/TCC/ITIS	Optional
33.	Plaza IP address change	BO System/IP address changed by user	BO System	Optional
34.	AVC IP address change	AVC/IP address changed by user	DCS/TCC/VGS/ITIS	Required
35.	Lane ID change	AVC and/or TCC/Lane ID changed by user	DCS/TCC/BO SYSTEM	Required
36.				
37.	AVC License expired	AVC/	DCS/TCC/BO SYSTEM	Optional
38.	AVC License updated	AVC/	DCS/TCC/BO SYSTEM	Optional
39.	AVC Data Storage Device reset	AVC/	DCS/TCC/BO SYSTEM	Optional
40.	AVC Data Storage Device error	AVC/	DCS/TCC/BO SYSTEM	Required
41.	Wrong Direction	AVC/Defined elsewhere in document. Also see reverse passage.	DCS/TCC/VGS/ITIS	Required
42.	AVC Mode change	AVC/AVC switches between primary and pseudo lane-Ids (ramp/mainline swapping) Generate Incident when the lane is activated to process transactions for the pseudo lane AND generate the Incident for each passage processed in the pseudo state.	DCS/TCC/VGS/ITIS	Required if applicable.
43.	Ramp/Mainline barrier	AVC/Incident generated when any vehicle is detected through the Ramp/Mainline barrier. The additional sensors installed in the barrier – typically between mainline and ramp.	DCS/TCC/VGS/ITIS	Required
44.	Run-Through Violation	AVC/Incident generated when any vehicle pass through the AVC (in any direction) without any	DCS/TCC/VGS/ITIS	Required

ID	Name	Source/Comment	Reported to	Required /Optional
		valid method of payment.		
45.	Critical end – Sensor failure	AVC/Generated by the AVC when two or more of the sensors are no longer faulty.	DCS/TCC/ITIS	Required
46.	Serious start – DCS/AVC comms fail	DCS /Generated by the DCS when a communication failure with the AVC is detected by the DCS	VGS/ITIS	Required
47.	Serious End – DCS/AVC comms fail	DCS /Generated by the DCS when a communication failure with the AVC is restored	VGS/ITIS	Required
48.	Critical error mode time exceeded	DCS/ The DCS will determine the critical error mode time duration of all critical AVC Incident events. In instances where there are contiguously overlapping critical Incidents (e.g. a subsequent AVC critical Incident event occurring prior to the resolution of a previous/current AVC critical Incident event being resolved) the DCS shall calculate the critical mode error time duration of this event using the time stamp of the first critical AVC Incident fail as the start time of the event and the time stamp of the last AVC critical Incident OK as the end time for the event, for the combination of all such critical Incidents as constitutes this contiguously overlapping set of AVC critical Incidents. The DCS will generate this Incident per AVC. It will be generated if the critical mode period is longer than 4 (four) hours, or the period as specified in the Project Document (Volume 3). This Incident will be generated continuously for every continuous 4 (four) hour period interval, or corresponding period interval specified in the Project Document (Volume 3), that the AVC remains in critical error mode	DCS/ITIS	Required
49.	Critical error mode traffic exceeded	DCS/ The DCS will generate this Incident per AVC if the traffic processed whilst the AVC is in critical error mode exceeds 10 vehicles	DCS/ITIS	Required
50.	Serious error mode time exceeded	DCS/ The DCS will determine the AVC Serious mode error time durations of all critical AVC Incident events. In instances where there are contiguously overlapping serious AVC Incidents (e.g. a subsequent AVC serious Incident event occurring prior to the resolution of a	DCS/ITIS	Required

ID	Name	Source/Comment	Reported to	Required /Optional
		<p>previous/current AVC serious Incident event being resolved) the DCS shall calculate the serious error mode time duration of this event using the time stamp of the first serious AVC Incident fail as the start time of the event and the time stamp of the last serious AVC Incident OK as the end time for the event, for the combination of all such serious Incidents as constitutes this contiguously overlapping set of AVC critical Incidents. The DCS will generate this Incident per AVC. It will be generated if the serious mode period is longer than 24 (twenty four) hours, or the period specified in the Project Document (Volume 3).</p> <p>This Incident will be generated continuously for every continuous 24 (twenty four) hour period interval, or corresponding period interval specified in the Project Document (Volume 3), that the AVC remains in serious error mode</p>		
51.	AVC data missing – Critical error mode	DCS/ When compiling the AVC traffic and Incident/Fault log summaries for the previous calendar day (consolidation period), the DCS will check if hourly summaries (audit file) were received from all the AVCs (No less than 24 summaries (audit file periods) must be available for each AVC). The DCS will generate this Incident for every AVC where summaries for the complete consolidation period for that AVC have not been received.	DCS/ITIS	Required
52.	DCS reboot	DCS/The DCS shall generate this Incident when the DCS application/service is restarted	DCS/ITIS	Required
53.	ITIS data submission failure	DCS/The DCS shall generate this Incident indicating any ITIS file submission error. This includes data and reply retrieval and submission errors.	DCS/ITIS	Required
54.	Positive Discrepancy (PD)	AVC/The AVC shall generate this Incident in the event where the manual vehicle classification received from the TCC is a lower Vehicle Class than that detected by the AVC. This Incident shall also be generated in the event where no manual vehicle classification has been received from the TCC (e.g. Violation without manual classification).	DCS/ITIS/VGS/TCC	Required

ID	Name	Source/Comment	Reported to	Required /Optional
55.	Negative discrepancy (ND)	AVC/The AVC shall generate this Incident in the event where the manual vehicle classification received from the TCC is a higher Vehicle Class than that detected by the AVC.	DCS/ITIS/VGS/TCC	Required
56.	Reversible Lane AVC pair – Active AVC	AVC/Incident generated by the active AVC in a reversible Lane, upon being activated for Vehicle processing. Also generated at the end of the hour to indicate current state of the AVC.	DCS/ITIS/TCC	Required, if applicable
57.	Reversible Lane AVC pair – Dormant AVC	AVC/Incident generated by the dormant AVC in a reversible Lane upon being made 'inactive' for Vehicle processing. Also generated at the end of the hour to indicate current state of the AVC.	DCS/ITIS/TCC	Required, if applicable
58.	Critical End – AVC Storage 90% Full	AVC/AVC Data storage device (e.g. Hard drive or flash) disk 90% full cleared.	DCS/TCC/ITIS	Required, if applicable
59.	...			
N	AVC Incident n

7.4.5.2 RSS and other Toll System Incident/Fault messages

The Contractor shall ensure that the Toll System can manage up to 1000 (one thousand) different RSS and other Incident/Fault messages. The table below contains the RSS and other Incidents as defined by the Employer. The rules under which the Incidents are generated are described below and elsewhere in the Contract.

TABLE 7-16: INCIDENT MESSAGES (ORT)

ID	Name	Source / Comment	Reported to	Required /Optional
RSS Controller Reporting				
1001.	Serious start – RSS Controller Memory 90% full	Data storage device (e.g. Hard drive or flash) disk 90% full. This status is to be checked at least, once every hour and reported when valid.	DCS/BOS/ITIS	Required
1002.	Critical start - RSS Data Storage Device error	RSS Controller /	DCS/BOS/ITIS	Required
1003.	Un-transmitted data	RSS Controller / Any transaction data deleted by	DCS/BOS/ITIS	Required

ID	Name	Source / Comment	Reported to	Required /Optional
	deleted	user or system before successfully transmitted to the Back Office System.		
1004.	Gantry UPS power failed	RSS Controller / Power to RSS fail (Gantry UPS power)	DCS/BOS/ITIS	Required
1005.	Gantry UPS power OK	RSS Controller / Power to RSS restored (Gantry UPS power)	DCS/BOS/ITIS	Required
1006.	RSS User access - login	RSS Controller / User accessed the RSS Controller (Software login)	DCS/RSS/BOS/ITIS	Required
1007.	RSS User access - logout	RSS Controller / User access to RSS Controller terminated (Software log-out)	DCS/RSS/BOS/ITIS	Required
1008.	RSS time update	RSS Controller / RSS time updated by user or time server via the primary or secondary communication network	DCS/RSS/BOS/ITIS	Required
1009.	Serious start – RSS primary communication failure	RSS Controller / Generated by the RSS Controller when a communication failure (primary) with the Back Office System is detected	DCS/BOS/ITIS	Required
1010.	Serious End – RSS primary communication failure	RSS Controller / Generated by the RSS Controller when a communication link (primary) with the Back Office System is restored	DCS/BOS/ITIS	Required
1011.	Serious start – RSS backup communication failure	RSS Controller / Generated by the RSS Controller when a communication failure (backup) with the Back Office System is detected	DCS/BOS/ITIS	Required
1012.	Serious End – RSS backup communication failure	RSS Controller / Generated by the RSS Controller when a communication link (backup) with the Back Office System is restored	DCS/BOS/ITIS	Required
1013.	RSS reboot	RSS Controller / The RSS Controller shall generate this Incident when the RSS Controller application/service (or any part(s) thereof) is restarted	DCS/ITIS	Required
1014.	Positive discrepancy (PD)	RSS Controller / The RSS shall generate this Incident in the event where the RVC (from the Validation Lists) is a lower vehicle class than that detected by the AVC.	DCS/BOS/ITIS	Required
1015.	Negative discrepancy (ND)	RSS Controller / The RSS shall generate this Incident in the event where the RVC (from the Validation Lists) is a higher vehicle class than that detected by the AVC.	DCS/BOS/ITIS	Required

ID	Name	Source / Comment	Reported to	Required /Optional
1016.	Run-Through violation	RSS Controller / Incident generated by the RSS when any vehicle passage through a Tolling Point (in any direction) on the Red List or without the detection of a valid Identifier occurs.	DCS/BOS/ITIS	Required
AVC Reporting				
1017.	AVC reboot/restart	AVC / Recorded by RSS controller on/during boot cycle and AVC application restart.	DCS/BOS/ITIS	Required
1018.	Serious start – AVC Communication fail	RSS Controller / Tag Reader communication failure detected and reported by the RSS Controller	DCS/BOS/ITIS	Required
1019.	Serious end – AVC Communication OK	RSS Controller / Communication restoration detected by RSS Controller	DCS/BOS/ITIS	Required
1020.	Critical start - AVC failure	AVC / Generated by the AVC when any fault condition is detected via built-in tests	DCS/BOS/ITIS	Required
1021.	Critical end - AVC failure	AVC / Generated by the AVC when any fault condition previously signalled via built-in tests is cleared	DCS/BOS/ITIS	Required
Tag Reader Reporting				
1022.	Serious start – Tag Reader Communication fail	RSS Controller / Tag Reader communication failure detected and reported by the RSS Controller	DCS/BOS/ITIS	Required
1023.	Serious end –Tag Reader Communication OK	RSS Controller / Communication restoration detected by RSS Controller	DCS/BOS/ITIS	Required
1024.	Critical start Tag Reader failure	Tag Reader / Generated by the Tag Reader when any fault condition is detected via built-in tests	DCS/BOS/ITIS	Required
1025.	Critical end Tag Reader failure	Tag Reader / Generated by the Tag Reader when any fault condition previously signalled via built-in tests is cleared	DCS/BOS/ITIS	Required
ANPR Camera(s) Reporting (Front/Rear)				
1026.	ANPR Camera Communication fail	RSS Controller / ANPR Camera communication failure detected and reported by the RSS Controller	DCS/BOS/ITIS	Required
1027.	ANPR Camera Communication OK	RSS Controller / Communication restoration detected by RSS controller	DCS/BOS/ITIS	Required

ID	Name	Source / Comment	Reported to	Required /Optional
1028.	Serious start - ANPR Camera failure	ANPR / Generated by the ANPR Camera when any fault condition is detected via built-in tests	DCS/BOS/ITIS	Required
1029.	Serious end - ANPR Camera failure	ANPR / Generated by the ANPR Camera when any fault condition previously signalled via built-in tests is cleared	DCS/BOS/ITIS	Required
Scene Camera(s) Reporting				
1030.	Serious start - Scene Camera communication failure	RSS Controller / Scene Camera communication failure detected and reported by the RSS Controller	DCS/BOS/ITIS	Required
1031.	Serious end - Scene Camera Communication OK	RSS Controller / Communication restoration detected by RSS controller	DCS/BOS/ITIS	Required
1032.	Critical start - Scene Camera failure	Scene Camera / Generated by the Scene Camera when any fault condition is detected via built-in tests	DCS/BOS/ITIS	Required
1033.	Critical end - Scene Camera OK	Scene Camera / Generated by the Scene Camera when any fault condition previously signalled via built-in tests is cleared	DCS/BOS/ITIS	Required
DCS Reporting				
1034.	RSS data missing – Critical error mode	DCS / When compiling the AVC traffic and Incident/fault log summaries for the previous calendar day (consolidation period), the DCS will check if hourly summaries (audit file) were received from all the Tolling Points (No less than 24 summaries (audit file periods) must be available for each Tolling Point). The DCS will generate this incident for every Tolling Point where summaries for the complete consolidation period for that AVC have not been received.	ITIS	Required
1035.	DCS reboot	DCS / The DCS shall generate this Incident when the DCS application/service is restarted	ITIS	Required
1036.	ITIS data submission failure	DCS / The DCS shall generate this Incident indicating any ITIS file submission error. This includes data and reply retrieval and submission errors.	ITIS	Required
Critical/Serious Error Mode Reporting				

ID	Name	Source / Comment	Reported to	Required /Optional
1037.	Critical error mode time exceeded	<p>RSS Controller / The RSS Controller will determine the critical error mode time duration of all critical incident events. In instances where there are contiguously overlapping critical incidents (e.g. a subsequent critical incident event occurring prior to the resolution of a previous/current critical incident event being resolved) the RSS shall calculate the critical mode error time duration of this event using the time stamp of the first critical incident fail as the start time of the event and the time stamp of the last critical incident OK as the end time for the event, for the combination of all such critical incidents as constitutes this contiguously overlapping set of critical incidents. The RSS will generate this incident if the critical mode period is longer than 4 (four) hours, or the period as specified in the Project Document (Volume 3).</p> <p>This incident will be generated continuously for every continuous 4 (four) hour period interval, or corresponding period interval specified in the Project Document (Volume 3), that the RSS remains in critical error mode</p>	DCS/BOS/ITIS	Required
1038.	Critical error mode traffic exceeded	RSS Controller / The RSS Controller will generate this incident per Tolling Point if the traffic processed whilst any RSS component(s) is in critical error mode exceeds 10 vehicles	DCS/BOS/ITIS	Required
1039.	Serious error mode time exceeded	<p>RSS Controller / The RSS Controller will determine the serious mode error time durations of all critical incident events. In instances where there are contiguously overlapping serious incidents (e.g. a subsequent serious incident event occurring prior to the resolution of a previous/current serious incident event being resolved) the RSS shall calculate the serious error mode time duration of this event using the time stamp of the first serious incident fail as the start time of the event and the time stamp of the last serious incident OK as the end time for the event, for the combination of all such serious incidents as constitutes this contiguously overlapping set of critical incidents. The RSS will generate this</p>	DCS/BOS/ITIS	Required

ID	Name	Source / Comment	Reported to	Required /Optional
		incident if the serious mode period is longer than 24 (twenty four) hours, or the period specified in the Project Document (Volume 3). This incident will be generated continuously for every continuous 24 (twenty four) hour period interval, or corresponding period interval specified in the Project Document (Volume 3), that the RSS remains in serious error mode		
1040.
N	AVC Incident n

7.4.6 TRANSMITTED DATA

7.4.6.1 Media:

- (a) The Contractor shall apply for and provide any of the following communication mediums for IT IS data submission:
- A virtual private network (VPN) utilising PSTN or digital line for dial-up connection directly to the Employer's FTP server
 - Mobile network (VPN) utilising mobile network based dial-up for dial-up connection directly to the Employer's FTP server
 - A virtual private network (VPN) utilising mobile network based GPRS, EDGE, 3G connection etc. directly to the Employer's FTP server
 - A virtual private network (VPN) utilising DSL line for direct connection the Employer's FTP server
 - Mobile MMS transmission of files via the Cellular phone network to the Employer's FTP server
 - In the event that the Employer has not supplied the infrastructure connection at the ITIS side to support the VPN connections listed above, the Contractor shall transmit ITIS data files utilizing the existing FTP server from a standalone workstation via the internet.
 - This shall require the Contractor to unload the compressed, encrypted and signed ITIS data files from the Back Office System and DCS to removable media and transfer it to the stand alone workstation.

- (b) ITIS data files from the Back Office System and DCS shall be compressed using WinZip, encrypted and signed using RSA PKCS #1 v1.5 standard and SHA1 hashing algorithm.

- (c) Key generation:

- i. Two pairs of RSA keys will be generated by the Employer, the public key (Public Key 1 and 2) will be sent to the Contractor. The Contractor shall store one public key (Public Key 1) on the DCS computer and the other key (Public Key 2) on the Back Office System server. The Contractor shall store both keys in a secure manner such as utilizing a Secure Application Module (SAM).
- ii. The Contractor shall generate two RSA key pairs of which the public component will be sent to the Employer (Public Key 3 and 4). The Contractor shall store one private key (Private Key 3) on the DCS and the other private key (Private key 4) on the MIS/BOS server. The DCS and Back Office System Software/Hardware should not allow these key to be retrieved in an unauthorised manner.
- iii. The RSA keys will be 1024 bit and a single key sent in the following format.

```
<RSAKeyValue>
<Modulus>[base64]<Modulus>
<Exponent>[base64]</Exponent>
</RSAKeyValue>
```

- (d) Signing and Encryption

- i. The Contractor shall use the Public Key 1 and Public Key 2 to encrypt the data (DCS/RSS and Back Office System respectively) and then use the SHA1 algorithm to generate two message-digests of the encrypted data (this being the hash representation of the encrypted data).
- ii. The Contractor shall then use Private Key 3 and 4 respectively to generate the signature for the encrypted data by encrypting each message digest.
- iii. The Contractor shall construct the DCS and Back Office System data files using ANSI characters except where base64 is specified to store the signature and data values.

```
<message>
<sender>(Unique identifier for message sender)</sender>
<signature>(Signature generated) [base64 encoded]</signature>
<data>(Encrypted data) [base64 encoded]</data>
</message>
```

- (e) Signature verification and decryption
 - i. ITIS will verify the authenticity of files submitted by the Contractor. The following process will be used to verify the source
 - ii. The message signatures will be decrypted using the Public Key 3 and 4 sent by the Contractor (as indicated in the sender element).
 - iii. The two message-digests will then be created, by ITIS, for the encrypted data (DCS and Back Office System) using SHA1.
 - iv. These message-digests will then be compared by ITIS to the respective decrypted signatures, and if they correspond then the sender has been authenticated (data is seen as being sent by the source).
 - v. Once the sender's identity has been authenticated ITIS will then decrypt the Back Office System and DCS data (using Private Key 1 and 2) and process it.
- (f) Security Risks
 - i. The RSA encryption algorithm using a 1024bit key length is seen as strongly secure, there is currently no known way to reverse engineer the encryption keys in a reasonable amount of time. The greatest risk lies in the storage of the private keys. If the private key is compromised then the data is not secure.
 - ii. The compressed, encrypted and signed files shall be transmitted by the Contractor via the available and approved communication link and using the File Transfer Protocol (ftp). In cases where the Contractor is using a VPN between the Back Office System and ITIS, and the DCS and ITIS, the Contractor shall implement systems to automate the transmission and resubmission on the DCS and Back Office System for all types of files. At no stage shall the Contractor have access to these files in unencrypted format, other than a copy of the DCS data made available in a separate, secured directory on/at the DCS. Manual data submission may only be used in cases of network or system failure. Only electronic media will be acceptable by the Employer. Media can include:
 - 1. Write-once or write-many compact disks (CD-R or CDRW or DVD)
 - 2. USB removable media including USB hard drives or USB memory sticks.

7.4.6.2 Frequency

- (a) The frequency of file transfers shall be dependent on the file type and available communication channels. See table below.

TABLE 7-17: FREQUENCY OF FILE TRANSFERS

File Type	Frequency	Interface Deadlines for file transmission purposes	Type of application
ALL RECORDED AVC/RSS TRAFFIC DATA	Daily, the next calendar day	Within 4 hours after midnight, the end of the previous calendar day.	Conventional / ORT
VALIDATED CORRECT AVC/RSS TRAFFIC DATA	Daily, the next calendar day	Within 24 hours after midnight, the end of the previous calendar day.	Conventional / ORT
ALL RECORDED RSS INCIDENT/FAULT LOG DATA	Daily, the next calendar day	Within 4 hours after midnight, the end of the previous calendar day.	ORT
VALIDATED CORRECT RSS INCIDENT/FAULT LOG DATA	Daily, the next calendar day	Within 24 hours after midnight, the end of the previous calendar day.	ORT
ALL RECORDED AVC INCIDENT/FAULT LOG DATA	Daily, the next calendar day	Within 4 hours after midnight, the end of the previous calendar day.	Conventional
VALIDATED CORRECT AVC INCIDENT/FAULT LOG DATA	Daily, the next calendar day	Within 24 hours after midnight, the end of the previous calendar day.	Conventional
VALIDATED CORRECT BACK OFFICE SYSTEM DAILY TRAFFIC DATA	Daily within 2 days	Within 48 hours after midnight, the end of the previous calendar day.	Conventional / ORT
VALIDATED CORRECT BACK OFFICE SYSTEM MONTHLY TRAFFIC DATA	Monthly within 5 days	Within 5 days after midnight at calendar month-end	Conventional / ORT
VALIDATED CORRECT BACK OFFICE SYSTEM MONTHLY REVENUE DATA	Monthly within 5 days	Within 5 days after midnight at calendar month-end	Conventional
VALIDATED CORRECT BACK OFFICE SYSTEM MONTHLY INCOME DATA	Monthly within 5 days	Within 5 days after midnight at calendar month-end	ORT

- (b) The Contractor shall respond to the status message of the acknowledgement file on the ftp server ("xx.ack" file on the ftp server directory), after a waiting period of 2 (two) hours, following the deadlines above, for the Employer to put acknowledgement files back on the ftp server. The Contractor shall transmit or retransmit the data file or rename the acknowledgement file ("red"), depending on the "ack-file" instruction received, within the next 2 (two) hours. For example, the AVC traffic file must be transferred within two hours after midnight (00:00:00 to 03:59:59). The Employer will put

an acknowledgement file ("xxx.ack") on the ftp server (04:00:00 to 05:59:59). The Contractor shall respond to the ".ack" file within the next two hours by transmitting missing files, retransmitting files or renaming the successful ".ack" files to ".red" (06:00:00 to 07:59:59). The Contractor shall check the status of the ftp server and its acknowledgement files at least every 6 (six) hours in order to respond in time to the requirements of the different file types.

- (c) The above window period will be active for the transmission of data files. If a data file is submitted late, out of the window period (after the deadline indicated above), it will not be processed via the conventional methods. The file will be put in a queue where it will remain until an authorised user accepts or denies the load of the file. It shall be the Contractors responsibility to formally notify the Employer's Representative of any files that were submitted late. Only the Employer's Representative can authorise ITIS to load any late submitted file. Acceptance of files would be done on merit and within the penalty structure of this agreement. After this stage the appropriate acknowledgement file will be generated.

7.4.6.3 The above scheduling may be modified during the Works Period in order to equalise the load on the ITIS ftp server which may result in a different timing schedule to that noted above. The Toll System shall therefore be configurable to modify transmission times/intervals, reading ".ack" files as well as retransmitting ITIS files. File transfer Location and Procedure:

- (a) The Employer will inform the Contractor of its own secure FTP Software, supplied by the Employer, and this will be the destination for transferred files and the source for acknowledgement files. The directory structure of the FTP site will consist of a directory for each Control Centre linked to the CTROM contract. These will contain separate directories, one for AVC/RSS and one for Back Office System data. Separate login-IDs and passwords will be required to access these directories.
- (b) The Employer will delete data files once the files have been checked and imported from the FTP Site and the acknowledgement file created for the Contractor to read.
- (c) The Employer will archive and clear the processed acknowledgement files periodically once the Contractor has acknowledged the file (changed the file extension to ".red").

7.4.6.4 Data Format and File Structure:

All data will be printable ASCII except end-of-data markers. Files will have fixed structures consisting of fixed length file name, a body of one or more data records. All fields shall be delimited by a vertical bar/pipe (|). Numeric fields are represented as "999" and transmitted with padding where applicable. The delimiter characters are defined as:

- (a) End-of-field: Vertical bar/ pipe (|);
- (b) End-of-record: Carriage return/ Line Feed;

- (c) End-of-data: A carriage return and line feed will be used to identify the end of file. (The Windows ASCII character set to be used)

The last field in each record must also end in a vertical bar, and the last record in a file must end in carriage return, line feed.

7.4.6.5 AVC Traffic Data Transmission format for Conventional Tolling applications:

- (a) This file will contain summarised traffic data, transmitted from the AVC to the DCS, rolled-up per hour, on the DCS, for a full 24-hour period (the previous calendar day) and be named according to the naming convention;
- (b) Data must be transmitted for each Lane and each hour even if a Lane was closed or the AVC was not operational during a specific hour or longer;
- (c) File Naming:

EXAMPLE: 001_2002_04_13.AVC

TABLE 7-18: AVC TRAFFIC DATA FILE FORMAT

Description	Length	Sample
Predefined Virtual Toll Plaza ID – padded	3	001
Spacer	1	_(underscore)
Operating Date : yyyy_mm_dd – padded	10	2002_04_13
File extension .avc: First data file .avr: Retransmitted file	4	.avc

- (d) The Virtual Toll Plaza ID in the file name shall always be represented by three(3) digits.
- (e) "Operating date" refers to that date relevant to the traffic data in the file.
- (f) File Content:

EXAMPLE: 001|20020413|0|01|07MN|0|3|01|1678|

TABLE 7-19: AVC TRAFFIC DATA FILE CONTENT

Field	Field name	Req.	Data Type	Format	Sample
1	Predefined Virtual Toll Virtual Plaza ID	Yes	Number	999	001
2	Operating Date (yyyymmdd)	Yes	Number	99999999	20020413

Field	Field name	Req.	Data Type	Format	Sample
3	Validated 0: Un-validated 1: Validated-Correct – No AVC/TCC transaction number sequence mismatches, missing AVC transaction numbers or missing AVC audit files 2: Validated-Incorrect – AVC and TCC sequences indicate mismatches, missing AVC transactions or AVC audit files	Yes	Number	9	0
4	Hour (00-23)	Yes	Number	99	01
5	Lane ID	Yes	Char (4)	99AA	07MN
6	AVC status mode: 0: Normal Mode. No errors and communicating with Lane Computer 1: Local mode – No communication with TCC 2: Serious error mode – Operates with non critical errors 3: Critical error mode – Operates with critical errors 4: Shutdown mode – The AVC is part of a pair in a Reversible Lane and the other unit is active	Yes	Number	9	0
	5: Fail mode – No data received from AVC 6: Inactive mode (Dormant lane number used for ramp/mainline swapping) 7: Mixed mode - combination of the above statuses				
7	AVC Critical Error count	Yes	Number	Long	3
8	Toll Class 01: Class 1 02: Class 2 03: Class 3 04: Class 4	Yes	Number	99	01
9	Passage Count	Yes	Number	Long	1678

7.4.6.6 AVC Incident/Faults Log Data Transmission format for Conventional Tolling applications:

- (a) This file will contain summarised AVC Fault Log data rolled-up per hour and be named according to the naming convention. Data must be transmitted for all Lanes even if the

Lane was closed or not used for any specific hour. AVC Incidents/Fault Log data records with zero counts shall not be included in the file.

(b) File Naming:

EXAMPLE: 001_2002_04_13.AFL

TABLE 7-20: AVC INCIDENT / FAULTS LOG DATA TRANSMISSION FORMAT

Description	Length	Sample
Predefined Virtual Toll Plaza ID	3	001
Spacer	1	_ (Underscore)
Date & hour : yyyy_mm_dd	10	2002_04_13
File extension .afl: First data file .afr: Retransmitted file	4	.afl

(c) File Content

EXAMPLE: 001|20020413|0|01|07MN|0|001|3|1678|

TABLE 7-21: AVC INCIDENT / FAULTS LOG DATA FILE CONTENT

Field	Field name	Req.	Data Type	Format	Sample
1	Predefined Virtual Toll Plaza ID	Yes	Number	999	001
2	Operating Date (yyyymmdd)	Yes	Number	99999999	20020413
3	Validated 0: Un-validated 1: Validated-Correct – No AVC/TCC transaction number sequence mismatches, missing AVC transaction numbers or missing AVC audit files 2: Validated-Incorrect – AVC and TCC sequences indicate mismatches, missing AVC transactions or AVC audit files	Yes	Number	9	0
4	Hour (00-23)	Yes	Number	99	01
5	Lane ID	Yes	Char (4)	99AA	07MN

Field	Field name	Req.	Data Type	Format	Sample
6	AVC status mode: 0: Normal Mode. No errors and communicating with Lane Computer 1: Local mode – No communication with TCC 2: Serious error mode – Operates with non critical errors 3: Critical error mode – Operates with critical errors 4: Shutdown mode – The AVC is part of a pair in a Reversible Lane and the other unit is active 5: Fail mode – No data received from AVC 6: Inactive mode (Dormant Lane number used for ramp/mainline swapping) 7: Mixed mode - combination of the above statuses	Yes	Number	9	0
7	AVC Incident ID	Yes	Number	999	001
8	AVC Critical Error count	Yes	Number	Long	3
9	Total AVC Incident Count for the hour	Yes	Number	Long	1678

7.4.6.7 DCS Incident/Faults Log Data Transmission format for Conventional Tolling applications:

- (a) This file will contain summarised DCS Fault Log data rolled-up per hour and be named according to the naming convention. Data must be transmitted for all Lanes even if the Lane was closed or not used for any specific hour. DCS Incidents/Fault Log data records with zero counts shall not be included in the file.

- (b) File Naming:

EXAMPLE: 001_2002_04_13.DFL

TABLE 7-22: DCS INCIDENT / FAULTS LOG DATA TRANSMISSION FORMAT

Description	Length	Sample
Predefined Virtual Toll Plaza ID	3	001
Spacer	1	_ (Underscore)
Date & hour : yyyy_mm_dd	10	2002_04_13

Description	Length	Sample
File extension .DFL: First data file .DFR: Retransmitted file	4	.dfl

(k) File Content

EXAMPLE: 124|20100423|1|15|01MS|0|049|3|1245|

TABLE 7-23: DCS INCIDENT / FAULTS LOG DATA TRANSMISSION FORMAT

Field	Field name	Req.	Data Type	Format	Sample
1	Predefined Virtual Plaza ID	Yes	Number	999	124
2	Operating Date (yyyymmdd)	Yes	Number	99999999	20100423
3	Validated 0: Un-validated 1: Validated-Correct – No AVC/TCC transaction number sequence mismatches, missing transactions or missing audit files 2: Validated-Incorrect – AVC and TCC sequences indicate mismatches, missing AVC transactions or AVC audit files	Yes	Number	9	1
4	Hour (00-23)	Yes	Number	99	15
5	Lane ID	Yes	Char (4)	99AA	01MS
6	AVC status mode: 0: Normal Mode. No errors and communicating with Lane Computer 1: Local mode – No communication with TCC 2: Serious error mode – Operates with non critical errors 3: Critical error mode – Operates with critical errors 4: Shutdown mode – The AVC is part of a pair in a Reversible Lane and the other unit is active 5: Fail mode – No data received from AVC 6: Inactive mode (Dormant Lane number used for ramp/mainline swapping) 7: Mixed mode - combination of the above statuses	Yes	Number	9	0
7	DCS Incident ID	Yes	Number	999	049

Field	Field name	Req.	Data Type	Format	Sample
8	DCS Critical Error Count	Yes	Number	Long	3
9	Total DCS Incident count for the Hour	Yes	Number	Long	1245

7.4.6.8 RSS Traffic Data Transmission format (for ORT type applications):

- (a) This file will contain summarised traffic data, generated and recorded at the RSS and transmitted to ITIS from the DCS, rolled-up per hour, for a full 24-hour period (the previous calendar day) and be named according to the naming convention.

- (b) File Naming:

Example: 1001_2010_04_13.rss

TABLE 7-24: RSS TRAFFIC DATA TRANSMISSION FORMAT (ORT)

Description	Length	Sample
Predefined Tolling Point ID – padded	4	1001
Spacer	1	_(underscore)
Operating Date : yyyy_mm_dd – padded	10	2010_04_13
File extension .rss: First data file .rsr: Retransmitted file	4	.rss

- (c) The Tolling Point ID in the file name shall always be represented by four (4) digits.
- (d) "Operating date" refers to that date relevant to the traffic data in the file.
- (e) File Content:

Example: 1001|20100413|01|0|3|06|1678|

TABLE 7-25: RSS TRAFFIC DATA FILE CONTENT (ORT)

Field	Field name	Req.	Data Type	Format	Sample
1	Predefined Tolling Point ID	Yes	Number	9999	1001
2	Operating Date (yyyymmdd)	Yes	Number	99999999	20100413

Field	Field name	Req.	Data Type	Format	Sample
3	Validated 0: Un-validated 1: Validated-Correct – No unframed data, missing transaction sequence numbers or audit files 2: Validated-Incorrect –Unframed data, missing transaction sequence numbers or missing audit files detected	Yes	Number	9	0
4	Hour (00-23)	Yes	Number	99	01
5	RSS status mode: 0: Normal mode. No errors and communicating with BOS/DCS 1: Local mode – No communication with BOS/DCS 2: Serious error mode – Operates with non critical errors 3: Critical error mode – Operates with critical errors 4: Fail mode – No data received from RSS 5: Mixed mode - combination of the above statuses	Yes	Number	9	0
6	RSS critical error count	Yes	Number	Long	3
7	Vehicle Class 05: Class A1 06: Class A2 07: Class B 08: Class C	Yes	Number	99	06
8	Passage Count	Yes	Number	Long	1678

7.4.6.9 Back Office System Traffic Data Transmission format for Conventional Tolling applications:

- (a) This file shall contain summarised traffic data for a 24-hour period, per calendar day, (rolled-up per hour) and be named according to the specified naming convention. Data must be transmitted for all Lanes even if the Lane was closed for the specific hour. The 24-hour period must start at 00:00:00 and end at 23:59:59.
- (b) File Naming

Example: 001_2002_04_13.trf

TABLE 7-26: BO SYSTEM TRAFFIC DATA TRANSMISSION FORMAT

Description	Length	Sample
Predefined Virtual Toll Plaza ID	3	001
Spacer	1	_ (underscore)
Date : yyyy_mm_dd	10	2002_04_13
File extension .trf: First data file .trr: Retransmitted file	4	.trf

(c) File Content

Example: 001|20020413|0|01|07MN|0|01|1678|

TABLE 7-27: BO SYSTEM TRAFFIC DATA FILE FORMAT

Field	Field name	Req.	Data Type	Format	Sample
1	Predefined Virtual Toll Plaza ID	Yes	Number	999	001
2	Operating Date (yyyymmdd)	Yes	Number	99999999	20020413
3	Validated 0: Un-validated 1: Validated-Correct – No AVC/TCC/BO System transaction number sequence mismatches, missing TCC transaction numbers or missing TCC audit files. All manual transactions have been captured. All BO System validation procedures are complete,	Yes	Number	9	0
	including the correction of discrepancies completed, shifts have been locked preventing any further modification..				

Field	Field name	Req.	Data Type	Format	Sample
	2: Validated-Incorrect – AVC/TCC transaction number sequences indicate mismatches, missing AVC/TCC transactions or AVC audit files. Manual transactions not captured, correction of Vehicle Class discrepancies not complete. Shifts not locked to prevent modification				
4	Hour (00-23)	Yes	Number	99	01
5	Lane ID	Yes	Char (4)	99AA	07MN
6	Lane Mode 0: Open (if the Lane was open for any portion of the hour) 1: Closed 2: Lane in shutdown mode (dormant part of Reversible Lane set) 3: Inactive (Dormant Lane number used for ramp/mainline swapping) 4: Fail mode (no data received) 5: Mixed mode (combination of above modes)	Yes	Number	9	0
7	Toll Class ID	Yes	Number	99	01
8	Passage Count	Yes	Number	Long	1678

- (d) The intention of validating Back Office System data is to ensure that all required operational procedures have been completed before the “validated complete” flag can be assigned to any ITIS-data file originating from the Back Office System. Should any vehicle passage transactions be processed manually or not recorded by the TCC, such transactions shall be captured manually on the Back Office System. Once these transactions are captured verified and reconciled on the Back Office System the test for inconsistent or missing AVC/TCC transactions might be overwritten since those transactions are represented by the manually captured Back Office System transactions.

7.4.6.10 Back Office System Traffic Data Transmission format (for ORT type applications):

- (a) This file shall contain summarised traffic data for a 24-hour period, per calendar day, (rolled-up per hour) and be named according to the specified naming convention. The 24-hour period must start at 00:00:00 and end at 23:59:59.

(b) File Naming:

Example: 1001_2010_04_13.trf

TABLE 7-28: BO SYSTEM TRAFFIC DATA TRANSMISSION FORMAT (ORT)

Description	Length	Sample
Predefined Tolling Point ID	4	1001
Spacer	1	_ (underscore)
Date : yyyy_mm_dd	10	2010_04_13
File extension .trf: First data file .trr: Retransmitted file	4	.trf

(c) File Content:

Example: 1001|20100413|0|01|200|123|06|1678|

TABLE 7-29: BO SYSTEM TRAFFIC DATA FILE CONTENT (ORT)

Field	Field name	Req.	Data Type	Format	Sample
1	Predefined Tolling Point ID	Yes	Number	9999	1001
2	Operating Date (yyyymmdd)	Yes	Number	99999999	20100413
3	Validated 0: Un-validated 1: Validated-Correct – No RSS/Back Office System transaction number sequence mismatches. All Back Office System validation procedures are complete, including the correction of discrepancies including Vehicle Class. Data has been locked preventing any further modification.	Yes	Number	9	0
	2: Validated-Incorrect – RSS/Back Office System transaction number sequences indicate mismatches, missing transactions. Correction of discrepancies (including Vehicle Class) not complete. Data not locked to prevent modification				

Field	Field name	Req.	Data Type	Format	Sample
4	Hour (00-23)	Yes	Number	99	01
5	Vehicle Class ND Count (only un-validated data)	Yes	Number	Long	200
6	Vehicle Class PD Count (only un-validated data)	Yes	Number	Long	123
7	Vehicle Class ID	Yes	Number	99	06
8	Passage Count	Yes	Number	Long	1678

- (d) The intention of validating Back Office System data is to ensure that all required operational procedures have been completed before the “validated complete” flag can be assigned to any ITIS-data file originating from the Back Office System.

7.4.6.11 Back Office System Revenue Data Transmission format for Conventional Tolling applications:

- (a) This file will contain summarised Revenue data for daily and monthly periods, as applicable, and be named according to the naming convention as specified. The body of the file will contain for each Payment Group a record indicating the total Revenue for the Payment Type as well as a record for each type of Discount given for that Payment Type and the Payment Mechanism used. Individual records shall be representative of the financial reconciliation, cash-up and deposit structure of the Contractor, on a calendar day basis. Files shall be compiled and submitted on the Control Centre level and not at Virtual Toll Plaza level. The Contractor's intended implementation of this data file needs to be submitted to the Employer's Representative for approval. The daily Revenue file is identified by the use of the complete calendar day in the file name, representing the data in the file. The monthly Revenue file shall be identified by the replacement of the day (“dd”) in the file name with the literal “99”.

- (b) File Naming

Example: 001_2002_04_13.rev

TABLE 7-30: BO SYSTEM INCOME DATA TRANSMISSION FORMAT

Description	Length	Sample
Predefined Virtual Toll Plaza ID	3	001
Spacer	1	_ (underscore)
Date : yyyy_mm_dd	10	2002_04_13 Note “dd” shall be replaced with “99” for the monthly income file.

Description	Length	Sample
File extension .rev: First data file .rer: Retransmitted file	4	.rev

(c) File Content

Example:001|20020401|20020430|2|000|003|002|001|001|215687.34|

TABLE 7-31: BO SYSTEM INCOME DATA FILE CONTENTS

Field	Field name	Req.	Data Type	Format	Sample
1	Predefined Control Centre ID	Yes	Number	999	001
2	Data Start Date (yyyymmdd)	Yes	Number	99999999	20020401
3	Data End Date (yyyymmdd)	Yes	Number	99999999	20020430
4	Validated 0: Un-validated 1: Validated-Correct 2: Validated-Incorrect	Yes	Number	9	0
5	Payment Group ID	Yes	Number	999	003
6	Payment Type ID	Yes	Number	999	002
7	Discount Type ID	Yes	Number	999	001
8	Payment mechanism ID	Yes	Number	999	001
9	Value (ZAR.cc) pos/neg	Yes	Number	9999999.99	215687.34

7.4.6.12 Back Office System Income Data Transmission format (for ORT type applications):

- (a) This file will contain summarised Income data for daily and monthly periods, as applicable, and be named according to the naming convention as specified. The body of the file will contain for each Payment Group a record indicating the total Income for the Payment Type as well as a record for each type of discount given as well as the Payment Mechanism used. Individual records shall be representative of the data, on a calendar day basis. Files shall be compiled and submitted on the Control Centre level. The Contractor's intended implementation of this data file needs to be submitted to the Employer's Representative for approval. The daily Income file is identified by the use of the complete calendar day in the file name, representing the data in the file. The monthly Income file shall be identified by the replacement of the day ("dd") in the file name with the literal "99".

(b) File Naming

Example: 1001_2010_04_13.inc

TABLE 7-32: BO SYSTEM INCOME DATA TRANSMISSION FORMAT (ORT)

Description	Length	Sample
Predefined Tolling Point ID	4	1001
Spacer	1	_ (underscore)
Date : yyyy_mm_dd	10	2010_04_13 Note "dd" shall be replaced with "99" for the monthly income file.
File extension .inc: First data file .inr: Retransmitted file	4	.inc

(c) File Content

Example:001|20100401|20100430|1|012|001|004|215687.34|

TABLE 7-33: BO SYSTEM INCOME DATA FILE CONTENT (ORT)

Field	Field name	Req.	Data Type	Format	Sample
1	Predefined Control Centre ID	Yes	Number	999	001
2	Data Start Date (yyyymmdd)	Yes	Number	99999999	20100401
3	Data End Date (yyyymmdd)	Yes	Number	99999999	20100430
4	Validated 0: Un-validated 1: Validated-Correct 2: Validated-Incorrect	Yes	Number	9	1
5	Payment Group ID	Yes	Number	999	012
6	Discount Type ID	Yes	Number	999	001
7	Payment mechanism ID	Yes	Number	999	004
8	Value (ZAR.cc) pos/neg	Yes	Number	9999999.99	215687.34

7.4.6.13 Acknowledgement file

- (a) An acknowledgement file will be generated for each file received by the Employer. If the file is found to be missing when the maximum allowed delay period as stipulated in clause 7.4.6.2 has elapsed, the Employer will generate the acknowledgement file indicating this by setting the "Result" field to 2. Once the Contractor's system has read the acknowledgement file it must change the extension to ".red". The Employer will archive and clear the acknowledgement files periodically.

(b) File Naming

Example: 001_2002_04_13_avc.ack

TABLE 7-34: ACKNOWLEDGEMENT FILE

Description	Length	Sample
Original File Name	Fixed (14)	001_2002_04_13
Spacer	1	_ (underscore)
Original File extension	3	avc / afl / rss / dfl / trf / rev / inc
File extension .ack: Acknowledgement from the Employer .red: Contractor modify "ack" to ".red" after Contractor has read the acknowledgement.	4	.ack

(c) File Data

Example:20020413|0|001450204139999|

TABLE 7-35: ACKNOWLEDGEMENT FILE DATA

Field	Field name	Req.	Data Type	Format	Sample
1	Acknowledgement Date	Yes	Number	99999999	20020413
2	Result: 0: Successful 1: Unsuccessful (retransmit) 2: Missing 3: Late Transmission 4: File previously successful	Yes	Number	9	0
3	Validation Key	Yes	Number	99999999999999 99 (15)	0014502041399 99

7.4.6.14 Retransmission and Data request

- (a) Transmissions of files or retransmissions will be requested using the acknowledgement file. This file will be created once the original transmitted file has been successfully or unsuccessfully imported or found by the Employer. If, however, the file is found to be missing when the Employer imports files, the acknowledgement file will be generated with the result field containing the value two (2). Similarly "0" for successful imports, "1" where there was some sort of error, "3" for late submissions (received after the deadline) and "4" if the same data file has already been acknowledged. In the event that

the Contractor does not receive an acknowledgement file, as expected, the Contractor shall inform the Employer's Representative without delay.

(b) Action table

TABLE 7-36: RETRANSMISSION AND DATA REQUEST ACTION TABLE

Sequence	Description	Responsibility
1	Compile Data File	Contractor
2	Transmit File	Contractor
3	Resubmit file if not acknowledged by the Employer	Contractor
4	Test File Contents, if available	The Employer
5	Import File Data	The Employer
6	Create Acknowledgement File for: <ul style="list-style-type: none"> • Acknowledge File Receipt , Or • Request File Resubmission, Or • Request Unsent File • Late Transmission Awaiting the Employer's Action or • File previously successfully acknowledged 	The Employer
7	Check Acknowledgement File and rename	Contractor
8	Loop back to 1 – 7 if required	Contractor
9	Remove Acknowledgement File if read.	The Employer

7.5 BACK OFFICE SYSTEM AND TRAFFIC ANALYSIS SYSTEM INTERFACE

7.5.1 GENERAL

7.5.1.1 Should it be required, the Back Office System shall provide an interface to the Traffic Analysis System, as specified in clause 6.6. This interface shall be used for the transmission of Abbreviated Transaction Records in near real time for traffic analysis purposes onto the Traffic Analysis server. The interface shall also allow the Traffic Analysis System to request evidential images associated with particular Transaction Records.

7.6 BACK OFFICE AND TCH SYSTEM INTERFACE

7.6.1 Introduction

7.6.1.1 The TCH System will be responsible for ensuring that all information necessary to be transmitted are included in the interface and are correctly transmitted or received.

7.6.1.2 The Contractor shall provide a communication link for file and data transmission.

7.6.1.3 The TCH System is responsible for checking any file and data formats that are flagged as not conforming to agreed interface standards. Where file or data formats are not accepted, it shall be sent back to the originating Contractor so that that Contractor can check and change to overcome the error. The TCH System will validate Transaction Record transmission periods.

7.6.1.4 The TCH System will keep track and report on all interface file and data formats that do not comply with the interface standard.

7.6.1.5 Where possible the interfaces between the various sub-systems should comply with the following minimum requirements:

- (a) If a secure VPN connection is not possible between the two sub-systems, all data to be exchanged must be encrypted.
- (b) Where applicable the system must adhere to SANS 1795 (South African Standard Specification: Road Traffic Law enforcement systems) requirements.
- (c) Where data is not exchanged via secure VPN connections, the information exchange must be via an industry standard interface.
- (d) Where a large volume of data is involved in the interface, only the modifications made to the data should be exchanged between the systems. An example of such an interface is the exchange of Validation List information. Only added, deleted and updated information should be passed from the TCH to the Contractor. At certain configurable times of the day the system will however exchange complete lists.

7.6.1.6 The actual file and data format shall be defined in an interface document as provided by the TCH. The frequency shall be agreed upon by the interfacing parties.

7.6.2 PRINCIPLES

7.6.2.1 With the exception of the Customer interface into the TCH, the Back Office System shall be responsible to upload data from their system to the TCH System in a specific directory structure. The TCH will define this directory structure.

- 7.6.2.2 The TCH will not send data to the various systems. It will store all information destined for the various systems in a specific directory structure. From here it will be the responsibility of the remote system to retrieve the information.
- 7.6.2.3 The TCH will require the remote system to acknowledge files downloaded.
- 7.6.2.4 It will be the responsibility of the remote system to move the downloaded file from the TCH System directory to a 'processed' directory on the TCH server once it has successfully downloaded it.
- 7.6.2.5 The moved file will be kept by the TCH in the remote directory for a configurable period of time. There will be no restriction on the remote system to retrieve any of the files stored in the 'processed' directory while they are available.
- 7.6.2.6 Once the configurable period has expired, the TCH System will remove the file from the 'processed' directory and the remote system will no longer have access to this file.
- 7.6.2.7 Refer to the diagram below for a schematic representation of the flow of ETC Transactions between the systems.

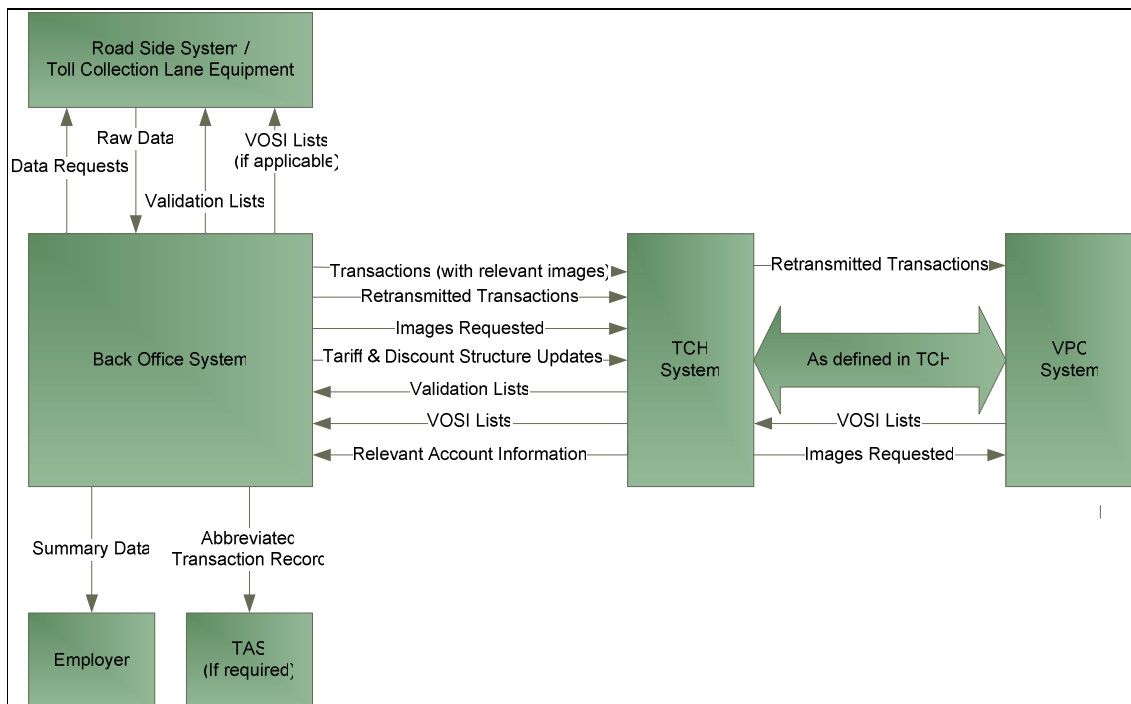


FIGURE 7-1: ETC TRANSACTION FLOW OVERVIEW

7.6.3 TCH INTERFACE FILE AND DATA FORMATS

7.6.3.1 The interface messages in Table 7-37: Interface - TCH and Contractor relates to the interface between the Back Office of the Contractor and the TCH. This table is an indication of the type of information that needs to be transferred between the TCH and the Contractor. However, the full interface will be specified in the Interface document supplied by the TCH.

TABLE 7-37: INTERFACE - TCH AND CONTRACTOR

No.	Title and Direction	Description
1	Security Keys from TCH	The TCH is responsible for managing and distributing Security Keys for all encrypted transmission taking place within the system, including for the DSRC Transaction Record, as well as the overall monitoring of transmission with the assistance of other entities, to determine when there has been a security breach and the Security Keys may need to be changed. The Contractor shall adhere to the prescribed mechanism for distribution and protection of Security Keys.
2	Tariff Table from Contractor	Each Contractor will be responsible for preparing its own Tariff Table in the agreed format and at agreed times and transmitting it to the TCH.
3	Tariff Table Acceptance or Rejection from TCH	The TCH will check the Tariff Tables received from Toll Agencies and will confirm acceptance to the originating Contractor (or will reject it if it does not conform to agreed rules).
4	Temporary Suspension of Tolling from Contractor	In unusual circumstances, a Contractor may suspend Tolling at one or more Tolling Points/Toll Lanes and shall notify the TCH of the locations and duration of the suspension. The transactions shall be discarded.
5	Discounts and Exemptions from Contractor	The Contractor will prepare and maintain a list of Discounts and Exemptions that apply to the Tolling Points/Toll Plaza under its control. The actual Discounts will be included in the Tariff Table and the Customers to which they will apply will be entered onto the Customer Account when the Discount is agreed by the Contractor (or the TCH for National Discounts and Exemptions). Transaction Records for the vehicles to which Discounts should apply will be annotated with the Discounted toll at the Contractor based upon the Tariff Table and the Green List and may be checked by the TCH.
6	Discount Approvals	The Back Office shall notify the TCH of Customers who qualified for Discount and the zones where the Discount will be applicable. This is applicable to Discount types where the Road User had to apply for Discount, e.g. Public Transport Discount.
7	Green List from TCH	The TCH will compile a Green List of all vehicle Identifiers included on active Customer Accounts and any Exempt Vehicles associated with Automatically Allocated Accounts and the Contractor will obtain it from the TCH at an agreed timescale.
8	Grey List from TCH	The TCH will compile a Grey List of active Customer Accounts with balance below the agreed limit. The Contractor will obtain it from the TCH at an agreed

No.	Title and Direction	Description
		timescale.
9	Red List from TCH	The TCH will compile a Red List of Tags that have been issued and not returned and are currently not associated with an active Customer Account, the Account has insufficient funds, are hot-listed or the Tag have been reported as stolen. The Contractor will obtain the list from the TCH at an agreed timescale.
10	VOSI list from TCH (If required)	The TCH will compile a VOSI list and the Contractor will obtain the list from the TCH at an agreed timescale.
11	Transaction Records from Contractor	The Contractor shall send in an agreed format and meeting agreed accuracy requirements, all ETC Transaction Records for Chargeable Events taking place within its area of operation. The Transaction Record may have an attached Evidential Record.
12	Rejected Transaction Records from TCH	The TCH may reject any Transaction Records that do not meet agreed standards of accuracy and will notify the Contractor with a Reconciliation Code. The rejection may be of the Transaction Record itself and/or any attached Evidential Record. Where a Contractor elects to Opt Out of using the VPC, the TCH shall advise the Contractor of any Transaction Records associated with a Violation that would otherwise be sent to the VPC and which the TCH is unable to accept.
13	Rejected Transaction Records from VPC	The VPC may reject Transaction Records sent to it and where the issue is indicated as arising from the Contractor, the TCH shall pass the rejection message back to the Contractor with a Reconciliation Code.
14	Transaction Record error message from TCH	Where the TCH discovers an error in a Transaction Record from a Contractor, it shall send a Transaction Record error message to the Contractor with a Reconciliation Code.
15	Request for Evidential Record from TCH	The TCH may request an Evidential Record for any Transaction Record that it has received from a Contractor within an agreed timescale.
16	Accounting/payment information from Contractor	The TCH will receive from each Contractor in an agreed format and to an agreed timescale an Account Statement that includes details of all Transaction Records and charges and a request for payment of the value of the Transaction Records
17	Queries on accounts etc. from TCH	The TCH Contractor may query items on the Road User Account Statement from the Contractor in an agreed format and to an agreed timescale
18	Response to queries from Contractor	The Contractor shall respond to the queries raised by the TCH Contractor in an agreed format and to an agreed timescale
19	Final accounting/payment information from TCH	The TCH shall issue a final account Statement for the period to each Contractor, taking into account any responses to queries that it accepts
20	Statement of Service Charges from TCH	The TCH will provide a Statement to each Contractor of Transaction Records processed and service charges due.

7.7 INTERFACE CONTROL DOCUMENT (ICD)

7.7.1 GENERAL

- 7.7.1.1 The Contractor shall develop a detailed Interface Control Document (ICD) that specifies the interface between the RSS / Toll Lane and the Back Office System, including the Validation Lists, alarm conditions or Incidents and Transaction Record exchanges. This ICD shall include all the data fields, the meaning and explanation of each data field, the character set used and the file formats for all the communication, and the frequency of the communication between the RSS / Toll Lane and the Back Office System.
- 7.7.1.2 The TCH will supply an Interface Control Document that specifies the interface between the TCH and the Back Office System.

SECTION 8. RELEVANT TCH SYSTEM SPECIFICATIONS

8.1 GENERAL

8.1.1 Overview

8.1.1.1 The Transaction Clearing House is a National SANRAL initiative and the purpose of the TCH is to provide ETC Customer Account management and transaction Clearing services for ETC Transactions. Transactions of Potential Violators of Opt-in Toll Agencies are sent via the TCH to the VPC.

8.1.1.2 Every Toll Agency, Concessionaire, CTROM Contractor, etc shall be required to interface to the Transaction Clearing House (TCH) for the processing of ETC Transactions.

8.1.1.3 The role of the TCH is specified in the following clauses.

8.1.2 TRANSACTION RECORDS

8.1.2.1 Transactions generated by the Road Side System/Toll Lane are received and validated by the Back Office System. From there the Back Office System will send them to the TCH. The TCH System then either processes the Transaction Record or it passes it on to the VPC (in case of Opt-in Toll Agencies).

8.1.2.2 All Transaction Records send by the Back Office System to the TCH System shall comply with the minimum Transaction Record requirements.

8.1.2.3 The TCH System will not accept any duplicate Transaction Records.

8.1.3 TCH TRANSACTION PROCESS FLOW

8.1.3.1 Transaction records shall be sent to the TCH within a predefined time. Transaction Records send to the TCH will be verified and validated by the TCH. The Transaction Record can be:

- (a) Directly linked to a pre-paid Customer Account;
- (b) Directly linked to a post-paid Customer Account;
- (c) An Exempt Account;
- (d) A Free-passage Account;
- (e) A Day Pass Account; or
- (f) A Potential Violation.

8.1.3.2 Transaction Records that are not valid will be rejected by the TCH.

8.1.4 TRANSACTION EXCEPTIONS

8.1.4.1 Tag-VLN mismatches (ORT only)

- (a) The Back Office System shall monitor the usage of VLN's linked to a specific Tag (where applicable) and shall notify the TCH System if the System has detected that the Customer has swapped his Tag between vehicles for a configurable number of times within a pre-defined period. The TCH will inform the Customer that his Discount will be removed from future Transaction Records if he doesn't stop the swapping.
- (b) When the Customer reaches a configurable threshold number of Tag swaps within a pre-defined period, the TCH System will remove Discount allocation from the Account and inform the Back Office System not to apply any further Discount to the Identifier.

8.1.5 TRANSACTION COUNTER

- 8.1.5.1 The TCH continually monitors the Tag transaction counter included in the Transaction Record to detect when the Tag may have ceased to operate reliably.

8.1.6 CUSTOMER SERVICES

- 8.1.6.1 All Customer Service functions shall be performed directly on a remote workstation linked to the TCH system. The Contractor shall be responsible for the Hardware and communications link support to ensure that the workstations linked to the TCH are always available.
- 8.1.6.2 The Back Office System shall facilitate the handling of queries as required via the VPC/TCH interface. These queries shall be limited to project specific transactions, including but not limited to Discount allocation, vehicle classification, etc.

8.1.7 WEB ACCESS

- 8.1.7.1 The TCH website will contain references to the Employer's website and project specific websites of Contractors using the TCH.

8.1.8 APPROVAL OF EXEMPT ACCOUNTS

- 8.1.8.1 Exempt Accounts will be handled at Back Office System level in case of Conventional / Hybrid Toll Plazas.
- 8.1.8.2 The Contractor shall add VLN / Tag numbers to the national Exempt list in case of ORT. In case of Conventional /Hybrid Toll Plazas, these transactions should not be sent to the TCH.

8.1.9 VALIDATION LISTS

8.1.9.1 Although there will be many lists being exchanged between the TCH and Toll Agencies, there are specific lists of interest that needs to be made available.

8.1.9.2 Green List

- (a) The Green List contains all Tag numbers and VLN's that are to be accepted by the Toll Agencies.
- (b) The Green List is made available in full once a day at an off-peak time.
- (c) Changes to the Green List are available at regular configurable intervals as defined by the Standard Specifications for Operations & Maintenance of CTROM Projects: ETC Interoperability – Business Rules (Volume 2 Book 8a).
- (d) The Green List contains at least the following information for each vehicle linked to a Customer Account:
 - i. VLN;
 - ii. Personal Account Number (Tag number);
 - iii. Generic Vehicle Class;
 - iv. Project Vehicle Class;
 - v. Account Type, e.g. Pre-paid Tag Account; and
 - vi. Discount Category.

8.1.9.3 Grey List

- (e) The Grey List contains a list of Personal Account Numbers and VLN's where the associated Pre-Paid Customer Account has a low balance.
- (f) The full list is made available at regular configurable intervals as defined by the Standard Specifications for Operations & Maintenance of CTROM Projects: ETC Interoperability – Business Rules (Volume 2 Book 8a).
- (g) The Grey List contains at least the following information:
 - i. VLN; and
 - ii. Personal Account Number (Tag number).

8.1.9.4 Red List

- (a) The Red List contains a list of Personal Account Numbers and VLN's where the associated Account has insufficient funds.
- (b) The full list is made available at regular configurable intervals.
- (c) The Red List contains at least the following information:
 - i. VLN;
 - ii. Personal Account Number (Tag number); and
 - iii. Reason.
- (d) Transaction Records linked to Red Listed identifiers will not be paid by the TCH.

8.1.9.5 VOSI List

- (a) Should the functionality with regards to VOSI required by the Employer, the full VOSI list is made available to the Contractor at regular configurable intervals.
- (b) The VOSI list contains at least the following information:
 - i. VLN;
 - ii. Make of Vehicle;
 - iii. Model of Vehicle;
 - iv. Colour of Vehicle;
 - v. Personal Account Number (if applicable); and
 - vi. Reason for inclusion on the list.

8.1.9.6 Exempt List

The Contractor shall compile and manage a detailed list of Exempt Vehicles and Free Passage vehicles, applicable to each route or Tolling Point.

8.1.10 **CASH-UP PROCESS**

- 8.1.10.1 The TCH System makes provision for the recording of money received from Road Users and the Cash-up, banking and reconciliation of the money.

8.1.11 SETTLEMENT BETWEEN THE TCH AND THE CONTRACTOR

8.1.11.1 Transaction Records are generated at a Contractor level and it is the responsibility of the TCH to ensure that once the Transaction Records are cleared, the Contractor is paid for the Transaction Records.

8.1.11.2 A basic description of the settlement process follows:

- (a) Transactions are sent to the Back Office System from the RSS.
- (b) Once the Back Office has validated the Transaction Records it is sent onward to the TCH. As the Transaction Records are received by the TCH, it will accumulate the amounts owed to the Contractor.
- (c) The TCH System will accumulate the Transaction Record value to the Contractor, responsible for the specific toll transaction.
- (d) Once the Transaction Record has been received and verified as compliant by the TCH System it will provide the basis for payment and settlement.
- (e) If the TCH rejects a Transaction Record it must inform the Contractor of such an action. This will give the Contractor the opportunity to rectify the Transaction Record and re-submit it.
- (f) At the end of a defined period of accumulating Transaction Records, the TCH will send the Contractor a detailed list of the Transaction Records to be settled via EFT as well as the amount of processing fees due.
- (g) The accumulated amounts are consolidated into EFT instructions sent to the TCH for payment.
- (h) The EFT instruction is then passed onto an institution to perform the switching between the TCH bank and the Contractor's bank.
- (i) The Toll Agencies bank receives the EFT transfer.
- (j) The EFT is reflected on the bank statements and can be verified against the list of Transaction Records sent to the Contractor.
- (k) A separate EFT instruction is required for the settlement of processing fees by the Back Office.

8.1.12 POP CUSTOMER SERVICE FACILITIES

8.1.12.1 The Contractor shall supply, install and maintain all Hardware, systems, interfaces and communications as required at the PoP Customer Service Facilities. (Refer to the Standard

Specifications for Operations and Maintenance of CTROM Projects: General (Volume 2 Book 2a).

- 8.1.12.2 The TCH shall supply application Software for PoP Customer Service facilities to be used for payments of ETC accounts and other TCH functions. The Contractor shall be required to install and do first line maintenance on the TCH supplied application Software. The Contractor shall also be responsible for the procurement, installation and maintenance of operating system and DBMS Software for PoP Customer Service facilities.
- 8.1.12.3 The Contractor may however provide alternative PoP Customer Service facilities Software, provided that the data can be successfully interchanged between the TCH System and this Software.

SECTION 9. RELEVANT VPC SYSTEM SPECIFICATIONS

9.1 OVERVIEW

9.1.1 GENERAL

9.1.1.1 The Violations Processing Centre (VPC) is a SANRAL initiative and the purpose of the VPC is to provide enforcement for unpaid toll fees. The VPC is a separate entity from the TCH, but it should be noted that transactions can only be sent to the VPC via the TCH, i.e. the interface to the VPC will be through the TCH.

9.1.1.2 The Violations Processing Centre (VPC) shall provide for the processing and collection of unpaid toll fees and unpaid Customer Accounts, the managing of evidence related to exceptions, and the possible administration of prosecuting procedures as required by the AARTO process. Toll Agencies shall have the option to process their Violations through the VPC, referred to as Opt-in Toll Agencies, or to handle Violations internally by themselves, referred to as Opt-out Toll Agencies.

9.1.1.3 The role of the VPC in Opt-in Toll Agencies is specified in the following clauses.

9.2 REVENUE RECONCILIATION

9.2.1.1 The Back Office System shall reconcile data received back from the VPC via the TCH interface in order to validate payment of ETC Transactions, the status of unpaid transactions.

9.2.1.2 The Contractor shall also reconcile the invoiced processing fees against payments made to the VPC and guaranteed toll fee payments made by the VPC.

9.2.1.3 Applicable reporting shall be provided to reconcile these payments due and paid on a daily bases as well as on a monthly basis. Toll fees and their payment should be kept and reported separately from the Processing fees and their payment.

9.2.1.4 The VPC System shall automatically report reconciliation details containing the processing status of each Transaction Record entered into the VPC to the Toll Agencies via the TCH on a daily basis.

9.3 INCENTIVES OFFERED BY TOLL AGENCIES FOR ACCOUNT REGISTRATION

9.3.1 DISCOUNTS/INCENTIVES

9.3.1.1 The Employer or a specific Contractor, as part of the strategy to incentivise Road Users to register accounts with the TCH, might require the VPC System to credit all or a portion of the allocated administration fees in exchange for registering an account.

9.3.1.2 It shall be possible to configure such incentives on the VPC System according to the latest Employer's policies as contained in the Standard Specifications for Operations & Maintenance of CTROM Projects: ETC Interoperability – Business Rules (Volume 2 Book 8a).

9.3.1.3 The VPC System shall invoice the TCH per Contractor account. This Discount will be recovered from the applicable Contractor.

9.3.1.4 The VPC System shall report on and reconcile any adjustments. The Back Office System shall incorporate these Discounts into their financial reporting.

9.4 EXEMPT VEHICLES IDENTIFIED VIA VPC OPERATIONS

9.4.1 EXEMPT VEHICLE POLICY

9.4.1.1 The VPC System shall facilitate the identification of Exempt Transaction Records and refer Transaction Records for Exempt Vehicles, for which the Minister of Transport has granted an exemption in terms of the appropriate Act or notice, back to the TCH with appropriate reference for the return. The Back Office System shall reclassify these transactions to be allocated to their own Exempt Customers.

9.4.1.2 The VPC System shall reconcile Guaranteed Payments against these Transaction Records and invoice the TCH for the funds already incorrectly paid for such Exempt Transaction Records per Contractor.

9.4.1.3 The VPC System shall facilitate the identification and verification of Exempt Transaction Records through the following processes:

- (a) The Image verification process; and
- (b) The debt collection process, where vehicles qualifying for exemption shall be identified by means of invoicing and the response to the Tax Invoices send.

9.4.1.4 If a Tax Invoice has been issued, the VPC System shall cancel the Tax Invoice by means of a Credit Note.

9.4.1.5 The VPC System shall reconcile all Exempt Transaction Records. The VPC System shall report on the number of Exempt Transaction Records and cost involved to identify and refer Transaction Records per Exempted Entity per Contractor.

9.4.1.6 The Contractor shall be responsible for Exempt Customers per route. The Contractor shall ensure that all registered exempt users are identifiable to prevent Exempt transaction from reaching the VPC. If the VPC had to identify Exempt transactions, the Contractor will have to pay a processing fee.

9.4.1.7 The Back Office System shall be able to receive Exempt transactions back into the system and update the Transaction Record details in compliance with the Tax legislation.

9.4.2 CUSTOMER SERVICES

9.4.2.1 All Customer Service functions will be performed directly on a remote workstation linked to the VPC System. The Contractor will be responsible for the Hardware and communications link support to ensure that the workstations linked to the VPC are always available.

9.4.2.2 The Back Office System shall facilitate the handling of queries as required via the VPC/TCH interface. These queries shall be limited to project specific transactions, including but not limited to Discount allocation, vehicle classification, etc.

9.4.3 INTERFACING WITH TOLL AGENCIES

9.4.3.1 All payments and invoicing between the Opt-in Toll Agencies and the VPC will be routed via the TCH.

9.4.3.2 All Transaction Records send to and from the Opt-in Toll Agencies to the VPC will be routed via the TCH.

9.4.4 INTERFACING FOR CUSTOMER SERVICE PURPOSES

9.4.4.1 Customer Service Facilities Stations

The VPC System shall interface with the CSF Stations to be utilised at all Customer Service facilities, to perform the following functions:

- (a) Capture payments for Tax Invoices;
- (b) Capture Road User queries and grievances;
- (c) Provide secure access to Violator Accounts;
- (d) Inform Road Users of options and mechanisms within the Violation Recovery Process;
- (e) Print receipts;
- (f) Enable Road Users to view images linked to their Violator Account;
- (g) Print reports/statements;
- (h) Capture Nominations/Representations on Tax Invoices (only at Satellite Centres);
- (i) Provide a link to the NaTIS system to facilitate Nominations/Representations on Infringement Notices; and

- (j) Provide a link to the NaTIS system to receive and capture payments for Infringement Notices on both the NaTIS and VPC Systems.

The VPC shall specify minimum requirements for all Equipment to be provided for Customer Service Workstations. This will include the requirements for POS, Tag Readers, printers, etc. as specified.

9.4.4.2 Data compliancy

The Back Office System shall implement all measures to ensure the compliancy to data requirements to provide enforceable transactions to the VPC. These include all data items as required for the different phases (depending on type of lane and opt-in to VPC) and certification of applicable Equipment.

9.4.4.3 Equipment certification status

The Back Office System shall report the certification status of Equipment by means of an indicator in the Transaction Record backed by submission of certificates for manual verification as required by the VPC.

SECTION 10. SAMPLE SIZES FOR ACCURACY CALCULATIONS

10.1 SCOPE

10.1.1 PURPOSE OF SECTION

10.1.1.1 This specification requires that certain accuracies be measured and proven, not only at the initial test stage (at the site acceptance testing for example), but also during the course of the contract. This section specifies how the sample sizes, corresponding precision levels or error margins and other related measurements, are calculated.

10.1.1.2 The statistical population distribution employed, as relevant for dichotomous population spaces, shall be the binomial population distribution (normal approximation), and shall be used for the following accuracy determinations:

- (a) AVC classification accuracy and AVC count accuracy – for both axle based classification/count and volumetric systems;
- (b) Tag read accuracy;
- (c) ANPR read accuracy, APNR capture accuracy, ANPR trigger accuracy; and
- (d) Transaction framing accuracy.

10.2 AXLE BASED AVC VERIFICATION FOR CONVENTIONAL/HYBRID TOLL PLAZAS

10.2.1 OVERVIEW

10.2.1.1 Each AVC shall meet or surpass the following accuracy requirements for each AVC accuracy category as a function of Vehicle throughput commensurate with the Traffic demographic prevailing at the Toll Plaza during the Contract Period.

TABLE 10-1: AVC ACCURACY

AVC Accuracy Category	AVC Accuracy Requirement
Overall Vehicle count	99.9 %
Class 1 classification	99.6 %
Class 2 classification	95.0 %
Class 3 classification	96.0 %
Class 4 classification	99.0 %

10.2.1.2 Where applicable, an AVC classification accuracy of 98% and a vehicle count accuracy of 99.9% are required for motorcycles.

10.2.1.3 The Traffic sample, over which the AVC accuracy requirements per AVC accuracy category shall be measured for the specified accuracy monitoring periods, shall be equal to the total Vehicle throughput through the designated Traffic sampling space (Toll Lane/Virtual Toll Plaza/Control Centre) as specified in clause 10.2.1.7 for the relevant accuracy monitoring period.

10.2.1.4 This will be subject to the Traffic samples indicated above being greater than or equal to certain minimum Traffic sample sizes, per AVC accuracy category over the designated Traffic sampling space as specified, for the relevant accuracy monitoring period. The minimum Traffic sample sizes are as indicated in the Project Document (Volume 3). If, due to exceptional circumstances, the minimum Traffic sample size cannot be met within the requisite AVC accuracy monitoring period for a particular AVC accuracy category, the monitoring period may be extended or an alternate minimum sample size determined using the formula indicated in clause 10.2.1.5 for the AVC accuracy category in question. This shall be at the discretion of the Employer's Representative.

10.2.1.5 The minimum Traffic sample sizes are determined using the Binomial population distribution (Normal approximation) per AVC accuracy category employing the following formulae:

$$n = p (1-p) (z_{\alpha/2} / d)^2$$

$$d = z_{\alpha/2} (p (1 - p) / n)^{1/2}$$

where n denotes the sample size required for a predetermined margin of error d, p denotes the proportion of vehicles counted/classified with a 100(1-α)% level of confidence and where $z_{\alpha/2}$ is the value from the Normal distribution Z tables which has an area α/2 below it.

10.2.1.6 The minimum Traffic sample size determination is concurrently influenced by the Traffic demographic of the Traffic sampling space for which it is determined over a specified time period, where it is taken as a proportion (f) of the total Traffic population of the Traffic sampling space over the specified time period, such that the margin of error (d) of the Traffic sample is in correlation with the total Traffic population prevalent of the respective Traffic sampling space. Hence, respective Toll Lanes/Virtual Toll Plazas/Control Centres at which the total Traffic populations are low and therefore result in correspondingly smaller sample sizes will thus have higher margins of error for the determined Traffic sample.

10.2.1.7 In addition to the preceding Toll System Functional Compliance verification, the AVC classification accuracy shall be determined over the following accuracy monitoring periods and Traffic sampling spaces:

TABLE 10-2: AVC CLASSIFICATION ACCURACY

Description				Traffic Sampling Space			Accuracy Monitoring Period
Initial	AVC	classification	Accuracy	Employer's	Representative	designated	3 months

Description	Traffic Sampling Space	Accuracy Monitoring Period
verification	individual Toll Lanes	
Post initial AVC classification accuracy verification (i.e. continuous accuracy monitoring):		
a) Continuous AVC classification accuracy monitoring per Control Centre/Control Centre grouping	Individual Control Centre/Control Centre grouping (all Toll Lanes contained in the Control Centre/ Control Centre grouping)	1 month
b) Continuous AVC classification accuracy monitoring per Virtual Toll Plaza/Toll Lane Grouping	Virtual Toll Plaza/Toll Lane Grouping (all Toll Lanes contained in the Virtual Toll Plaza/Toll Lane group)	3 months

10.2.1.8 All requisite parameter values and criteria inter alia, the confidence levels, maximum margins of error, respective proportion values and Traffic sampling space data that are employed in the minimum Traffic sample size determinations are indicated in the Project Document (Volume 3).

10.2.1.9 The AVC classification accuracy as measured by the AVC and subsequently verified by the Contractor using the VGS system, or other system approved by the Employer's Representative, shall be reported in accordance with the accuracy monitoring period specified in clause 10.2.1.7. This shall be deemed the Measured AVC classification accuracy (AVCm).

10.2.1.10 The AVC classification accuracy against which the accuracy requirement specified in clause 10.2.1.1 shall be compared for certification/penalty purposes, shall be the Measured AVC accuracy value plus the margin of error (d) based on the sample size (n), such that;

AVC Classification Accuracy = (Measured AVC classification accuracy (AVCm) + margin of error (d))

10.2.1.11 The Contractor shall also report the AVC Classification Accuracy together with the calculated margins of error, in accordance with the accuracy monitoring period specified in clause 10.2.1.7. The margins of error (d) per AVC accuracy category, determined on the total Vehicle throughput over the respective accuracy monitoring periods, shall be determined based on the formulae for the Binomial population distribution (Normal approximation):

$$d = z_{\alpha/2} (p (1 - p) / n)^{1/2}$$

where p denotes the proportion of vehicles counted/classified at a certain level of confidence, in this instance p is equal to the specified accuracy requirement percentages for each AVC accuracy category indicated in clause 10.2.1.7 (e.g. for Toll Class 1 the p value will be 0.996). The $Z_{\alpha/2}$ is the value from the cumulative normal distribution Z tables which has an area $\alpha/2$ below it and is dependent on the confidence level chosen for the Traffic sample.

- 10.2.1.12 The confidence levels that shall be used pertaining to the Traffic sample sizes for each of the AVC classification accuracy categories shall be as follows:

TABLE 10-3: CONFIDENCE LEVELS FOR TRAFFIC SAMPLES

Parameter	Confidence level	$Z_{\alpha/2}$ value (from Standard Z Table)
Class 1 classification	95%	1.96
Class 2 classification	95%	1.96
Class 3 classification	95%	1.96
Class 4 classification	95%	1.96

(Refer to the Project Document (Volume 3) or Government Gazette for any further details relating to vehicle classes.)

- 10.2.1.13 Example: The margin of error d for Toll Class 1 over an accuracy monitoring period of one month where the total Vehicle throughput was 10 000 Toll Class 1 Vehicles over the Traffic sampling space, would be determined as follows:

$$d = Z_{\alpha/2} (p (1 - p) / n)^{1/2}$$

here: $p = 0.996$ for Toll Class 1

$$Z_{\alpha/2} = 1.96$$

$$n = 10\,000$$

$$\text{Hence, } d = 1.96 (0.996 (1 - 0.996) / 10\,000)^{1/2}$$

$$= 0.124\%$$

If then for example, the Measured AVC accuracy (AVC_m) for Toll Class 1 for this 10 000 Vehicle sample was 99.5%, the AVC accuracy is then 99.62% (99.5% + 0.124%), which exceeds the specified 99.6% AVC accuracy requirement.

TABLE 10-4: SAMPLE SIZES FOR ACCURACY REQUIREMENT - CONVENTIONAL/HYBRID TOLL PLAZAS

	Conventional/Hybrid Lanes Classification and Count Accuracy				
Accuracy Requirements	Class 1	Class 2	Class 3	Class 4	Count
Specified accuracy level	99.6%	95%	96%	99%	99.9%
Confidence level	95%	95%	95%	95%	99%
Z α /2 value (from Standard Z Table)	1.96	1.96	1.96	1.96	2.5758
<i>*Sample size based on limiting criteria (for information purposes)</i>	<i>2500</i>	<i>200</i>	<i>250</i>	<i>1000</i>	<i>10000</i>
Minimum allowable sample size	3000	250	300	1100	11000
Margin of error	Recalculate for revised samples				

*Sample size based on limiting criteria cannot be used due to sample determinations at the limits of the binomial population distribution.

10.2.1.14 The measured AVC classification accuracy (AVC_m) shall exclude the AVC errors.

10.2.1.15 The AVC classification errors shall include:

- (a) The AVC incorrectly classifies the Toll Class of a Vehicle;
- (b) The AVC is unable to classify a Vehicle; and
- (c) The AVC does not assign a Toll Class to a Vehicle.

10.2.1.16 The AVC error per Toll Class shall be the number of Vehicles in that Toll Class incorrectly classified by the AVC, taken as a percentage of the actual total Vehicle passages registered in that Toll Class during the accuracy monitoring period. The actual Toll Class shall be verified by the Video Grabbing System or other method approved by the Employer's Representative.

10.2.1.17 The overall AVC count accuracy shall be the total number of Vehicles accurately counted as a Vehicle by the AVC taken as a percentage of the actual total Vehicle passages during the accuracy monitoring period.

10.2.1.18 Accurately counted Vehicles counted by the AVC shall exclude all AVC count errors which include:

- (a) All Vehicle passages that pass over the AVC undetected;
- (b) All Vehicle passages reported by the AVC without an actual Vehicle passage occurring.

10.2.1.19 All requisite parameter values and criteria inter alia, the confidence levels, maximum margins of error, respective proportion values and Traffic sampling space data that are employed in the minimum Traffic sample size determinations are indicated in the Project Document (Volume 3).

10.2.1.20 The AVC count accuracy as verified by the Contractor using the motion based recording on the DVR included in the VGS system, or other system approved by the Employer's Representative, shall be reported in accordance with the accuracy monitoring period specified in clause 10.2.1.23. This shall be deemed the Measured AVC count accuracy (AVCmc).

10.2.1.21 The AVC count accuracy against which the accuracy requirement specified in clause 10.2.1.1 shall be compared for certification/penalty purposes, shall be the Measured AVC count accuracy value plus the margin of error (d) based on the sample size (n), such that; AVC Count Accuracy = (Measured AVC count accuracy (AVCmc) + margin of error (d))

10.2.1.22 The Contractor shall also report the AVC count accuracy together with the calculated margins of error, in accordance with the accuracy monitoring period specified in clause 10.2.1.23. The margins of error (d) per AVC accuracy category, determined on the total Vehicle throughput over the respective accuracy monitoring periods, shall be determined based on the formulae for the Binomial population distribution (Normal approximation):

$$d = z_{\alpha/2} (p (1 - p) / n)^{1/2}$$

where p denotes the proportion of vehicles counted/classified at a certain level of confidence, in this instance p is equal to the specified total count accuracy requirement percentages indicated in clause 10.2.1.1. The $z_{\alpha/2}$ is the value from the cumulative normal distribution Z tables which has an area $\alpha/2$ below it and is dependent on the confidence level chosen for the Traffic sample.

10.2.1.23 The AVC count accuracy shall be determined over the following accuracy monitoring periods and Traffic sampling spaces:

TABLE 10-5: AVC COUNT ACCURACY VERIFICATION

Description	Traffic Sampling Space	Accuracy Monitoring Period
Initial AVC Count Accuracy verification	Employer's Representative designated individual Toll Lanes	≤ 3 months (to reach minimum Traffic sample 11 000 Vehicles)
Post initial AVC count accuracy verification: AVC count accuracy	Employer's Representative designated individual Toll Lanes	Period selected by the Employer's Representative that meets the

Description	Traffic Sampling Space	Accuracy Monitoring Period
monitoring per Virtual Toll Plaza/Toll Lane Grouping	or Virtual Toll Plaza/Toll Lane Grouping (all Toll Lanes contained in the Virtual Toll Plaza/Toll Lane group) or other grouping specified by the Employer's Representative	minimum Traffic sample size of 11 000 Vehicles.

- 10.2.1.24 The confidence levels that shall be used pertaining to the Traffic sample sizes for the overall count accuracy shall be as follows:

TABLE 10-6: CONFIDENCE LEVELS FOR COUNT ACCURACY

Parameter	Confidence level	Z $\alpha/2$ value (from Standard Z Table)
Overall Vehicle count	99%	2.58

- 10.2.1.25 The initial certification of the accuracy of the AVCs, subsumed in the overall AVC compliance process, shall be conducted over a 3 month period as indicated in clause 10.2.1.7. It shall be conducted in a representative sample number of Toll Lanes for which the respective minimum sample sizes, parameter values and other criteria are as indicated in the Project Document (Volume 3). It shall be incumbent on the Contractor to institute the necessary measures, including inter alia selective biased Toll Lane usage in a Virtual Toll Plaza, to ensure that the minimum Vehicle throughput levels are processed in each designated sample Toll Lane during the three month initial accuracy certification period. The Employer's Representative shall designate the representative sample Toll Lanes.
- 10.2.1.26 As part of the initial AVC accuracy certification process, the Contractor shall be required to independently prove the veracity of the AVC total count accuracy such that the Vehicles counted by the AVC can be compared to the actual number of Vehicle passages through a Toll Lane. The Contractor shall accomplish this, by activating motion detection based recording on the Digital Video Recording Equipment that forms part of the VGS system. The motion based recording shall be activated for the entire Employer's Representative designated sample Toll Lanes to capture all Vehicle passages over a predetermined time interval, for comparison against the AVC registered Vehicle counts. The DVR motion based detection shall be configured to trigger recording only when movement is detected in the AVC area of the Lane/Lanes being monitored. The Contractor shall provide full details of the AVC count verification procedural process together with full details of Equipment to be utilised, included as part of the AVC accuracy certification procedural manual described below. The Contractor may submit an alternative AVC Vehicle count verification procedure for approval to the Employer's Representative.
- 10.2.1.27 The burden of proof shall be upon the Contractor to adduce and establish conclusively that the AVCs meet the accuracy requirements as specified. As part of this process, the Contractor shall

compile and submit for approval to the Employer's Representative a comprehensive AVC accuracy certification procedural manual at least one month prior to the start of the initial 3 month AVC accuracy certification process. It shall include for the documentation of all operational procedures that will be implemented by the Contractor to ensure completion of the AVC accuracy certification within the specified time period. It shall further, detail all the required activities that will be performed by the Contractor, including all administrative and procedural activities elaborated on in clause 10.2.1.28 to determine the AVC accuracy during and following the 3 month initial certification period.

- 10.2.1.28 As part of the accuracy certification process, the Contractor shall be responsible for the administrative and procedural processes involved in the gathering, collating and processing of all data related to this process such that the AVC status and accuracy for each AVC accuracy category may be accurately determined. This shall include for the gathering and processing of all necessary AVC data, Toll Class Discrepancy data, audit reports, Toll Class Discrepancy images, corrected classification data, and all other information that may be required to correctly determine the AVC status and accuracy. This shall also include for the collation and submission of all necessary data outputs in the form of reports, tables, requisite corroboratory information and calculations to enable the Employer's Representative to verify the AVC accuracy results. The Contractor shall submit monthly progress reports, with accompanying supplementary information, on the AVC accuracy certification process to the Employer's Representative. Templates of all reports related to the initial accuracy certification period and post initial certification period shall be included in the AVC accuracy certification procedural manual for approval by the Employer's Representative.
- 10.2.1.29 The Contractor shall submit the completed AVC accuracy results of the initial accuracy certification, accompanied by the necessary corroboratory details as specified above, within forty five days after the completion of the three month certification period.
- 10.2.1.30 The specified classification accuracy shall be maintained for at least a 3-month period without re-calibration of the AVC. This functionality shall be initially measured as a concurrent process during the initial AVC accuracy certification period. The Employer's Representative may instruct the Contractor to perform additional ad hoc tests of this functionality in certain Toll Lanes during the Contract Period.
- 10.2.1.31 The Contractor shall determine and report the AVC Accuracy on the Contractor's monthly report. This shall include all relevant documentation and accompanying corroboratory detail as specified in clauses 10.2.1.27 and 10.2.1.28 above. AVC Accuracy report templates and accompanying information details structure and format shall be submitted to the Employer's Representative for approval.

10.3 ACCURACY VERIFICATION FOR ORT BASED SYSTEMS

10.3.1 OVERVIEW

- 10.3.1.1 The minimum traffic sample sizes per accuracy category for the various sample spaces shall be determined by using the binomial population distribution (normal approximation) per accuracy category, employing the following formulae:

$$n = p (1-p) (z_{\alpha/2} / d)^2$$

$$d = z_{\alpha/2} (p (1 - p) / n)^{1/2}$$

- 10.3.1.2 In the above formulae, n denotes the sample size required for a predetermined margin of error d, p denotes the proportion of vehicles counted/classified with a 100(1-α)% level of confidence and where $z_{\alpha/2}$ is the value from the Normal distribution Z tables which has an area $\alpha/2$ below it.

10.3.2 SAMPLE SIZE DETERMINATION

- 10.3.2.1 The determination of minimum sample sizes per accuracy category is provided in TABLE 1-1, below. These determinations are based on the following limiting criteria as relevant for the binomial population distribution:

$$np > 10 \text{ and } n(1 - p) > 10$$

- 10.3.2.2 The corresponding precision levels or margins of error per accuracy category for the various sample sizes are also provided in Table 10-7.

TABLE 10-7: SAMPLE SIZES PER ACCURACY REQUIREMENT

	ANPR Accuracy			Transaction Framing	DSRC	Open Road Tolling Classification and Count Accuracy	
Accuracy Requirements	Read Rate	Capture Rate	Trigger Rate	Framing	Tag Read	Classification	Count
Specified accuracy level	90%	92.5%	95%	99.5%	99.5%	98.5%	99.5%
Confidence level	95%	95%	95%	95%	95%	95%	99%
$Z_{\alpha/2}$ value (from Standard Z Table)	1.96	1.96	1.96	1.96	1.96	1.96	2.5758

	ANPR Accuracy			Transaction Framing	DSRC	Open Road Tolling Classification and Count Accuracy	
Accuracy Requirements	Read Rate	Capture Rate	Trigger Rate	Framing	Tag Read	Classification	Count
<i>*Sample size based on limiting criteria (for information purposes)</i>	100	150	200	2000	2000	667	2000
Minimum allowable sample size	250	250	250	3000	3000	700	3000
Margin of error	Recalculate for revised samples						

*Sample size based on limiting criteria cannot be used due to sample determinations at the limits of the binomial population distribution.

- 10.3.2.3 The margin of error shall be added to the measured accuracy, i.e. for certification/monitoring purposes, the final accuracy shall be the measured accuracy value plus the margin of error (d) based on the sample size (n), such that:

$$\text{Accuracy} = \text{measured accuracy} + \text{margin of error (d)}$$

- 10.3.2.4 The minimum allowable traffic sample sizes per accuracy category are provided in the Table above. The corresponding margins of error for these sample sizes for each accuracy category is indicated in the row below the minimum allowable sample size values.

- 10.3.2.5 The Traffic sample, over which the accuracy requirements as per the accuracy category specified in clause 10.3.1.1 shall be measured for the specified accuracy monitoring periods, shall be equal to the total Vehicle throughput through the designated Traffic sampling space (Toll Lane/Virtual Toll Plaza/Control Centre) as specified in clause 10.3.3, for the relevant accuracy monitoring period.

- 10.3.2.6 This will be subject to the Traffic samples indicated in clause 10.3.2.5 being greater than or equal to Traffic sample sizes, per accuracy category over the designated Traffic sampling space as specified, for the relevant accuracy monitoring period. The Traffic sample sizes are as indicated in the Project Document (Volume 3). If, due to exceptional circumstances, the Traffic sample size cannot be met within the requisite accuracy monitoring period for a particular accuracy category, the monitoring period may be extended or the minimum sample size as indicated in table Table 10-7: Sample Sizes per Accuracy Requirement

- 10.3.2.7 1 for the accuracy category in question may be used. This shall be at the discretion of the Employer's Representative.

- 10.3.2.8 The following calculation provides an example of the values within the above table. If the classification accuracy for class 1 vehicles needs to be confirmed as 99.6% or better, the margin of error d where the total vehicle throughput was 3000 class 1 vehicles over the traffic sampling space, would be determined as follows:

$$d = z_{\alpha/2} (p (1 - p) / n)^{1/2}$$

where: $p = 0.996$ for class 1

$$z_{\alpha/2} = 1.96$$

$$n = 3000$$

$$\begin{aligned} \text{Hence, } d &= 1.96 (0.996 (1 - 0.996) / 3000)^{1/2} \\ &= 0.226\% \end{aligned}$$

If then, for example, the measured accuracy for class 1 for this 3000 class 1 vehicle sample was 99.5%, the accuracy is then 99.726% (99.5% + 0.226%), which exceeds the specified 99.6% accuracy requirement.

- 10.3.2.9 The measured AVC classification accuracy (AVC_m) shall exclude the AVC errors. The AVC classification errors shall include:

- (a) The AVC incorrectly classifies the Toll Class of a Vehicle;
- (b) The AVC is unable to classify a Vehicle;
- (c) The AVC does not register a passage;
- (d) The AVC registers a passage without there being an actual Vehicle passage; and
- (e) The AVC does not assign a Toll Class to a Vehicle

- 10.3.2.10 The AVC error per Toll Class shall be the number of Vehicles in that Toll Class incorrectly classified by the AVC, taken as a percentage of the actual total Vehicle passages registered in that Toll Class during the accuracy monitoring period. The actual Toll Class shall be verified by the Video Grabbing System or other method approved by the Employer's Representative.

- 10.3.2.11 The measured Tag Read accuracy (TR_m) shall exclude the Tag Read errors. The Tag Read errors shall include:

- (a) The corrupt data read;
- (b) The Tag Reader is unable to read a Tag;
- (c) The Tag Reader does not register a Tag transaction;
- (d) Duplicate or multiple Tag transactions for a single vehicle passage;
- (e) The system create a false Tag transaction

- 10.3.2.12 The measured ANPR read accuracy (ANPRRm) shall exclude the ANPR read errors. The ANPR read errors shall include:
- (a) Images that are interpreted incorrectly by the OCR engines
- 10.3.2.13 The measured ANPR Capture accuracy (ANPRCm) shall exclude the ANPR Capture errors. The ANPR Capture errors shall include:
- (a) Vehicles that pass through the ANPR capture zone that do not result in a Vehicle Licence Number image
- 10.3.2.14 The measured ANPR Trigger accuracy (ANPRTm) shall exclude the ANPR Trigger errors. The ANPR Trigger errors shall include:
- (a) False triggered images
- 10.3.2.15 Accurately Framed data by the system shall exclude all system Framed errors which include:
- (a) All data captured and generated during a transaction (including but not limited to Tag read information, vehicle classification data and Vehicle Licence Number images) that cannot be combined to accurately identify a single vehicle.
 - (b) All data that cannot be linked to a unique and sequenced transaction number.
 - (c) Source data that cannot be traced to the originating sub-system and time of measurement.
- 10.3.2.16 The overall count accuracy shall be the total number of Vehicles accurately counted as a Vehicle by the system taken as a percentage of the actual total Vehicle passages during the accuracy monitoring period.
- 10.3.2.17 Accurately counted Vehicles counted by the system shall exclude all system count errors which include:
- (a) All Vehicle passages that pass over the Toll system undetected;
 - (b) All Vehicle passages reported by the Toll system without an actual Vehicle passage occurring.
- 10.3.2.18 All requisite parameter values and criteria inter alia, the confidence levels, maximum margins of error, respective proportion values and Traffic sampling space data that are employed in the minimum Traffic sample size determinations are indicated in the Project Document (Volume 3).
- 10.3.2.19 The actual sample size upon which accuracy measurements shall be calculated shall be equal to the total number of measurements taken over the specified monitoring period or the minimum allowable sample size taken over the same monitoring period, whichever is the larger. The

minimum Traffic sample size determination is concurrently influenced by the Traffic demographic of the Traffic sampling space for which it is determined over a specified time period, where it is taken as a proportion (f) of the total Traffic population of the Traffic sampling space over the specified time period, such that the margin of error (d) of the Traffic sample is in correlation with the total Traffic population prevalent of the respective Traffic sampling space. Hence, respective Toll Lanes at which the total Traffic populations are low and therefore result in correspondingly smaller sample sizes will thus have higher margins of error for the determined Traffic sample.

10.3.3 ACCURACY MEASUREMENTS

10.3.3.1 The accuracy shall be determined over the following accuracy monitoring periods and traffic sampling spaces:

TABLE 10-8: Traffic Sampling Space and Test Conditions

Description	Traffic Sampling Space	Accuracy Monitoring Period
Initial accuracy verification (performed at the start of the contract, i.e. typically at the site acceptance testing).	Individual Lane/s designated by the Employer's Representative, or random transaction samples, as applicable, such that the minimum traffic sample size is accomplished (using sampling without replacement). Refer to Table 10-7.	Measurements shall be conducted independently and concurrently (without interruption) at each designated representative sample Lane or random transaction sample, as applicable, such that the minimum sample size for that accuracy category is accomplished.
Post initial accuracy verification (performed after the start of but during the contract, i.e. typically when the accuracy is in doubt).	Individual Lane/s designated by the <u>Employer's Representative</u> , or random transaction samples, as applicable, such that the minimum traffic sample size is accomplished (using sampling without replacement). Refer to Table 10-7.	Measurements shall be conducted independently and concurrently (without interruption) at each designated representative sample Lane (typically on monthly basis) or random transaction sample, as applicable, such that the minimum sample size for that accuracy category is accomplished.

10.3.3.2 All requisite parameter values and criteria inter alia, the confidence levels, maximum margins of error, respective proportion values, accuracy monitoring period and traffic sampling space data that are employed in the minimum Traffic sample size determinations are indicated in the Project Document (Volume 3)

10.3.3.3 The accuracy as measured by the system and subsequently verified by the Contractor using a continuous video recording system of all the traffic through that Lane, or other system approved by the Employer's Representative shall be made available and reported to in accordance with the accuracy monitoring period specified in clause 10.3.3.1. This shall be deemed the Measured accuracy.

- 10.3.3.4 The burden of proof shall be upon the Contractor to adduce and establish conclusively that the system meet the accuracy requirements as specified. As part of this process, the Contractor shall compile and submit for approval to the Employer and/or his Representative a comprehensive accuracy certification procedural manual at least one month prior to the start of the accuracy certification process. It shall include for the documentation of all operational procedures that will be implemented by the Contractor to ensure completion of the accuracy certification within the allocated time period. It shall further, detail all the required activities that will be performed by the Contractor, including all administrative and procedural activities.
- 10.3.3.5 As part of the accuracy certification process, the Contractor shall be responsible for the administrative and procedural processes involved in the gathering, collating and processing of all data related to this process such that the status and accuracy for each accuracy category may be accurately determined. This shall include for the gathering and processing of all necessary data, discrepancy data, audit reports, discrepancy images, corrected data, and all other information that may be required to correctly determine the status and accuracy. This shall also include for the collation and submission of all necessary data outputs in the form of reports, tables, requisite corroboratory information and calculations to enable the Employer and/or his Representative to verify the accuracy results. The Contractor shall submit monthly reports, with accompanying supplementary information, on the accuracy certification process to the Employer and/or his Representative. Templates of all reports related to the initial accuracy certification period and post initial certification period shall be included in the accuracy certification procedural manual for approval by the Employer and/or his Representative.
- 10.3.3.6 The Contractor shall submit the completed accuracy results of the initial accuracy certification, accompanied by the necessary corroboratory details as specified above, together with the log files and source data to the Employer within seven (7) days after the month end (during which the data were captured).
- 10.3.3.7 The Contractor shall ensure that for the duration of the accuracy monitoring period, no system or Software changes or re-calibration are undertaken. If such changes are eminent or if the system must be upgraded, then the accuracy monitoring period shall start again and the data collected during the interrupted period shall be discarded.
- 10.3.3.8 The Contractor shall determine and report the accuracy in a monthly report. This shall include all relevant documentation and accompanying corroboratory detail as specified in this section. The accuracy report templates and accompanying information details structure and format shall be submitted to the Employer or his Representative for approval.

10.3.4 **FAILURE TO COMPLY WITH THE ACCURACY REQUIREMENTS**

- 10.3.4.1 The Contractor shall note that failure to meet the required accuracies, shall result in performance adjustments, as is specified within the Standard Specifications for Operations and Maintenance of CTROM Projects: Performance Measurement (Volume 2 Book 6a).

- 10.3.4.2 In the event that the accuracy requirements for both the initial accuracy monitoring as well as post initial accuracy monitoring, as applicable, is not met, the Contractor shall redo the tests. The Toll System shall only be deemed complaint once all accuracy requirements have been met.

**SECTION 11. APPENDIX A TO TOLL SYSTEMS: ILLUSTRATIVE
SOLUTION FOR A TEST PLAN**

11.1 ILLUSTRATIVE SOLUTION FOR A TEST PLAN

11.1.1 TABLE OF CONTENTS

11.1.1.1 The table of contents for an illustrative solution for a Test Plan is listed below:

1. Introduction

2. Corporate Testing Philosophy and Standards

3. Project-Specific Test Program

3.1. Project Test Schedule

3.2. Project Test Staffing Levels, Competencies, Responsibilities and Authorities

3.3. Project Test Hardware and Software Configuration

3.4. Test Tool Identification

3.4.1. Requirements Tracking Tool

3.4.2. Issues Tracking Tool

3.4.3. Defects Tracking Tool

3.4.4. Automated Testing Tool

3.4.5. Simulators

3.5. Software Defect Removal Strategies

3.5.1. Design Reviews

3.5.2. Code Walk Thru's

3.5.3. Internal Test Phases

3.5.3.1. Unit Testing

3.5.3.2. Integration Testing

3.5.3.3. Functional Testing

3.5.3.4. Regression Testing

3.5.3.5. Other

4. Project-Specific Test Procedure Standards

4.1. Defect Severity Level Definitions

4.2. Test Procedure Development Standards

4.3. Standard Test Procedure Contents (Guideline for test procedures)

4.3.1. Introduction

4.3.1.1. Test Purpose

4.3.1.2. Test Platform (including required Equipment)

4.3.1.3. Time Estimate

4.3.1.4. Pre-requisites

4.3.1.5. Set-up

4.3.2. Individual Test Conditions/Steps

4.3.2.1. Test Condition Identifier (i.e. reference to requirement)

- 4.3.2.2. Description
- 4.3.2.3. Expected Results
- 4.3.2.4. Actual Results
- 4.3.2.5. Notes

5. Formal Project Test Overview (Based on section 2.4)

- 5.1. Pre-commissioning Testing
 - 5.1.1. System Factory Acceptance Testing
 - 5.1.1.1. Location
 - 5.1.1.2. HW and SW Configuration
 - 5.1.1.3. Objectives
 - 5.1.1.4. Acceptance Criteria
 - 5.1.1.5. Entry Criteria (Pre-requisites to be met before testing can commence)
 - 5.1.1.6. Exit Criteria (Requirements for successful completion of the tests)
 - 5.1.1.7. Individual Test Procedures
 - 5.1.2. Hardware Factory Acceptance Testing
 - 5.1.2.1. Location(s)
 - 5.1.2.2. HW Configuration
 - 5.1.2.3. Objectives
 - 5.1.2.4. Acceptance Criteria
 - 5.1.2.5. Entry Criteria (Pre-requisites to be met before testing can commence)
 - 5.1.2.6. Exit Criteria (Requirements for successful completion of the tests)
 - 5.1.2.7. Individual Test Procedures
- 5.2. Migration Testing of Legacy Accounts
 - 5.2.1. Objectives
 - 5.2.2. Roll Back Strategy
 - 5.2.3. Acceptance Criteria
 - 5.2.4. Entry and Exit Criteria
 - 5.2.5. Individual Test Procedures
- 5.3. Accuracy Testing
 - 5.3.1. Objectives
 - 5.3.2. Schedule
 - 5.3.3. Standard Process
 - 5.3.4. Verification Procedures
 - 5.3.5. Equipment Requirements
 - 5.3.6. Safety Requirements
- 5.4. Commissioning Testing
 - 5.4.1. Site Acceptance Test Phases
 - 5.4.1.1. Registration Module
 - 5.4.1.2. 1st Tolling Point / Plaza
 - 5.4.1.3. Back Office (including integration with Lane/Tolling Point)

- 5.4.1.4. Full System Integration (including TCH)
- 5.4.1.5. Future Tolling Points/Lanes/Back Office (with integration)
- 5.4.2. Site Acceptance Test Procedures
 - 5.4.2.1. Installation Verification Procedures
 - 5.4.2.2. Sub-System Verification Procedures
 - 5.4.2.3. Integration Test Procedures
 - 5.4.2.4. Functional Compliance Procedures
 - 5.4.2.5. Stress Test Procedures
 - 5.4.2.6. Accuracy Test Procedures
- 5.5. Disaster recovery Testing (Test the Plan)
- 5.6. Trial Operation Testing
 - 5.6.1. Tolling Point(s)/Toll Lane
 - 5.6.2. ORT Back Office (including integration with Lane/Tolling Point)
 - 5.6.3. Full System Integration (including TCH)
- 5.7. Continuous Testing (Post Commissioning)
 - 5.7.1. Regression Testing
 - 5.7.2. Testing related to Upgrades and Latent Defect Correction
 - 5.7.3. Report Accuracy Testing
 - 5.7.4. Other Ongoing Testing