

City and County of Honolulu
Department of Transportation Services
Rapid Transit Division (RTD)

CORE SYSTEMS
DESIGN-BUILD-OPERATE-MAINTAIN
CONTRACT

TECHNICAL PROVISIONS
TP-5 FARE VENDING
ISSUE FOR PROPOSALS – NOT FOR CONSTRUCTION

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Prepared for:
Honolulu High-Capacity Transit Corridor Project

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TP-5.1 Summary

These Contract Documents specify the requirements for the design, manufacturing, furnishing, assembly, testing, inspection, and installation of the Fare Collection System for use on the City of Honolulu's High Capacity Transit Corridor System Project. The Fare Collection System consists of Ticket Vending Machines (TVMs), a Data Collection / Information System (DC/IS), Revenue Collection Equipment, related data communication networks to allow the TVMs to communicate with a central fare collection computer, and the spare parts, tools, test equipment, documentation, software listings, training, technical assistance, and warranty required as part of this Contract. These ticket vending machines are to be very simple in operation; initially accepting coins, and bills, as payments for fares dispensing paper ticket as fare products. The TVMs must have the capability of an up-grade using credit cards and Smart Cards for fare payment, at some time in the future. Simple parking pay station equipment will suffice as a Ticket Vending Machine as long as they have all capability mentioned above and requirements indicated in these technical specifications.

The fare collection equipment specified herein shall be installed for use on the City's light rail line.

The TVMs are intended for the purpose of selling paper tickets to the City's patrons by accepting coins and bills.

Tickets vended by TVMs are issued with date and expiration date/time printed onto the fare media upon purchase.

The Contractor shall provide a Fare Collection System, which is service-proven as defined herein. The Contractor shall provide and install materials that are new and free of defects and that conform to the requirements of these Technical Provisions.

The Contractor shall ensure that each subcontractor has a complete copy of these Technical Provisions.

TP-5.1.1 Station Description

Stations will have raised concrete and masonry platforms. Station platforms will be approximately 270 feet in length. Shelter over the TVMs will not necessarily be provided. Fare collection equipment may be installed at sites, (such as park and ride lots) other than stations, as deemed appropriate by the City. TVMs shall be designed to be both weather and environmentally protected.

As a rule, TVMs will be installed off-platform to alleviate platform congestion and create a Fare Paid Zone.

Ticket Vending Machines will be located off-platform in the general line of passenger flow approaching the platform ramp. These machines will usually be located to the right of the ramp, and will be situated so that the front of the machines face the approaching passengers and minimize queuing interference with traffic flow. The station architectural drawings indicate where each piece of equipment will be located. The preliminary station architectural drawings are under development.

TP-5.1.2 City Resident Engineer Approval

All references to 'RE approval' in this document means the RE will review and recommend appropriate action upon the Contractor's submittals only for the limited purpose of verifying their conformance with information given and the design concept expressed in the Contract Documents.

TP-5.1.3 Site Access and On-site Work

On-Site work for the installation and testing of the Fare Collection System and the testing of installed Fare Collection System is located in and around the city of Honolulu, Hawaii. The Contractor shall plan and execute safe access to the work site for on-site work. Such safe access shall be afforded to the general public, patrons, the City employees, construction equipment and vehicles in accordance with the Contract.

The Contractor shall take into consideration the following guidelines for on-site work:

- Minimize nighttime disturbance of hotel, apartment, dormitory, single family and condominium residents in the area as required by the local rules and regulations of the jurisdictional agencies.
- Minimize disruption to retail, office, school and university operations.
- Avoid restricting public rights-of-way.

The Contractor shall not prevent access for other contractors to the work site.

Access to the sites for installation of the fare collection equipment shall be governed by the completion of other City contracts. These dates will be subject to revision as the design and construction of the station facilities progresses, therefore, the Contractor shall incorporate flexibility into its planning of the overall schedule for this Contract's progression and completion.

If a facility is needed to store equipment locally in the Honolulu area, it is the Contractor's responsibility to arrange such storage.

The current schedule of access for start of this Contract's on-site work (installation of fare collection system) is as shown in the Terms and Conditions of the Contract Documents.

The Contractor shall be responsible for protecting all utilities, station platforms and other the City property, streets, private property, and shall repair any damage to these facilities at the Contractor's expense.

TP-5.1.4 Coordination with Other Contractors

The execution of this Contract will require coordination between the Contractor and other City contractors. The Contractor shall coordinate all designs, and installation activities with the following City contractors as a minimum:

- LRT Signals and Communications
- Station Finishes Contractor
- Maintenance and Storage Facility Contractor
- Line Section Contractor(s)

The Contractor shall inform the Resident Engineer (RE) should any issues develop requiring the RE's attention or coordination with these and other contractors.

TP-5.1.5 Reference Standards

The following is a list of standards referenced in the Contract Documents. The list is not intended to be all-inclusive. The latest revision in effect for each standard at the time of NTP shall be used in conjunction with the Contract Documents.

- Americans with Disabilities Act (ADA)

- American National Standards Institute (ANSI)
 - ANSI X9.24 – Financial Services Retail Key Management
 - ANSI 7810 – Identification Cards – Physical Characteristics
- American Welding Society (AWS)
 - AWS B2.2 – Standard for Brazing Procedure and Performance Qualification
 - AWS C1.1 – Recommended Practices for Resistance Welding
 - AWS D1.1 – Structural Welding Code-Steel
 - AWS D1.2 – Structural Welding Code-Aluminum
 - AWS D1.6 – Structural Welding Code–Stainless Steel
- Federal Communications Commission emission limits
- MIL-HDBK-132 – Protective Finishes for Metal and Wood Surfaces
- National Fire Protection Association (NFPA)
 - NFPA 70 – National Electrical Code
 - NFPA 130 – Standard for Fixed Guideway Transit and Passenger Rail Systems
- Underwriters Laboratories (UL)
 - UL Standard 751 – Vending Machines
- International Electro-technical Commission (IEC)
 - IEC 60529 (IEC 529) – Degrees of Protection Provided by Enclosures

TP-5.1.6 Existing System Description – Fare Media

TP-5.1.6.1 Base Material

All tickets to be issued by the TVM shall utilize plain paper 0.007” to 0.008” thick as the base material.

TP-5.1.6.2 Preprinted Graphics

Text and graphic designs shall be printed on one side of the tickets. All text and graphics shall be free of smudges and shall be printed in such a way to withstand normal handling and use without degradation. Text shall be printed in sizes ranging from 8 point to 50 point (0.08” to 0.5” high) using fonts similar to those currently in use. All graphics shall be printed in one color, similar to that currently in use.

TP-5.1.6.3 Packaging and Bundling

Each bundle of ticket stock shall contain at least 2,000 tickets and be retained by a suitable support sized to handle ticket stocks. Ticket bundles shall be in roll or fan-fold stack form; individual die-cut tickets shall not be used by the TVMs. As delivered, each bundle of ticket stock shall be individually banded to prevent accidental spillage or unwinding.

TP-5.1.7 Environmental Requirements

TVMs, at the City’s sole discretion, may be installed with no shelter provided over the equipment. TVMs shall be designed and be capable of operating or being stored without shelter under the climatic conditions specified herein. Solar radiation will cause cabinet exterior and interior temperatures to rise considerably above ambient. All components shall continue to operate normally at elevated machine-enclosure temperatures.

Coin, bill, ticket, and other openings and enclosure joints will be subject to wind-driven dust and rain and shall be designed to assure proper operation of the equipment under such adverse conditions through the use of shutters or covers that shall open automatically when patrons activate the TVM. All exposed surfaces including the push buttons, display screen, and coin and bill components shall be unaffected by detergents and cleaning solvents, including the infiltration of such materials into the machine as caused by using a sponge or brush to hand clean the unit. Means shall be provided to expel moisture within the TVMs to assure continued, reliable operation. Ticket stock shall be maintained in condition for proper feed and printing/ encoding and activating.

Airborne particulates shall not affect the operation of the TVMs.

The equipment finish, graphics panels, and all surfaces, including lettering, maps, and other information displayed on the equipment shall be resistant to ultraviolet radiation and air contaminants.

TP-5.1.7.1 Electrical Design Requirements

All electrical and electronic systems shall be designed using only materials and components of proven quality and reliability. All devices shall be de-rated to operate within the acceptable range for electrical stress versus temperature for the type of service for which this Fare Collection System is required.

Each TVM shall have a main power switch internal to each enclosure that removes all power from the unit.

If an air conditioning unit or similar device is used to cool the interior of the TVM, it shall also have a main power switch internal to the TVM that removes all power from the unit.

Separate ground wires shall be used to properly ground the TVMs; all equipment, components and parts shall be grounded. Grounding shall be provided to ensure all conductive material is connected to a common ground point. The grounding scheme shall be configured so that performance of the equipment is not compromised due to common mode impedance coupling. The Contractor shall submit the grounding scheme to the RE for review and approval at the Definitive Design Review.

TP-5.1.7.2 Electrical Design Criteria

The equipment shall be designed to comply with UL Standard 751, "Vending Machines," NFPA 70, "National Electric Code," and applicable local requirements.

Electrical equipment shall be designed for a minimum of 10 years life, stable operation, and safety in the expected environment. Equipment shall withstand repeated exposure to abusive users and repeated opening of enclosures without damage.

All equipment shall be stable in its operation and shall not require adjustment except at major overhaul periods.

All electrical equipment shall operate within the manufacturer's recommended maximum temperature, power, or current ratings, or those identified in these Technical Provisions, whichever is more stringent.

All fare collection equipment shall be designed to operate with +10% to -20% fluctuations in line voltage without any equipment damage or service interruption. Variations in the supply voltage outside this range, or supply interruptions in excess of 20 milliseconds shall cause an orderly

shutdown of the Fare Collection Equipment at the point where the voltage falls outside the reliable operating voltage range of a module. The equipment shall automatically return to its normal state of operation when the voltage returns to its normal operating range.

A GFCI duplex convenience outlet rated at 120 Vac, 15 amps shall be easily accessible within the interior of each TVM to aid service personnel in the connection of any tools or test instrumentation. This outlet shall be protected by a separate circuit breaker internal to the TVM enclosure and be grounded. Voltage transient suppression shall be provided to protect all equipment connected to this outlet.

TP-5.1.7.3 Transient and Surge Suppression

High voltage transients, on power and/or signal interface lines, including those due to nearby lightning strikes, shall not damage the equipment.

Voltage transient suppression shall be provided for the protection of components and circuitry involving semiconductor devices. The fare collection equipment shall be capable of withstanding transients of 3.0 kV peak pulse with a total energy of 400 joules without damage, improper operation or shutdown. The functional status of any such surge and transient suppressor circuitry shall be visible at all times when the outer door is open.

Each fare collection equipment enclosure shall contain a readily accessible master circuit breaker that shall remove power from the Fare Collection Equipment when actuated. Each of the modular components (*e.g.*, coin processing unit, bill processing unit, ticket and pass issuing unit, electronic control unit, etc.) shall have appropriate circuit protection as required by the design of the equipment. Suppression means shall not result in deterioration of performance.

TP-5.1.7.4 Electromagnetic and Radio Frequency Interference

The fare collection equipment shall be designed to operate without causing harmful interference or being affected by interference such as external transients, magnetic, electrical, and radio frequency fields. Shielding and line filtration shall be provided within the fare collection equipment to protect electronic components and assure full operation under electrical interference within the station environment including: operation of radio transmitters in the stations or on trains; transmitting or receiving from a hand held radio set or cellular telephone adjacent to the fare collection equipment; adjacent operation of rail vehicles with direct current third rail power and occasional arcing; power lines; station equipment such as lighting and communication equipment; and, from proximity to heavy-duty internal combustion engines such as those found on buses, trucks, and locomotives.

The equipment shall be designed to prevent radiation of radio and electrical signals to external equipment and shall not affect operation of other equipment in the rail system or to other outside systems. All equipment shall conform to Federal Communications Commission emission limits as expressed in Part 15 of the FCC rules.

Table 1-1. Federal Communications Commission Listing

Electromagnetic Emission	FCC, Part 15, Subparts A&B
Conducted Limits	EN 55022, Class A
Radiated Emission Limits	EN 55022, Class A
Railway Applications – Electromagnetic Compatibility	EN 50121, Part 4
Electromagnetic Immunity	IEC 1000-4-1
Electrostatic Discharge Immunity	IEC 1000-4-2

All wiring shall be planned and selected to avoid electrical interference in the operation of sensitive high frequency systems. This shall include the use of shielded cables, chokes, filters, and capacitors to avoid possible interference with these systems. Apparatus creating electromagnetic interference emissions shall be designed to contain these emissions within their package area. Suppressors shall be incorporated across inductive devices to minimize switching transients.

TP-5.1.7.5 Environmental Standards

Climatic Conditions

The fare collection equipment shall be capable of being operated at the specified performance levels, stored, and maintained without impairment resulting from the natural or induced environmental conditions within which the City will use or store the equipment. TVMs shall be designed to be resistant to liquid ingress caused by driving rain and incidentally splashed water such as would occur during routine equipment and/or platform cleaning. Equipment enclosures shall comply with International Electro-technical Commission Standard 529 (IEC529) to level IP34 or equivalent.

The climatic factors listed in the Special Provisions shall be used as design guidelines and shall be considered as operational requirements. Actual localized temperatures and conditions within the TVMs may be more severe than the ambient climatic conditions and the Contractor shall be responsible for evaluating these during the design effort. Additionally, the Contractor shall be responsible for advising the City if there are any special environmental factors to which its equipment may be sensitive that are not listed in the Special Provisions. The Contractor shall insure that no equipment damage occurs during manufacture, storage, and shipment as a result of climatic conditions.

TP-5.1.7.6 Electrical Standards

Power provided in the stations for the TVMs will be 120 Vac, 60 Hz, 20 amp (maximum), single-phase alternating current with separate ground wires. Voltage range tolerance shall be +10% to -20% and frequency range of +1 Hz to -3 Hz. Each TVM will be provided power from a dedicated, separate circuit.

TP-5.1.7.7 Definitions

Wherever in these Contract Documents the following terms and abbreviations are used, the intent and meaning shall be interpreted as follows:

- **Bank Card** – A credit or debit card issued by a bank or financial institution.

- **Baseline Design** – The design of the Fare Collection System or any of its components, apparatus, systems, subsystems, or materials, which have received both drawing approval and First Article approval by the Resident Engineer.
- **Calculations** – Numerical computations performed to demonstrate compliance with the Contract Documents.
- **Comment** – Written critiques of the Contractor’s submittals to the Resident Engineer.
- **Component** – Any device having distinct electrical or mechanical characteristics and having connection points to be connected to other components to form a sub-assembly.
- **Contract Data Requirement List (CDRL)** – Items to be provided by the Contractor to the Resident Engineer as defined by these Contract Documents.
- **Contract Drawings** – Drawings provided as part of the Contract Documents.
- **Contractor’s Drawings** – Items such as detail drawings, graphs, diagrams, and sketches, which are prepared by the Contractor to detail its work.
- **Days** – Unless otherwise designated, days as used in the Contract Documents shall be understood to mean calendar days.
- **Days, Working** – Normal working days, Monday through Friday, exclusive of holidays. Office holidays are New Year’s, Memorial, Independence, Labor, Thanksgiving, Christmas Day, or days so celebrated.
- **Equal** – Whenever the words “equal” or “approved equal” are used in connection with make or quality of material or equipment in these Contract Documents, the Resident Engineer’s decision as to whether any material or equipment proposed is equal to that specified shall be binding and final on both the Contractor and the City.
- **Failure** – The inability of a component or equipment to function or perform its intended function as designed or specified.
- **Failure Rate** – The frequency of failure, expressed as failures per unit of time (in days) or failures per number of cycles (number of transactions). Failure rate is the mathematical reciprocal of MTBF or MCBF.
- **First Article** – The first one of any production component of the fare collection equipment that is produced. The Contract Documents provide that production components not be manufactured prior to drawing approval, so the First Article shall have been made to approved drawings.
- **Independent Failure** – A failure, which is not the result of another failure, either directly or indirectly.
- **Indicated** – As used in the Contract Documents, “indicated” shall be understood to mean, “as shown in the Contract Drawings,” or “as described in the Contract Documents.”
- **Interface** – The points where two or more systems, subsystems or structures meet, transfer energy, or transfer data or information.
- **Maintainability** – The ability of the Fare Collection System to be maintained by the City’s maintenance staff, including enhancement of access to equipment and components that require maintenance.
- **Mean Cycles Between Failures (MCBF)** – The mean number of operating cycles between successive independent failures.
- **Mean Time Between Failures (MTBF)** – The mean operating time interval between successive independent failures.

- **Modular** – Composed of standardized, interchangeable units, designed to facilitate maintenance and repair.
- **Module** – A standardized, interchangeable unit, designed to facilitate maintenance and repair.
- **Operating Cycle** – A complete transaction: for the TVM, the purchase of one or more tickets by a patron in a single operation (*e.g.* the purchase of two round-trip tickets is one operating cycle).
- **Pass** – Ticket for unlimited rides within a designated time period (*e.g.*, a specified day).
- **Product Data** – Illustrations, standard schedules, performance charts, instructions, brochures, diagrams, instructions, warnings and other information furnished by the Contractor to illustrate or explain the fabrication, assembly, installation, maintenance or operation of materials, equipment, or some portion of the work.
- **Proof** (used as a suffix) – Apparatus is designated as dustproof, waterproof, etc., when so constructed, protected, or treated that its successful operation is not interfered with when subjected to the specified material or condition.
- **Reliability** – The probability of performing a specified function without failure and within design parameters for the period of time or the number of cycles specified under actual service conditions.
- **Safe** – Secure from liability to harm, injury, danger or risk; free from danger or risk.
- **Safety** – The condition in which persons are free from threat or danger, harm, or loss arising from improper design, manufacture, assembly, malfunction, or failure of the fare collection system or any of its components or elements.
- **Service-Proven** – Identical or near identical equipment, which has demonstrated successful operation in a transit industry environment similar to that anticipated for the City.
- **Shop Drawings** – Drawings or sketches prepared by the Contractor for use in its manufacturing facility, assembly facility, or shop, to fabricate, assemble, and/or install parts of the Fare Collection System, whether manufactured by it from raw materials or purchased from others in a ready-to-use condition.
- **Sub-Assembly** – Two or more components combined into a unit for convenience in assembling or servicing equipment.
- **Surplus Payment** – Deposit of an amount, for a selected fare greater than required.
- **System Accuracy** – The measurement of the fare collection system's precision in accounting for monies deposited and dispensed.
- **Tamperproof** – Items are designated as tamperproof when they cannot be easily loosened, opened, or penetrated with commonly available tools such as a flat blade or Phillips screwdriver or pliers.
- **Ticket** – A printed medium to provide proof of payment.
- **Tight** (used as a suffix) – Apparatus is designated as watertight, dust tight, etc., when so constructed that the enclosing case shall exclude the specified material.
- **Time-Out** – When a prescribed amount of time has elapsed during which a specified action has not occurred.

TP-5.2 *Ticket Vending Machine*

The Ticket Vending Machine (TVM) shall be designed to sell tickets and passes by coins and/or bills as well as having the capability of accepting bankcards (credit and debit), and smart cards. The bank cards and smart cards will not be used upon system start up but can be activated at any time after that date. TVMs shall be capable of printing and issuing different tickets, passes or combinations thereof from within the same housing. In general, each TVM shall:

- Accept U.S. coins, bills and bank cards (credit and debit) and Smart Cards
- Respond to patron's choice of action
- Display the amount due based on patron selections
- Prints, and issues tickets, passes and receipt
- Capable of vending rolling period passes
- Display instructions and notices
- Return monies deposited if a transaction is canceled or aborted
- Register and store accounting data
- Provide bilingual audio output of messages and instructions
- Contain both local and remote security and alarm systems
- Communicate over a network to receive commands and also transmit and receive data regarding sales, revenue, accounting, equipment status, and security information and alarms
- Communicate over a network to send and receive data regarding bank card and smart card transactions
- Shall have push buttons for patron input
- Activate a magnetically encoded ticket or pass
- Preliminary design drawings of the TVM and all major assemblies shall be submitted for RE approval at the Definitive Design Review

TP-5.2.1 Current Fare Instruments

Fare instruments or products currently in use in Honolulu include:

- Semester passes
- All Day Tickets
- Monthly, half month pass
- Reduced fare
- Transfer
- Summer Youth Pass
- Tickets
- Coins
- Bills

TP-5.2.2 Operation

Each TVM shall normally be ready to respond to a patron selection when it is in the idle condition. If the TVM is not ready, all operating functions shall be disabled. A programmable display screen and push buttons shall be provided for patrons to complete a transaction. The

display screen shall direct the patron through the steps of the transaction with the patron's inputs being entered through push buttons.

It shall be possible for the patron to change any selection up to the moment when the first coin or bill is deposited or when a bankcard has been inserted. Once payment media has been inserted it shall no longer be possible for new patron selections to be made until the current transaction has been completed or canceled.

The TVM shall normally accept cash payment as the default mode. The TVM instructions shall allow the customer to select another type of payment such as bank card. Payment types shall be mutually exclusive; that is, each transaction shall only be by cash, bankcard. Once cash equal to, or exceeding the amount due is inserted into the TVM, the coin and bill slots shall close. Attempts at simultaneous payment by both cash and a bankcard shall result in the transaction being automatically canceled.

When failures occur during a transaction, the TVM shall make every attempt to complete the transaction or return all deposited funds.

TP-5.2.2.1 Normal Operations

In normal operating mode, issuing fare media shall require the following sequence of actions:

- **Step 1** – Patron selects type and quantity of tickets desired by pressing one or a combination of two or more push buttons.
- **Step 2** – TVM display screen shall display amount due and instructions.
- **Step 3** – Patron inserts payment.
- **Step 3a** – For a cash payment the display screen shall decrement displayed amount due based on money collected by TVM.
- **Step 3b** – For credit/debit card payment, patron inserts a bank card, selects payment type (CREDIT or DEBIT), then enters their personal identification number – “PIN” – for debit cards, and follows the instructions on the display screen.
- **Step 4** – When payment equal to or in excess of correct fare value has been collected, the TVM shall prompt the patron as to whether a receipt is desired, and then issues the selected ticket(s) as necessary and receipt if requested. Ticket(s) receipts shall be deposited in the ticket/coin return bin.
- **Step 4a** – If authorization for the bankcard transaction is received the TVM shall issue the selected ticket(s) and a receipt, if desired.

In the event a patron's card is not authorized, the TVM shall display an appropriate message and return to Step 2 (showing the ticket selected and the amount due). The patron may then resume the transaction with cash, a different card, or cancel the transaction.

- **Step 5** – If the patron chooses to receive a receipt, it shall be printed and deposited in the ticket/coin return bin. If the patron elects not to receive a receipt or makes no response to the prompt within a software configurable time-out period, no receipt shall be issued.
- **Step 6** – TVM shall record the necessary transaction data and return to the idle condition.

TP-5.2.2.2 Limited Operation

Operation of the TVM shall continue to operate in a limited capacity in the event of a failure of one or more components; assuming that the failure poses no risk of further damage to the TVM

or its components, the TVM shall remain in service as long as it is capable of vending tickets. At a minimum, the TVM shall provide the following reduced level of operations:

Table 2-1. Limited Operations of TVM

Failure of:	Shall Result in Continued Operation as:
Bill system	Coin, bankcard operated ticket vendor capabilities. Message on TVM to be displayed: "No Bills Accepted."
Bank card subsystem	Message on TVM to be displayed: "No Bank Cards Accepted."
Receipt printed (if separate) or empty receipt stock	No receipts available for bank card transactions. Message on TVM to be displayed: "No Receipts Available."
Communications with FCNC	Message on TVM to be displayed: "No Cards Accepted."

Whenever possible, the TVM shall remain in service even if multiple failures occur; for example, it shall be possible for the TVM to simultaneously be in both "No Coins Accepted", or credit/debit only mode and "Exact Fare Only" mode. Only the failure of those components necessary to vend tickets (*i.e.* ticket and pass issuing unit, ECU, power supply, patron keyboard) or a combined failure of both the bill and coin systems shall cause the TVM to go out of service. In a similar manner, failure of the components associated with bank cards acceptance shall not place the TVM out of service if the cash handling components are operational. The TVM's Electronic Control Unit shall indicate the limited operating condition to the Fare Collection Network Controller.

TP-5.2.3 TVM Transaction Process Characteristics

The TVM shall provide the following bankcard transaction process characteristics in accordance with ABA standards.

The TVM shall accept the following credit cards:

- American Express
- Discover
- MasterCard
- Visa

In addition, the TVM shall accept debit cards accepted by the following networks:

- Cirrus
- Plus

All attempts at using non-bank cards (e.g. department store credit cards) shall be rejected locally by the TVM. Only cards with successfully read ABA-standard encoding shall be passed on to the Fare Collection Network Controller for further processing.

Each fare table entry (ticket type selection) shall have an associated City software configurable parameter that determines whether the selection can be purchased with a bankcard. For those fare table entries that are not identified as being available for purchase with bankcards, the bank card processor shall not be enabled when the associated ticket type is selected. Such transactions shall

be “Cash Only”, and the TVM shall display an appropriate message whenever the patron selects such tickets.

Distinct bankcard transaction time-outs, modifiable by the City where possible, shall be provided for each required input.

The patron shall have the ability to cancel the bankcard transaction up until the time authorization is received by the TVM.

All bank card transactions shall be screened by the Fare Collection Network Controller prior to issuing ticket(s). If the FCNC is inoperative or communications to the FCNC are disabled, bank card transactions shall be unavailable; all TVMs shall enter “Cash Only” mode.

All bankcard transaction data shall be recorded and stored on the Fare Collection Network Controller. No credit or debit card numbers shall be recorded by the TVM.

TP-5.2.3.1 Transaction Speed

This section describes the expected transaction speed of the TVM.

Cash Transactions

The assumed speed of TVM transactions is a critical parameter in the calculations used to determine the number of TVMs required at each platform. Transaction time is calculated as the time from completion of ticket selection to when the ticket and all change are deposited in the ticket/coin bin.

Assuming all inserted coins and bills are accepted on the first insertion and all transactions are for the purchase of a single ticket, the time required to complete the following sample transactions shall not exceed the following.

Table 2-2. Maximum TVM Transaction Times

Sample Transaction Content	Maximum Time to Complete
One bill inserted Two coins returned	10 seconds
Four coins inserted Two coins returned	12 seconds
Two bills inserted Four coins returned	15 seconds
One bill inserted Four coins inserted Two coins returned	17 seconds
Five bills inserted Four coins returned	25 seconds
Credit/Debit Card Transaction	30 seconds

In addition, for all varieties of transactions listed above, the time between the completion of the transaction (when all coins and tickets are deposited in the ticket/coin return bin) and the TVM is available to begin another transaction shall not exceed 3 seconds.

If a transaction is canceled by the patron before money has been deposited the TVM shall immediately return to the idle screen. If a transaction is canceled after money has been deposited and before the first ticket is printed, all money shall be returned and the TVM shall resume its idle condition within 5 seconds of the cancellation.

Where possible, TVM speed shall be optimized by the use of concurrent activities. For example:

If a canceled transaction requires the return of coins and bills, both the coin and bill systems shall be commanded to do so simultaneously.

Bank Card Transactions

Transaction times for bank card transactions, measured from the time a card is inserted into the TVM to the time a ticket is dispensed, shall not exceed the following times (excluding PIN entry time and clearing house processing time):

- When the Fare Collection Network Controller is on-line with the clearing house: 10 seconds.
- When the Fare Collection Network Controller is not on-line with the clearinghouse and communications must be established: 15 seconds.

TP-5.2.3.2 Patron Interface

The patron interface with the TVM shall be at the front of the machine. All patron interface openings shall be designed to preclude unauthorized access. Patron interfaces for cash, bankcards are described below.

Cash

It shall be possible to deposit coins and bills in any sequence. Deposited coins and bills shall be verified electronically and physically for denomination and validity. If all verification conditions are not fulfilled, each unverified coin or bill shall be rejected and returned.

It shall be possible for the patron to change any selection up to the moment when the coin or bill is deposited. Once coins or bills have been deposited, they shall be returned to the patron only if rejected by the TVM, the transaction has been canceled by the patron, the TVM times out before the full fare has been inserted, or because the transaction has been otherwise aborted. Once payment media has been inserted, it shall no longer be possible for new patron selections to be made until the current transaction has been completed or canceled.

Bank Cards

A push/pull (insert/remove) card processor such that the bankcard is not “captured” completely by the TVM shall be utilized. The card slot shall be designed so that any liquids entering the slot are immediately drained away from the card processor mechanism.

ISO 7810 size cards (2 1/8” X 3 3/8” X 0.030” thick) shall be accepted, with magnetic data stripe.

The bank card processor shall be capable of simultaneously reading ISO tracks 2 and 3 in accordance with ABA standards.

On TVMs, a secure keypad for PIN entry when debit cards are used shall be provided. The PIN shall employ DES Encryption as required in accordance with banking requirements. The PIN keypad shall be distinct from the selection pushbuttons, and shall be mounted adjacent to the bankcard processor. The PIN keypad shall be made of steel, resist vandalism, and shall be

suitable for outdoor installation. The keypad shall be subject to RE review and approval at the Definitive Design Review.

If not provided by the PIN pad, two additional pushbuttons for selecting the card type, labeled “CREDIT” and “DEBIT” shall be provided. If the TVM employs variable-function selection pushbuttons similar to ATM machines, the selection of card type may be via the patron selection keyboard.

If a separate display is required for the PIN pad (for messages between the TVM and clearing house that are encrypted or otherwise not available to the TVM ECU), the display shall provide at least 2 rows of 20 characters with the same viewing angles, character size, and other characteristics of the passenger display. The PIN pad display shall be subject to Resident Engineer review and approval at the Preliminary Design Review.

Receipts shall be provided if requested by the patron.

TP-5.2.3.3 Receipt Printing

Receipts shall be printed either by the ticket and pass-issuing unit using audit stock or a separate printer for receipts only. Receipts shall be deposited in the ticket/change bin within 3 seconds after the patron responds affirmatively to the prompt requesting whether a receipt is desired. Receipts shall be printed for all bank card transactions.

If a separate receipt printer is used, it shall be able to print all alphanumeric characters in both upper and lower case. Printed characters shall be produced with a minimum height of 0.12 inches. The approximate height to width ratio of the characters shall be 5:3. The printer shall be of the impact dot matrix or direct thermal type.

If receipts are unavailable due to an inoperative receipt or empty receipt stock, the TVM shall continue to accept bankcards for payment. However, in such cases, before the transaction is forwarded to the FCNC, the TVM shall inform the patron that no receipts are available and prompt the patron to cancel the transaction if a receipt is desired.

Receipts shall be at least 1.5 by 3 inches, shall clearly indicate that the document is a receipt and not a valid ticket, and shall contain the following information:

- TVM Number – up to eight alphanumeric characters to be provided by the RE within 60 days after NTP.
- Date- month, day and the last two digits of the year, totaling nine characters (e.g., 03-MAR-97).
- Time – four digits separated by a colon and followed by two-letters “AM” or “PM”, using a 12-hour clock (e.g., 11:45 AM, 1:20 PM.).
- Station name where purchased – up to 16 characters.
- Ticket type – up to 16 characters.
- Truncated bank card number (last four digits) and type (Visa, MasterCard, etc.).
- Purchase price.
- Authorization number.

Other information to comply with Federal Regulation E and other banking standards promulgated by the American Bankers Association and/or to be provided by the RE within 90 days after NTP.

A conceptual description of the function, configuration, and arrangement of all devices on the front panel shall be submitted to the RE for its review as part of the Definitive, and Interim Design Review.

TP-5.2.3.4 Push Buttons

Push buttons shall be provided for patrons to choose their transaction, cancel a transaction, and perform other operations as necessary. The push buttons shall:

- Be made of stainless steel or hardened aluminum or die cast zinc and coated for protection from skin burns if touched when heated by direct sunlight.
- Have a flat front surface of approximately 1 square inch to provide proper finger contact.
- Not rotate.
- Provide an audible tone upon being depressed.
- Provide less than 8 ounces of resistance to depressing.
- Protrude no more than 0.25 inches from the face of the front panel.
- Be protected against vandalism, including impact resistance from pounding, such as by a person's foot or fist.
- Be liquid resistant.
- Provide sealed contacts for all switches.
- Not be removable from the outside.
- Be easily replaceable from the inside.
- Be spaced to accommodate labeling directly adjacent to each button. (Such labeling shall be in conformance with ADA requirements).
- Be non-fading.
- Push buttons shall function properly with the same amount of applied force irrespective of where the force is applied on the front surface of the button.

TP-5.2.3.5 Patron-operated Controls

Patron-operated controls shall provide for the following inputs from the patrons:

- If the TVM employs buttons with static definitions, at least 16 fare selection push buttons shall be provided, and the TVM shall accommodate future additional buttons totaling at least 30 fare selection buttons. Additional buttons shall not require cutting or drilling the front door. Any supplied pushbuttons that have no initial purpose defined shall not be capable of being activated by the patrons and shall be disabled. The City shall easily enable such disabled pushbuttons at any time. Provisions for future patron selection buttons and the process to enable inactive buttons shall be documented and submitted to the RE for review and approval at the Interim Design Review.
- If the TVM employs a user interface where buttons are redefined as the transaction progresses, at least 6 fare selection buttons shall be provided directly below or to the side of the display screen. The dynamically defined menus that can be constructed shall be at least three layers deep, and shall provide at least 216 (63) entries in each fare table (current and future).
- One LANGUAGE push button, which will alternately toggle the displayed messages (and voice messages, if activated) between English and Japanese.
- One VOICE message push button, which, if depressed, shall cause message(s) to be announced to the patron in the currently selected language.

- An ACCEPT OVERPAYMENT push button shall be provided in close proximity to the CANCEL button. This button will be used when the TVM is in “Exact Fare Only” mode and the patron chooses to overpay and receive no change for the ticket selected. If the TVM employs variably defined buttons, the ACCEPT OVERPAYMENT function may be incorporated as needed as one of these buttons.
- One CANCEL push button which, if activated before the correct fare has been inserted, shall cancel the fare category selected, return monies inserted, deactivate the voice message system (if activated), and restore displayed messages to English (if another language had been selected). No patron-initiated cancellation of the transaction shall be possible once ticket printing commences.
- If the TVM employs a user interface such as a touch screen, all the functions associated with patron operation shall be clearly indicated on the touch screen. The touch screen shall be a long term commercially available unit sized to clearly show the options and processing necessary for the purchase of fare media. A patron shall physically touch the screen to register their choice. A protective shield over the screen shall protect the screen from damage and vandalism and shall not inhibit the patron’s ability to make a selection nor increase the time required for recognition and processing once the screen has been touched.

TP-5.2.3.6 Instructional Graphics

Instructions shall be contained on the front panel of the TVM to clearly indicate each step a patron must follow to choose and purchase a ticket or tickets. The sequence of steps shall be clearly indicated by the use of graphics and symbols.

The display of instructions and graphics shall be designed to minimize glare and other effects of sunlight and ambient lighting that could otherwise reduce the readability of display and instructions on the TVM.

The following features shall be provided:

- A common, raised symbol (*e.g.*, a 3-inch high “\$”), subject to RE review and approval at the Preliminary Design Review, shall be contained in a designated position on each TVM, such that a vision-impaired person could readily identify the equipment as a TVM.
- Raised lettering and Braille shall be provided for each selection button, insertion slot, and ticket/coin return bin on the TVM front control panel. Braille shall be fabricated in the Raster Braille method or Photocast (etched zinc) ADA signs and secured with adhesive strong enough to withstand the heat found in Honolulu. Raised lettering and Braille instructions shall be in conformance with the signage requirements contained in Section 4.30 of the ADA.
- If the TVM employs selection buttons with static definitions, each button’s label shall be individually replaceable. If the TVM employs buttons that are redefined as the transaction progresses, the buttons shall be labeled numerically (*i.e.*, 1 through 6); since these labels will not be subject to change, they may be in a single panel.
- An unbroken tactile path of raised chevrons for example on the front panel of the TVM, leading from the common symbol shall be provided to indicate the steps a patron must follow to purchase a ticket. The chevrons shall be pointed in the direction of the path to be followed.
- All instructions, and graphics directly applied to the front face of the TVM shall be presented in American English and Braille. Conceptual designs of the TVM instructions

and related graphics shall be submitted for review by the RE as part of the Definitive and Interim Design Reviews.

TP-5.2.3.7 Audible Tones

The TVM shall emit a distinctive tone to provide audio feedback to the patron each time a button is pressed in circumstances where additional patron input is required to complete the transaction (such as when the patron must choose whether to cancel a transaction with excess payment pending when no change is available). The volume of the tone shall be field-adjustable, and shall be audible in all station environments and separate tones shall be provided to distinguish between valid and invalid operations.

TP-5.2.3.8 Multi-lingual Capabilities

The TVM shall include a separate push button or touch screen area on the front panel to toggle the display and the voice message system between English and Japanese. Displayed and audio messages shall be as closely translated between the languages as possible.

Pressing the alternate language button at any time during a transaction shall cause the TVM to switch displayed and audio messages to the next language in the sequence.

While in idle mode, the TVM shall default to English displays and voice messages. Whenever a transaction is completed or canceled, the TVM shall return to English. When an alternate language is selected in the idle screen and the patron takes no further action, the displayed messages shall revert to English after a City-adjustable period, initially set to 45 seconds.

The Contractor shall support with text and audio files at least 6 languages including English and Japanese. The City shall be able to select desired languages from these supported languages for inclusion into the ticket vending machines at a future date. Text and audio files shall be downloadable from the FCNC to the TVMs via the WAN.

The Contractor shall verify the proper language usage in both the audio and text files.

TP-5.2.3.9 Patron Display Screen

A trans-reflective, back-lighted Liquid Crystal Display (LCD) or RE-approved equivalent screen bearing simple, basic instructions shall sequentially instruct the patron as to the purchase of any ticket or pass available for sale by the TVM. The display shall use dark characters on a light background.

The display screen shall provide a level of visibility sufficient to allow all displayed instructions to be easily read by the patron under all ambient light conditions and without the need for any additional peripheral light source.

The display screen shall indicate amount due upon selection of ticket type by the patron. The remaining amount due from the patron shall be continuously updated by the amount of fare inserted and accepted by the TVM.

The display screen shall be capable of displaying at least 36 alphanumeric characters per line and at least four lines at a time. Each character shall be at least 0.35 inches tall and be generated using at least a 5 × 7 matrices of dots. The display shall be able to show all numbers, upper and lower case letters, ASCII punctuation and common characters. The display screen shall be protected by a polycarbonate shield or RE-approved equal.

A video display screen, i.e. similar to an Automated Teller Machine, may be substituted. Selection buttons shall be arrayed around the perimeter of the screen for passenger input and shall be software programmable. Displayed messages shall be at least 0.4 inches high. The message content shall be programmable by the City. The selection buttons shall be programmable by the City.

The Contractor shall submit to the RE for approval information on type of display and patron messages to be displayed. Conceptual design of the patron display unit, messages, and shield, shall be submitted for review, and approval, to the RE as part of the Definitive and Interim Design Reviews. The RE shall approve the screen resolution and sign.

All text messages and information that varies according to ticket type that is displayed on the patron display shall be capable of being easily modified by the City. All such messages shall be configured on the Fare Collection Network Controller (FCNC) and shall be downloaded to the TVMs via the network and shall be transferable to the TVMs via a Solid State Memory Module (SSMM) or other removable storage media. The procedures to modify patron display message content and format shall be presented for review and approval at the Final Design Review.

TP-5.2.3.10 Voice Instructions

The TVM shall on demand of the patron provide audible voice instructions. The voice system shall utilize digitally recorded and stored human speech to replicate the Japanese dialect spoken in Honolulu, not computer synthesized speech. No additional moving parts shall be required to play back the recorded information.

The TVM shall contain a vandal resistant speaker mounted inside the TVM and its output shall be clearly audible from outside and in front of the TVM at all places within the viewing envelope.

The messages shall be stored in digital form and be modifiable by the City. Messages shall be in English and City selected languages. The message system shall have a total recording capacity of at least 6 minutes for each language at a sampling rate of at least 12 kHz. The City shall provide all recorded messages in a format specified by the Contractor at least 90 days prior to TVM installation.

The system shall function as follows: VOICE button shall be provided on the front of the TVM, and shall be the first button along the tactile path. The VOICE button shall provide for the following functions:

- Message On. If the TVM is in the idle state when the VOICE button is pressed, a brief introductory instruction message shall be output in the currently selected language, followed by the appropriate message for the idle screen. If the TVM is not in the idle state (a transaction is in progress), the message for the current screen shall be output in the currently selected language.
- Message Off. Depressing the VOICE button when the voice message system is activated shall cause the voice messages to be terminated.

Context-sensitive voice messages shall provide, in audio form, the information shown on the TVM display or conveyed by the TVM. Other messages, such as the return of an inserted bill, which may not be accompanied by a visual message on the TVM display, shall also be provided as required. Audio messages shall also be provided to indicate the value remaining to be deposited for purchase of the selected ticket(s). Each variable message shall occur as close as possible to the event or change in transaction status as possible and be as brief as possible to

convey the necessary information. Content of all voice messages shall be subject to RE review and approval at the Final Design Review.

The intra-transaction time-out counter shall begin decrementing at the completion of the voice message for each step of the transaction.

Upon pressing the CANCEL button or the transaction being aborted by the TVM, a "Transaction Canceled" message shall be played and the voice message system shall toggle to off. The next activation of the VOICE button shall cause the message associated with the then-current step of the transaction to be played in the currently selected language.

When a transaction is completed and the TVM returns to the idle state, the voice message system shall toggle to off. The next activation of the VOICE button shall cause the message associated with the then-current step of the transaction to be played in the currently selected language.

A conceptual description of voice messaging system hardware, software and operation shall be submitted for RE review and approval at the Definitive Design Review.

TP-5.2.3.11 Coin and Bill Slots

The coin entry slot shall be sized to limit the dimensions of inserted material to the largest coin accepted, the SBA dollar (half dollar coins will not be accepted). To minimize jams, the coin slot shall also be sized to prevent the simultaneous insertion of two coins, especially two dimes.

The bill entry slot shall be designed to guide the bills fed via an entry base into the TVM and/or returned from the activation module without jamming. Rejected bills shall be securely gripped at the entry slot or a separate slot if used.

The bill return slot shall be designed to present and securely grip bills returned from the bill escrow module.

The coin entry slot and the bill entry and return slots shall be robust and scratch resistant and be designed to withstand wear and abrasion for the life of the TVM.

The bill entry slot shall be protected with a rain shield. The bill slot shall be designed to prevent liquid from entering the TVM. The bill entry base and rain shield shall be molded into one replaceable module. The rain shield shall not inhibit sight lines or the insertion or retrieval of bills. The bill entry slot rain shield shall be made of durable clear polycarbonate material at least 0.25 inches thick or RE-approved material, and shall be easily replaceable from inside the machine only. The bill entry slot rain shield shall protect the top and both sides of the slot and protrude no more than 4 inches from the front surface of the TVM. The bill entry slot shield shall extend approximately 1 inch beyond the edge of the bill insertion slot/ramp. The design of the rain shield shall be subject to RE approval at the Interim Design Review.

TP-5.2.3.12 Ticket/Coin Return Bin

The opening for the ticket/coin return bin shall be recessed and covered with clear polycarbonate spring-loaded or weighted door that opens inward, and which does not present a pinching hazard when opened and closed by patrons. The door shall be at least 0.25 inches thick and completely cover the opening when closed. The bin and its door shall be robust, scratch-resistant, and visually prominent. The geometry of the bin and its door shall minimize intrusion into the machine while the ticket/coin return bin door is open. The bin shall be designed to drain any liquids placed in the bin to the outside of the TVM. The preferred minimum height of the centerline of the ticket/coin return bin shall be compliant with ADA standards.

As soon as a patron has completed payment for a transaction or a transaction is canceled that shall result in coins being deposited in the ticket/coin return bin, a light in the ticket/coin return bin shall begin flashing. The ticket/coin return bin light shall continue flashing until five seconds after all tickets and coins have been deposited there by the TVM, or until the next transaction is initiated, whichever occurs first.

TP-5.2.3.13 In-service/Out-of-service Indicator

Under normal operations, the displays shall indicate that the TVM is functional and is in service by instructing the patron to make a selection. Limited operation of the TVM in the event of a component failure, or when possible, complete loss of operation, shall be indicated on the patron display. If the TVM is taken out of service by disconnection, loss of power, or by failure of the internal power supply or modules, a blank patron display or some other visible means shall indicate that the TVM is inoperative.

TP-5.2.3.14 Information Signage Holder

An information signage holder shall be provided for the front of the TVM to allow suitable printed information explaining the operation of the TVM and fares, the City transit information, and service announcements or newsletters to be displayed. The information signage holder shall be glazed with a polycarbonate panel, which shall be provided with a weather seal and suitably vented to prevent condensation. Information signage size, type, and characteristics shall be determined at the Interim Design Review, and shall in general utilize the maximum space available on the front of the TVM.

The information signage holder shall be accessible from inside the TVM, and shall be secured to the front of the TVM from within.

The City and the contractor shall work together on the design of the signage to be placed in the information signage holder. Completed information signage shall be provided to the RE during final design for review and approval.

TP-5.2.3.15 Service Interface

Inside the TVM, located within easy reach and viewing while the outer door is open, shall be a keypad and alphanumeric display for use by maintenance and revenue service personnel.

The service keypad shall be used to enter access codes and maintenance commands; all routine service interaction with the TVM shall be via this keypad. The service keypad shall have all digits (0 through 9) and other keys as required to interact with the TVM.

Command prompts, error codes, and other servicing information shall be shown on the service display. This display shall be either:

- A separate alphanumeric display capable of displaying the full ASCII character set in a minimum of two lines of 20 characters each; or
- The patron display mounted so that service personnel can rotate it for viewing while the TVM outer door is open.

The service display shall be used to indicate TVM error codes, and shall have the capability of displaying multiple error codes, such that one error code shall not need to be cleared to display other error codes.

The conceptual design of the service keyboard and display shall be subject to RE review and approval at the Definitive Design Review. A preliminary listing of service commands, error

displays, diagnostic messages, etc. that are available with the service interface shall be submitted for RE review and approval at the Interim Design Review.

TP-5.2.3.16 TVM Security and Access Control

TVM Keys and Locks

Controlled key locks shall be furnished to implement three levels of security as outlined in Table 2-3.

Table 2-3. TVM Keys and Locks

Type of Access	Personnel Afforded Access
Equipment access, front door	A, B
Lamp enclosure (if separate)	A
Bill vault, replacement	B
Coin vault, replacement	B
Alarm disable key (if provided)	A, B
Coin vault, opening	C
Bill vault, opening	C

A = Maintenance crew and administrative personnel
B = Revenue service crew
C = Money processing crew at revenue facility

Any additional locks or keys shall be submitted to the RE for review and approval at Interim Design Review.

High security locks and keys shall be furnished and are subject to the review and approval by the RE. Descriptive documentation and/or catalog cuts of all high security locks and keys for the TVM shall be submitted as part of the Interim Design Review.

Any locks in addition to those listed above in Table 2-3 shall be subject to the review and approval of the RE. The description and proposed purpose of any TVM locks in addition to those listed in Table 2-3 shall be submitted for review and approval at the Interim Design Review as part of. All locks performing the same function shall be keyed alike so that they are interchangeable among all TVMs. Security keys shall be registered, and replacements shall be available only to City-authorized personnel directly from the manufacturer. Twenty-five sets of keys shall be provided and shipped under separate cover directly to the City's Director of Treasury Services.

In order to avoid excessive stress on the lock and key a device other than the key shall activate the front door latching mechanism. All security locks shall capture and hold the key whenever the lock is open.

Access to TVM Interior

Access to the interior of the TVM for maintenance and servicing shall be by opening the front door with a key. Under normal operating circumstances, the TVM shall require the following steps for an individual to gain access to the interior of a TVM for either servicing or maintenance (if the proper access method is not followed, the alarms shall be activated):

- Proper key is used to open front door of TVM.

- Within a prescribed time period (software configurable by the City and initially set to 30 seconds), the individual must enter his or her individual code on the service keypad inside the TVM. The TVM shall allow a maximum of three attempts to enter a proper individual code; failure to enter a valid code within the time limit or three successive failed attempts shall be considered an intrusion which shall activate the local siren and result in a revenue security alarm being recorded by the TVM and transmitted to the FCNC. A display or other indication visible from the inside of the TVM shall indicate valid or invalid input.

The TVM shall relate the individual's identification code to an internally recorded name or employee number. Audit and maintenance receipts printed by the TVM shall never include sufficient printed information to allow unauthorized access or another employee's identity to be used to gain entry.

If the TVM includes an access panel in the pedestal, opening the panel shall require that the TVM front door is opened first and all proper entry procedures are followed before the access panel may be opened. If the pedestal access panel is opened without proper front door access authorization, the TVM siren shall sound and the alarm unit shall cause the TVM to notify the FCNC of a security breach.

Other access methods may be proposed by the Contractor prior to or as part of the Interim Design Review, and are subject to review and approval by the RE.

Internal Access Restrictions

The TVM shall be programmed with individual codes and corresponding security codes, which shall restrict the actions taken by the individual based on his or her authorized activities. A database of security codes, personnel codes, and maintenance and servicing functions shall be developed by the Contractor and loaded into each TVM. The City shall have full access to modifying this database. The Contractor shall provide a means by which each TVM can be easily updated remotely and locally with this database. A detailed description of the TVM access method, security codes, restrictions per security code, and security code database content and modification procedures shall be provided for Resident Engineer review and approval as part of the Interim Design Review.

Security codes and personnel codes shall contain a minimum of four and a maximum of eight alphanumeric or numeric characters.

Personnel codes shall be assigned to one or more of three distinct categories for access permissions. For example, it shall be possible for one personnel code to be assigned to both the maintenance and administrative categories. Each function shall be individually assignable to any category. Activities permitted to each of these categories by default are defined in following. Additional activities and functions shall be defined as necessary by the Contractor for RE review and approval at the Interim and Final Design Reviews.

The arrangement of modular mechanical and electrical components and money containers shall be such that normal maintenance including change-out of defective modules shall neither require removal of nor provide access into the coin and bill containers. Maintenance personnel shall not be permitted access to monies. Only revenue service personnel shall be permitted to handle devices that store money, (*i.e.* vaults, hoppers). Access to the contents of money storage devices shall be limited to money processing crews within the cash counting facility. Removal of a cash storage device by any person not so authorized shall activate the local siren and result in a revenue security alarm being recorded by the TVM and transmitted to the FCNC.

TP-5.2.3.17 TVM Cabinet Construction

Equipment Enclosure

The equipment enclosure design for the TVMs shall be of unpainted stainless steel. Any external accoutrements (such as button panels) shall be robust and vandal-resistant. All internal carbon steel framing and equipment supports shall be protected with plating or paint in accordance with these technical provisions.

The cabinet shall have a stainless steel leveling base, which shall accommodate variations in the concrete base at the station platform. Mounting shall be in accordance with these requirements: leveling shall be accomplished by means of shims, washers or adjusting feet with suitable locking as approved by the RE prior to or as part of the Interim Design Review.

Access to the equipment shall be provided by a hinged front door having a minimum of 110 degrees of opening and be equipped with a latch to hold the door at approximately 90 and 110 degrees of opening while servicing. When closed, the door shall seat in a manner which shall prevent insertion of a pry bar or other tools to force open the door.

The door hinges and/or pivoting mechanism shall be tamperproof and adjustable to allow for proper alignment of the door and locking devices, and prevent any wear or binding between the enclosure and the door when opening or closing the door. All hinge and latch hardware and metal surfaces subject to sliding contact shall be stainless steel.

With the outer door latched, it shall not be possible to view any internal components or insert any foreign objects into the cabinet through the gaps between door and cabinet. Equipment enclosures shall comply with International Electro-technical Commission Standard 529 (IEC529) to level IP34 or equivalent.

If a forced air ventilation system is required, the air intake shall be baffled and screened to exclude insects and shall be located away from light sources. The air intake shall be fitted with an easily replaceable disposable type filter designed for replacement no more frequently than annually.

Table 2-4. Default Access Permission by Personnel Category

Personnel Category	Permitted Functions
Maintenance	Open outer door Diagnose modules Print and review TVM status, events, and diagnostics data Exchange modules (excluding those containing cash) Set date/time clock Replenish ticket stock Place recovered jammed money in coin or bill vault
Revenue service	Open outer door Diagnose modules Print and review revenue status, sales history, TVM status, events, and diagnostics data Exchange coin/bill vaults Set date/time clock Replenish ticket stock Place recovered jammed money in coin or bill vault
Administrative	Open outer door Diagnose modules Print and review revenue status, sales history, TVM status, events, and diagnostics data Set date/time clock Place recovered jammed money in coin or bill vault Alter TVM configuration and operating parameters Alter fare table Alter personnel security code database Alter/add ticket types

The exterior of the equipment enclosures shall be unpainted stainless steel. The TVM enclosure shall be finished with a random orbital pattern or other RE-approved finish. Contractor shall submit a sample of the finished stainless steel of the TVM cabinet for the RE’s review and approval prior to or as part of the Interim Design Review.

Conceptual plan and elevation drawings of TVM showing outer door open and closed, and drawings of TVM interior showing all module locations, including those mounted to inside of exterior door, shall be submitted for RE review and approval at the Interim Design Review.

Drawings showing TVM modules in service positions, indicating servicing and maintenance clearances, shall be presented for RE review and approval at the Interim Design Review.

Lighting Fixture

The TVM shall be equipped with a lighting fixture to achieve the following:

- Illuminate the front face of the TVM.
- Protrude no more than four inches from the front face of the TVM and not create a bumping hazard, and have rounded corners.

- Be weatherproof and equipped with ballast for operation in the extremes of temperature required.
- Provide a level of lighting sufficient to allow instructions and other items on the front of the TVM to be easily read by the patrons without the need for any additional peripheral light source under all lighting conditions. Lighting intensity shall be suitable for vision-impaired patrons under the most adverse lighting conditions.
- Meet the vandal-resistant strength requirements specified for the cabinet. The material, thickness, and finish of the fixture enclosure shall be the same as those for the TVM housing.
- Constructed to keep dirt, moisture, and insects out.
- Provide space at the front of the lighting fixture for a replaceable nameplate with graphics or text.
- Contain a commercially available fluorescent lamp and circuit and be constructed to allow easy replacement of the lamp.
- Provide a light sensor to automatically turn on the light fixture when ambient light conditions on the reading surface of the TVM falls below 25 foot-candles. A bypass switch inside the enclosure shall permit the lighting fixture to be switched on and off manually.
- The top of the TVM shall slant to the rear of the TVM to prevent any accumulation of moisture.

TP-5.2.3.18 Protection Against Vandalism and Burglary

For protecting against vandalism and burglary for each TVM, the following requirements shall be met:

- All latches shall be secure and robust.
- All external screws shall be tamperproof.
- All fasteners used to secure equipment shall be concealed and tamperproof.
- All hinges for the front door shall be concealed.
- Security locks with profile catches shall be used.
- Locks and keepers shall be drill-resistant stainless steel, and shall be mounted flush with the outside surface of the access door.
- The access door shall be locked with at least a three-point, latching device with a bascule bolt and hook bar, or equivalent construction.
- The TVM design shall hinder any use of burglary tools.
- All gaps between the door and the cabinet shall be consistent along each edge and shall not exceed 0.08 inches when the door is latched.
- Reinforcement shall be provided at the positions where there is the possibility of burglary.
- A clear polycarbonate shield, at least 0.25-inch thick, or approved equal, shall protect the display screen. The shield shall be easily replaced from inside the TVM.
- Each TVM shall be equipped with an alarm system as described for indicating unauthorized intrusion, burglaries, and faults.
- Conceptual security provisions, including lock(s) and door latching schemes for the TVM, shall be submitted for RE review and approval at the Definitive Design Review.

TP-5.2.3.19 Coin Processing Unit

The TVMs shall accept the following U.S. coins: nickels, dimes, quarters, Sacagawea, Presidential and Susan B. Anthony (SBA) dollar coins. The coin-processing unit shall be capable of accepting at least two other denominations of coins (such as tokens) for future use.

Each TVM shall be equipped with a coin processing unit consisting of the following coin handling modules: a coin acceptor/verifier, a coin vault, and a chassis and its associated wiring and electronic devices. Each coin storage module (*i.e.* vault) shall be key-locked into the TVM and shall be removable from the TVM without tools. Any module containing coins shall remain secure when removed from the TVM; access to money stored in such modules shall be granted only with keys available in the cash counting facility.

The coin-processing unit shall automatically switch to an out-of-service condition if any coin-processing module is not installed or not operating properly.

The coin-processing unit shall be electrically and mechanically constructed to fulfill the requirements of these technical provisions. Complete performance and real-time status information shall be available locally and remotely at the Fare Collection Network Controller.

Documentation describing design and operation of the coin processing system including verification, rejection, and vaulting processes shall be submitted for RE review and approval at the Definitive Design Review.

Coin Acceptor/Verifier

The coin acceptor/verifier shall include a coin insertion mechanism and a verifier to accept only the specified U.S. coins. The verifier shall reject and return to the ticket/coin return bin rejected, counterfeit, excessively bent and foreign coins, as well as slugs, and other foreign objects. The coin acceptor/verifier shall be capable of accepting and discriminating between at least seven types and denominations of coins.

The coin acceptance and verification process shall take less than two seconds per deposited coin, measured from the instant the coin is inserted into the coin slot until the coin acceptor is ready to process another coin.

The coin insertion mechanism shall be designed so that liquids entering through the slot flow out of the TVM to avoid damage to the TVM and its components. The coin acceptor slot shall be equipped with a protective shutter to insure that foreign matter cannot enter the unit. The coin acceptor slot shutter shall remain closed until a ticket is selected. The shutter shall automatically open once a ticket type has been selected and the fare has been displayed. The shutter shall close automatically whenever one of the following situations occurs:

- Fare amount due has been inserted into the TVM.
- A bankcard is inserted in the bank card processor.
- Cancel button has been pressed or the transaction is automatically canceled.
- Coin vault is full.
- Coin is jammed.
- TVM or coin processing unit switches to an out-of-service condition.
- The patron changes ticket selection to a type not available due to stock depletion or other malfunction.
- Provisions shall be made to prevent the retrieval of coins by fishing such as with wire or attached thread.

Coins shall be electronically verified based upon their diameter, thickness, and metallic content. Coin verification shall be consistent and repeatable. The criteria for verifying coins shall be software adjustable for each coin value.

As part of the Definitive Design Review, the Contractor shall prepare and submit a document defining the standards of acceptance and rejection for each of the coins specified. The document shall delineate the variations of metal content and dimensions that are allowable and affect coin verification. This data will be used for adjustment and verification of the coin acceptor tolerances.

Documentation describing adjustments, revisions, and calibration procedures for the coin processing system and the procedure for reconfiguring the coin-processing unit to accept other coins shall be submitted for RE review and approval at the Interim Design Review. The Contractor shall furnish any equipment and software necessary to adjust the coin-processing unit and to reconfigure the coin-processing unit for other coins.

Coin Acceptance Rate

The coin acceptor/verifier shall meet the following minimum acceptance rates:

- 98% of valid coins shall be accepted upon initial insertion.
- 99% of valid coins shall be accepted upon one reinsertion.

All known counterfeit coins, common slugs, foreign coins, and coins of denominations not accepted by the TVM shall be rejected upon every insertion.

$$AR = \frac{I - R}{I}$$

The acceptance rate (AR) is defined as follows:

Where: I = Total number of valid coin insertions
R = Total number of valid coin rejections

Coin Accuracy

The coin acceptor/verifier shall identify valid acceptable coins with at least 99.95% accuracy. Accuracy (A) is defined as follows:

$$A = \frac{V - M}{V}$$

Where: V = Total number of coins accepted
M = Total number of misidentified coins

TP-5.2.3.20 Coin Vault

Each TVM shall be equipped with a removable coin vault having a capacity of at least 300 cubic inches. The coin vault shall function as an end collection container for coins. Coins shall enter the coin vault through an opening in the coin vault. It shall not be possible to open the coin vault while installed in the TVM, nor shall it be possible to install an open or unlocked coin vault into the TVM.

When properly installed in the TVM, it shall be impossible to access coins in the coin vault without damaging the vault in an obvious manner.

The coin vault shall be designed and constructed as a safe box of sturdy construction, manufactured from hardened steel or steel alloy of similar strength or other RE approved material, and shall withstand regular removal, replacement and normal handling without deformation or in any way interfering with the insertion and removal process. When dropped from a height of three feet on a concrete floor on any corner or side, the full coin vault shall remain fully operational, shall suffer no more than cosmetic damage, shall not open nor shall its locking mechanism be impaired. The coin vault shall have a handle or handles placed to avoid injury, which provides adequate gloved-hand clearance for easy insertion, removal and carrying. The maximum weight when full shall not exceed 40 pounds.

Provision shall be made to detect a full coin vault and a nearly-full vault, which shall cause an event to be recorded and transmitted to the FCNC. The determinations of full and nearly full conditions shall be independently software configurable and adjustable by the City. The TVM shall cease to accept coins (*i.e.* enter "No Coins Accepted" mode) when the coin vault becomes full.

Coin System Security Interlocks

The coin vault shall be installable in one unique position, and concealed, tamperproof sensors shall detect when a coin vault has been properly installed. The coin vault and storage units shall be locked into the TVM in such a manner that they do not interfere with maintenance of the coin acceptor mechanism.

The coin vault shall be self-locking and self-sealing, so that when it is removed from the TVM, it cannot be opened locally or re-inserted in a TVM without emptying the contents of the vault through authorized means. Access to coins shall not be possible at any time during maintenance or revenue transfer operations, but shall only be accessible by controlled-key lock.

Each coin vault shall have a visually and electronically readable component code and serial number. The TVM shall automatically read and identify as valid the component code and serial number of each inserted coin storage module. This information shall be made available in both local and remote mode. The TVM shall read the electronically readable component code at a frequency fast enough to insure that the component cannot be exchanged without the TVM detecting the removal of the unit. The electronically readable component code and serial number shall not require the connection or disconnection of cables when replacing the coin storage module. Any connections for the electronic serial number shall be rugged, suitable for repeated insertions and removals over the expected life of the equipment.

Each component code and serial number shall also be provided on a securely attached but replaceable tag. This tag shall be made of etched or stamped metal or other RE approved material and shall be oriented upright and visually readable when the coin handling module is installed in the TVM.

Serial numbers shall consist of at least four digits and shall be applied in a unique series to each type of coin container in the TVM. The contractor shall submit its proposed numbering scheme for the serial numbers to the RE for approval at the Interim Design Review.

Internally generated audit tickets shall be automatically issued each time any coin storage module is removed from and inserted into the TVM. The audit tickets shall show the TVM number and location, type of module removed/inserted, date, time, technician name or employee number (not

security code), component serial number(s), the total monetary amount in the module, and a breakdown of quantity of coin denominations stored in the module.

If a coin storage module is removed or replaced while the TVM is out of service, when the TVM is restored to service, the TVM shall automatically adjust all appropriate money counters to reflect that a module has been exchanged or removed.

A report indicating the status, location and contents of each coin storage module shall be available on demand both locally at the TVM and remotely at the FCNC.

TP-5.2.3.21 Coin Jams

In the event a foreign object or coin, slug, bent coin, or a coin having a sticky substance on it becomes jammed inside the coin acceptor, a coin release mechanism shall cause the jammed coin(s) to be released into the ticket/coin return bin. While the TVM is in service, activation of the cancel push button shall cause the coin release mechanism to activate (either directly via mechanical means or indirectly via electronic means).

When the coin system detects a jam in the coin acceptor, the coin release mechanism shall be automatically activated. At no time shall the coin entry slot open to accept additional coins, if another coin is already jammed in the coin system.

It shall be possible for maintenance and revenue service personnel to gain quick access to the jam to remove any jammed object if activation of the cancel push button does not clear the jam.

TP-5.2.3.22 Recovered Jammed Coins

It shall be possible for an authorized technician to secure recovered jammed coins into the coin vault. With the TVM door open, the technician shall be able to initiate coin acceptance and recover jammed coins from the coin acceptor. If possible, during this procedure coins shall be sent directly to the coin vault. When all recovered jammed coins have been inserted, the TVM shall cease coin acceptance and generate an audit ticket indicating the date, time, TVM number, technician name or number (not security code), and the value of recovered coins inserted.

TP-5.2.3.23 Bill Processing Unit

Each TVM shall be equipped with a bill-processing unit, which shall accept at least 12 different types of bills inserted in any of the four possible length-wise orientations. The bill-processing unit shall be capable of accepting each current variant of \$1, \$5, \$10, and \$20, bills.

The bill-processing unit shall include a bill validator, bill escrow module, bill vault, and a chassis and its associated wiring and electronic devices.

The bill validator, the bill escrow module, and the bill vault shall be electrically and mechanically constructed to fulfill the requirements of these technical provisions. Complete performance and status information shall be available locally and remotely at the Fare Collection Network Controller.

The bill validator, bill escrow module, and bill vault shall be manufactured by the same manufacturer and mounted together as one unit. Within a TVM, no bill-processing module shall function unless all bill-processing modules are properly installed and connected to the TVM. The bill-processing unit shall automatically switch to an out-of-service condition if any one bill-processing module is not installed or operating properly.

Documentation describing operation of the bill processing system, including verification, rejection, escrowing, returning, and vaulting processes, shall be submitted for RE review and approval at the Definitive Design Review.

Bill Validator

The bill validator shall accept one bill at a time and shall determine the denomination and validity of the bill. If the bill is acceptable, the bill validator shall forward the bill to the escrow module. If rejected, the bill shall be returned and gripped so that the TVM retains a hold on the bill until the patron removes the bill from the bill validator slot. The bill validator shall be designed to reject or expel pieces of paper or other foreign material, which can be introduced into the bill slot. A motorized conveyor shall pull the bill into the insertion slot once its leading edge is inserted in the slot. It shall be possible for maintenance and revenue service personnel to gain ready access to the bill path to clear jams. A mechanical blocking function shall be provided to prevent withdrawal of a bill after acceptance.

The TVM shall be configurable by the City to inhibit the acceptance of any denomination and insertion orientation; as delivered, the TVMs shall accept \$1, \$5, \$10, and \$20 bills in any of four orientations. As the US Treasury releases the pending new designs of bills, the bill-processing unit shall be capable of being programmed to accept the new designs while continuing to accept the current designs. The contractor is responsible for making all modifications to the bill validator for acceptance of any new U.S. Treasury releases until the factory integration tests are completed. The methods and procedures for adjusting the acceptance characteristics of the bill-processing unit shall be submitted as part of the Interim Design Review.

The bill validator shall include a shutter over the slot where the bills are inserted or a similar feature to ensure that foreign matter cannot enter the TVM. The shutter shall open or be activated once a ticket type has been selected and the TVM has displayed the fare. The shutter shall automatically close or be deactivated when one of the following situations occur:

- Fare amount due has been inserted into the TVM.
- A bankcard is inserted in the bankcard processor
- Cancel button has been pressed or the transaction is automatically canceled.
- Bill vault is full.
- Bill is jammed.
- Bill escrow is full.
- TVM or bill processing unit switches to an out-of-service condition.
- The patron changes ticket selection to a type not available due to stock depletion or other malfunction.

Except when bills are jammed, when the bill validator is removed from the TVM it shall not be possible to retrieve or fish bills from the bill vault.

Bill Acceptance/Rejection Criteria

The bill validator shall determine the denomination and validity of both sides of a bill by dimension checks and pattern and color recognition. The bill validator shall be able to detect counterfeit bills, including copies made in either single or double-sided printing on an electronic copier. Bill verification shall be consistent and repeatable. The bill validator shall be adjustable to differences in bills in circulation due to bill production and printing variances. The bill validator shall be adaptable to reject fraudulent currency that may be introduced to circulation.

Valid bills to be accepted by the bill acceptor shall include the following:

- New, old, and worn bills
- Bills that have been folded, then unfolded
- Bills that have been crumpled, then un-crumpled
- Bills of current and recent printing series in general circulation
- Clean and dirty bills
- Damp bills

The bill acceptor can reject bills with the following physical defects. Bills with these defects are not considered as valid for purposes of determining acceptance rate:

- Bills with torn corners with a side length exceeding $\frac{3}{4}$ inch
- Bills with sticky substances, such as tape or food smears
- Bills with tears in them that exceed:
 - Longitudinally, $\frac{1}{4}$ of bill length
 - Transversely, $\frac{1}{2}$ of bill width
- Bill that are saturated or have been washed
- Bills with holes
- Bills with staples, or other items attached to the bill
- Bills with excessive pen, pencil, or marker lines

The bill validator shall meet the following acceptance rates for bills:

- 95% of valid bills shall be accepted upon initial insertion.
- 97% of valid bills shall be accepted within two insertions.

All known counterfeit bills, color photocopies of valid bills, duplicates made by other known means, foreign bills, and bills of denominations not accepted by the TVM shall be rejected upon every insertion.

$$AR = \frac{I - R}{I}$$

The acceptance rate (AR) is defined as follows:

Where: I = Total number of valid bill insertions
R = Total number of valid bill rejections

Bill Accuracy

The bill validator shall identify valid acceptable bills with at least 99.99% accuracy. Accuracy (A) is defined as follows:

$$A = \frac{V - M}{V}$$

Where: V = Total number of bills accepted
M = Total number of misidentified bills

Bill Escrow Module

A bill escrow module shall be part of the bill-processing unit. Once the bills are verified and accepted, the bill acceptor shall forward the bills to the escrow module to put in reserve temporarily until completion or cancellation of the transaction. The escrow module shall have the capacity to store and return to the TVM patron as necessary a maximum of 15 bills in one stack. When the escrow is full, the bill acceptor shall reject any patron attempts to insert an additional bill and so inform the patron on the patron display.

In the event a transaction is canceled by the patron, the TVM times out, or the TVM switches to an out-of-service condition, the exact same bills inserted for the transaction shall be returned through a return slot that does not require the bills to reverse direction when transported within the TVM to the return slot. The bill escrow return slot shall maintain a grip on the returned bills such that the bills do not fall or can be wind-blown from the TVM upon return.

When a transaction is completed, all bills in the escrow module shall be transported to and stored in the bill vault for retention. It shall not be possible to manually intercept and retrieve coins and bills from their respective chutes that direct money from their escrows to the vaults.

Bill Vaults

The bill-processing unit shall be equipped with a removable bill vault. The bill processing system shall support two varieties of bill vaults. The standard bill vault shall have a minimum capacity of 1000-stacked bills in street condition. With the exception of storage capacity, the bill vaults shall be identical, and all TVMs and bill processing systems shall readily accept either type of vault. As delivered, all TVMs shall be equipped with high capacity bill vaults.

Bills shall be stored in a neat stack in the bill vault. It shall not be possible to open the bill vault while it is installed in the TVM, nor shall it be possible to install an open or unlocked bill vault into the TVM.

When properly installed in the TVM, it shall be impossible to access bills in the bill vault without damaging the vault in an obvious manner.

The bill vault shall be designed and constructed as a safe box of sturdy construction, manufactured from hardened steel or steel alloy of similar strength or other RE approved material, and shall withstand regular removal, replacement and normal handling without deformation in any way interfering with the insertion and removal process. When dropped from a height of three feet on a concrete floor on any corner or side, the full bill vault shall remain fully operational, shall suffer no more than cosmetic damage, shall not open nor shall its locking mechanism be impaired. The bill vault shall have a handle or handles placed to avoid injury, and provides adequate gloved-hand clearance for easy insertion, removal and carrying. The maximum weight of the vault when full shall not exceed 20 pounds.

Provision shall be made to detect a full bill vault and a nearly-full vault, which shall cause an event to be recorded and transmitted to the FCNC. The TVM shall cease to accept bills (*i.e.* enter “No Bills Accepted” mode) when the bill vault becomes full.

Bill System Security Interlocks

The bill vault shall be locked into the TVM and shall be provided with security interlocks to restrict access to monies on a “need to gain access” basis defined in TP-5.4.2.9. A security interlock in the TVM shall ensure that bills shall leave the escrow module for transfer into the bill vault only when a bona fide bill vault is inserted fully in its operating position. The bill vault shall be installable in one unique position, and concealed, tamperproof sensors shall detect when

a vault has been properly installed. The bill vault shall be locked into the TVM in such a manner that it shall not interfere with maintenance of the bill validator.

The bill vault shall be self-locking and self-sealing, so that when it is removed from the TVM, it cannot be opened locally or re-inserted in the TVM without emptying the contents of the vault through authorized means. Access to bills shall not be possible at any time during maintenance or revenue transfer operations, but shall only be accessible by controlled-key lock.

Each bill vault shall have a visually and electronically readable component code and serial number. The TVM shall automatically read and identify as valid the component code and serial number of each inserted bill vault. This information shall be made available in both local and remote mode. The TVM shall read the electronically readable component code at a frequency fast enough to insure that the bill vault cannot be exchanged without the TVM detecting its removal. The electronically readable component code and serial number shall not require the connection or disconnection of cables when replacing the bill vault. Any connections for the electronic serial number shall be rugged, suitable for repeated insertions and removals over the expected life of the equipment.

The component code and serial number of each bill vault shall also be provided on a securely attached but replaceable tag. This tag shall be made of etched or stamped metal or other RE approved material and shall be oriented upright and visually readable when the bill vault is installed in the TVM.

Serial numbers shall consist of at least four digits and shall be applied in a unique series to the bill vaults in the TVM. The Contractor shall submit its proposed numbering scheme for the serial numbers to the RE for approval at the Preliminary Design Review.

Internally generated audit tickets shall be automatically issued each time the bill vault is removed from and inserted into the TVM. The audit tickets shall show the TVM number and location, type of component removed/inserted, date, time, technician name or employee number (not security code), vault serial number, the total monetary amount in the vault, and a breakdown of quantity of bill denominations stored in the vault.

If a bill vault is removed or replaced while the TVM is out of service, when the TVM is restored to service, the TVM shall automatically adjust all appropriate money counters to reflect that a bill vault has been exchanged or removed.

A report indicating the status, location and contents of each bill vault shall be available on demand both locally at the TVM and remotely at the FCNC.

All appropriate money counters shall reset automatically when the bill vault is removed.

Bill Jams

In the event a bill becomes jammed inside the bill validator, the bill validator shall immediately cease accepting bills and make several attempts to automatically clear the jam by alternately reversing its transport motor to return the jammed bill to the bill return slot. Upon failure to clear the jam, the TVM shall cancel the transaction, return all monies possible, and leave the bill system out of service.

At no time shall the bill entry slot open to accept an additional bills if another bill is already jammed in the bill system.

It shall be possible for maintenance and revenue service personnel to gain quick access to remove any jammed bill.

Recovered Jammed Bills

It shall be possible for an authorized technician to recover jammed bills. With the TVM door open, the technician shall be able to initiate bill acceptance and insert recovered jammed bills into the bill acceptor. When all bills have been inserted, the TVM shall cease bill acceptance and transfer the bills from the escrow into the bill vault. At such time, the TVM shall generate an audit ticket indicating the date, time, TVM number, technician name or number (not security code), and the value of recovered bills inserted.

TP-5.2.3.24 Ticket Issuing Unit

Each TVM shall be equipped with a ticket issuing unit to meet the requirements of these technical provisions. A conceptual description of the TVM ticket unit shall be submitted for RE review and approval at the Definitive Design Review.

Function

The ticket unit shall be able to select, cut, print, and dispense tickets and passes of different types. In addition, a dedicated roll or stack for audit tickets and receipts shall be provided. The expected ticket types to be vended by the TVM are shown in Table 2-5.

Ticket Printing

The TVM shall be equipped with a printer or printers capable of printing, cutting, and issuing all ticket/pass. In addition, the TVM shall be equipped to print and issue patron receipts and audit tickets for accounting and registration requirements of these technical provisions.

The printer(s) shall be able to print all alphanumeric characters in both upper and lower case. Printed characters shall be produced with a minimum height of 0.12 inches and a height up to 1.0 inch. The approximate height to width ratio of the characters shall be 5:3. The printer(s) shall be of the impact dot matrix or direct thermal type, with the flexibility of being programmed to print the following configuration, which affords the City ticket security.

The City-approved graphics requirements are as follows:

- Various print sizes on the same ticket
- Reverse printing (light characters on dark background)
- Composite type over several lines
- Vertical and horizontal character orientation
- Depending upon ticket type, the printer shall be capable of printing, the following information on each ticket.
- TVM Number – up to eight alpha-numeric characters to be provided by the RE within 60 days after NTP.
- Expiry Date – month, day and the last two digits of the year, totaling nine characters (e.g., 03-MAR-03); the date shall be printed only on tickets validated on issue (such as one-trip tickets).
- Expiry Time – four digits separated by a colon and followed by two letters “AM” or “PM,” using a 12-hour clock (e.g., 11:45AM, 1:20PM.); the time shall be printed only on tickets validated on issue (such as one-trip tickets).
- Station name where purchased – up to 16 characters.
- Fare type – up to 16 characters.

- Other information to be printed on the tickets shall be provided by the RE within 60 days after NTP.

Excluding strips of multiple tickets and the time required to print any City-specified graphics, all ticket print data as listed above shall be printed and the ticket deposited in the coin return/ticket bin within five seconds from start of the print cycle. (The print cycle begins when sufficient money has been inserted and verified to purchase the selected ticket.)

Ticket print data shall be clearly legible to patrons. It shall be printed in characters as large and clear as possible, consistent with generally accepted ticket printing formats. Printing shall not degrade the physical condition of the ticket. There shall be no extraneous marks placed on the ticket as a result of the printing operation.

The printing shall not be erasable with chemicals without leaving any traces of erasure, shall be water and fade resistant, and shall not smear, blur, or transfer upon immediate handling by a patron. Character fonts shall not have any missing dots, and all dots shall be complete, closed, aligned, and filled. Contrast shall be uniform throughout the entire print. Outlines of printed characters shall not be blurred to the degree that the character print cannot be read at a distance of 18 inches from the surface of the ticket. The Contractor shall submit printing samples on actual ticket stock samples for RE approval as part of the Interim Design Review.

The City shall be able to make modifications to the ticket print format, and to print additional print types. Changes shall be able to be performed by the City employees through software configurable parameters. Ticket printing format, including information to be printed, print location, orientation, size and font, and number of tickets per transaction and per cut (*i.e.* the size of strips when multiple tickets are sold) shall be controlled by programmable software and the required print file shall be downloadable to the TVMs from the FCNC.

If impact dot-matrix printing is used, printing ink shall be contained in a ribbon cartridge that shall be readily replaceable when expended and shall operate effectively for at least 2,000,000 characters or six months, whichever occurs first. If applicable, the printer shall use a ribbon cartridge that is commercially available from at least two sources in the United States.

Ticket stock(s) shall be continuously gripped and positively fed through the ticket issuing mechanism from the storage area to the printing/encoding area, for subsequent cutting to separate the ticket from the remaining stock, and for issue. Whenever more than one roll/stack of identical stock is used for additional capacity, the TVM shall have the capability of automatically switching from one ticket stock roll/stack to another of identical stock, once the first roll/stack has been depleted.

The ticket printing system shall sense the progress of the ticket through the printer and detect the completion of the ticket dispensing process. A sensor shall detect when the ticket has left the printer on its way to the coin return/ticket bin. Should the ticket fail to clear this sensor, the TVM shall go out of service and return all deposited funds.

An adjustable sensor shall be provided to detect when each remaining ticket stock is 10% to 25% of capacity. When this sensor is activated, the ECU shall record as an event and transmit to the FCNC a ticket stock low condition. When any ticket stock is depleted, the ECU shall record as an event and transmit to the FCNC a ticket stock empty condition. If a patron subsequently selects a ticket requiring stock that the TVM cannot dispense (due to stock depletion or other malfunction), the TVM shall display "Selection not Available."

Replacement of stock shall not require a technical person nor shall it be possible to incorrectly orient the ticket stock.

The Contractor shall submit type of printer, model, manufacturer, and type of ribbon cartridge (if applicable) for the RE’s approval as part of the Interim Design Review.

Ticket Stock Description

The TVM shall have the capability of dispensing paper roll or fanfold ticket stock that is commercially available in the United States. Tickets shall be credit card size (3.375 in. long x 2.125 in. wide, as dispensed) with nominal thickness of 0.007” to 0.010”. Each roll/stack of ticket stock shall contain at least 2,000 tickets and be retained by a suitable support sized to handle the City’s ticket stocks. The Contractor shall specify limits of ticket stock size, weight, and thickness as part of the Interim Design Review.

Fare media sample for the location of logos and pre-printed data will be provided at Interim Design Review.

Tickets to Be Vended

The City’s existing fare structure and tickets to be vended by the TVMs are listed below. Any changes to this list shall be confirmed or modified by the RE within 120 days after NTP.

Table 2-5. Ticket Types

Ticket Type	Material	TVM Sale	Pre-sale
Timed ride – 60 or 90 minute	Paper	Printed at time of sale	None
Day pass	Paper	Printed at time of sale	None
7 day pass	Paper	Printed at time of sale	None
Special ticket	Paper	Printed at time of sale	None

Audit Tickets

On demand of an authorized technician and as required, the TVM shall produce audit tickets. Each audit ticket shall indicate the date, time, TVM number, technician name or number (not security code), and other specific information as required. Audit ticket samples shall be provided for the RE’s approval as part of the Interim Design Review.

Where audit tickets provide information that is subject to modification, including coin and bill denominations and ticket types, means shall be provided that permit the City to easily modify printed text. For example, should the City decide to accept \$50 bills, add a new ticket type, or change the name of a ticket type; all affected audit tickets shall be easily reconfigured to accommodate the change.

At a minimum, the following audit tickets shall be provided.

Table 2-6. Audit Tickets to Be Produced

Audit Ticket	Reference
Coin vault removal / insertion	0
Bill vault removal / insertion	0
Recovered money inserted	TP-5.2.3.22, 0
TVM current status	<input type="checkbox"/>
TVM revenue status	0
TVM daily sales history	<input type="checkbox"/>
TVM diagnostics	0

Ticket Cutter Mechanism(s)

Each printer in the ticket and pass issuing unit shall be equipped with a self-sharpening cutting mechanism to cut individual tickets or strips of tickets from the roll or fan-fold ticket supply. Each cutter shall produce at least 1,000,000 cuts without requiring replacement or sharpening. The cutter mechanism(s) shall cut one or more tickets at a time.

TP-5.2.3.25 Electronic Control Unit

Each TVM shall be equipped with an Electronic Control Unit (ECU) to control, store, coordinate, supervise, and respond as appropriate to the status, operation, security, and accounting of all TVM functions.

The ECU shall cause the display screen to display instantaneously, with minimal perceptible delay to the patron, information programmed to be displayed in response to patron push button input. For example, upon selection of a fare by pressing a push button, the display screen shall react instantaneously by displaying the ticket type selected and amount of fare due.

The ECU shall be equipped with a Central Processing Unit, Random Access Memory, Input and Output (I/O), Non-Volatile Memory, removable Solid State Memory Module, and Software capable of performing all control and data processing functions of the TVM. The ECU shall be suitable for operation in an electrified transit system trackside environment.

A conceptual description of the TVM ECU shall be submitted for RE review and approval at the Definitive Design Review.

ECU Hardware

The ECU shall be based on an embedded microprocessor or an IBM PC-compatible industrial microcomputer system. The ECU shall run an up-to-date version of its operating system or an operating system approved by the Resident Engineer. The ECU at a minimum shall be equipped with:

- A microprocessor with adequate processing speed for the type of service for which it is intended, including the bank/smart card processing.
- Adequate random access memory for operating program(s) and other temporary needs. The ECU shall have sufficient RAM to avoid the use of virtual memory (i.e. a hard disk) as a means of temporarily supplementing RAM during normal TVM activities. Provision shall be furnished to permit plug-in upgrade ability to double the amount of memory initially supplied.

- Non-volatile memory device(s) for operating system and application software, data registers, status flags, ticket/pass text, fare tables, event records, etc. Capacity shall exceed current storage needs by at least 200%.
- An interface for removable storage media as required for software upgrades and data transfers.
- A removable solid-state memory module (SSMM) for data backup.
- Additional (unused) asynchronous communication ports, minimum of two, or the ability to communicate with at least two additional internal modules without requiring additional ECU hardware.
- Ability to support the selected and RE-approved operating system.
- Keypad and display for entry of commands to retrieve, display, and print diagnostic, status, accounting, and registration data locally at the TVM.
- An internal clock.
- Components as necessary to support the Voice Messaging System.
- The ECU hardware shall be subject to RE review and approval as part of the Definitive Design Review.

Data Memory

A programmable memory shall be provided to contain all station names and designated zones, all types of tickets and passes, and a minimum of two sets of fare tables (one current, one future). The programmable memory shall be downloadable from the FCNC.

All data corresponding to ticket/pass sales, TVM status, and/or diagnostics shall be stored in the data memory for accounting and registration, and shall be processed to accommodate the requirements of these technical provisions. Non-volatile data storage shall be provided for accounting, registration, and event data; the contents of these registers shall be updated with each transaction or event. A copy of the contents of the non-volatile data registers shall be stored on the removable solid-state memory module as described herein. All TVM sales, status, and event data shall be successively and safely registered, even if a power failure occurs.

Removable Solid State Memory Module

All dynamic data that is unique to each TVM, including configuration, register, status, and event data recorded in the ECU non-volatile memory, shall be duplicated in a removable Solid State Memory Module (SSMM) to be used in the event that the ECU becomes inoperative and must be replaced. The SSMM shall be subject to RE review and approval at the Interim Design Review.

The SSMM shall use non-volatile memory and store data listed herein and all other data required to reactivate a TVM to its previous working state without further data entry. Configuration information that is generic to all TVMs, such as fare tables, ticket/pass text, and display text, may be stored on the SSMM or may be retrieved by the TVM from the FCNC upon reinitialization. If restoration of a TVM requires data to be retrieved from the FCNC, alternate methods of retrieving this data shall be provided for times when the FCNC or data network are inoperable.

The SSMM shall be readily accessible and easily exchanged without the use of tools. When an ECU is replaced, the removable Solid State Memory Module from the faulty ECU will be installed in the new ECU. When the new ECU is activated, it shall retrieve all data from the SSMM (copy the data to its own non-volatile memory) before resuming service.

The SSMM shall be capable of storing all TVM dynamic data, and its capacity shall exceed current storage needs by at least 200%. The SSMM shall have a minimum life of at least 5 years as determined by on-board battery life (if used) and/or re-write cycle limitations (if devices such as EEPROMs are used). Data in the SSMM shall remain unaltered for at least 1 year when not installed in an ECU.

Data in the SSMM shall be updated concurrently with the non-volatile memory internal to the ECU; no queuing of updates to the SSMM shall be permitted. Data in the SSMM shall at all times (to the extent possible due to hardware limitations) be identical to the ECU's non-volatile memory so that in the event of ECU failure, no transaction data is lost.

The contents of the non-volatile data shall be compared at least once per day to the contents in the SSMM. In addition, this comparison shall be made each time a TVM is placed into operation. Any discrepancies in this comparison shall result in an SSMM failure event being recorded by the TVM and reported to the FCNC.

The TVM shall require a properly installed SSMM to enter service.

TP-5.2.3.26 TVM Operating System Software

The ECU shall employ commercially available operating system software. The operating system shall be of the latest version available from the supplier as of the date of the signing of this contract, and shall be capable of performing all tasks necessary to support the TVM and its application software, including the ability to perform multiple tasks concurrently and communicate with the FCNC. Updates to the operating system application software shall be downloadable from the FCNC.

Upon issuing a command from the internal maintenance keyboard, the ECU operating system shall perform an orderly shutdown (preserving all file and data integrity) and restart. It shall not be necessary to cycle power to the ECU to restart the operating system.

The ECU shall also employ a "watchdog" timer that automatically initiates an orderly operating system restart (*i.e.* a system shutdown and reboot) in the event of a software-induced failure such as a total suspension of all activities due to a programming error.

The operating system shall be subject to the review and approval of the Resident Engineer at the Interim Design Review.

TP-5.2.3.27 TVM Application Software

TVM application software shall consist of software code that operates on the ECU for control and supervision of TVM functions. A flow chart of all possible patron transactions, showing all interactive instructions and messages to be displayed and/or provided by the TVM, cancellation processes, timeouts, etc. shall be prepared and submitted to the RE for review at the Interim Design Review and approval at the Final Design Review.

In addition:

- The software shall be designed, coded, and implemented consistent with industry accepted software design and coding practices. Software shall contain appropriate levels of security to prevent unauthorized access to software modules.
- The software shall be modular in design, using a Graphical User Interface (GUI) in all workstations, and shall be easily software configurable by the City. The software modules shall be written in one industry standard high-level language (not microprocessor assembly language).

- Diagnostic software shall be furnished for testing and troubleshooting of all TVM functions. TVM application software shall include all software packages necessary for real-time TVM diagnostics and accounting and registration communications between the TVMs and the Fare Collection Network Controller.
- The TVM software shall permit the City to control various aspects of the TVM operations by varying the values of parameters. The variable parameters shall be modifiable both locally and remotely by downloading information via the DCIS. A complete preliminary listing of all variable operational parameters for the TVM shall be submitted for RE review and approval at the Interim Design Review.

TP-5.2.3.28 Fare Tables

The TVM and Fare Collection Network Controller shall be capable of supporting at least three fare tables (one current and two future), each with a capacity of at least 216 entries, where an entry in the fare table provides all configuration data corresponding to a ticket type selectable by passengers. (This number, equal to 63, is derived from the maximum number of ticket selections that can be obtained from a 3-layer menu of 6 variable-definition buttons. The fixed-definition patron keypad alternative shall also provide at least 216 entries per fare table.)

The TVM application software shall be designed to accommodate the existing fare structure as reflected by the tickets to be vended. The TVM shall be capable of accommodating at least 12 other ticket types. Additionally, the fare table shall be able to accommodate such new policies as peak/off-peak fares, holiday fares (up to 24 holidays per year), weekend fares, rail-to-bus transfers as a surcharge to any fare, multiple zone fares (up to seven zones), and additional period passes good for a number of days from the date of purchase (i.e. a 5-day or 30-day pass). The fare structure shall also be developed so it will not preclude the changeover from a zone based fare system to a distance based fare system. The fare matrix used should allow for a seamless conversion between the two types of fare systems and shall have no impact on the operation of the TVM software or the customer.

Once new fare tables are created on the Fare Collection Network Controller (FCNC), it shall be possible to download the new fare table(s) from the FCNC to the TVMs via the data communications link. New fare tables shall also be transferable onto a solid-state memory module (SSMM) or other removable storage media, which can then be loaded into the TVM by a service technician. Once fare tables are downloaded into the TVM, the new fare table shall be activated automatically in the TVM at the specified date/time as programmed by the City.

Each entry in the fare table shall at a minimum contain:

- The price of the selection.
- Software configurable text of the messages on the passenger display.
- Information to be printed and magnetically encoded on the ticket.
- The number of tickets issued per transaction.
- The number of tickets per strip (cut).
- A variable parameter to specify the validity period of the ticket (expressed in minutes from the current time and days from the current date) for all tickets that have a variable expiry date and time.
- Necessary information to identify the proper voice message to play when the ticket type is selected.
- Associated variable text for those audit receipts that include a listing of ticket types.

For ticket printing, it shall be possible to program content (fixed and variable), location of all printed text on the ticket, character fonts and sizes, and print orientations.

Contractor shall provide the software utilities for adding, changing, and deleting text on tickets, passenger display messages, and accounting/registration printouts where ticket types are listed.

The structure and layout of the fare table entries and the TVMs ability to accommodate existing and future fare policies shall be subject to RE review and approval at the Interim and Final Design Reviews.

TP-5.2.3.29 Cancel Functions

In the event that one of the following conditions occurs prior to commencement of ticket/pass issue, the ECU shall initiate a cancel signal, causing all deposited monies to be returned and the transaction to be cancelled. Whenever a transaction in progress is automatically canceled by the TVM, an explanatory message shall be shown on the patron display.

Cancel Button – Actuation of the cancel button shall cancel the transaction. Once ticket issuing has begun, the cancel button shall have no effect.

Time Out – Time out shall occur if a transaction is not continued within the City software configurable time spans (see TP-5.2.3.30).

Overpayment Limit Exceeded – Deposit of an amount in excess of a permitted limit of overpayment while the TVM is in “Exact Fare Only” mode shall cancel the transaction. (Note that if this value is set to zero, all overpayments while the TVM is in “Exact Fare Only” mode shall result in canceled transactions.) The limit of overpayment shall be specified by the RE within 60 days after NTP and shall be a software configurable, adjustable parameter by the City.

Excessive Coins or Bills Inserted – Insertion of quantities of coins or bills greater than software configurable limits (initially set to a maximum of 15 bills and 30 coins but adjustable by the City) shall cause the TVM to cancel the transaction and return all deposited funds.

Shutdown – unless otherwise specified elsewhere in these technical provisions, any shutdown condition, including AC power failure, shall result in cancellation of the transaction, the return of all deposited funds, and orderly shutdown of the TVM.

TP-5.2.3.30 Time-out Operations

An intra-transaction time-out function shall be provided which shall limit the time between successive steps of inserting the required money or any other patron input after initiating a ticket selection. The timer shall start after selection is commenced, and shall reset and re-start after each patron input or insertion of a coin or a bill. If the patron’s input, including the insertion of money, is interrupted for more than a software configurable number of seconds at any point before the full value of the fare has been collected and ticket issuing has been initiated, the transaction shall be automatically canceled, all deposited funds returned, and the TVM shall return to the idle state.

The City shall be able to easily program different time spans ranging from 1 to 90 seconds for the intra-transaction time-out operation of the TVMs. The different time spans for time out operation shall be downloadable from the FCNC.

Similar to the intra-transaction time-out described above, an inter-transaction time-out shall also be provided. This timer shall limit the amount of time the TVM waits after completion or cancellation of a transaction requiring the return of deposited money before resuming the idle

state. The inter-transaction time-out shall be initially set to 5 seconds but shall be adjustable by the City from 0 to 15 seconds in increments of 1 second.

Other time-out periods, as applicable to the transaction process, shall also be software configurable by the City. All time-outs shall be identified in the review of the transaction process that shall occur at the Interim Design Review, and shall be subject to RE approval at the Final Design Review.

The following additional time-outs relating to the bank card and smart card operations shall be included with software configurable time-out parameters:

- The time the TVM will wait for a response from the patron to the prompt for whether a receipt is desired. Initially, this should be set to 10 seconds, if no response is provided after this period, the TVM shall resume its idle state.
- The time the TVM will wait for a response from the FCNC for bankcard transaction authorization. This software configurable parameter shall be initially set to 20 seconds.

TP-5.2.3.31 ECU Clock

Each ECU shall contain its own real-time electronic clock, which shall be used to generate time signals and maintain an accurate record of year, month, day, date, and time.

The clock shall contain calendar data to automatically determine the year, month, date, and day, and time, for at least 15 years. Without manual input or communications from the FCNC, the TVM clock shall automatically adjust for changeovers between standard and daylight savings time and account for leap years. The TVM clock shall be set to the current date and time.

A battery or batteries shall be provided to retain accuracy of the clock during periods the TVM is shut down. The battery capacity shall be sufficient to retain clock accuracy for a period of at least five years. An indication of the need to replace the battery shall be provided prior to the battery requiring replacement, or if not available, the TVM maintenance manuals shall clearly identify each battery and its recommended replacement interval.

The clock shall be synchronized and/or reset locally by numeric keypad input and shall also be synchronized and/or reset by remote communication from the Fare Collection Network Controller. The clock shall be synchronized by the FCNC each time the TVM is polled by the FCNC, which shall be no less than once per day. The TVM shall also request clock synchronization from the FCNC each time the TVM is powered up and/or initialized. If the TVM's internal clock indicates a time more than 5 minutes different from the time as reported by the FCNC, a clock-warning event shall be recorded by FCNC.

The Contractor shall provide information on local and remote clock reset/synchronization functions as part of the Interim Design Review.

TP-5.2.3.32 Accounting, Registration, Diagnostics, and Events

The Electronic Control Unit shall process and store all ticket/pass sales, TVM status, event, and diagnostics in the data memory unit and transmit this information upon demand to the network controller. Access to data records at the TVM shall be restricted to authorized personnel on a need to know basis. (Data access to be granted depending on authorization codes used to gain internal TVM access.)

All recorded data shall be accessible directly from the TVM. Service personnel shall be able to access and print out all data accessible by them on audit ticket stock. All accounting, registration, event, and diagnostic information shall be sent to the Fare Collection Network Controller. and

shall on demand be transferable to a SSMM within the TVM for later manual transfer to the FCNC. All logged events and alarms shall be time and date stamped. All accounting and registration information stored by the TVM SSMM shall be protected against any unauthorized manipulation.

At a minimum, this data shall include the following:

- Current TVM Status.
- Status of the TVM shall be recorded and updated to reflect changes in the TVMs condition. Current status information shall be available to all personnel authorized to gain entry to the TVM. Any change in TVM status shall be immediately forwarded to the FCNC. On demand, the TVM shall print an audit ticket indicating all status conditions and the date and time each condition occurred.

At a minimum, the TVM shall record and report (via the FCNC and on-demand printed audit receipts) the status conditions as listed in Table 2-7. The complete list of TVM status properties to be recorded and reported shall be subject to RE review and approval at the Interim and Final Design Reviews.

Table 2.7 Current TVM Status Conditions Recorded and Reported

Status Category	Conditions Reported
TVM Operating Status	OK / Out of Service
Coin Status	OK / No Coins Accepted
Change Status	OK / Exact Fare Only
Bill Status	OK / No Bills Accepted
Module Operating Status (For each module)	OK / Jammed / Out of Service / Fault / Not Communicating / etc.
Patron Selection Button Status	OK / Button Jammed (Specify Button)
Ticket Stock Status (For each stack)	OK / Low / Empty / Last Number Issued (where pre-serialized stock is used)
Bill Vault Status (with serial number)	OK / Not Present / Near Full / Full
Coin Vault Status (with serial number)	OK / Not Present / Near Full / Full
SSMM Status	OK / Not Present / Fault / Data Mismatch
Power Status	OK / Battery Power
Communications Status	Host senses lack of communication
Security Status	OK / Door Open / Authorized Entry / Intrusion
Intrusion Alarm Status	OK / Intrusion Alarm Active
Impact Alarm Status	OK / Impact Alarm Active
Silent Alarm Status	OK / Silent Alarm Active
SCADA Security Relay Status	OK / Active
SCADA Attention Relay Status	OK / Active
Bank Card System Status	OK / No Cards Accepted
Receipt Status	OK / No Receipts Available
Bank Card Module	OK / Jammed / Out of Service / Fault / Not Communicating / etc.
Receipt Printer Status (If separate)	OK / Jammed / Out of Service / Fault Not Communicating / etc.
Receipt Stock Status (If separate)	OK / Low / Empty
Battery Alarm	OK / Low

TVM Revenue Status

On demand, an audit ticket with TVM revenue status information shall be printed. This information is to be restricted to those personnel with administrative and revenue access privileges.

The complete list of TVM revenue status properties to be recorded and reported shall be subject to RE review at the Interim and approval at Final Design Reviews.

At a minimum, each TVM shall record and transmit to the network controller the following information about current revenue status.

- Serial number of each money vault

- Contents of bill vault (total and by denomination)
- Contents of coin vault (total and by denomination)
- Total value of all money currently stored in all devices
- TVM Daily Sales and Activation History

For each calendar day of operation, the TVM shall track and record information on daily sales history. The TVM shall retain this information for each day until it is successfully transmitted to the FCNC. The TVM shall be capable of storing these daily totals for at least 7 days. On demand, the TVM shall print audit tickets reflecting this information for the current day and the previous day. This information shall be restricted to those personnel with administrative and revenue access privileges.

The complete list of TVM daily sales statistics to be recorded and reported shall be subject to Resident Engineer review at the Preliminary and approved at Final Design Reviews.

At a minimum, each TVM shall record and transmit to the network controller the following information about daily sales history:

- Total number of ticket sales by type
- Total value of ticket sales by cash and by type
- Total gross cash inserted for purchases
- Total gross cash dispensed as change
- Total net cash collected (inserted minus dispensed) due to purchases
- Total of overpayments (surplus payments when no change available)
- Total value of coins and bills inserted by City personnel to secure recovered jammed money
- Total value of coins and bills in removed cash vault(s)
- Total net value of cash inserted and removed by patrons and City personnel
- Total number and value of ticket sales by credit card and by type
- Total number and value of ticket sales by debit card and by type
- Total number of authorization requests, approvals, and denials
- Total number of tickets activated by type

If cash storage devices (vaults or hoppers) are removed or exchanged while the TVM is inoperative, upon restoration of operation the TVM shall identify the affected modules and automatically adjust all appropriate registers. The TVM shall assume that any such changes occurred on the day that the change was first noticed (*i.e.* on the day the TVM was restored to operation).

TVM Diagnostics

The TVM shall also record and report a variety of diagnostic statistics and information to the FCNC, including:

- Days and number of tickets printed since printer ribbon replaced (if applicable).
- Days and number of tickets printed since thermal print head cleaned and replaced (for each print head, if applicable).

- Service days and number of cycles (where applicable) for each major module since last maintenance activity. (Maintenance activities to be recorded by manual entry of codes at TVM.)
- Rolling average rejection rate of coins over the last 100 coins inserted by denomination (i.e. the percentage of rejected coins over the last 100 coins inserted).
- Rolling average rejection rates of bills over the last 100 bills inserted by denomination (i.e. the percentage of rejected bills over the last 100 bills inserted).
- Days and number of cards read since bankcard processor was cleaned. (Cleaning activity to be recorded by manual entry of maintenance code.)
- Days and number of cards read since smart card processor was serviced. (service activity to be recorded by manual entry of maintenance code).
- The complete list of TVM diagnostics to be recorded and reported shall be subject to RE review at the Interim Design Review and Final Design Reviews.

Events Data

In addition to the above data elements, all events shall be recorded by the TVM and reported to the Fare Collection Network Controller. At a minimum, the following events shall be recorded and reported:

- TVM initialized (*i.e.*, ECU boot)
- Ticket stock low / empty / replaced
- TVM polled by FCNC
- Exact fare only mode begin / end
- Power lost / restored
- Module failure (*e.g.* coin system failure)
- Outer door unlocked / locked
- Ticket stock low / empty / replaced
- Outer Door opened / closed
- Bill, coin, or ticket jam
- Entry authorized by security code
- Communication to station LAN lost / restored
- Entry authorized by alarm key switch (if applicable)
- SSMM data retrieved
- Coin vault removed / installed
- Intrusion detected / cleared
- Coin vault near full / full
- Impact sensor activated / cleared
- Bill vault removed / installed
- Silent alarm activated / cleared
- Bill vault near full / full
- TVM clock error (*i.e.* excessive time difference)
- Failed/Interrupted Authorization Requests
- Manual diagnostic test routine initiated

Provisions shall also be made for the TVM to record and report to the FCNC when polled and on demand user-initiated events. Maintenance and/or revenue technicians will introduce these events, which will be used primarily to record maintenance activities, by entering commands and codes on the internal maintenance keyboard. For each major module for which maintenance histories will be tracked, a manually entered maintenance event code shall be assigned. Whenever such a maintenance event code is entered, the corresponding module's maintenance date and cycle counter (if applicable) shall be reset.

Each event record shall contain, as appropriate, the TVM number, date, time, event code, employee identification number, TVM status, component code of inserted or removed component, and cash contents by denomination.

Event recording of each opening of a TVM door is required. Such recording shall include the identification of individual accessing the interior of the TVM, date, and time.

Errors caused by communication line problems shall be recorded or errors resulting there shall be recorded.

Each event shall be capable of being classified into one of four priorities. Event priorities shall be software configurable by the City at the Fare Collection Network Controller. Each event category shall also be City software configurable as either an on-line or off-line event. On-line events shall cause the TVM to initiate communications to the FCNC and transmit information about the event. Off-line events shall be recorded locally by the TVM and transmitted to the FCNC upon the next polling. As delivered to the City, event priorities 1 through 3 shall be defined as on-line events. Event priority 4 is an off line event.

Events shall also be classified into categories to simplify later reporting and analysis. Each event shall be assigned to one of the following categories: Maintenance, Revenue, Administrative, or Other.

The complete list of events to be recorded and the priority and category of each shall be submitted to the RE for review at the Interim Design Review and is subject to RE approval at the Final Design Review.

Alarm Conditions

On-line events shall be considered alarm conditions of varying severity. Alarm conditions shall be transmitted by the TVM as soon as possible to the FCNC. The following events shall be categorized as alarms (*i.e.* on-line events):

Table 2-7. Alarm Condition Priorities for Fare Collection Equipment

Description	Priority
TVM Revenue Service Alarms	
Bill vault full	2
Coin vault full	2
Exact fare mode	2
Supplemental coin hopper empty	2
Ticket stock empty	2
Bill vault nearly full	3
Bill vault removed	3
Coin vault nearly full	3
Coin vault removed	3
Ticket stock low	2
Receipt stock low (if separate)	3
Receipt stock empty (if separate)	2
TVM Maintenance Alarms	
Alarm unit out-of-order	2
Bill processing unit out-of-order	2
Coin processing unit out-of-order	2
Patron display out-of-order	2
Patron keyboard out-of-order	2
Power loss TVM IS DISABLED	2
Ticket and pass issuing unit out-of-order	2
TVM out of service	2
Solid State Memory Module out-of-order	3
TVM time-of-day clock error	3
Bank card system out of order	2
Receipt printer out of order (if separate)	2
Security Alarms	
Intrusion (unauthorized entry)	1
Intrusion attempt (impact sensor activated)	1
Unauthorized removal of cash storage device	1
Silent alarm	1
Outer door open	3
Service entry (authorized entry)	3

For each alarm event, a corresponding event to clear the alarm shall be transmitted by the TVM as soon as the alarm condition is no longer present. For lower priority alarms (2 and 3), the alarm condition shall be cleared either automatically by the TVM or by manual intervention, as is appropriate to the alarm. Priority 1 alarms shall remain in effect until the following actions occur, at which time the TVM shall transmit a corresponding event to clear the alarm:

Table 2-8. Actions Required to Clear Priority 1 Alarms

Priority 1 Alarm	Action(s) to Clear
Intrusion (unauthorized entry)	Valid login at TVM
Intrusion attempt (impact sensor activated)	Valid login at TVM or 60 seconds (adjustable) without further impact activity
Unauthorized removal of cash storage device	Valid login of administrative user at TVM
Silent alarm	Valid login at TVM or TVM outer door secured

A description of alarm processing shall be submitted for RE review and approval at the Interim Design Review.

TP-5.2.3.33 Power Supply

The TVM shall be equipped with a modular, filtered power supply, which shall be connected to the incoming grounded electrical service as specified herein. The power supply shall be connected to the incoming electrical service and deliver all of the necessary operating voltages for the TVM.

An “ON-OFF” switch shall be provided within the enclosure, which shall turn the TVMs power supply on, or off; this switch shall be separate from the main circuit breaker that removes all power from the TVM. While the TVM power supply is off, integrity of the non-volatile memory and the internal clock shall be maintained. With the power supply switch off, it shall be possible to service the machine and make field repairs and/or module replacement without risking the safety of maintenance personnel.

While the TVM power supply switch is off, the inside of the TVM shall be illuminated by either the lighting top or by an internal service light that remains powered. Appropriate warning labels shall be provided on or near any components or cables that may have hazardous voltages present while the TVM power supply switch is off. A separate main circuit breaker or switch shall be provided that removes all power from the TVM.

If required by design, a reset switch shall be provided to restore operation after correcting a failure. Indicator lamps shall be provided to show that all aspects of the power supply are functional.

Hardware including the case, heat sinks, and printed circuits of the TVM power supply shall be protected against all environmental conditions. The need for adjustments shall be avoided wherever possible by the use of appropriate circuitry, stable components, and high tolerance circuits.

Whenever the TVM shuts down due to loss of commercial power, upon restoration of power, the TVM shall automatically resume operations within 90 seconds and shall return to operational status within 6 minutes.

A conceptual description of the TVM power supply shall be submitted for RE review and approval at the Definitive Design Review.

TP-5.2.3.34 Supplemental Battery Power

The TVM shall be equipped with a battery operated supplemental power supply integral to the TVM and connected to the primary power supply. This battery power supply shall be used in the event the incoming voltage falls below the reliable TVM operating voltage as specified in TP-5.1.7.2 and in the event of loss of AC power to the TVM. The supplemental power supply shall contain a battery, a trickle-charge circuit, and appropriate indicators. The ECU shall monitor the power supply's source of power and shall transmit a power alarm to the FCNC as soon as it is informed that battery power is being utilized. The supplemental power supply shall be of sufficient capacity to permit the TVM to perform the following functions in the event of an AC power failure or fault, or other fault, which would cause the TVM to shutdown without AC power:

- If the entire fare value has been collected prior to loss of AC power but after ticket printing/ encoding has commenced, the transaction shall be completed. This includes ticket printing/ encoding, issuance of all change due, and transfer of inserted money to associated vault(s) or coins/drums/carousels.
- If loss of AC power occurs before the entire amount has been collected or prior to ticket printing/ encoding, the transaction shall be canceled and the inserted money shall be returned to the patron.
- Transmit a power loss alarm message to the Fare Collection Network Controller.
- Record an event in the TVMs non-volatile memory indicating date and time of power loss.
- Provide for an orderly shutdown of the TVM such that no data loss occurs.

At no time shall a transaction be permitted to commence while the TVM is operating on battery power.

Batteries in the supplemental power supply shall have an expected life of no less than 5 years of normal use. An indication of the need to replace the battery shall be provided prior to the battery requiring replacement, or if not available, the TVM maintenance manuals shall clearly identify each battery and its recommended replacement interval.

The supplemental power supply shall be subject to Resident Engineer review at the Definitive Design Review and approval at the Interim Design Review.

TP-5.2.3.35 Alarm Unit

Each TVM shall be equipped with an alarm unit, which shall have the ability to monitor TVM security conditions and report them to the Electronic Control Unit (to be forwarded to the Fare Collection Network Controller). The alarm unit shall also control a relay to identify intrusion conditions of the TVM to the City's SCADA system. The alarm unit and its operation shall be subject to RE review at the Definitive Design Review and approval at the Interim Design Review.

The alarm unit shall have the following features and perform the following functions:

- The alarm unit shall by switch, optical detector, or other means detect status of the outer door lock and the opening of the outer door.
- The alarm unit shall detect and report pending and active security breaches to the ECU.

The alarm unit shall be equipped with an electronic or mechanical siren that shall be capable of emitting a sound level of at least 110 dB (A) measured at a distance of three feet with the door

open. Whenever the siren is sounding, the TVM shall go out of service. When the siren is silenced, the TVM shall perform self-diagnostics, and if possible, resume normal operations.

An electromagnetic relay that connects to the City's SCADA system shall be controlled by the ECU system. While the TVM is secure and operating normally, these relays shall be in the normally closed position. One relay (hereafter referred to as the SCADA security relay) will be dedicated to security violations and shall be activated (opened) whenever a security breach or is detected or the silent alarm is activated.

The alarm circuitry, separate alarm battery supply, SCADA relays, and siren shall be installed in a distinct secured enclosure that cannot be disassembled or bypassed in the allotted time for access authorization.

When entry is authorized, the ECU shall cause the alarm unit to disarm. If not disarmed within the prescribed time period, the alarm unit shall activate the siren for a City-software configurable period of one to five minutes or until entry is authorized. The SCADA security relay shall be continuously energized while a security breach is in progress or until entry is authorized. Each time the TVM is secured, the alarm unit shall reset and resume monitoring TVM security.

Each time a security breach or impact is detected, an event record of the activation with date and time shall be created and stored in the non-volatile register memory of the ECU.

The alarm unit shall monitor the security status of the TVM independent of the ECU; if the ECU is disabled for any reason, the alarm unit shall continue to operate and monitor the TVM for security breaches and impacts.

The alarm unit shall be powered by a rechargeable battery that is trickle-charged while commercial power is available. During power outages, the alarm unit shall utilize battery power to continue to monitor the security status of the TVM, and if an impact, unauthorized entry or other security breach is identified, the alarm unit shall utilize battery power to activate the local siren and the SCADA security relay. The battery shall have sufficient capacity to operate the siren and SCADA security relay for at least 30 minutes and operate the alarm unit for a period of at least 24 hours.

Each TVM shall have a secure local control switch or other secure means which permits the alarm system to be disarmed in the event entry, must be gained while the ECU or maintenance keypad (where security codes are entered) is disabled. The alarm system shall inform the ECU as soon as possible whenever the secure local control switch has been used to disarm the unit. The ECU shall record the event in its non-volatile memory and immediately report the event to the Fare Collection Network Controller. The TVM may not be put back into service until the secure local control switch has been reset.

If a security breach occurs while the ECU is disabled or the TVM is without power, upon restoration of power or ECU operation, the alarm unit shall transmit to the ECU that a breach occurred and shall activate the SCADA security relay; the ECU shall record the event in its non-volatile register memory and immediately transmit the alarm to the Fare Collection Network Controller.

An adjustable impact sensor shall be provided that can detect severe frontal blows to the TVM and attempts at unauthorized or forced entry. The alarm unit shall activate the siren and the SCADA attention relay as soon as the impact sensor is triggered. In such cases, the siren shall shut off and re-arm after a separate City software configurable time period (default 60 seconds), unless continued impacts or attempts at intrusion are detected.

The impact sensor shall detect severe blows induced by abusive patrons and vandals, and shall be most sensitive to blows applied to the front of the TVM. Impacts of lesser force applied elsewhere to the TVM enclosure shall not cause the siren to sound. At time of delivery, the impact sensor shall be adjusted so that blows that are caused by a 1 pound object moving at 80 feet per second, applying perpendicular force in an area of 1 square inch anywhere on the TVM door, shall cause the TVM siren to sound. The City shall be able to adjust this sensor for greater or lesser sensitivity. The operation of the impact sensor shall be demonstrated for RE review and approval at the Interim Design Review.

The alarm unit and the ECU shall exchange “heartbeat” messages at least once every two seconds. If the ECU detects a failure of the alarm unit, it shall record the event in its non-volatile memory and transmit an alarm unit failure message to the FCNC. If the alarm unit detects failure of the ECU, the alarm unit shall operate in its stand-alone mode until communication with the ECU is restored.

An internal momentary contact switch, hidden inside the TVM but readily accessible, shall permit an authorized technician to trigger a “silent” alarm, even if the ECU is not operational at the time. When activated, this switch shall cause the alarm unit to operate the SCADA security relay but shall not activate the siren. If the ECU is operational, pressing this button shall also cause the ECU to transmit a suitable warning message to the FCNC. The “silent” alarm shall be cleared by a subsequent command entered on the maintenance keypad.

TP-5.2.3.36 Service Indicators

Each TVM shall have a visible exterior indication that the equipment is in need of servicing. This shall be accomplished by use of one or more blinking lights, visible from a distance of 300 feet from the TVM. Service indicators should be on or near the top of the TVM. The service indicator shall be activated under any of the following conditions:

- TVM is out of service (except during power failure)
- TVM is in Exact Fare Only mode
- One or more TVM modules has failed
- Coin vault is near full or full
- Bill vault is near full or full
- A security breach is in progress
- Communication with the FCNC has failed

The indicators shall be subject to RE review at the Definitive Design Review and approval as part of the Interim Design Review.

TP-5.2.3.37 TVM Test Routines

The TVM shall be capable of conducting a variety of test routines.

Self-Diagnostic Tests

Each TVM shall automatically perform self diagnostic tests at regular intervals (at least once per hour) and each time the TVM is initialized. Self-diagnostic tests shall at a minimum confirm communications integrity with all major modules, and to the extent possible, exercise all electro-mechanical devices. Any failures identified during self-diagnostics shall be recorded in the TVMs internal status registers and result in a corresponding event being recorded by the TVM and transmitted to the FCNC. The TVM shall indicate status using a local display and printout

from the TVM upon request by technician. Self-diagnostic test routines shall be subject to RE review and approval at the Interim Design Review.

Manual Tests

Each TVM shall be capable of performing test routines under manual command while the TVM is out of service and the front door is open. These tests shall permit the technician to easily determine that a module is functioning properly. Under no circumstances shall these test routines result in the printing of a valid ticket, coins or bills being deposited in the vaults, or revenue totals being altered in any way.

The TVM shall maintain accurate count of manually printed test tickets for those ticket stocks that are sequentially numbered.

The results (pass/fail) of all tests shall be displayed using a device or display that is visible while the TVM door is open.

Each manual diagnostic test routine shall result in an event being transmitted to and logged by the FCNC.

At a minimum, the following test routines shall be available:

- Print a voided test ticket (one from each stock)
- Exercise coin acceptor system (allow coins to be inserted, validated, and returned)
- Exercise bill acceptor system (allow bills to be inserted, validated, escrowed, and returned)
- Send test message to the Fare Collection Network Controller and receive acknowledgment
- Exercise all display elements of the patron display
- Verify alarm unit, SCADA relays, and siren functionality
- Verify ECU and removable solid-state memory module (SSMM) contents match
- Test patron selection keypad (verify functionality of all buttons)

A descriptive listing of all manually initiated diagnostic routines shall be subject to RE review and approval at the Interim Design Review.

Remote Tests

It shall also be possible to initiate test routines remotely from any Revenue and Maintenance Workstation connected to the Fare Collection Network Controller. All remote tests shall be conducted only while the TVM is out of service but in communication with the FCNC. If the TVM is in service, remote testing shall be preceded by a remote command to remove the TVM from service. Remote diagnostic tests shall be subject to RE review and approval at the Interim Design Review.

At a minimum, it shall be possible to remotely instruct the TVM to:

- Report current status of all modules
- Remove the TVM from service (and cancel any transaction in progress)
- Reset the bill acceptor system (cause the unit to initialize and return to idle state)
- Reset the coin acceptor system (cause the unit to initialize, and return to idle state)

- Reset the ticket and pass issuing unit (exercise all ticket stock controls and return the ticket and pass issuing unit to idle state)
- Send test message to the TVM and receive acknowledgment
- Restore the TVM to service
- In addition, the TVM shall perform the following functions on demand of an authorized technician manually initiating the tests on site
- Read a test card in the bank card processor and display results on the patron display
- Print a test receipt
- Request a test authorization from the FCNC, which shall be rejected by the FCNC without requesting authorization from the clearinghouse

Under no circumstances shall the remote exercising of these test routines result in tickets or coins being dispensed other than the release of previously jammed tickets, coins, or bills.

TP-5.2.3.38 City Communication Requirements

Each TVM shall be equipped to be connected to the central Fare Collection System Network Controller, and shall be equipped with all necessary communications hardware and software to meet the requirements of these technical provisions. Each station shall have a communications link that connects all TVMs at that station together into a Local Area Network (LAN).

As part of the Preliminary Design Review, the Contractor shall provide information on the communication protocol interfaces supported by the TVM system and which shall be compatible with the City's communication system. Data transfer shall be through a WAN that supports TCP/IP. The identification, design and programming of necessary interfaces to existing application systems shall be the Contractor's responsibility. Interface identification, design and programming shall be at the direction of the City. Final approval regarding the necessity of identified interfaces and the subsequent design and programming of said interfaces shall be by the City. The Contractor shall be required to coordinate all development with the appropriate Information Technology Services Departments. The Central Computer shall handle all interfacing necessary for verification of bank credit and ATM (debit) card transactions with the selected bank or clearinghouse.

The Contractor shall coordinate its work with the City's Communications Contractor.

TP-5.2.3.39 Bankcard Processor

A bankcard processor (BCP) shall be provided in each TVM. The BCP shall consist of a bankcard reader. A PIN pad and card control electronics, and it shall be capable of processing all electronic payment media accepted by the Fare Collection System, including: credit, debit and check cards. The BCP shall be capable of completing a bankcard transaction in 15 seconds or less, when financial institution authorization is provided within 10 seconds.

Card Reader/Encoder

The card reader / encoder shall read and verify information on magnetic tracks 1 and 2 and read, write and verify information on track 3 of cards encoded in accordance with current ABA, ANSI and ISO standards.

The read / encode device shall read and encode magnetic stripe bankcards utilizing standard ABA and ISO formats.

PIN Pad

The PIN pad shall operate interactively with the device in which it is installed and shall supply transaction data to the device as an interface for the user. The necessary push buttons shall be provided to support bankcard transactions in accordance with banking industry standards. Each PIN pad shall be equipped with DUKPUT encryption and all messages generated by the PIN pad shall be encrypted in accordance with ABA, ANSI and ISO standards. The PIN pad shall also be useable for verification of service person ID cards when used for access to an AFC device.

BCP Electronics

The BCP electronics shall:

- Accept credit and check cards from American Express, VISA, MasterCard and Discover, and provide the capability to accept credit cards from other networks.
- Accept debit cards from, CIRRUS, MAESTRO, PULSE, and PLUS and two local or regional debit card networks in the Honolulu region, and provide the capability to accept debit cards from other networks, or accepted debit cards as approved by the City.
- Require acknowledgement of the purchase price.
- Permit canceling of the transaction or changes to the ticket value up to the point of acknowledgement of the fare media value, which shall occur immediately prior to the request for authorization.
- Limit attempts to enter a PIN, required for all debit cards, to three. When exceeded, the display shall indicate the reason and return to the standby mode.
- Request approval of credit/ debit/ check transactions in real time from the FCNC. Once a successful read of the credit, debit, or check card has been achieved, a PIN has been entered when required, and the media value selected, the transaction information shall be passed to the bank clearinghouse through the FCNC for immediate approval by the banking network. Transaction requests shall take priority over all non-security related transmissions.
- Provide software configurable limits (from 1 to 10) on a number of transactions permitted and the value (from \$1 to \$500) that can be purchased by a single card within a software configurable period (from 1 to 24 hours).
- Initiate a signal to the patron display and to the FCNC to indicate the non-availability of a printed receipt.

In the event that a ticket cannot be dispensed for an approved credit, debit or check card transaction, means shall be provided to reverse such transactions.

Display Screen

The display screen shall be a light emitting diode (LED) type or illuminated LCD. The display screen shall be clearly readable in all lighting characteristics found on the rail system in Honolulu, which includes light and direct sun light. The display screen type and design shall be submitted for RE review and acceptance at the Interim design review. Messages and graphics shall be configurable by the City.

The display screen shall provide the following messages at a minimum:

- Insert card
- Time remaining
- Not able to process

- Out of service

Specific messages shall be software configurable and downloadable from the FCNC. Specific means of modifying display screen messages shall be subject to review and acceptance at the critical design review.

All messages shall be presented in English and City selected languages.

TP-5.3 Money Carts

This section specifies functional requirements for the revenue transport carts (RTCs). RTCs are carts utilized by revenue collection as a means to transport money and ticket supplies to and from TVMs, and the revenue transport trucks (supplied by others like a secure money truck). Upon completion of collection of all monies from the station equipment the revenue will be transported to a money counting facility where the same carts will be used to transport revenue from the money trucks to the revenue counting facility.

TP-5.3.1 Functional Requirements

The contractor shall provide RTCs for transporting money and supplies to and from TVMs and the money truck. RTCs shall be provided as follows:

- The Transport servicing cart is a cart used to store and transport coin and bill vaults, ticket stock, units to and from the money truck and the Ticket Vending Machines at each station.
- The contractor shall provide seven servicing carts each capable of holding inventory for four TVMs.

TP-5.3.1.1 Design and Construction

TP-5.3.1.2 Construction

The carts shall be constructed of a sturdy, lightweight, rigid frame that carries the wheel and support structure that is designed to carry the items specified. The interior compartments and sections or dividers shall be made of sheet metal and designed for rugged use. The gauge of the sheet metal shall be submitted to the RE for review and approval.

The compartments to store cash boxes and bill stackers shall be configured in a honeycomb or cell like structure so as to assure stiffness and resistance to bending or racking due to the weight of filled cash boxes under full loading. It shall be possible to easily slide full vaults and full supplemental change storage units into and out of their compartments.

The carts shall be designed to be operated by one person to provide means to transport revenue. Transportation of the cart to and from each station shall be by truck that shall be furnished by others.

The carts shall be equipped with appropriate storage racks to hold coin and bill vaults, ticket rolls or stacks, units need for servicing TVMs.

TP-5.3.1.3 Design

The design of the carts shall take into consideration ergonomic factors related to loading and unloading the cart and pushing and pulling it at full loads by a single person. Proper maneuverability and safety factors shall be of prime importance. The maximum horizontal force needed to move a fully loaded cart on level surface should not be greater than 30 pounds.

Means shall be provided to enable carts to be tied down to the revenue truck bed to hold it securely in place when being transported.

Means shall be provided by use of covers or doors retention bars or equivalent means to prevent items stored in the compartments and drawers from sliding out.

An unloaded collection cart shall not weigh more than 25 lbs. and shall be able to be easily grasped by 2 persons and put into the revenue truck. The money cart design shall permit up to 300 lbs. weight to be carried for a total loaded weight of 325 lbs.

A handle shall be provided at the top end of each cart to enable the cart to be maneuvered. A second handle shall be provided at the front and lower end of the cart to enable a second person to assist in lifting and storing an empty cart in the truck. Means shall be provided in the design of the top handle to automatically lock the wheels whenever the cart is stopped and to release the brake when movement is desired.

There shall be no sharp edges or corners on any money cart. Interior edges shall not be hazardous to personnel using the cart.

The contractor shall submit complete design information for the money carts at the Interim design review for RE review and approval. This shall include a materials list, drawings, and elevations and design calculations demonstrating that the cart structure can support the maximum operational loads, shocks, and torques encountered in service without sustaining distortion or deformation.

TP-5.4 *Data Collection and Information System*

All TVMs shall communicate with the Data Collection and Information System (DCIS) via local area networks at each station and an City installed fiber optic network.

The core of the DCIS shall be a PC-based computer, called the Fare Collection Network Controller (FCNC), which shall:

- Collect sales and revenue data and ticket activation data from the TVMs.
- Collect ticket activation data from the TVMs.
- Send information to the TVMs (such as fare structures, date/time, etc.).
- Generate management reports on demand and automatically per pre-determined schedule.
- Monitor and report maintenance, revenue, and security alarms.
- Request and receive authorization requests from the TVMs, perform local authorization checks and communicate with a transaction clearing house for authorizations. When authorization is granted or denied, the Fare Collection Network Controller shall forward the information to the TVM for completion of the transaction.

All TVMs shall be connected to a Contractor-furnished Data Collection and Information System (DCIS). The DCIS shall provide automatic monitoring and control of all devices connected to the network. The system shall also provide automatic detection of transmissions that were successfully sent via the network; unsuccessful transmissions shall be recorded locally at the monitored device for automatic re-transmission. After three attempts at re-transmission a failure indication shall be logged and alarmed.

TP-5.4.1 General

The Contractor shall furnish, install, configure, and connect computer hardware and software for processing, displaying, communicating, and printing fare collection equipment data and information for security, maintenance, revenue, accounting, fare collection data analysis, and bank card transaction clearing purposes.

The Contractor shall coordinate with the RE and the City's Communications Contractor as necessary to install, interconnect, and make operational the DCIS.

Data processing and transmission shall be at a rate suitable for the required task; patrons shall perceive no delays due to TVM interaction with the DCIS, and computer workstation users shall not experience unreasonable delays. The Contractor shall size and configure the fare collection system such that under normal conditions, the combined time-period to send and receive a transaction does not exceed five (5) seconds. This includes the time necessary to communicate with the debit/credit card clearing house. It does not however include the time necessary to process the transaction. If the FCNC does not receive a response from the clearing house within thirty (30) seconds from the initiation of the request by the FCNC, the transaction shall be reversed.

TP-5.4.2 Components

Components of the DCIS fall into three categories: networking, computer hardware, and computer software. The main elements of the DCIS are:

- Local data communications network ("Station LAN") at each LRT passenger station. The station LAN shall consist of a point to point Multi-Mode. Fiber Optic SC or ST connection connecting all TVMs in a station to a common hub located in the

communication enclosure provided by the City's Communications Contractor. The City's fare collection contractor will provide all cable from each mounting pedestal to the hub.

- A Wide Area Network employing a Synchronous Optical Network (SONET) fiber optic system (supplied by the Communications Contractor). Each station will have a single Multi-Mode Fiber Optic SC or ST connection that will be dedicated to fare collection data transmission from the station to the DCIS.
- A Fare Collection Network Controller (FCNC), which shall connect to a LAN provided by the others. The fare collection contractor shall provide front-end communications interface hardware and/or software as necessary to establish these connections.
- A variety of workstations and other interfaces with the FCNC. Workstations are to include computer and ancillary equipment from major equipment manufacturers as described in following sections. Interfaces include the points where two or more systems, subsystems, or structures meet, transfer energy, or transfer data or information.

TP-5.4.2.1 Server Equipment

The servers shall be the latest and most appropriate equipment. Servers shall be configured to support a network connection of at least 1-gigabit per second. All hard drives utilized by each server shall be hot swappable and use RAID protection to increase performance and reliability. Total usable drive space shall support two years of online transactional data and 3 years summary data and be of sufficient size to hold the operating databases, application software and all other applicable data on the central server. Drive space shall be easily expandable to support future growth and be implemented with a spare capacity of 100%. All components shall be rack mountable, including the console, keyboard and accessories.

TP-5.4.2.2 Supporting Equipment

The Contractor shall provide networked laser printers to support output of maintenance logs, reports, and all other documents.

TP-5.4.2.3 Rack Units

Rack units shall be provided for each location for the housing and protection of various components. The racks shall be industrial grade and support industry standard twenty-three inch rack mountable equipment. They shall have casters for easy movement of the rack, including ventilation and fans for cooling enclosed equipment and environmental filtering.

Rack units shall be enclosed on the top, rear, front, back and sides. The front and rear of the enclosures shall be hinged and lockable doors for access to equipment. Front and rear doors shall be translucent for viewing enclosed equipment.

The rack units shall include mounted power supplies, multiport KVM switches with integrated keyboard, monitor and pointing device, and provisions for industrial computer systems, uninterruptible power supplies and communications equipment.

TP-5.4.2.4 Uninterruptible Power Supplies

The Contractor shall provide UPS systems capable of allowing the system to complete a shutdown without loss of data.

TP-5.4.2.5 Remote Workstation Hardware

All workstations shall consist of the latest and most appropriate equipment.

TP-5.4.2.6 Server and Workstation Software

All software to include but not limited to operating systems, reporting tools, development Tools, relational database management systems (RDBMS), and ancillary off the shelf applications shall consist of the latest and most appropriate products and versions.

TP-5.4.2.7 Software Licensing

All purchased or delivered software will be licensed directly to the City All license documentation will be delivered to the City at time of installation and prior to acceptance.

TP-5.4.2.8 Software Upgrades

All purchased or delivered software will be the most current version and will be upgraded, patched or have the most current manufactures service packs applied at time of installation. Software updates that need to be applied after the system is in production must be scheduled in advance according to criticality and performed in a manner, which minimizes interference with operation. Regular maintenance upgrades require advance notice of at least two weeks and must be communicated to the City and scheduled during approved days and times. Critical/emergency upgrades require as much notice as possible and must be communicated to the City and scheduled during approved days and times, and approved prior to deployment.

TP-5.4.2.9 Database

The fare collection FCS shall store all pertinent data relating to the operation of the fare collection system in one or more relational databases. These databases shall be managed by a commercially available software package. The database manager shall support standard Structured Query Language (SQL) commands and queries, and shall be of sufficient flexibility and power to perform the necessary functions described herein.

- The relational database manager (RDBM) software package shall include the necessary add-on tools to allow the City to customize reports, create queries, generate reports in graphical format, and integrate with other commonly used software packages such as spreadsheets, word processors, presentation packages, and so on. All databases shall store data in a format that complies with the Open Database Connectivity (ODBC) standard such that data may be exchanged as necessary with other similarly compliant applications.
- The Relational Database Management System (RDBMS), and all supporting and ancillary tools, modules, and software applications shall consist of the latest and most appropriate products and versions as approved by the City.
- The Contractor shall utilize the RDBMS to configure all necessary database tables, relationships, queries, reports, data entry forms, and automated data population procedures. The Contractor shall ensure that the database meets all requirements of these specifications. The statistics listed in the operations and planning transit overview sections are provided to assist the Contractor in determining database capacity and performance requirements.
- The Contractor shall provide and implement a software configurable method for the City to restrict access to particular fields and tables within the databases based on access levels.
- The Contractor shall ensure that the security features of the database cannot be bypassed. For example, the usage of alternative report writing software shall not allow access to the data.

- The Contractor shall provide and implement database indices to enhance reporting functionality. These indices shall be finalized during the design reviews.
- The Contractor shall provide and implement a means of auditing all data generated by the DCIS.
- The DCIS shall ensure that no data is removed from the databases until a successful archival of the data, to removable media, has been created and verified.

TP-5.4.2.10 Archival, Backup, and Restoration

The DCIS shall have an automated method, including hardware and software, for the unattended archival and restoration of the database, and other relevant files to and from removable media.

Archival, backup, and restoration shall be software configurable to allow for the selection of which components to archive as well as which components to restore.

Archival, backup, and restoration shall not hinder nor prevent access to system functionality and applications.

Archival, backup, and restoration shall occur in a timely manner as approved by the City.

The archival and backup of databases shall be a complete archival, including all transactions that occur during the archival process. This archival and backup shall be flexible to allow the archival or backup of entire databases or smaller portions of the databases, such as a table within the databases.

The archival, backup, and restoration of the databases shall not hinder nor prevent access to the reporting functionality.

The archival, and backup and restoration of the databases shall not hinder access to the databases for more than one (1) hour per twenty-four (24) hour period.

TP-5.4.2.11 Data and Reporting

The DCIS shall provide reliable transfer of data to and from all components. It is highly desirable to incorporate error-checking protocols. All TVM data shall be transferred to the DCIS and will include the following general criteria:

- Have the ability to produce both local jurisdictional and regional level reports
- Will be flexible in its reporting and have the capabilities to produce “canned” and “ad hoc” reports
- Will create a record for every transaction (all ridership information will be captured per rider)
- Have the flexibility to change category data types as needed
- Fare category (#tickets, tokens, Senior, Youth, Disabled, etc.)
- Boarding location
- Time of Transaction

TP-5.4.2.12 Revenue Data Requirements

The DCIS must have the ability to capture the following Revenue information for the purpose of generating “canned” and “ad hoc” monthly reports:

- Revenue – Raw Data:

- Weekday, Saturday, Sunday, Holiday
- Fare Category: Senior, Youth, etc.
- Jurisdictions
- Date

TP-5.4.2.13 Additional Requirements – Format

The output format of all queries and reports shall be of similar style. Each report and query shall produce data in tabular format with each column clearly titled on each page. Each row of output data (excluding column titles) shall be consecutively numbered.

All reports shall include a cover page that provides the title of the report, the date and time the report was generated, the user requesting the report, and the complete list of input parameters and sorting keys used to create the report.

Every page of all reports and queries shall include a header that indicates the title of the report, a one-line synopsis of key input parameters, the beginning and ending date and time (where appropriate), the date and time the report was created, and the page number of the report.

A database of all data transferred from the TVMs to the DCIS shall be available to the City for the production of reports. Menu driven report generation software shall be provided to allow the user to design and store an unlimited number of report formats, which are to be used for generation of FCS reports.

Once a format has been designed, its title, along with a 30-character description, shall be stored and added to the menus. Access to created report formats shall also be through password access.

Each query and report shall have access permissions assigned to limit availability to those users authorized to view data presented by the query or report. Formats will be provided by the City in the Design Review. These reports shall be in addition to the standard reports provided with the Contractor's system. Reports shall provide a title heading on the top of each page indicating the date and time of day when the report was requested. Reports containing data from TVMs shall also identify the date for which the data applies.

Output

It is highly desirable that the results of all queries and reports shall be selectable by the workstation user to be available on the user's workstation monitor or printer. When results are displayed on the workstation monitor, it shall be possible to quickly scroll through the output by line and by page, to move to the first and last page, and to select a specific page number for display.

It shall also be possible for the workstation user to select query and report output in a form that is exportable to other applications, such as spreadsheets and graphical report presentations/programs.

Frequency of Reporting

Each prepared query and report shall also be capable of being automatically processed at pre-determined dates, times, and frequencies.

Ad Hoc Reporting

Software shall be provided to enable authorized workstation users to prepare new or modified queries and reports with a minimum of programming knowledge. Such customized queries and

reports shall be capable of being executed as they are created, and shall be capable of being added to the menu of prepared queries and reports.

When added to the prepared query and report menu, customized queries and reports shall be treated by the same as any Contractor-supplied query or report. Authorized users shall also be able to edit and delete any prepared query or report on the selection menu. For experienced programmers, the system shall permit the use of SQL commands to create specialized queries.

DCIS Performance GUI

The Contractor shall provide and implement a graphical method for displaying each DCIS Performance Report. These reports shall be automatically updated and displayed on a software configurable periodic basis and shall display results based on easily configurable report parameters.

The system shall include a software configurable method for defining various levels of warnings and alarms to correspond with the varying information monitored by the system.

The system shall include a software configurable method of responding to the various warnings and alarms. These responses shall include, but are not limited to, the emailing and paging of personnel as determined by the type and/or level of warning or alarm. The system shall also include escalation functionality.

All Performance Reports shall contain real time data as of the time of execution of the report.

Access to the Performance GUI shall be based on the same access levels and privileges as the standard reports. Access to the Performance GUI shall be from authorized workstations as determined by the City

Server/Computer Report

The system shall report all software/hardware issues within the system. This report shall include, but not be limited to:

- Status of critical software/hardware such as the databases, operating system, system applications, drives, memory etc.
- Notification of critical events, such as software crashes, database errors, resource issues, drive failures, etc.
- Other criteria as determined by the City

Security Access Report

Each server or computer shall be tracked for security reporting purposes. This report shall be sorted by computer location and shall include all manual activities, all telephone accesses, and all downloading activities. The time and description of all accesses shall be reported. The Contractor shall submit all log messages for RE approval.

TP-5.4.3 Technical Support – Training

TP-5.4.3.1 IT Training

Training shall be provided to fully familiarize City personnel with all aspects of the system software, including the structure of the applications, tables utilized, all network communications and settings, plus other similar information.

The training plan and training documentation shall be approved prior to the training. The trainer for this course shall be technical in nature as the training will be highly technical and not end-user type training. At the conclusion of training, the involved personnel, including the Database Administrators, Programmer Analysts, Administrators, and Network Analysts shall have a thorough understanding of all aspects of the system.

Documentation

The Contractor shall furnish the City with five (5) copies of complete written documentation describing all equipment and software to be furnished, including:

- Brochures;
- Magnetic strip card specifications, with information fully defining all aspects of the card stock and coding to be utilized. (This information will be considered confidential.)
- Product specifications for all computer equipment; and
- Software descriptions.

All documentation described in this section shall be provided in hard copy and electronic formats. The electronic documents shall be delivered in the most current version of MS Word.

Functional Description

A customized Functional Description shall be provided that contains a high-level definition of the hardware, data communications, software, and firmware, and the functions performed by each. The Functional Description shall serve as a complete introduction to the system.

TP-5.4.3.2 Final Design

The following information shall be included in the final design:

- Detail of the hardware configuration showing all major hardware and sub-systems. The overview shall include block diagrams in sufficient detail to show the inter-relationships of major hardware sub-systems and the elements that comprise them.
- A detailed description of the major hardware sub-systems, the elements that comprise them, their inter-relationships, and the functions they perform, availability, processor performance, spare mass storage, and device redundancy shall be described.
- Detail of the major software sub-systems, describing the software, the inter-relationship of software within a sub-system, and the relationship between sub-systems.

High-level software block/flow diagrams shall be included to enhance the reader's understanding of the overall capability of the system. The sub-systems to be described shall include but not limited to:

- Operating systems
- Network software
- interfaces
- Support utilities
- Database
- Display, and report generation
- Data Communications systems
- A complete description of the software and the individual functions performed by the software.

- Significant features, concepts, and algorithms pertaining to each function shall be described, with special emphasis on equipment, software, and features unique to the system.

Software Documentation

The Contractor shall provide complete documentation for every aspect of the system.

The documentation for each version of each program shall be complete and comprehensive to include, but not be limited to:

- Complete source code listings with fully documented statements
- Comprehensive flow charts
- Block diagrams explaining the system as a whole and showing how the individual programs are inter-related. The software documents shall clearly identify what data elements are stored, the source of each data element, how data are structured, transferred and utilized. This shall include the software logic, processing rules, restrictions and exceptions, default conditions, hard and soft wired parameters and the overall process by which each of the reports specified is generated.

Data Flow Diagram and Database Tables

Data diagrams shall be developed. All programs shall be defined and described fully showing all inputs/outputs, samples of reports, logic flows and major functions described, as well as assumptions used during program development. Detailed functional requirements and schema diagrams shall also be provided.

TP-5.4.3.3 System Network Architecture

DCIS networking covers:

- The entire system in a Wide Area Network
- Station area networking and communications
- Communications between the FCNC and its peripheral devices.
- The conceptual design of the DCIS network architecture, and communication methods and protocols for: station LAN, between TVM and NIU (if required), between station and FCNC, between FCNC and workstations, and between TVMs shall be submitted for RE review at the Interim Design Review and for approval at the Final Design Review.

TP-5.4.3.4 Network Interface Unit Functional Description

If necessary, the Contractor shall provide a Network Interface Unit (NIU) at each station to facilitate communications between the TVMs and the Fare Collection Network Controller. If required, the NIU shall act as an interface between the station LAN and the Wide Area Network.

If an NIU is required, it shall be installed by the Contractor in the TVM. The NIU shall introduce delays in communications of no more than 1 second, and shall not reduce data transmission integrity.

TP-5.4.3.5 Workstation Networking

A total of three workstations shall be installed in two locations.

The Administrative Workstation shall be integrated directly with the Fare Collection Network Controller.

Two Revenue and Maintenance Workstations shall be installed at the MSF facility, connected to the Fare Collection Network Controller via a T-1 connection (supplied by others).

The communications protocol employed over the T-1 connection for these workstations shall be submitted to the RE for approval at the Interim Design Review.

TP-5.4.3.6 Connection with Maintenance Test Station

A Maintenance Test Station, consisting of spare fare collection equipment configured as a working station, shall be installed at the MSF facility and shall communicate with the FCNC via a T-1 connection (supplied by others). The communications protocol employed over the T-1 connection for the Maintenance Test Station shall be submitted to the RE for approval at the Interim Design Review.

TP-5.4.3.7 DCIS Computer Hardware

TP-5.4.3.8 Fare Collection Network Controller

A PC-based Fare Collection Network Controller (FCNC) shall be used to provide a communications and processing link between all TVMs and the PC-based workstation(s) to be provided under this Contract. The FCNC shall perform all required functions to upload and download information from and to the TVMs. The Fare Collection Network Controller shall fulfill the requirements of the Data Collection and Information System as defined herein.

The Fare Collection Network Controller shall consist of computer and ancillary equipment from major computer equipment manufacturers. A conceptual description of FCNC hardware shall be submitted at the Interim Design Review for RE review and approval. Final FCNC make, model, and other hardware selection are subject to RE approval at the Final Design Review.

The FCNC shall be a state-of-the art computer suitable for server application. Although FCNC computer hardware selection and sizing shall be the responsibility of the Contractor, the FCNC shall employ the most recently available Intel or approved equal microprocessor in a configuration that meets the needs of the City and satisfies the purpose for which it is intended.

TP-5.4.3.9 User Workstations

Three user workstations shall be provided as part of this contract. The FCNC shall be capable of supporting up to four additional workstations without replacing any component of the FCNC. Software licenses provided by the Contractor shall permit the City to add up to four additional user workstations without fees, conditions, or restrictions. Each computer workstation shall be a state-of-the art computer suitable for workstation application, and shall employ the most recently available Intel microprocessor or approved equal in a configuration that meets the needs of the City and satisfies the purpose for which it is intended.

TP-5.4.3.10 Administrative Workstation

The administrative workstation shall consist of the monitor, keyboard, mouse, and printer connected to the FCNC computer as described herein.

TP-5.4.3.11 Revenue and Maintenance Workstation Hardware

The revenue and maintenance computer workstations shall consist of computer and ancillary equipment from major computer equipment manufacturers, subject to RE approval at the Final Design Review.

The revenue and maintenance workstations shall be installed at the MSF facility. The revenue and maintenance workstations shall be identical and shall consist of the following minimum hardware:

- Intel or approved equal microprocessor-based personal computer in a tower or mini-tower case.
- Internal hard disk storage, 200 gigabyte minimum, with maximum average access time of 10 milliseconds. At the time of delivery to the City, hard disk free space shall be no less than 75% of the total disk capacity.
- Random Access Memory, 32 megabytes minimum
- Two or three button mouse.
- Laser printer, 8 pages per minute, 600 dots per inch resolution minimum.
- CD-ROM drive, 12-speed minimum.
- Color SVGA 17" monitor, 0.26 mm pitch non-interlaced maximum, 1024 x 768 flicker-free, and corresponding video board.
- 101-key keyboard.
- SSMM interface.
- Microphone, speakers, and interface hardware necessary to support recording, editing, and playback of digitally recorded voice messages.
- Hardware ports as necessary for equipment and network connections, minimum of two serial ports and one parallel port.
- Network interface cards or devices necessary to connect and communicate over the networks defined herein.
- Associated cabling.
- Uninterruptible Power Supply with battery capacity to power the PC and monitor for a minimum of 15 minutes.

TP-5.4.4 FCNC Software

Software on the Fare Collection Network Controller shall consist of current commercial versions of operating system software, relational database management software, and other applications needed to perform the FCNC functions. In addition, the Contractor shall not supply proprietary application software as necessary, and shall configure all software programs for optimal performance of the FCNC and its associated networks.

Contractor shall furnish printed technical and user documentation of all software furnished. If the Contractor requires a software license, it shall be identified and unconditionally provided to the City.

A conceptual description of the FCNC application software, user interface, and database tables shall be submitted for RE review and approval as part of the Interim Design Review. Preliminary description of FCNC software functions, including database layout and update procedures, polling processes, on-line help, etc. shall be submitted for RE review and approval at the Interim Design Review.

As delivered and licensed to the City, the software and database structures for the DCIS shall have the capacity to support:

- At least 300 TVMs

- At least 10 TVMs per passenger station
- At least 50 passenger stations
- At least four local computer workstations connected via an local area network
- At least four remote workstations at the MSF facility, connected via a T-1 link
- A Maintenance Test Station (see TP-5.9.5) located at the MSF facility, connected via a T-1 link
- An Ethernet link to the bankcard clearing house interface equipment

TP-5.4.4.1 FCNC Operating System Software

The operating system of the FCNC shall be a 32-bit system and shall be capable of supporting multiple concurrent users and multiple concurrent tasks per user. The FCNC operating system shall be compatible with the operating systems of the workstations and shall fully support communications to the TVMs and NIUs (if applicable).

The FCNC operating system shall be subject to RE approval at the Interim Design Review.

TP-5.4.4.2 FCNC Application Software Functions

Application software for the FCNC shall consist of software programs supplied by the Contractor, configuration files used to customize user interfaces and other operational characteristics of the FCNC, prepared reports and queries, special software tools, other commercially available software packages, and any other special functions resulting from software provided as part of the FCNC.

The FCNC application software shall provide the following functions.

Real-Time Status and Event Monitoring

As on-line events are reported to the FCNC, a graphical summary of the status of all TVMs shall be updated and maintained by the FCNC. Using graphics of sufficient detail to create a recognizable pictogram of the City system map showing all stations, the FCNC shall provide current status information to any connected workstation.

The FCNC shall indicate system status in three levels of detail. At the highest level, the pictogram shall show all stations and shall depict the status of station equipment and communications by the use of colors defined in Table 4-1.

Table 4-1. Status Display Colors and Conditions

Display Color	Status Conditions
Green	All Equipment at Station Functioning Normally
Blue	Access in progress or attention needed at one or more TVM (Priority 3 alarm in effect)
Yellow	One or more TVM malfunctioning, out of service, or off-line (Priority 2 alarm in effect)
Red	Security alert – i.e. intrusion, impact, silent alarm, etc. (Priority 1 alarm in effect)
White	No Connected Equipment at Station

When a station has more than one alarm in effect, the station shall be shown in the color of the highest priority alarm. For example, if a station has one TVM out of service and an intrusion alarm at another TVM, the station shall be shown in red.

When a workstation user selects a station, a schematic diagram of the equipment at the station shall be displayed, using the same color scheme described above to indicate the status of each TVM.

When a workstation user selects a specific TVM from the second level of status display, detailed information about the item shall be displayed in text form, including the status of each internal module, operating status, date and time of most recent related event, etc.

TP-5.4.4.3 Data Polling and Event Recording

Each TVM shall be capable of being polled at any time selected by the City, and the polled data shall be capable of being transmitted from each TVM for a pre-selected and modifiable time slice.

Polled data shall be available on demand and from automatic polling at a pre-selected frequency and time (*e.g.*, each day at 2 AM). Received data shall be automatically processed and populated into all pertinent databases.

The FCNC shall record the date and time each TVM was last polled.

Polling of TVMs shall provide the following:

- Cash in TVMs by coin and bill denomination in all cash storage devices.
- TVM status and status of all modules.
- Sales since last polling, separated by ticket type per day and by cash and bankcard.
- Cash removed from and added to the TVM since last polling.
- All events recorded but not previously transmitted to FCNC.
- Date and time synchronization.
- Bankcard transaction information.

Downloading Data and Configuration Files

From any computer workstation connected to the FCNC, based on password/user ID security, any authorized user shall be able to download to any single TVM, any station of TVMs, and all TVMs:

- Fare tables
- Security access codes
- Configuration files
- Operational parameters
- New and updated ticket layout and text
- New and updated patron display screen text
- New and updated voice message files
- Any other information necessary for the operation and maintenance of the TVMs

It shall be possible for any authorized user to specify the date and time when any data download is to occur, and to review and cancel any previously scheduled download.

TP-5.4.4.4 Remote Control of TVMs

From any computer workstation connected to the FCNC, each TVM shall have the capability of being controlled by an authorized user, based on password/user ID security, to perform the following functions:

- Put a TVM in service or out of service.
- Cause the TVM to perform self-diagnostics of any selected module or all modules.
- Reset the TVM (*i.e.* cause the TVM to restart all programs without affecting data registers).
- Enable or disable any payment mode.

TP-5.4.4.5 TVM Configuration Management

All configuration files and operational parameters of the TVMs shall be managed by the FCNC. No change to these files or parameters shall be transmitted to any TVM without a record of the change being stored on the FCNC.

The FCNC shall store all changes made to all configuration files and operational parameters and allow for historical review of no less than the previous 100 changes made. Records of each change to TVM configuration files and operational parameters shall include the workstation user responsible for the change, the date and time the change was made, the TVMs to which the change was transmitted, and the date and time of transmission.

Methods to alter configuration files and operational parameters shall not require the workstation user to edit files with a text editor, but shall instead utilize preformatted input forms supported by the relational database manager.

As required in these technical provisions, some operational parameters shall be capable of being downloaded to any single TVM, any station of TVMs, and all TVMs. All other operational parameters and configuration files shall be downloaded to all TVMs only.

The configuration files and operational parameters to be managed shall include at the minimum the following information:

- Station names
- TVM locations and types
- Fare tables
- TVM ticket print format
- Display screen configuration
- Operational parameters such as timeouts, vault full levels, accepted bill denominations, etc.
- Event descriptions, categories, and priorities
- Cash handling device (*i.e.* vault, hopper) serial numbers in system
- Digitally recorded voice message file assignments (when to play which message)
- Technician identification and access codes

Preliminary description of procedures to track and modify all operational parameters and downloadable information shall be submitted for RE review and approval at the Interim Design Review.

TP-5.4.4.6 Voice Messaging System Management

Each entry in the fare table includes a record identifying the voice message associated with the ticket type. Other voice messages that are common to all ticket types are played during TVM transactions. The FCNC shall provide software tools to manage the assignment of all voice messages to each step of all TVM transactions. All voice messages shall be recorded and stored in the FCNC. The City shall have the capability to record and add messages to the FCNC.

Management of voice messages shall also permit the City to assign new voice messages to additional ticket types created by the City, and to delete voice message assignments for ticket types that are discontinued by the City. Each voice message file shall be individually tracked and managed.

A preliminary description of procedures to track, modify, and download digitally recorded voice message files shall be submitted to the RE for review and approval at the Interim Design Review.

TP-5.4.4.7 Database Queries and Reports

The software shall provide the City with the capability to query the database to produce a series of information reports for auditing, cash and ticket control, and fare management information. The structure of the data shall be such that the City can access the data files with database programs to produce their own reports, in addition to those provided by the Contractor. Reports shall be capable of being generated on a timed basis or on-demand.

TP-5.4.4.8 Query, Report, and Database Input Forms

These input forms shall be displayed on the workstation screens and provide “fill-in-the-blank” simplicity of use. Each blank on the input form shall correspond to a field in the associated database table.

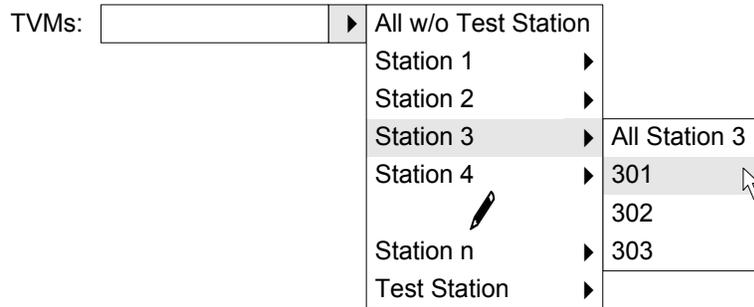
Each query and report shall have an input form to enter data necessary to perform the task. Each input form shall be customized to the task being performed, and all shall follow similar layout and design themes.

The general design of input forms shall be submitted to the RE for review and approval at the Interim Design Review. The detailed design of all input forms shall be subject to RE review and approval at the Final Design Review.

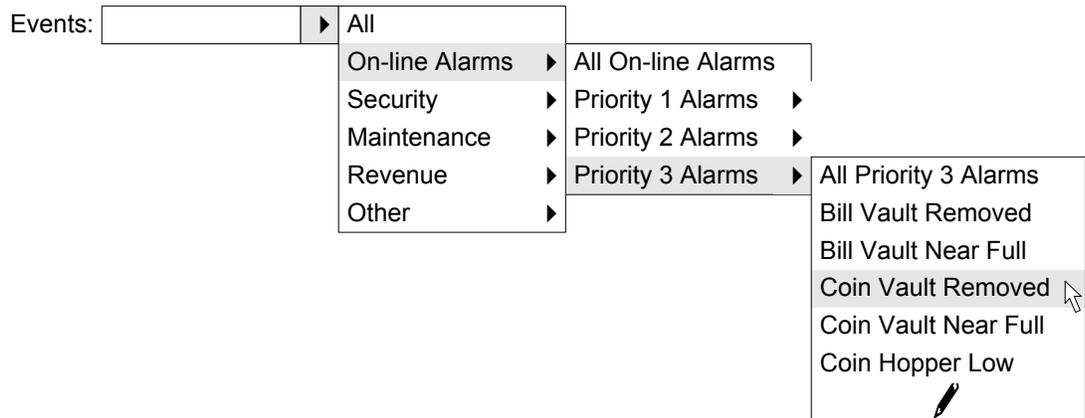
Input forms shall provide the following features and capabilities.

- As necessary, the input forms shall prevent the user from completing the task until all required fields have been populated.
- Where possible, input forms shall restrict entries to valid values.
- All configuration data and operational parameters shall be populated and edited using input forms.
- The input forms for queries and reports shall allow the user to select gradually more specific information by the use of pull-down menus.

Using input forms, it shall be possible for a workstation user to select all TVMs (the default), all TVMs at any station, and any individual TVM for any query or report where TVM selection is relevant. When all TVMs are selected, data from the Maintenance Test Station TVMs shall be omitted. As an example, the diagram below indicates how such a selection process could be implemented on those input forms where TVM selection is required, and shows TVM 301 being selected.



Similarly, using input forms it shall be possible to select all events (the default), all events of a given category, all events of a specified priority, and any individual event type for any query or report where event selection is relevant. The following diagram depicts how an input form requiring event selection could be implemented, and shows Coin Vault Removed events being selected:



Where selections are restricted to valid values, the first value in of the top menu layer shall be the default value for that selection.

Where possible, the pull-down menus shall be constructed from configuration database information, such as TVM numbers and locations, event descriptions and categories, ticket types, employee identification, etc. Pull-down menus utilizing configuration database information shall be automatically updated whenever the configuration data is changed by the City.

All input forms for reports or queries that review historical data shall include a field to filter data by the day of week. Using this field, it shall be possible to select data pertaining to all days (the default), all weekdays (Monday through Friday), all weekend days (Saturday and Sunday), and any single day of the week.

Where input forms require manually entered information, such as date and time ranges, the input forms shall utilize error checking to insure that data entry is correct.

When an input form is used to create a query or report, all fields to be populated shall be candidates for sorting keys. Each query or report input form shall provide for a minimum of 3 fields to be selected as sorting keys, and each sorting key shall be configurable to sort in ascending or descending order. Default sorting keys shall be defined for each input form where used.

TP-5.4.4.9 Query and Report Output Format

Access to this function should be limited to a system administrator that is responsible for operating the fare collection system. Revenue personnel are normally concerned with collecting and tracking money. The maintenance group is responsible for repairing equipment. Therefore there should be a system administrator function for maintaining the system configuration and fare tables.

The output format of all queries and reports shall be of similar style. Each report and query shall produce data in tabular format with each column clearly titled on each page. Each row of output data (excluding column titles) shall be consecutively numbered.

All reports shall include a cover page that provides the following information:

- Title of the report
- Date and time report was generated
- User requesting the report
- Complete list of input parameters and sorting keys used to create the report
- Every page of all reports and queries shall include a header that indicates the title of the report, a one-line synopsis of key input parameters (such as TVMs, event category, etc.), the beginning and ending date and time (where appropriate), the date and time the report was created, and the page number of the report.

The results of all queries and reports shall be selectable by the workstation user to be available on the user's workstation monitor or printer. When results are displayed on the workstation monitor, it shall be possible to quickly scroll through the output by line and by page, to move to the first and last page, and to select a specific page number for display.

It shall also be possible for the workstation user to select query and report output in a form that is exportable to other applications, such as spreadsheets and graphical report presentations programs.

The general query and report output format shall be subject to RE review and approval at the Interim Design Review.

TP-5.4.4.10 Queries and Reports to Be Provided

The Contractor shall provide several queries and reports at time of FCNC delivery. The prepared queries and reports shall be presented in a menu form for selection at any time. Each query and report shall have access permissions assigned to limit availability to those users authorized to view data presented by the query or report.

Each prepared query and report shall also be capable of being automatically processed at predetermined dates, times, and frequencies. It shall be possible for the City to identify reports to be run daily, weekly (*e.g.* every Wednesday), monthly (*i.e.* the first day, last day, or any specific day of each month), quarterly, and so on.

The queries and reports to be provided at time of delivery can be grouped into three major categories:

Summary Reports, which provide an historical view of data within a date range. These reports may include detailed information and/or totals of related events or transactions, and shall indicate the polling status of each TVM listed or the overall polling status of TVMs included in the report if TVMs are not listed individually.

Status Reports, which provide “snapshots” of TVM conditions, usually are for the most recent data available. All status reports shall list the date and time each TVM was last polled.

Database Reports, which provide printouts of configuration files, operational parameters, and other data used to determine operations of the TVMs. Database reports shall indicate the date and time the database table being shown was last modified and by whom.

A listing and conceptual description of all standard queries and reports shall be submitted to the RE for review and approval at the Interim Design Review.

Query and Report output format shall be subject to RE review and approval at the Final Design Review.

The following queries and reports shall be provided.

Summary Reports

Sales Summaries. At least three sales summaries shall be provided.

The **Detailed Sales Summary** shall provide sales information (number of transactions and dollar value) about each TVM by ticket type.

The **TVM Sales Summary** shall provide total transactions and sales for each TVM, grouping sales of different ticket types together.

The **Ticket Sales Summary** shall provide total transactions and dollar value of sales by ticket type. In addition, the report shall calculate the total number of trips sold, using the number of tickets in multiple ticket transactions, and assuming a fixed number of trips per day for all passes. The input form for this report shall include a space to input this variable value.

Cash Transaction Summary. This report shall provide detailed information about each transaction included in the query. Information to be provided shall include the date and time of the transaction, the ticket type purchased, the coins and bills inserted and coins returned in change. This report will be used sparingly by the City, but will typically serve the purpose of investigating customer complaints.

Overpayment Transaction Summary. Similar to the Cash Transaction Summary report, detailed information about each transaction that included an overpayment shall be provided by this report.

Cash Handling Summaries. Numerous cash handling summary reports shall be provided. These reports shall be used to balance and compare revenue receipts with bank deposit reports, as well as for other revenue and accounting purposes.

The **Bill Vault Removed Summary** shall provide a record of each bill vault removed during the time interval in question, and shall include vault serial number, vault contents, and identification of the employee that removed the vault.

Vault Tracking Summaries. Two varieties of vault tracking reports shall be provided.

The **Detailed Vault Tracking Summary** shall list all vault activities during the time period specified, and shall include the vault serial number, vault type, event, date and time, and employee removing or inserting the vault. If a vault serial number is not listed in the vault serial number database, the vault shall be considered a “rogue” and the vault type shall indicate that the vault is unknown.

The **Vault Search Summary** shall provide information about the last activity related to the specified vault(s) during the time interval specified.

Cash Flow Summary. This report shall summarize the net cash flow for each TVM specified during the time interval in question. Cash removed shall include the value of coins and bills in all removed vaults

Event Summaries. Two types of event summary reports shall be provided.

The **Detailed Event Summary** shall provide the date, time, event, employee identification (where applicable), and any associated event data for each event during the interval specified. Associated event data need not be reformatted in the report, but need only be printed in the format in which it is received.

The **Event Last Occurrence Summary** shall provide the same information on each event as in the Detailed Event Summary, but shall include only the last occurrence of each event type requested during the interval specified. This report shall permit review of maintenance and revenue activities (such as when a specific preventive maintenance action was last performed).

Status Reports

Current Equipment Status. Three current equipment status reports shall be provided that produce reports showing status of all system elements and components.

The **System Status** report shall provide status information on communications, operational, security, and power status of each TVM included in the report query.

The **Module Status** report shall provide operational status information on each module of selected TVMs.

The **Revenue Status** report shall provide status condition information for the coin and bill vaults, and all ticket stacks for selected TVMs.

Reject Ratios. The most recently reported reject ratios for the coin and bill systems shall be reported for each selected TVM.

Module Maintenance Status. The number of days and cycles since each major module has been maintained for each selected TVM shall be provided.

Cash on Hand. The total cash stored in all modules of each selected TVM shall be provided.

Polling Status. The latest polling date and time for each selected TVM shall be provided.

Current Vault Location. The serial number of each vault, shall be provided for all selected TVMs.

Current Software Configuration. The current versions of all TVM application software, configuration files, fare tables, and other downloadable software shall be provided by this report or each selected TVM. The report shall also include the date that the software was loaded onto each TVM.

Database Reports

Fare Table. This report shall provide a printout of the current fare table, any pending fare table (including the date and time the pending table is to become effective), all ticket and patron display text, voice file assignments, and other information related to ticket selection and price.

Operational Parameters and Configuration Files. All operational parameters and configuration files shall be listed by this report. Where operational parameters are specific to individual TVMs (such as vault near-full levels) these parameters shall be listed by each TVM.

Network Configuration. Information on the configuration of the network, such as communications port assignments, shall be provided by this report.

Sales Site / TVM Assignment. The station names, TVM numbers, and other station specific information shall be provided by this report.

Employee ID / Name / Permissions. All information relating an employee name to an identification code and access permissions shall be provided by this report.

Vaults in System. A listing of all coin vaults, bill vaults, shall be provided by this report. Each cash storage device shall be identified by type and serial number.

TP-5.4.4.11 Query and Report Customization

Software shall be provided to enable authorized workstation users to prepare new or modified queries and reports with a minimum of programming knowledge. Such customized queries and reports shall be capable of being executed as they are created, and shall be capable of being added to the menu of prepared queries and reports. When added to the prepared query and report menu, customized queries and reports shall be treated by the FCNC the same as any Contractor-supplied query or report. Authorized users shall also be able to edit and delete any prepared query or report on the selection menu.

For experienced programmers, the FCNC shall permit the use of SQL commands to create specialized queries.

For the first 12 months of revenue service, the Contractor shall provide technical assistance to the City as necessary to modify or create up to 20 additional City specified queries and reports.

A complete description of the query and report customization capability shall be submitted for RE review and approval at the Final Design Review.

TP-5.4.4.12 Polling Status and Output Data Validity

The validity of presented data shall be indicated on each query and report where necessary. Data validity shall be determined by whether the TVM or TVMs included in the report or query have been polled since the end of the reporting interval. For example, a TVM's data is valid for a report of sales and events ending noon January 1 if the TVM has been polled anytime after that time, because all sales and events data up to noon January 1 will be included in the polled data. (Conversely, if the TVM's last polling is 2 AM January 1, a report for all events ending noon January 1 would not include any events that occurred between 2 AM and noon, and would thus be invalid.)

If a TVM is not polled due to TVM or DCIS failure, query and report outputs shall clearly indicate that the data is not valid due to faulty polling status. Where a query or report lists data by individual TVM, each item shall indicate the validity of the data. Where a report or query summarizes data from more than one TVM, the validity of the data shall be indicated on the report and shall be based on whether data from all TVMs included in the report has been received since the end of the reporting interval.

TP-5.4.4.13 Fare Collection Network Controller Alarm Monitor

The fare collection system shall, through the FCNC, transmit current alarm and security conditions to the workstations in a separate room at the City’s Central Control Facility.

The FCNC shall send alarm conditions to the workstations and re-send alarm conditions as required in the event an alarm condition receipt verification is not received from the workstation operator.

In addition to the alarms listed in Tables 4.2 communications alarms detected by the FCNC shall be treated as follows and transmitted to the workstations as required:

Table 4-2. Communications Alarm Condition Priority

Alarm Type	Priority
Communications Alarms	
Banking network malfunction (if a Cash/Bank/Card TVM option is exercised)	2
Communication network malfunction	2
Station (or NIU, if required) off-line	2
TVM off-line	2

All events that trigger and clear alarms shall be transmitted by the FCNC to the workstations. If an “outer door open” event is received by the FCNC and a corresponding “entry authorized” or “entry unauthorized” message is not received within an City programmable time (default 45 seconds), the FCNC software shall assume that an intrusion is in progress and shall transmit such an alarm to the workstations.

TP-5.4.4.14 Equipment Modification and Configuration Control

A database shall be included in the FCNC that tracks the subcomponents within each TVM. An input form and database report shall be provided for this database.

A user interface screen shall be used to develop input forms and data base reports. The configuration control records shall include an identification by serial number and nameplate information, of each major component and part installed and assembled in each TVM. Configuration control records shall be delivered by the Contractor at the time of commencement of revenue service and shall accurately represent the configuration of the TVMs. Once revenue service begins, maintenance of the configuration control database shall be the responsibility of the City.

TP-5.4.4.15 Network Security

Access to the fare collection system either directly through the Fare Collection Network Controller or any of its devices shall be secure, in that unauthorized users shall not be able to alter or view data. The network environment shall be secure.

Access to the system shall be password protected, with various levels of passwords as appropriate to ensure a secure database.

Users shall be assigned passwords based upon the security level requirements associated with their specific functions.

Passwords shall be modifiable only by the password owner and by use of a master password.

Password databases shall be encrypted so that they are not readable by displaying the contents of the database.

Entered passwords shall be masked on the display monitor.

Revenue data, such as sales and transaction data, vault contents data, and all bank/smart card transaction data shall not be alterable by anyone.

The FCNC shall store data describing all TVM configuration changes, including who made the change, the date and time of the change, and the configuration of the TVM prior to and after the changed configuration.

Debit card personal identification numbers (“PINs”) shall not be passed to or stored by the FCNC in other than encrypted form.

PIN data shall be encrypted, stored, and transmitted in accordance with governing bank requirements and per ANSI X9.8, Personal Identification Number Management and Security. TVM PIN pad hardware and software shall provide required encryption.

TP-5.4.4.16 DCIS Network Administration

Software on the FCNC shall perform all necessary administrative functions for the DCIS network. These functions shall at a minimum include:

- Review of polling status, and the ability to manually initiate polling of specified devices.
- Automatic synchronization of date and time of all networked devices.
- The ability to enable and disable any networked device.
- Monitoring of file transfer records and status.
- Supervision and display of current status of the network and the fare collection system, by individual TVM, stations of TVMs, and all TVMs
- Communications line status and error checking/clearing functions.
- Diagnostic and troubleshooting software that shall provide effective communications fault diagnosis.
- The ability to add and delete stations, add and delete TVMs at a station, and to change names of existing stations.
- Startup and shutdown procedures for whole system, work stations, FCNC.

TP-5.4.4.17 FCNC System Administration

Because the Fare Collection Network Controller shall be accessed by multiple users and shall act as a central control and data repository for the entire fare collection system, the Contractor shall provide all necessary tools to allow the City to efficiently administer the FCNC computer. At a minimum, the following administrative functions shall be supported on the FCNC.

- Adding and deleting authorized workstation users.
- Setting, maintaining, and controlling passwords used to access individual functions.
- Automatic and manual verification of data storage integrity, including error checking and correcting routines.

- Automatic data summarizing and archiving. The FCNC shall be capable of storing all data received from the TVMs for at least 18 months, and summarized data for at least 10 years.
- Detailed data shall consist of all transaction and event data that is received from the TVMs. Summarized data shall consist of daily totals of all transactions and events.

Summarized data shall be automatically generated and stored on the FCNC prior to archiving the detailed records to removable media backup. Once per month, detailed data that is older than an City adjustable parameter (default 18 months) shall be automatically copied (archived) to removable storage media. Once the copy on the removable media is verified against the original, the detailed data shall be deleted from the on-line database tables.

TP-5.4.5 Workstation Software

Workstation software shall be fully compatible with communications with the FCNC, and shall support the variety of uses described in these technical specifications. Application software, specific to each workstation, shall be supplied that provides the functionality required for the purposes intended. A conceptual description of the workstation application software and user shall be submitted for RE review and approval as part of the Interim Design Review.

TP-5.4.5.1 Workstation Operating System

The operating system of the workstations shall be a 32-bit system and shall be capable of supporting multiple concurrent tasks per user. The workstation operating system shall be compatible with the operating system of the FCNC.

The workstation operating system shall be subject to RE approval at the Interim Design Review.

TP-5.4.5.2 Workstation User Interface

The workstations connected to the FCNC shall employ a user interface that is similar across all workstations and application programs. The user interface shall offer the following features.

- Design and implementation utilizing a graphical user interface such as Windows or X-Windows.
- On-line, real-time software interaction with the database, while the TVMs are on-line.
- Pull-down and/or pop-up menu-driven screens.
- Consistent use of keys, icons, menu items, etc. from screen to screen.
- Error checking by field with correction required prior to advancing to the next field.
- Use of color to highlight messages and to distinguish input from displayed output.
- Required passwords for entry into each application.
- Extensive use of the mouse for pointing to menu items or fields for further action, such as editing or executing a step.
- Context-sensitive help.
- Canceling functions within the menus, and screens, shall be invoked by the same key for all screens.
- The ability to direct all query results and reports to any available printer, the workstation screen, or to a comma-delimited ASCII file.

TP-5.4.5.3 Workstation Application Software

While many functions will be common between workstations, each workstation shall have application software that is designed to perform the tasks associated with the workstation.

TP-5.4.5.4 Administrative Workstation

The Administrative Workstation shall provide those functions necessary to administer the FCNC and other elements of the DCIS. Other general workstation functions, such as querying the database and generating reports, shall also be supported. The following specific functions shall be available on the administrative workstation.

- Administer FCNC and network
- Monitor status of DCIS
- Monitor status of TVMs
- Query database and generate reports
- Read and write SSMMs

A preliminary description of administration workstation user interface, features, and capabilities shall be submitted for RE review and approval at the Interim Design Review.

TP-5.4.5.5 Revenue and Maintenance Workstations

Access to this function should be limited to a system administrator that is responsible for operating the fare collection system. Revenue personnel are normally concerned with collecting and tracking money. The maintenance group is responsible for repairing equipment. Therefore there should be a system administrator function for maintaining the system configuration and fare tables.

The Revenue and Maintenance Workstations will be the most heavily used workstations, and shall provide City personnel with the following capabilities.

- Monitor status of DCIS
- Monitor status of TVMs
- Manage TVM configuration and operational parameters
- Manage fare tables
- Initiate and schedule upload and download of data from and to TVMs
- Query database and generate reports
- Read data from SSMMs and format/initialize SSMMs for use in installed TVMs
- Manage voice message system, and create, delete, and edit voice messages
- Remotely control TVMs

A preliminary description of revenue and maintenance workstation user interface, features, and capabilities shall be submitted for RE review and approval at the Interim Design Review.

TP-5.4.5.6 Security and Alarm Monitor

The workstations shall have application software that provides the following features.

A security and alarm-monitoring program shall be configured to automatically execute upon reboot and power up of any workstation.

Events shall be indicated by the security and alarm monitoring application on the workstations in the following manner:

- **Priority 1 Events** (on-line) shall be reported both visually and audibly at the workstation.
- **Priority 2 Events** (on-line) shall be reported visually.
- **Priority 3 Events** (on-line) shall be reported visually.
- **Priority 4 Events** (off-line) shall be recorded locally by the TVM, shall be reported to the FCNC upon polling, and shall not be indicated on the workstation. These are events that occur while the TVM is operating off-line as a stand alone unit.

When an alarm condition (*i.e.* an on-line event) is reported from a TVM, the workstation screen shall display the information (*e.g.* station, TVM number, alarm condition) in a clear and unambiguous manner, and for Priority 1 alarms, a distinctive tone shall also sound. The displayed message shall continue until the alarm condition is reported cleared (by the TVM).

When a condition that causes an alarm is corrected, the TVM shall transmit to the FCNC a corresponding event message, which shall cause the alarm monitoring system to automatically clear the related alarm on the workstation screen.

A preliminary description of security workstation user interface, features, and capabilities shall be submitted for RE review and approval at the Preliminary Design Review.

TP-5.4.6 Bank Card Transactions

TP-5.4.6.1 General

Bankcard transactions shall be processed, authorized, settled, and accounted through the Fare Collection System Controller and its data communications facility with a single bankcard clearing institution.

The Contractor shall be responsible for establishing the connection between the Fare Collection Network Controller and the Contractor-selected bankcard clearinghouse, and providing all associated FCNC software for purposes of determining validity of and approving (or rejecting) bankcard transactions initiated at the TVM.

The City will negotiate contracts with others to act as the bank and clearing house service providers for any bankcard transactions made via the TVMs. The Fare Collection Contractor shall be responsible for coordinating any and all agreements and technical interfaces necessary with these service providers for handling bankcard transactions.

It is anticipated that the service provider must certify the bankcard system prior to permitting transactions to occur. The City will assume costs with the service provider for the first 80 hours of consultation and testing time; any additional time with the service provider's technical assistance required for certification shall be the responsibility of the Fare Collection Contractor.

TP-5.4.6.2 Bank Cards to Be accepted

The following credit cards shall be accepted by the TVM: VISA, American Express, MasterCard, and Discover. Acceptance of other types of credit cards shall require modification of a software configurable table, resident on the FCNC, containing ranges of Bank Identification Numbers (BINs) corresponding to the accepted credit card types.

All debit cards with ABA-compliant encoding shall be accepted by the TVM and forwarded to the Fare Collection Network Controller for further processing. The clearinghouse will determine if the card is to be accepted for the transaction.

TP-5.4.6.3 Bank Card Usage Limits

For purposes of controlling potential losses through bankcard fraud, the Fare Collection Network Controller shall maintain a database of all bankcard sales. The database shall impose checks of transactions requests; if such checks are not passed, the transaction shall be denied:

The database shall be updated automatically for each bankcard sale.

The database shall limit the number and value of transactions in total and by type for individual credit cards for given durations. Such limits shall be software definable and modifiable by the City. For example, it shall be possible to deny a bankcard transaction request for the same card when a third 7 day ticket transaction is requested within a 10-day period and when the total value of card transactions exceeds a specified dollar amount in a given week.

The database shall include an City-maintained list of bank cards and optionally smart cards that are known to be unacceptable (*i.e.* the “local hotlist”).

TP-5.4.6.4 Bank Card Clearing

All bank card transactions, shall be verified by the Fare Collection Network Controller, prior to being sent to the financial clearing institution. All requests for bankcard transaction authorization shall be sent to a single bankcard-clearing house from the Fare Collection Network Controller. From the clearing house, subsequent transmission of bankcard information shall be forwarded by the clearinghouse to the appropriate financial institution. The authorization process shall be capable of simultaneous transactions, *i.e.*, it shall not be required that one transaction is received and processed prior to the next transaction request being processed.

TP-5.4.6.5 Funds Settlement

The Fare Collection Network Controller shall generate an electronic settlement report and transmission with the appropriate financial institution. Once the settlement report has been successfully transmitted, a hard copy report shall be scheduled for printing. The settlement report shall be incremental in nature, containing transactions that have successfully occurred since the most previous transmittal of a settlement report.

TP-5.4.6.6 Bank Card Transaction Process

The bank card transaction process shall consist of the following steps:

Patron selects type of ticket(s). Each fare table entry (ticket type selection) shall have an associated City adjustable parameter that determines whether the selection can be purchased with a bankcard. The TVM shall activate the card processor only for those ticket types designated in the fare table as being eligible for purchase by bankcard.

Patron inserts (and removes) card into the processor. The TVM shall verify that the card is encoded according to ABA standards. The TVM shall prompt the patron to select CREDIT or DEBIT. If the card is a debit card, the patron shall be instructed to enter his or her PIN. The TVM shall forward all required transaction data to the FCNC.

If the patron uses a bank credit card, the FCNC shall confirm that the card is of a type to be accepted by comparing the BIN on the card to the range of BINs to be accepted.

If the patron's credit card is of a type to be accepted or if the card used is a debit card, the TVM shall automatically initiate a request for credit or debit card authorization. If the communication link with the FCNC or the communication link with the bankcard clearing institutions is not functioning, the transaction request shall be denied.

The FCNC shall check the bankcard number against a list maintained on the FCNC of known problem card numbers. If a pre-determined problem exists with the card, the transaction shall be disapproved.

The FCNC shall check to be sure a predetermined sales and usage (*i.e.* velocity) limits have not been exceeded for the card (*e.g.*, limitation may be a maximum of \$100 purchased by a bank card in one calendar month, or four transactions in a 30-day period, whichever occurs first).

If FCNC verification process is passed, the FCNC shall send the authorization request to the bankcard clearing institutions for approval.

While the transaction is in progress, the TVM shall display a message such as "Transaction in Progress – Please Wait" on the Patron Display.

When the FCNC receives authorization or disapproval from bankcard clearing institution, the information shall be immediately passed to the TVM.

Up to this point, the patron may cancel the transaction by pressing the CANCEL button. However, if the TVM receives approval and once ticket printing has commenced, the transaction may not be canceled by the patron, and a ticket shall be issued to patron by the TVM. If the transaction is not approved, a message shall be shown on the TVM indicating that the transaction request has been declined. If the transaction is canceled prior to receipt of approval, an appropriate message shall be shown on the TVM and the transaction shall not be posted.

If a ticket is printed and dispensed, TVM shall confirm that the sale has been completed and shall send a transaction record to the Fare Collection Network Controller. If the TVM did not print and dispense the ticket, or the transaction was otherwise aborted, the TVM shall send such notice to the FCNC. Such notice shall result in a transaction reversal advice and appropriate action shall be taken with the bankcard clearing institution. A sale shall not be posted within the TVM until the transaction has been successfully completed.

For debit card transactions the Fare Collection Network Controller shall transmit time-out reversals to the clearinghouse whenever it does not receive confirmation from the clearinghouse; the FCNC shall inform the TVM of the transaction failure. In general, whenever a transaction's satisfactory completion is in doubt, the FCNC shall err on the side of the patron and reverse the transaction. The transmit time out period shall be software configurable by the City.

Once per day at a time software configurable by the City a consolidated settlement report shall be compiled by the FCNC and transmitted to the bank and credit card clearing institutions with electronic and hard copy made for the City.

TP-5.4.6.7 Speed of Bank Card Transactions

The fare collection system shall be capable of simultaneously processing bankcard transactions from all TVMs and to all associated bankcard-clearing institutions.

The system shall be sized and configured such that the length of time to send and receive a transaction does not under normal conditions exceed 5 seconds. This time is measured from the time at the TVM when a bank card transaction is sent to the time the TVM takes action upon receipt of ticket printing or transaction terminated instructions from the FCNC, including time

necessary for communicating with the bank and credit card clearing institutions. This five-second goal excludes the time the transaction is being processed at the bankcard clearing institution.

TP-5.4.6.8 Encryption Keys

The clearinghouse will manage all DES encryption keys. The Fare Collection Network Controller shall require no encryption or decryption processing. The FCNC shall only pass encryption keys between the clearinghouse and the TVMs.

TP-5.4.6.9 Workstation Bank Transaction Functions

In addition to those other functions described herein, from any revenue and maintenance workstation connected to the FCNC, an authorized user shall have the capability to perform the following functions:

- Enable/disable bank/ smart card transactions at any single TVM, any station of TVMs, and all TVMs.
- Download minimum and maximum bank/ smart card transaction values, transaction timeouts, and other information necessary for bank/ smart card transactions to any single TVM, any station of TVMs, and all TVMs.
- Review, add, and delete entries on the list of known bad cards. The list shall include the card number, date entry was made, person making the entry, and reason for entry.
- Modify the BIN range table on the FCNC to add or delete accepted card types.
- Modify financial network operating parameters (*i.e.* variable parameters as established by clearing house protocols).

TP-5.4.6.10 Modifications to TVM Queries and Reports

Queries and reports that deal with cash sales and transaction data shall be modified to distinguish between cash and non-cash sales. The following Summary Reports shall include additional columns and/or rows where necessary:

- Detailed Sales Summary
- TVM Sales Summary
- Ticket Sales Summary
- Ticket Activation Summary

The following Status Reports shall be modified to include necessary information about the bankcard system:

- Module Status (to include status of bank card processor and receipt printer/stock if separate)
- Reject Ratios (to include misread ratio of bank card processor)
- Module Maintenance Status (to include card processor maintenance status)

The following Database Reports shall also be modified as required to support bankcard transactions:

- Fare Table
- Operational Parameters and Configuration Files

TP-5.4.6.11 Additional Queries and Reports to Be provided

The following reports shall be provided:

- **Credit/Debit Sales Summary.** Similar to the TVM Sales Summary report, this report shall provide the total number and value of bankcard transactions per TVM selected.
- The **Authorization Request Summary** shall provide the total number of authorization requests, authorizations approved, and authorizations denied, and authorizations aborted (due to patron cancellation, communications failure, etc.) by TVM for all TVMs selected.
- The **Authorization Denials Summary** shall provide a breakdown of authorization denials by the clearinghouse, local velocity check, and local blacklist by TVM for all TVMs selected.
- The **Detailed Authorization Denials Summary** shall provide detailed information about each denied transaction, including the date, time, ticket selected, price, card number, and reason for denial
- The **Bank Card Transaction Summary** shall supply a record for each bankcard transaction, and shall include the date, time, ticket type, price, card number, and authorization number.
- The **Local Hot List Content** database report shall include the card number; date the entry was made into the database, the user that made the entry, and the reason for the entry. In addition, the local blacklist report shall indicate the most recent date and time an attempt was made to use the card.

TP-5.5 *Quality Assurance*

TP-5.5.1 Program Management

The Contractor's program management shall be sufficiently comprehensive to enable the RE to ascertain that the Contractor will meet the requirements of the Contract Documents, and to enable the RE to monitor the contractual effort.

The Contractor shall designate a responsible individual, subject to approval by the RE, to serve as Program Manager for the entire term of the Contract. This individual shall have prior experience in management of Fare Collection System procurements and be familiar with design, subcontractor equipment procurements, construction, test, and inspection of Fare Collection Equipment.

The Contractor shall establish an organization to properly manage this Fare Collection System procurement program. The organization shall be highly responsive to the needs of the City as required in this Contract. Reference is made to view the Special provisions covering Program Management.

TP-5.5.1.1 Master Program Schedule

The Contractor shall use the approved Master Program Schedule for executing the work for this Contract. The Master Program Schedule shall conform to these technical provisions and to schedule and delivery requirements set forth in the Terms and Conditions of this Contract. Such portions of the Master Program Schedule may only be modified by Contract Change Order. In addition to printed copies, all submittals of the Master Program Schedule shall be provided on RE-approved electronic media.

The schedule shall include the following:

- Work item descriptions that convey the scope of work indicated. Work items shall be discrete items of work that will be accomplished under the Contract. Work items shall include the scheduled dates for submittal and required response dates for approval of Contractor drawings and documentation. It shall include the schedule for design reviews, procurement of materials and equipment, fabrication of materials and equipment and their installation and testing, delivery of City-furnished and other third party items and/or information, qualification tests and delivery, and testing of Fare Collection System. Estimated work item duration in whole working days shall be indicated.
- The sequence, successor, and predecessor interrelationships among work items shall be considered in developing the schedule and shall be so indicated.
- Work item descriptions shall be accompanied by narrative explanation of what the work item comprises and the basis for the estimated work duration.
- Sufficient detail shall be provided to indicate the manufacturing, testing, shipment, storage, and installation status of each TVM, validator, and the DCIS.

Existing or Anticipated Problems or Issues

Updated CDRL, including current status of all deliverables.

Updated Submittal List and Schedule, including current status of all submittals.

Updated action item log showing current status of all action items.

The Contractor shall also provide a narrative, which lists the work actually completed and reflects the progress in terms of days ahead of or behind the specified dates for each of the work items, as well as percent completed.

Action Item Log

The Contractor shall maintain a log of all identified action items. These action items shall be identified at design review meetings, monthly Progress Review Meetings, and through correspondence. All action items shall have a responsible party assigned. No action item shall be assigned to the RE without the RE's knowledge and concurrence. Each action item in the log shall contain:

- Item Number
- Description
- Requesting Party
- Assigned Party
- Status (open / closed / in progress / deferred / etc.)
- Date Opened
- Date Closed
- Progress Notes

TP-5.6 *Equipment Requirements*

TP-5.6.1 Design Life

Subject to the manufacturer's recommended maintenance practices, the Fare Collection System shall be designed for a minimum service life of 10 years of operation in the City service area. All equipment is expected to operate seven days per week and twenty-four hours per day.

TP-5.6.2 Prior Service Performance

Ticket vending machines shall be either identical to or derived from designs that are service-proven in an operating environment equal to or more severe than will be experienced in the Honolulu

TP-5.6.3 Code Requirements

The fare collection system shall be designed to comply with all applicable local, State, or national codes, ordinances, statutes, standards, and federal rules and regulations existing at the date of Contract execution. The Contractor shall be responsible for identifying all local, State, or national design codes, ordinances, statutes, standards, and federal rules and regulations applicable to Fare Collection System at the time of Contract award. The TVMs shall comply with the Americans with Disabilities Act as amended through the date of the signing of this contract.

TP-5.6.4 Installation Requirements

The fare collection station equipment (TVMs) shall be designed to be installed as stand-alone units, side-by-side units, back-to-back units, and in recessed areas. The TVM shall be a self-contained machine complete with its own cabinet and mounting stand or base, and have integral light fixtures to illuminate the front surface of the TVM. The TVMs shall be securely bolted to a concrete surface.

TP-5.6.5 Modular Components

Each of the basic functions within each type of machine shall be performed by modular components, which permit ready field replacement of inoperative modules to return the machine to service in minimal time. Repair and adjustment of modules shall be completed in shop facilities.

The individual modules shall be fixed in unitized frames, rails, or slides with fast latching devices, captive fasteners, or other means that do not require the use of tools for removal and replacement. Control and power connections shall be made via plug-in connections. Plugs and receptacles for modules shall be keyed to prevent a module from being plugged into the wrong receptacle. Each module shall be installable in only one correct position and that position shall be readily apparent to maintenance and servicing personnel. All sources of electrical interference shall be suppressed within the respective module to eliminate all potential EMI-generated deficiencies.

TP-5.6.6 Interchangeability

All parts, components, modules, assemblies, and removable devices provided under this contract shall be fully interchangeable among machines without the need to make adjustment for proper compatibility. Mechanical parts shall not require use of matched sets of parts. Equipment

enclosure mounting shall be identical for each TVM so that the equipment is fully interchangeable among stations without the need to make installation adjustments.

Modules and components, which are not interchangeable, shall not appear to be interchangeable, nor shall they be able to be installed into an incorrect slot, receptacle, rack, or location. The use of color-coding to identify non-interchangeability shall not be permitted unless stock replacement parts are also normally finished in the same colors and some other, physical means of preventing misapplication of components or modules is also employed.

TP-5.6.7 Human Engineering

The fare collection equipment shall be designed to ensure the safe, reliable and simple interface with patrons and maintenance/servicing personnel. The equipment shall provide patrons with displays, graphics and signage, controls and mechanisms, which are simple to use, easy to understand, and conveniently located. An inexperienced patron shall be able to understand the ticket purchase and activation process by following instructions given on and by the equipment. All such patron interfaces shall be user-friendly; that is, safe, predictable, simple to use, and in accordance with other applicable human engineering principles.

The fare collection equipment shall accommodate the broad range of patrons that use public transportation. The range of patrons paying fares will include commuters, shoppers, students, children, the elderly, patrons with impaired vision, patrons in wheelchairs, patrons with limited communications skills, and patrons who are hearing impaired.

TP-5.6.8 Safety

The Fare Collection System shall be free from safety hazards. The exterior surfaces of fare collection equipment, including all controls and appurtenances, shall have no sharp edges. Particular attention shall be given to protecting visually impaired persons who may explore the surfaces with their fingers. The edges of all panels, graphic displays and faceplates, and the surfaces of all exposed hardware such as hinges, locks, handles, and fasteners shall be free of sharp edges or burrs. The cabinet shall have no protrusions beyond its base, which could be bumped by a visually impaired person or by a person passing by or using the TVM. The spring-loaded door that covers the ticket/coin return bin, shall not present a pinching hazard. All interior surfaces and components with which patrons and/or maintenance personnel could come in contact shall be free of sharp edges or other hazards. The TVM shall contain an easily placed bar or similar device that will lock the door at the fully opened position. This is a clearance and safety issue necessary for ease of maintenance and removal of money components in especially windy conditions and accidental bumping.

All components shall be grounded and shall prevent electrical leakage or static charge. Electrical components shall have suitable warning graphics indicating the voltage present and other hazards.

TP-5.6.9 Security

The design and installation of the Fare Collection System shall discourage and minimize the effects of vandalism and theft, prevent unauthorized access to the interior of the Fare Collection Equipment, prevent unauthorized removal of the equipment from its installed location, and provide levels of access to the interior of the equipment for maintenance personnel, revenue servicing personnel, and money processing personnel at the City's revenue-counting facility. Access to the equipment by authorized personnel equipped with proper keys and individual

access code(s) shall be provided without undue delay. The means of locking the TVMs shall be subject to RE review and approval at the Definitive Design Review.

TP-5.6.10 Aesthetic Requirements

The fare collection equipment shall be designed to be attractive, with all controls, primary instructions, and patron interface display and inputs on a common front face of the enclosure. Lettering, lines, arrows, pictographs, signage, maps, color coding, indicator lights, and colors and physical features such as raised lettering and Braille (collectively referred to as “graphics”), and lighting shall be used to present aesthetically attractive and functional equipment.

A conceptual depiction of the TVM appearance, including graphics panels and other aesthetic design considerations, shall be submitted for review and approval at the Definitive Design Review.

All graphics shall be in accordance with the City’s graphics standards. Drawing number and are standard drawings indicating graphic details and color schedule. These are to be used for reference. Coordination with the contractor must be completed prior to conceptual depiction of the TVM appearance.

TP-5.6.11 Structural Design Requirements

The TVM shall be constructed to meet the following structural design requirements:

- The cabinets of the TVM shall form an integrated structure capable of resisting, without permanent deformation, fatigue, failure, or undue wear, and other stresses inherent in the type of service for which this equipment is intended including 200 lb/sf. applied horizontally in any direction at the top of the machine cabinet.
- The open TVM door shall be able to withstand a concentrated vertical force of 150 pounds applied at the extreme open edge of the door without causing damage or deformation of any part of the door or TVM cabinet.
- Except for plastic panels and covers, the fare collection equipment shall resist without damage a kick or punch resulting in a concentrated load of 200 lbs./in² while the equipment is operating and outer doors are secured.
- The TVM cabinet shall be completely unitized. All sections (excluding the leveling pedestal and light fixture) shall be suitably welded together with additional strengthening using bolts and rivets as necessary.
- All fare collection equipment shall be so arranged to distribute the equipment weight over the mounting base evenly. Apparatus requiring frequent inspection, maintenance or adjustment shall be readily accessible and replaceable.
- The mounting base and housing shall be incorporated into the unitized cabinet so that maximum use of metal consistent with good engineering practices can be obtained incorporating high-strength, low-weight features, and so that all Fare Collection Equipment is able to be installed on a fully interchangeable basis.
- Uniform construction and assembly techniques shall permit complete interchangeability of the Fare Collection Equipment and components of sub-systems among like machines.
- The Contractor shall securely install and anchor the fare collection equipment into the station platforms according to the installation instructions and plans approved by the City. Conduit will be provided by the appropriate Contractor to the fare collection equipment locations.

- The fare collection equipment shall be capable of being anchored into locations other than station platforms, such as building floors, mezzanine floors, and on concrete slabs.

The Contractor shall coordinate with the Station Finishes and other System's Contractors to ensure a successful installation. The RE shall provide contacts upon request.

TP-5.6.12 Maintainability

The equipment shall provide reliable operation over its design life, and shall be designed to require simple, minimal scheduled and unscheduled maintenance tasks. Fare collection equipment shall combine the advantages of simple mounting and accessibility for maintenance through the front of the machine. The interior of the equipment shall be designed to allow easy and safe access to service equipment and sub-assemblies. Adequate space shall be available to insert keys, to grasp, lift, and turn internal components, and to remove and replace units, components, connections, and ticket stock. As appropriate, guides, rails, tracks, handles, and captive fasteners shall be provided to facilitate installation and removal of modules. The means to access for service, remove, and replace all modules shall be subject to RE review and approval at the Preliminary Design Review.

Any component or module that must be lifted, except coin vaults when full, and coin hoppers when full, shall not weigh more than 20 pounds. Any exceptions to this weight limitation are subject to RE approval.

Adequate space for the use of standard tools shall be available as required. For ease of service, all electrical connections between components and sub-assemblies shall be established by means of connectors to allow rapid removal of a component and/or sub-assembly from the TVMs. Plug-in connections shall be made simply, quickly and securely, and shall be equipped with strain relief to prevent damage to cables and connectors.

TP-5.6.13 ADA Compliance

All operable controls shall be on the front vertical plane of the equipment, and shall meet the requirements of the version of the American with Disabilities Act in effect on the date of contract signing.

At the time of this writing the fare collection equipment shall comply with ADA requirements. The ADA requirements relevant to fare collection can be summarized as:

- All operable controls (coin/bill/card/ticket slots, buttons, ticket/coin return bin) shall be between 15 and 54 inches of the finished floor. The vending machines shall be designed with all controls as high as possible within this envelope.
- Displays, raised letters, Braille, and other instructional information shall be no more than 60 inches off the finished floor.
- Pushbuttons and other operable controls shall be identified with high-contrast raised lettering at least 0.625 inches tall as well as Braille.
- Within 72 inches of the floor, the front surface of the equipment shall have no objects protruding more than 4 inches.
- The TVM shall provide digitally recorded voice messages that "read" the contents of the patron display to assist visually impaired patrons through the transaction process.

Other ergonomic design considerations for the vending equipment may exceed ADA guidelines. For example, the force required to operate the buttons shall be less than 8 ounces, yet the ADA allows operable forces to be up to 5 pounds.

Descriptions and drawings of how ADA compliancy will be achieved for the TVM shall be submitted for RE review and approval at the Conceptual Design Review. The Contractor shall provide Braille panels with instructions to operate the TVMs and install these panels in a common location at each station (not on TVMs). The Contractor shall provide the RE with the text of these instructions for review and approval at the Final Design Review.

Controls and Operating Mechanisms

All controls pushbuttons, and other operating mechanisms of the fare collection equipment to be used by transit patrons “shall not require tight grasping, pinching, or twisting of the wrist.” (Source of quotation: Americans with Disabilities Act, Section.)

TP-5.6.14 Protruding Objects

Objects shall not protrude from the fare vending equipment in the plane nominally perpendicular to the station platform, except for the lighting fixture and bill entry slot rain shield. The light fixture shall extend no more than four inches beyond the front face of the TVM cabinet, and shall not be positioned in such a manner as to cause a bumping hazard. All objects that protrude 1 inch or more from the front plane of the TVM, including the light hood and the bill entry module, shall be designed with rounded corners and edges with minimum 0.25-inch radii to reduce the chances of injury.

TP-5.6.14.1 Viewing Distance of Graphics, Displays, and Signage

Fare vending equipment displays, graphics, screens signage, and all other instructions, labels, and information contained on the fare vending equipment shall be visually readable within all positions of a viewing envelope defined as follows:

- Distance from vertical plane of fare vending equipment front: 6 inches to 25 inches inclusive.
- Height above finished grade on which fare vending equipment is installed: between 43 and 70 inches.
- Lateral positioning in front of fare vending equipment: middle of TVM front face width.
- Any directions on the TVM front face shall be in both English and Japanese.

TP-5.7 *Testing*

The Contractor shall plan, perform, monitor, and document all tests required to prove the design and acceptability of the Fare Collection System, including all elements, subsystems, and the system as a whole, furnished under this Contract. The Contractor shall furnish Fare Collection Equipment that meets the criteria specified for all tests.

TP-5.7.1.1 *Ticket Vending Machines*

All qualification tests for the TVM shall utilize ticket stock that will be used in revenue service. No less than 150 days prior to the start of TVM qualification testing, the Contractor shall identify the quantities of each ticket stock type required to complete testing.. The Contractor shall provide the ticket stock for testing at least 30 days prior to commencement of qualification testing. Within 90 days of completing all TVM testing, the Contractor shall return unused ticket stock to the RE.

Functional Test

This test shall prove the proper functioning of all TVM features, performance criteria, and capabilities. This comprehensive test shall be performed using the FAI-approved TVM and shall utilize TVM application software that is complete and ready to enter revenue service. Where necessary, simulators or prototypes of the DCIS may be used in lieu of production versions.

At a minimum, the test shall cover the following:

All TVM operating conditions including but not limited to money acceptance, fault annunciation, ticket printing, bank card processing shall be tested.

All possible patron inputs and TVM responses shall be demonstrated, both with and without the voice messaging system activated.

The Contractor shall demonstrate all TVM service commands.

The Contractor shall demonstrate software control for: changing printing content and format, changing patron display content and format, altering operational parameters and configuration files, changing fares, and adding and deleting ticket types.

Coin vault, bill vault, and, bill escrow operation, and bill stacking tests to check capacity of bill vaults shall be performed.

All degraded modes of operation will be demonstrated for proper operation and indication.

Data transmission (upload and download), event recording and transmission, clock synchronization, SCADA relay operations, and other such functions shall be verified for proper operation.

Transaction times, TVM response times, time-out operations, and all other performance criteria that can be measured without resorting to numerous transactions shall be measured for compliance to the specifications.

The ability to exchange an ECU and use the SSMM to restore registered data and configuration settings shall be demonstrated.

- The printing exercise shall result in tickets that show all possible printed characters in each position: All 12 months

- All 31 days
- All 12 hours
- All minute values
- AM and PM characters or 24 hour clock characters
- All station numbers, zone values, and other printed characters.

Since it is anticipated that some software anomalies will be uncovered during this test, the Failure Review Board shall determine successful completion of this test. Any identified hardware design flaws shall be corrected and demonstrated before the Functional Test shall be declared complete.

Within 10 days of test completion, the Contractor shall submit to the RE the list of identified open issues. The Resident Engineer shall notify the Contractor within 5 days of receipt of this list, which if any open items must be resolved prior to successful completion of the Functional Test.

Cycle Test

After the TVM has passed its Functional Test, a Cycle Test shall be performed on the TVM using combinations of all fare categories and representative mixtures of bills and coins for each fare. Fare levels for the tests shall be selected by the RE to represent a sampling of both the projected fare levels for 2020 and the expected fare increases for at least ten years, based on inflation and extension of service.

The TVM cycling test shall consist of 3,200 completed transactions. Payment media to be used for this test shall be “street” money supplied by the contractor. It shall be the Contractor’s responsibility to acquire the coins and bills necessary for the test.

The test shall measure those performance criteria specified for TVMs which require large quantities of transactions, including coin and bill acceptance rates, reliability, and accuracy. A working Fare Collection Network Controller or a suitable simulator shall be provided to monitor all events triggered during the tests and to permit bankcard transactions.

The TVM Cycle Test shall consist of 4 sets of 800 transactions each. Each set of transactions shall exercise all ticket stacks, the bill system, and all selection keys.

At the beginning of each set of transactions, the coin and bill vaults shall be empty. During each set of transactions:

- Each selection shall be purchased at least 25 times
- Coins of each denomination shall be diverted to the coin vault
- Sufficient quantities of bills shall be inserted to cause the bill vault to fill and the TVM to enter “No Bills Accepted” mode
- At least one ticket stock shall be depleted
- At least 10% of all transactions shall occur with the voice system activated
- Cash/Bank cards shall be used for 50 transactions per set
- The TVM outer door shall remain closed

At the conclusion of each set of 800 transactions, the TVM shall be subjected to a complete audit; all coins and bills shall be counted and compared to reported quantities. All events reported by the TVM during the Cycle Test shall be fully explainable by the activities of the test.

Each subsequent set of transactions shall utilize a different fare structure, representative of projected fare increases over the next 10 years.

Successful completion of the Cycle Test requires:

- No more than two relevant failures..
- Overall audit accuracy to be within $\pm 0.1\%$
- Bill and coin acceptance rates to be within the limits set forth.
- All events to be accurately recorded and reported by the TVM.

All failures (relevant and non-relevant) shall be documented and explained in the Cycle Test report. The Cycle Test report shall also describe plans to rectify any relevant failures.

Maintainability Test

Upon successful completion of the cycle test, the Contractor shall conduct a Maintainability Test of the TVM. The purpose of this test shall be to determine that:

- The Contractor's TVM maintenance training is suitable and sufficient.
- The TVM maintenance manuals will satisfy the City's needs.
- The TVM conforms to maintainability requirements.

This test will be conducted in two phases. In the first phase, an abbreviated "dry run" of the Field Maintenance and Servicing training shall be conducted, utilizing draft versions of training materials and the **TVM Corrective Maintenance Manual**. This training shall be provided to a selected City maintenance technician, and shall provide 24 hours of training over a 3-day period.

When the training has been completed, the second phase of the test will be conducted over the next two days. During this phase of the test, the trained technician will be asked to correct a series of faults that have been injected into the TVM by the Contractor, and to perform some routine maintenance activities. The time required for the trained technician to resolve each fault, and the time to perform the routine maintenance activities, shall be recorded. Faults to be injected shall be randomly selected from a list previously agreed upon by the RE and the Contractor, and the technician shall have no prior knowledge of the candidate faults.

The test procedure for the Maintainability Test shall include no less than 24 candidate faults. In addition to the list of faults, a list of 12 routine maintenance activities, to include tasks to replace each major module, shall be included. For each fault and maintenance activity, the Contractor shall identify a reasonable time limit for the action when performed by an average technician, based on field experience with the equipment. The RE shall approve this list and the repair time limits prior to conducting the Maintainability Test. During the second phase of the test, no less than 10 fault corrections and 6 routine maintenance activities shall be performed.

Successful completion of the Maintainability Test shall *not* require that all repairs be performed within the time periods defined. Rather, the test is subjective, and shall seek only to identify any areas in the TVM design, maintenance training, or maintenance documentation that require further attention by the Contractor.

This test will be conducted in two phases. In the first phase, an abbreviated 'dry run' of the Field Maintenance and Servicing training utilizing draft versions of training materials and the **TVM Maintenance and Parts Manual**. This training shall be provided to a selected City maintenance technician, and shall provide approximately 4 hours of training.

When the training has been completed, the second phase of the test will be conducted. The test procedure for the Maintainability Test shall include no less than 8 candidate faults, which shall include removing foreign material jammed in the ticket slot. In addition to the list of faults, a list of 6 routine maintenance activities, to include tasks to replace each major module and the printer ribbon shall be included. For each fault and maintenance activity, the Contractor shall identify a reasonable time limit for the action when performed by an average technician, based on field experience with the equipment. The RE shall approve this list and the repair time limits prior to conducting the Maintainability Test. During the second phase of the test, no less than 3 fault corrections and 2 routine maintenance activities shall be performed.

Successful completion of the Maintainability Test shall *not* require that all repairs be performed within the time periods defined.

Environmental Test

Upon successful completion of the cycle test, the TVM shall be subjected to environmental extremes and a portion of the cycling test run to demonstrate the capability of the equipment to operate successfully under these conditions. At least 10% of the cycles in each test shall be run at the extremes of supply voltage specified herein.

TVM software for the environmental test shall be identical to that which was exercised during the successful cycle test.

The TVM shall be subjected to the following environmental test. The equipment shall be allowed to stabilize for a period of two (2) hours at each given environmental condition setting. Thereafter, the number of transactions to be processed shall be as indicated in Table 7-1. TVM Environmental Test Conditions, and the equipment cycled as per procedures established for Cycling Tests.

Table 7-1. TVM Environmental Test Conditions

Run No.	Exterior Temperature (degrees Fahrenheit)	Exterior RH (percent)	Input Voltage	# of Transactions
1	32	20-40	125	250
2	115	50	125	250
3	80	95	138	250
4	80	95	100	250
5	32	80	125	250

RH = Relative Humidity (non-condensing)

Successful completion of this phase of the Environmental Test requires no more than one relevant failure as defined herein.

In addition, a water ingress test shall be conducted, simulating worst-case rain and wind conditions. Wind-driven rain shall be applied to all four faces of the TVM for 15 minutes per side. After each 15-minute period, the TVM interior shall be inspected for water ingress. Any water inside the TVM shall be minimal and shall not result in hazardous conditions or potential component failure.

Successful completion of this phase of the Environmental Test requires no more than one relevant failure.

TP-5.7.1.2 DCIS

The Data Collection and Information System (DCIS) shall pass a separate battery of tests prior to installation. These tests shall be designed to confirm that the data system can perform its intended tasks accurately and with satisfactory responsiveness and ease of use. All tests of the DCIS shall take place prior to delivery of the equipment to the City and shall be scheduled with sufficient time to correct any errors detected during test. Where necessary, simulators or prototypes of the TVM may be used in lieu of production versions.

Report Generation Test

Data created to simulate the City Rail system installation (at least 126 TVMs in 21 stations) containing all data, event, transaction, and record types shall be used to conduct this test. The simulated data shall contain at least 5,000 transactions using all payment methods and 1,000 events, shall be randomly distributed over all TVMs, and shall represent a period of 2 years.

The Fare Collection Network Controller shall generate samples of all reports available. Format, layout, page and column headers, etc. shall be reviewed to confirm compliance with the designs approved at the Final Design Review. Contents of the reports shall be compared with the known contents of the data. Successful completion of the test requires 98.5% accuracy between report contents and known data.

Station Data Exchange Tests

A station LAN consisting of a single TVM (or a TVM simulator) and an NIU (if required) shall be established. Using converter devices if necessary, the Fare Collection Network Controller (FCNC) shall be connected to the station LAN.

The FCNC shall poll the TVM (or simulator) for its revenue data; accuracy of the received data shall be confirmed by generating the relevant reports. Additional polls for the TVM status shall also be initiated by the FCNC.

Alarms generated by the TVM (or simulator) shall be recorded and confirmed on the FCNC.

Other events, such as revenue servicing, shall also be instigated on the TVM (or simulator), and then corroborated on the FCNC.

Multiple new fare structures shall be downloaded to the TVM (or simulator) and confirmed.

Synchronization of the TVM (or TVM simulator's) clock shall also be confirmed by stimulating the FCNC to poll the TVM for data (data polling shall include the current date and time). The TVM (or TVM simulator) shall also be made to request the current date and time from the FCNC by simulating restoration to service.

Other downloadable data, such as the list of valid employee identification numbers, shall also be sent to the TVM (or simulator) for confirmation.

Passage of this test requires no discrepancies in station data exchange.

Security Workstation Confirmation Tests

Connecting a workstation to the FCNC shall test the FCNC's security and alarm monitoring application. All alarms generated by the TVM (or simulator) shall be transmitted to the workstation within time limits as required. The format of the message shall be confirmed to match the protocols approved at the Final Design Review. The test shall also substantiate that:

- Failure to receive a subsequent event within the time required when a “door open” event occurs results in an intrusion alarm
- All on-line event conditions are properly cleared by their corresponding event.

The FCNC shall also respond to requests for TVM status from the workstation by polling the TVM (or simulator) and passing the resulting message to the workstation.

Workstation Activities Tests

Functions to be performed by users of the maintenance and revenue workstations shall be validated. Tests shall be conducted to confirm that each class of user is restricted to the activities and information as approved at the Final Design Review.

System Administration and Maintenance Tests

All other functions required for operation and maintenance of the FCNC shall be exercised and verified.

TP-5.7.1.3 Factory Integration Test

When all qualification tests have been completed, the Contractor shall conduct a Factory Integration Test (FIT). The FIT shall confirm that when installed, all equipment will perform and communicate as required as a complete system.

The FIT shall be a two-part test. In the first part, all software modifications made since the Functional Test shall be reviewed with the RE, demonstrated, and tested. All software issues from prior tests shall be reviewed, and a plan to address remaining issues shall be prepared by the Contractor.

In the second part of the FIT, the FAI TVM shall be connected together with another TVM or simulators to create a two-TVM station LAN. This station LAN shall then be connected to the FCNC and its workstations to form a single-station fare collection system. Two SCADA loops shall also be connected between the TVMs and a SCADA console simulator.

During the FIT, the following activities shall occur:

- 250 transactions on each TVM (or simulator) involving all ticket types.
- Five revenue servicings, (one servicing for each 50 transactions) of all coin and bill storage devices on each TVM.
- Five clock synchronizations for the TVM shall be performed by downloading new date/time information from the FCNC.
- New fare structures and a variety of parameters downloaded from the FCNC five times, once per 50 transactions. Tickets of each type available shall be purchased from each TVM for each new fare structure.
- All possible alarm conditions (on-line events) shall be triggered at least once.
- Careful records of all transactions and events shall be kept. Reports shall be generated by the fare collection network controller to compare the reported results with the manual records.

Successful completion of the FIT requires:

- No more than one relevant failure with the equipment.
- Revenue discrepancies between vault contents, TVM audit receipts, and FCNC reports are less than 0.1%.

- All fare structure changes, operating parameters, and clock synchronizations are accurately received.
- All events and alarms are successfully transmitted, recorded, and reported at both workstations and the SCADA console.

With successful completion of the FIT, all software shall be “frozen” and no changes shall be made without authorization of the Resident Engineer. Version information for all software modules installed on the equipment shall be recorded by the Contractor. These records shall include the date and time the software was created, size of each file, and version number. Unless the RE authorizes changes, software to be installed for revenue service shall match that which was used to pass the FIT.

TP-5.7.1.4 Production Testing

Each subsequent production unit of equipment shall be subjected to a functional test after assembly, performed at ambient temperature conditions. The test shall utilize all modes of operation in the same manner as the cycling tests and shall include operation on the extreme limits of line voltage. Rejection criteria for coins and bill shall be tested; quality of printing assured and the Alarm System shall be tested for proper response.

The production test shall also include a 72-hour idle burn-in, where the completed equipment is left powered on in an idle state for at least 72 hours. Subsequent to this burn-in period, a quantity of 200 transactions shall be conducted to confirm that all modules remain fully operational.

TP-5.7.1.5 Pre-shipment Inspection

The Resident Engineer retains the right to conduct pre-shipment inspections of fare collection equipment. The program schedule shall include at least one day for final inspection by the RE per six TVMs after the equipment is completed, production tested, and prior to packing for shipment. All deficient items indicated in QA reports shall be corrected before pre-shipment inspection takes place. The Contractor shall provide a supervisor to accompany the RE or its representative during pre-shipment inspection.

The Contractor shall notify the RE at least 10 days in advance of scheduled shipping. Within 5 days of this notification, the RE shall inform the Contractor whether inspections will occur; if the RE opts not to inspect, the RE shall grant the Contractor permission to ship equipment in writing. No equipment shall be shipped to the City without written authorization from the Resident Engineer.

TP-5.7.1.6 Pilot Station Test

At least 120 days before installation is to begin, the RE shall identify a station to be designated as the pilot test station for a test to evaluate the station equipment, data network, and fare collection network controller. This station shall include at least 2 TVMs, and shall have a working fiber optic communications system in the communications enclosure.

After the fare collection station equipment has been installed and passes installation tests and inspections, the pilot station test shall commence. The Contractor shall provide on-site personnel for the duration of the test. Prerequisites to the pilot station test are:

- At least 2 TVMs installed and ready for revenue service.
- A complete station LAN installed.

- All necessary cabling to communications enclosure, and a Network Interface Unit installed (if necessary).
- A working fiber optic network (Installed by the City's Communications Contractor).
- A working SCADA system (installed by the City's Communications Contractor).
- A functional Fare Collection Network Controller, with at least one Revenue and Maintenance Workstation. (Revenue and Maintenance Workstation may be temporarily collocated with the FCNC.)

The pilot station test shall begin at least 30 days prior to commencement of system-wide installation. During the test period, the following activities shall occur:

- 250 transactions on each TVM involving all ticket types and purchase methods
- 100 tickets validated on each TVM.
- Five revenue servicings (one servicing for each 50 transactions) of all coin and bill storage devices on each TVM.
- Downloading new date/time information from the FCNC shall perform five clock synchronizations for the TVM.
- New fare structures and a variety of parameters downloaded from the FCNC five times, once per 50 transactions. Tickets of each type available shall be purchased from each TVM for each new fare structure.
- All possible alarm conditions (on-line events) shall be triggered at least once.

Careful records of all transactions and events shall be kept. Reports shall be generated by the fare collection network controller to compare the reported results with the manual records.

Successful completion of the pilot station test requires:

- No more than one relevant failure with the equipment.
- Revenue discrepancies between vault contents, TVM audit receipts, and FCNC reports are less than 0.1%.
- All fare structure changes, operating parameters, and clock synchronizations are accurately received.
- All events and alarms are successfully transmitted, recorded, and reported at both the workstation and the SCADA console.

TP-5.7.1.7 Installation Testing

After installation, the Contractor shall perform a test on each unit installed to confirm that the equipment is properly installed, interfaces properly with the Fare Collection Network Controller and SCADA, and performs as intended.

Installation testing shall consist of the following.

All installed equipment shall undergo as a minimum inspections for:

- Quality of installation
- Damage to equipment
- Missing components and parts
- Correct power, communication, and SCADA connections
- Correct positioning and mounting

All installed equipment shall be energized and exercised, and tested for function and operation.

All TVMs shall be subject to communications testing that shall confirm proper data exchange between the TVM and the Fare Collection Network Controller, and proper operation of each TVM's SCADA relays.

All inspections and tests shall be witnessed and accepted or rejected by the RE's designated representatives.

All spare units designated for the Maintenance Test Station as described herein shall be installed there by the Contractor prior to conducting installation testing and inspection. Other complete spare units shall be assembled (if necessary) and tested by the Contractor at the City's MSF facility to assure that the equipment has been received in good condition and operates properly.

TP-5.7.1.8 Systems Integration Test

When all equipment is installed, the Contractor shall conduct a Systems Integration Test (SIT). From a Revenue and Maintenance Workstation, communications with all TVMs shall be confirmed by initiating polling, and shall be confirmed on-line.

All elements of the DCIS shall be exercised to show that all reports can be generated and all data accessed, including all workstations and printers.

Confirmation tests of SCADA alarms shall be conducted at randomly selected stations by initiating a silent alarm at one TVM and disabling a module in a TVM at another station.

TP-5.7.1.9 Bank Card System Certification

The TVM and Fare Collection Network Controller shall pass a certification test in accordance with the City's anticipated contract with the clearinghouse service provider. This certification shall occur no later than 3 months before revenue service. The Contractor shall provide a report documenting the successful completion of this certification test.

Certification testing shall occur at the City's MSF facility using the Maintenance Test Station.

TP-5.8 *Materials and Workmanship*

The Fare Collection System shall be constructed of the highest quality materials suitable for trouble-free use in the intended environment. The Contractor shall be responsible for all materials and workmanship. It is the Contractor's responsibility to design, select, and apply all materials and workmanship to meet the requirements in the Contract Documents. Where alternate materials are offered, it is the responsibility of the Contractor to demonstrate the alternate materials are equivalent to the specified materials and to gain the RE's approval for the substitution.

Housings for the fare collection equipment shall have an attractive, finished appearance. No protruding screws, fasteners, or sharp edges shall be permitted on the exterior of the enclosures. All exposed fasteners shall be stainless steel. All fasteners accessible to the public shall be an approved tamper-proof design. All exposed edges shall be neatly rounded with no sharp edges or points.

Internally, there shall be no protruding screws, sharp edges, or exposed wires that could injure maintenance personnel. Internal component arrangement shall be neat, with access for service. Wiring shall be run in cables secured to supports. No self-tapping screws shall be used in areas where disassembly can normally be expected more frequently than once in every three years.

Paints, plastics, display covers, and light lenses shall be resistant to ultraviolet light. All internal fasteners that are not stainless steel shall be plated with cadmium or zinc. All external hinges, latches and locks shall be stainless steel or chrome-plated brass. All materials subject to corrosion shall be painted or plated. The coating method shall prevent corrosion for the life of the equipment. Dissimilar metals in contact shall be treated to prevent electrolytic corrosion at the contact areas. The Contractor shall be responsible for mechanically isolating the equipment cabinet base from the station platform-leveling base.

TP-5.8.1 Source of Supply

The Contractor shall be responsible for all of the workmanship, and all of the materials, components, equipment, and accessories in the design, supply, and installation and testing of the Fare Collection System.

The Contractor shall furnish equipment and materials from the manufacturers identified in Contractor's submittals, unless otherwise approved by the RE.

Only new and first quality materials conforming to the requirements of the Contract Documents and approved by the RE shall be used in the Fare Collection System, except for material used by the Contractor for convenience and which is not to be permanently incorporated in the Fare Collection System.

If it is found that sources of supply, which have been approved, do not furnish a uniform product, or if the product from such source proves unacceptable at any time prior to acceptance, the Contractor shall, at no additional expense to the City, take any and all steps necessary to furnish acceptable materials.

TP-5.8.2 Acceptability of Equipment

The award of this Contract does not imply the RE's approval of any or all of the equipment or materials identified in the Contract Documents. The Contractor is responsible for furnishing a completely functional system as defined herein.

The Contractor shall furnish the exact models of equipment and materials identified in submittals unless otherwise approved by the RE.

The approval by the Resident Engineer of any submittal does not imply that the RE has accepted any responsibility for the Contractor's design or that the RE has accepted any item of equipment or material. The RE shall give acceptance only after all work is complete and the complete Fare Collection System has been tested, as described within the Contract Documents.

If, at any time during the design, installation, testing, or prosecution of work under this Contract, it is found that equipment or materials furnished by the Contractor do not meet the specifications herein or will not provide a fully functional operating system as described herein, the Contractor shall, at no additional expense to the City, take any and all steps necessary to furnish acceptable equipment and/or materials.

The Contractor shall not be permitted nor permit its subcontractors to ship any Fare Collection Equipment or subsystems without first obtaining specific authority from the RE.

TP-5.8.3 Inspection of Materials and Workmanship

All supplies, materials, and workmanship shall be subject to inspection at the Contractor's Facilities, and to inspection and test prior to acceptance by the RE, in accordance with the Contract Documents. In case of defective material or workmanship, or nonconformity to the Contract Documents, the RE shall have the right either to reject the equipment with or without instructions as to their disposition, or to require their correction. The RE may inspect, in accordance with the Contract Documents, the Contractor's proposed material that has been installed on other Contracts.

TP-5.8.3.1 Structural Materials

TP-5.8.3.2 Low Alloy High Tensile Steel

As a minimum, low alloy, high tensile steel (LAHT) shall conform to the requirements of ASTM A 588 for structural shapes, plates, and bars. Cold- and hot-rolled LAHT sheets and strips shall conform to the requirements of ASTM A 606, Type 4. Alternative low-alloy, high-tensile steels to other specifications may be used, provided these detailed specifications are submitted to and approved by the RE as providing equivalent material for the proposed applications.

TP-5.8.3.3 Carbon Steel

Carbon steel shall conform to the requirements of ASTM A 36 for structural shapes, plates, and bars. Hot-rolled carbon steel sheets and strips shall conform to the requirements and ASTM A 570. As an alternative, carbon steel of structural quality to other specifications may be used, provided these detailed specifications are submitted to and are approved by the RE as providing equivalent material for the proposed applications.

TP-5.8.3.4 Alloy Steel

Alloy steel shall conform to requirements of AISI or ASTM specifications for the alloy specified. Heat treatment, carburizing, or nitriding shall be specified by the Contractor. The Contractor shall obtain certification of the process applied and this documentation shall be available for inspection by the RE for a period of not less than expiration of the warranty period for the last delivered unit of Fare Collection System.

TP-5.8.3.5 Stainless Steel

Alloys of stainless steel shall conform to the requirements of ASTM 304 for sheets and for structural shapes, plates, and bars. All stainless steel welds shall be sand blasted or wire brushed

to remove all slag and scale. All stainless steel surfaces shall be cleaned, and abraded where necessary, to present a uniform finish. Stainless steel for the TVM cabinet shall be low-carbon content type 304L or RE-approved equivalent austenitic stainless steel. The minimum thickness for TVM cabinetry shall be 2mm stainless steel for the TVM cabinet, 3 mm stainless steel for the door, 2 mm stainless steel for the encapsulating box, 1 mm stainless steel for the lighting fixture, and 2 mm stainless steel for the pedestal.

TP-5.8.3.6 Welding and Brazing

Welding

All structural welding practices not specifically covered elsewhere in this Scope of Work shall be in accordance with the requirements of the American Welding Society (AWS) “Structural Welding Code, Steel,” AWS D1.1; “Structural Welding Code, Sheet Steel,” AWS D1.3; and “Structural Welding Code, Aluminum,” AWS D1.2. Structural Welding code – Stainless Steel AWS D1.6. Resistance (spot or seam) welding shall conform to AWS C1.1. or RE approved equivalent welding, brazing and brazing practices. Additional information on definitions, processes, or questions pertaining to welding shall be referred to AWS Welding Handbooks.

Brazing and Soldering

All brazing shall be performed in accordance with procedures and requirements in AWS B2.2. All structural (not electrical) soldering shall be performed in accordance with procedures and recommendations in AWS Welding Handbook, Volume 2.

Joining and Fastening

Direct contact between untreated, electrically dissimilar metals is prohibited. Isolating and moisture-proofing materials appropriate to the materials being joined shall be used at all times.

TP-5.8.3.7 Fasteners

The Contractor and suppliers are responsible for selecting fastener types, sizes, styles, lengths, materials, grades, and finishes that shall meet requirements of the Contract Documents. The Contractor shall minimize the number of different sizes and styles of fasteners used.

All fasteners shall be specified under one of three categories; electrical and electronic, structural, or decorative. Fasteners internal to electrical or electronic components are specified herein. Fasteners that perform structural functions in electrical or electronic components such as mounting of boxes or cabinets are specified under Structural Fasteners. Fasteners exposed to the patron’s view are specified under Decorative and Appearance Fasteners.

Structural Fasteners

All structural fasteners shall have documentation identifying manufacturer and purchase specifications available for examination by the RE. This documentation shall include the fastener material or grade, and finish including plating material and specifications, when applicable. This documentation shall be available for a period of not less than expiration of the last fare collection unit’s warranty period.

Decorative and Appearance Fasteners

All fasteners that can be viewed by the patrons shall make a presentable appearance that includes fastener surfaces that are smooth, either bright or finished to match the surfaces being joined, and proper installation that is flush or contoured with the mating surface.

Self-tapping screws, where permitted by the RE, shall be plated martensitic stainless steel.

Fasteners on access panels, plates, covers, or other components accessible by the patrons shall be a RE-approved, tamper-resistant type.

All decorative and appearance fasteners shall have documentation that identifies the manufacturer, base material, plating or finish if applied, and the fastener type. A copy of this documentation shall be supplied to the City to enable purchase of matching parts. The Contractor or supplier shall maintain this documentation on file for the RE to review for a period of not less than the expiration of the warranty on the last Fare Collection Equipment unit delivered.

Threaded Fasteners

At least 12 threads shall be visible beyond all nuts. Captive nuts and fasteners shall be used where additional disassembly would be required to gain access or to remove or install screws or bolts.

TP-5.8.3.8 Washers and Lock Washers

Washers shall be used under the head of all bolts and nuts. Flat washers shall be used on both sides of all electrical connections (that is, under bolt head and under nut). At least 12 threads shall be visible beyond all nuts.

TP-5.8.3.9 Rivets and Lock Pins

Rivets and lock pins exposed to patrons shall be austenitic stainless steel or aluminum, as appropriate to the materials being joined. The Resident Engineer shall be the final arbiter in determining whether an application is hazardous to maintenance personnel.

TP-5.8.3.10 Plating of Fasteners

All carbon, alloy and martensitic steel fasteners shall be plated with cadmium or zinc, unless specifically waived by the RE.

TP-5.8.3.11 Rivet and Bolt Holes

Rivet and bolt holes shall be accurately located and aligned, and when necessary during assembly, holes shall be reamed round to specified size in position.

TP-5.8.3.12 Joint Fitting

Joints shall be properly fitted, whether exposed or concealed. Edges of panels shall have a smooth, finished appearance.

TP-5.8.3.13 Metal-to-Metal Connections

Where metal is riveted or bolted to metal, the contact surfaces shall be free of dirt, grease, rust and scale and shall be coated, except for stainless steel parts, with a metal base primer which conforms to Federal Specification TT-P-664, or approved equal. If aluminum parts are used for any purpose, metal-to-metal connections shall be in accordance with Aluminum Company of America (ALCOA) recommendations.

TP-5.8.3.14 Torqueing

All fasteners shall be torqued to the required value specified for the size and grade of the fastener used. Locknuts shall be torqued in accordance with their manufacturer's recommendations.

TP-5.8.3.15 Exterior Paint

The TVM cabinets shall be constructed of unpainted stainless steel.

TP-5.8.3.16 Decoration

Paint trim, printed instructions, and accents shall be applied by compatible paint, decals, or vinyl tape. Where decals or tape are applied, the edges shall be sealed with compatible clear coat paint. All paint, decals or tape shall be applied in accordance with manufacturer's instructions. All decals and or tape shall be capable of being used in the environment found in Honolulu. Catalog cut sheets providing the description and properties of the decals or tape should be submitted to the RE for approval.

TP-5.8.3.17 Interior

All surfaces of components not made of stainless steel shall be painted or zinc plated. The paint system shall be either a two coat primer-finish alkyd enamel paint system per Federal Specification TT-E-527 or an insulating, thermosetting, resin-based powder conversion coating applied in accordance with the manufacturer's recommendation and suitable for the intended environment. Any interior paint color(s), to be submitted to the RE for review and approval as part of the Preliminary Design Review, shall be white, near white, or light color to improve brightness in the interior. Service instructions shall be applied by contrasting, compatible paint, decals or vinyl tape. Permanently attached plaques are also acceptable for service instructions.

Seals and cover hardware shall not be painted.

TP-5.8.3.18 Wire and Cable Installation and Electrical Hardware

TP-5.8.3.19 General

The Contractor shall submit samples, specifications and qualification test documentation of each size and type of wire and cable specified, for approval at the Preliminary Design Review. Within this document, the term "wire" refers to a single insulated conductor of any size while the term "cable" refers to a wire or group of wires contained within an overall insulating covering. Cable may also be referred to as multi-conductor cable.

All requirements in this document referring to wire also apply to cable, except for requirements that explicitly apply to wire or cable only.

All wiring shall be designed, rated, and selected to last the life of the equipment. All wire, wire installation, circuit protection, and associated electrical hardware shall comply with the requirements of NFPA 70 "National Electric Code," UL751 "Standard for Safety, Vending Machines," equivalent DIN and CEN standards, and applicable local requirements.

TP-5.8.3.20 Wire

All power wire shall have a minimum voltage rating of 300 VAC/VDC and a minimum temperature rating of 135°C.

TP-5.8.3.21 Wiring

Wiring shall be sized for the intended load, voltage drop, installation method, and applicable codes.

All wiring within enclosures shall be attached to wire supports rigidly fastened to the enclosure structure. Wiring shall be free from edges, bolt heads, or similar areas, and shall not interfere with nor contact enclosure covers.

Wiring entering any removable enclosure shall be harnessed and secured to facilitate removal of the box. Wires from different wire runs shall not be harnessed together or with internal wiring.

All wiring shall be secured such that there is no strain on wire terminals, multi-pin connector pins, or other wire termination hardware.

Wire dress shall allow for sufficient slack at terminals to provide for shock and vibration induced movements, equipment shifting, alignment, cover removal and component replacement. Sufficient additional wire length shall be provided to allow sufficient slack for three replacement terminations, without excess tension. Wire splices are not permitted.

All wiring shall be bundled, sheathed, and routed neatly and shall be located such that access to modules is not obscured. Wire bundles shall not interfere with external test equipment.

All wire bundles and cables connecting door-mounted components to the interior cabinet shall be secured near the door hinge and routed to minimize bending and flexing when the door is opened and closed.

Cables or wires that pass through holes or cutouts shall be protected by secured grommets.

Conductors which operate at potentials differing by 50 volts or more shall not be cabled together.

Preliminary TVM wiring schematics shall be submitted for RE review and approval at the Preliminary Design Review.

TP-5.8.3.22 Wire Ties and Clamps

Wire ties, clamps, and anchors shall be nylon formulated for resistance to ozone and ultraviolet light, rated for outdoor service, and shall last the life of the equipment. Wire ties shall be installed with tools with automatic tensioning devices, as supplied by the wire tie manufacturer. Wire ties shall be installed with sufficient tension to restrain the wiring without indenting the wire insulation. Wire tie width shall be selected for intended wiring load and minimum insulation indentation.

If used, wire tie anchors shall be riveted or screwed to rigid structure. Adhesive-based wire tie anchors are not permitted. Bent-metal tabs are not permitted as cable anchors.

TP-5.8.3.23 Marking

The Contractor shall devise a wire and terminal designation system that coordinates all electrical circuits into a unified system. The system shall indicate location, circuit, device, wire number, terminal branch, position, etc and shall be incorporated onto the system schematics. Letters and numbers shall be used.

All wires and terminals shall be clearly identified with white or yellow permanent markers, with black printing or by continuous wire marking printed on the wire. The markers shall be oil and grease resistant. Printing shall be done by machine with permanent ink. Hand printing is prohibited. In addition, wires in multiple-conductor cables shall be color coded.

Each wire shall be labeled with both its circuit designation, and if attached to a terminal, its terminal designation. All wires shall be marked within three inches of the end of the wire.

TP-5.8.3.24 Terminal Boards

As used in this document, the term “terminal board” refers to all devices commonly called terminal blocks, terminal strips, terminal studs, or similar, to which wires are connected. Terminal boards shall be either stud type or compression clamp type, with barriers and approved by the RE.

Binding screw type terminal boards will be permitted only where approved and then only with Phillips head screws.

Each terminal board shall have at least one spare terminal.

Terminal boards shall be either, stud type, compression clamp, or push-on tab (FASTON type), with barriers and of a service proven series.

The terminal board insulation shall be a strong, high temperature rated, tracking resistant material that is not brittle. The material shall be either a filled reinforced thermosetting material or a thermoplastic material. General purpose phenolic is prohibited. Jumpers between adjacent terminals shall be plated brass or copper.

Adequate working space shall be provided to permit connecting wire terminals when using standard tools.

A maximum of four terminals shall be connected to any single terminal stud, provided that there is no interference between terminal barrels and sufficient threads protrude beyond the locknut. On terminal boards, the wiring shall be arranged so that no more than two terminals are connected to a stud, from each side of the terminal board.

On compression clamp terminal boards, a maximum of two terminals shall be connected to any one binding terminal. All connected wires shall be terminated with mechanical crimp type terminals.

TP-5.8.3.25 Wire Terminations

Wire terminals used shall be mechanical crimp type terminals. The Contractor shall submit the proposed product line for approval at the Preliminary Design Review. All terminals shall be plated copper.

Wire terminals shall be ring-lug type terminals. “FASTON” type terminals shall be of a type which permits at least 100 cycles of removal and re-attachment without losing proper grip. Terminals used with compression clamp terminal blocks shall have insulating collars and shall be of a series approved by the terminal board manufacturer for use with the selected terminal boards. Spring-spade terminals, sized to match the screw size so that they are retained by spring action, shall be used to connect to devices with retained screws.

Terminals used shall be insulated and shall have a metal strain relief device under the insulation that is crimped onto and grips the wire insulation simultaneously with the terminal. Other strain relief devices shall be submitted for approval. The insulation material shall be rated for the expected worst case temperature.

All wire terminals and connections shall be attached to the wiring with crimping tools and dies as recommended by the manufacturer and approved by the RE. Crimping tools shall be ratcheting types that insure a complete compression. The Contractor shall maintain these tools in proper calibration and insure that all personnel using them are properly trained.

A maximum of two wires shall be crimped in any one terminal.

TP-5.8.3.26 Cable Connectors

Cables shall be trained into final position while observing minimum bending radii.

Wire and cables connected directly to equipment modules shall be of sufficient length to allow access for removal and inspection of equipment. Wires and cables shall be continuous, without splices. All wiring between modules shall utilize quick-disconnect connectors suitably rugged for repeated removal and installation. All wiring internal to modules shall be connected via quick-disconnect connectors or terminals and terminal boards. Where cables connect to modules or where two cables connect together, at least one half of each connector pair shall be firmly attached to the enclosure, module, or a suitable bracket.

All cable connectors shall be equipped using crimp contacts. Contacts shall be selected for the intended wire size and as recommended by the manufacturer.

Adjacent connectors shall either use keying, different inserts, or different insert orientations to prevent erroneous connections.

Cables shall be clamped at the back of the connector by clamping over the cable jacket. Clamping on cable wires is prohibited.

Extension bodies shall be used where necessary to insure that there is sufficient room to terminate cable wires while providing the seal and clamp on the cable jacket.

All connectors shall have recessed pins to prevent bending and/or breakage during installation and removal. Cable connections shall be designed so that there shall be no voltage on exposed pins when connectors are disconnected.

All cable connector applications shall be submitted for RE review and approval at the Preliminary Design Review.

TP-5.9 *Systems Support*

TP-5.9.1 Installation

The Contractor shall install and connect the TVMs and related equipment. Subsequent to installation and connection, the Contractor shall test the Fare Collection Equipment and shall support Integrated Testing for the Fare Collection System in accordance with the Master Program Schedule. The Contractor shall furnish all hardware for the proper installation of the Fare Collection System. The Contractor shall comply with the requirements of layout, positioning, conduit assignment, and other features as detailed on the Station Contract Drawings.

TP-5.9.1.1 Installation and Interface Plan

As part of the Preliminary Design Review, the Contractor shall submit to the Resident Engineer for its review and approval an installation and interface plan. Such plan shall indicate the method of installation and connections, the installation schedule, and any support required of the RE. The Installation and Interface Plan shall also include the procedures for interfacing with the Facilities Contractor for project coordination.

TP-5.9.1.2 Typical Station Description

The platforms will be constructed to provide level boarding to the vehicles. Fare collection equipment shall be installed in designated areas as shown in the Station Contract Drawings.

TP-5.9.1.3 Off-platform Installations

Where fare collection equipment is to be installed off-platform, the installation site will consist of a concrete or masonry surface onto which the TVMs shall be installed. Concrete beneath the fare collection equipment will be at least 8" thick.

Other City Contractors will install conduit leading from the communications enclosure and from the wayside electrical control panel to a junction box, located at each position where a TVM may be installed.

TP-5.9.1.4 TVM Mounting

TVM mounting shall be in a secure, robust, and vandal- and burglar-proof manner. Equipment cabinet mounting to the station platform shall be by means of four stainless steel, 0.5-inch diameter anchor bolts, or approved equal, to be provided by the Contractor, which shall be embedded in the concrete platform by the City according to the bolt manufacturer's instructions. Electrical and communications wiring and cabling shall enter from underneath the TVM, through its base. The TVM shall be installed over the junction box such that no wiring or cabling is exposed outside the TVM cabinet or base.

The Fare Collection Equipment cabinets shall have an integral base with suitable means for leveling the machines upon installation to accommodate the platform slope. Access to the anchor bolts shall be through the hinged service front door or other access panels, subject to RE approval, in a manner, which shall prevent unauthorized access. The TVM shall be fully supported by its anchors.

Each TVM shall be aligned, positioned, and installed in accordance with the City's requirements. The RE shall provide such requirements not later than 120 days prior to the first delivered TVM.

The TVM installation design shall be submitted for RE review at the Interim Design Review and for approval at the Final Design Review. Wire and Cable Installation

The Contractor shall:

- Make the proper electrical power connections, including the furnishing and installation of wire, cable, and other material, as necessary, to each item of Fare Collection Equipment. The power cable shall be provided by others to each station site. Verification of proper wiring shall be conducted by the Fare Collection Contractor.
- Make the proper communications link connections, including installation of wire, cable, and other materials as necessary, between the cable supplied by the communications contractor stubbed up at the fare collection equipment pedestal and the Fare Collection Equipment.
- Make the proper SCADA connections, including the furnishing of wire, cable, and other materials as necessary, between the SCADA control panel (installed by others in the communications enclosure) and the Fare Collection Equipment. At each station, only two SCADA connections shall be made available for TVM monitoring, one for security breaches and one for situations requiring attention. Hence, all TVMs at each station shall be wired into two SCADA loops.

All wiring and cabling shall be pulled through the designated conduit as determined by the RE. The Contractor shall coordinate the design interfaces with the Station Contractor and the Communications Contractor. As part of the Preliminary Design Review, the Contractor shall submit specifications for wiring and cabling to the RE for review and approval.

Where station LAN cabling passes through junction boxes, at least 36 inches of additional cable shall be left neatly coiled in the box. Splices of the data cable in junction boxes are not permitted; all connections shall occur inside TVMs or inside communications enclosures.

TP-5.9.1.5 Finishing Requirements

The interface between the base of the TVM and the station platform shall be sealed with a material approved by the RE. The seal shall perform as a durable, attractive, watertight seal and shall be resistant to abrasion, weather, staining, and migration. The seal shall not deteriorate in any manner except as indicated in manufacturer's data. The seal shall be installed in compliance with the manufacturer's requirements and recommendations.

It shall be possible to remove and replace the TVM without damage to the platform, anchor bolts, or the equipment.

The seal, its color, performance specifications, and physical characteristics shall be submitted to the RE as part of the Interim Design Review.

TP-5.9.1.6 Installation Procedures

Not less than 60 days prior to delivery of the first Fare Collection Equipment, the Contractor shall submit for the Resident Engineer's review and approval drawings of the equipment installation, indicating details on the equipment installation, and electrical and communications connections. In addition, the installation and removal procedures shall be sufficiently detailed such that the City could perform TVM installation and removal.

TP-5.9.1.7 Manual Format

Manuals shall treat the TVMs as a single integrated system of components, sub-assemblies, and accessories designed to work together, and shall not be merely a collection of disassociated sections from various suppliers. The Contractor is responsible for insuring that all its suppliers' efforts are compatible and that interfaces among various subsystems are represented in sufficient detail to provide a clear and complete functional description of the Fare Collection System. In general, manuals are to be logically organized with systems and elements considered in descending order of importance.

- Operation instructions including step-by-step preparation for start-up, initialization, operation, shutdown, and identifying all hazards (such as sharp edges and high voltages).
- Control diagrams, as installed by the manufacturer.
- Sequence of operation by the control manufacturer.
- Wiring diagrams, as-installed.
- Diagrammatic location, function and tag numbers of each component.
- Maintenance instructions: Include step-by-step procedures for inspection, operation checks, cleaning, lubrication, adjustments, repair, overhaul, disassembly, and reassembly of the equipment for proper operation of the equipment. Include list of special tools, which are required for maintenance with the maintenance information.
- Possible breakdowns and repairs. Troubleshooting flow charts and/or symptom-action tables shall be included for diagnosis of any major system or control.
- Manufacturer's parts list of functional components, control diagrams and wiring diagrams, giving manufacturer's model number and manufacturer's part number.
- "Long-Lead-Time" spare parts list for spare parts not readily available on the open market or for which it is anticipated ordering and delivery time exceeds 10 days.
- List of nearest local suppliers of all equipment parts.
- Recommended preventive maintenance schedule for major system components.
- Manufacturer's warranty and guarantee data.
- Spare parts data including complete list of parts and supplies, with current unit prices and sources of supply.
- All equipment or tools, which are, required for the general up-keep, maintenance and overhaul of the equipment or product shall be listed. Suggested suppliers for all specialty tools shall be shown.
- Appendix: Include safety precautions and procedures, a glossary, and, if available at time of submittal, copies of test reports, and other relevant material not specified to be submitted.
- Index, in alphabetical order.

TP-5.9.1.8 Operating Diagrams

Where provided, operating diagrams shall conform to the following:

- Electrical wiring diagrams and other diagrams necessary for operation of the equipment shall be provided for Fare Collection Equipment.
- No single diagram shall show more than one system, or parts thereof.
- Diagrams shall be reproduced by photographic process to a size not to exceed 18 inches by 24 inches and shall be complete and legible in all respects. Systems shall be

subdivided into portions, which are operable from location where diagrams are installed, and to provide intelligible information within specified size. They shall be made on white paper and vacuum-sealed in transparent plastic material impervious to moisture and oil, and resistant to abrasion. Other formats which are equal in clarity; sharpness, durability and permanence will be considered.

TP-5.9.1.9 Content of Manuals

Manuals shall be organized and shall include, as a minimum, the information as follows:

TVM Manuals

TVM Operating Instruction Manual – shall contain all information needed for safe, proper, and efficient operation of the Ticket Vending Machines. Manuals shall include general orientation and familiarization with all features of the TVM. Detailed information shall be provided regarding location, function and operation of all controls, indicators, switches, hardware and reset buttons, and trouble diagnosis. All normal operational sequences shall be described in detail.

TVM Preventive Maintenance Manual – shall contain all information needed to enable maintainers to perform all periodic inspection and preventive maintenance tasks including all routine lubrication, inspection and replacement of consumable items. The manual shall contain recommended preventive maintenance schedules grouped, as much as possible, into compatible and convenient intervals of time, or operating hours. If binder size limitations permit, this manual may be combined with the TVM Corrective Maintenance Manual.

TVM Corrective Maintenance Manual – shall contain all information needed to enable maintainers to diagnose problems, and to make adjustments and repairs to all TVM components and sub-assemblies. Repairs include adjustments, repairs or replacements prescribed to restore the TVM components and subassemblies to a normal operational condition in an efficient and timely manner. The manual shall include, at a minimum:

- A general description of each subsystem, component and subassembly
- Procedures to exchange all major components
- Functional block diagrams
- Detailed schematics
- Wiring diagrams
- Pictorials with exploded views to permit easy parts identification

TVM Shop Repair and Overhaul Manual – shall contain a detailed description of each assembly and subassembly to enable maintainers to service, maintain, repair, replace, rebuild, and overhaul the TVM. The manual shall include:

- Complete systematic procedures
- Wear and tolerance limits for determining when overhauls are needed
- Overhaul procedures for all major components
- Special tools and equipment required
- Pictorials with exploded views to permit easy parts identification

If binder size limitations permit, this manual may be combined with the **TVM Parts Manual**.

TVM Parts Manual – shall enumerate and describe every TVM component with its related parts, including the supplier’s number, the Contractor’s number, and provision for entry of the City store’s number. Cut-away and exploded drawings shall be used to permit identification of all parts not readily identified by description. Parts common to different components, such as screws, shall bear the same Contractor’s number with reference to the other components where they are found. Each part or component shall be identified as being part of the next assembly. Commercially available items such as standard fasteners, fuses, lamps, fittings, switches, solenoids, and motors shall be identified by standard hardware nomenclature in addition to the Contractor’s number.

TVM Software and Programming Manual – shall describe how to operate and maintain the TVM software. Procedures for updating TVM application software (for when the DCIS is not available) shall be provided. The manual shall also include a high-level description of the TVM application software design and the function of all executable modules.

Revenue Servicing Manual – One or more manuals that fully documents the revenue servicing process. Included shall be information on emptying and filling coin recirculation system, coin replenishment tubes and cash vaults and other information as necessary to fully service the revenue portions of the TVM.

TVM Software Source Code Manual – One or more manuals shall also be provided (separately if necessary) that fully documents the TVM application software source code, including data files, data file structure, and data file mapping and cross-referencing. If necessary, the TVM software source code documentation shall be provided to the software escrow.

TP-5.9.1.10 DCIS Manuals

DCIS OEM Manuals – shall be provided unaltered. All manufacturers’ hardware and software documentation for the FCNC, workstations, and any associated networking hardware and software shall be supplied in their entirety. Where appropriate, these manuals may be bound with the Contractor’s documentation.

DCIS Administrator’s Manual – shall supply all necessary procedures to administer the FCNC and the associated networking hardware and software. Administrative requirements of the FCNC operating system software shall be described in detail or specific references to the manufacturer’s operating system documentation shall be supplied. All administrative procedures, including managing user accounts, data archiving, and backup creation and restoration (full and incremental) shall be provided in this documentation. All functions performed only on the FCNC Administrative Workstation shall also be documented in this manual.

DCIS Workstation User’s Manual – shall provide complete documentation on the use of the Revenue and Maintenance Workstations. All functions supported by these workstations shall be fully explained, including logging onto the system, querying the database, generating reports, altering fare tables and other operating parameters, downloading data, polling TVMs for data, managing the voice messaging system, and proper responses to all input requests. Extensive use of sample screens shall be employed throughout the manual.

DCIS Report Formatting Manual – shall provide instructions on how to create new queries and reports and to modify existing reports. Instructions on how to add reports to the list of prepared reports, to schedule reports for automated generation at predetermined times, and to delete unused reports shall also be provided. If necessary, specific references to manufacturer’s documentation shall also be provided to clarify instructions. If binder size limitations permit, this manual may be combined with the DCIS Design and Database Structure Manual.

DCIS Design and Database Structure Manual – shall describe the design of the DCIS network architecture and the communications protocols used between the FCNC, TVMs, and the FCNC workstations. The manual shall provide a complete description of the database structure, including definitions, parameters, and relations for all database fields, records, and tables.

DCIS Software Source Code Manual – One or more manuals shall also be provided (separately if necessary) that fully documents the DCIS application software source code, including data files, data file structure, and data file mapping and cross-referencing. If necessary, the DCIS software source code documentation shall be provided to the software escrow agent described herein.

TP-5.9.1.11 TVM Manual Addenda

All TVM, HHV and DCIS manuals shall include appropriate documentation of the operation, maintenance, repair, and software for the credit, debit and smart card modules and/or subassemblies. In addition, documentation describing the operation, administration, and design of the clearinghouse interface shall also be fully documented and included in the appropriate manual(s).

TP-5.9.1.12 Quantities of Manuals

The Contractor shall provide one high-quality reproducible master, one electronic copy, and the following quantities of each of the manuals described

Table 9-1. Quantities of Manuals to Be Supplied

Manual	Quantity
TVM Operating Instruction Manual	25
TVM Preventive Maintenance Manual	25
TVM Corrective Maintenance Manual	25
TVM Shop Repair and Overhaul Manual	25
TVM Parts Manual	10
TVM Software and Programming Manual	10
TVM Software Source Code Manual	1
TVM Revenue Servicing Manual	25
DCIS OEM Manuals	10
DCIS Administrator’s Manual	10
DCIS Workstation User’s Manual	10
DCIS Report Formatting Manual	10
DCIS Design and Database Structure Manual	10
DCIS Software Source Code Manual	1

TP-5.9.1.13 Drawings to Be Furnished by Contractor

TP-5.9.1.14 Time and Scope of Submittals

Within 30 days following final acceptance of the equipment, the Contractor shall supply quality electronically reproducible drawings of all fabrication assemblies, sub-assemblies, circuit

diagrams and arrangements of the Fare Collection Equipment, as finally furnished, accepted and modified.

TP-5.9.1.15 Software Source Code and Documentation

The City has no plans to modify supplied software without the Contractor's knowledge and consent. The City requires software source code and documentation to insure that should the need arise after expiration of the warranty and the Contractor is unable or unwilling to provide technical support, the City or a software consultant will have the capability to perform any needed software modifications.

TP-5.9.1.16 Time and Scope of Submittals

Within 30 days following final acceptance of the equipment, the Contractor shall supply software source code and documentation, in both electronic and hardcopy forms, for all software developed by the Contractor for the fare collection system purchased under this contract and from other contracts that are used in this contract. Contractor-produced software source code and documentation to be provided shall include all application software for the TVM ECU and the DCIS as well as any software developed for embedded microprocessors that are integrated into any modules for the TVM. Software flow charts and descriptions of operational software including the variables that are programmed for possible changes shall also be included in the instruction material.

Software documentation shall provide the following:

- General description and operation.
- Software architecture and basic program functions.
- Data flow information.
- Annotated source code listing, with comments and descriptions pertaining to each module sufficient allow an experienced programmer to understand the program.
- Detailed memory map and listing.
- Input/output port map.

In addition to the software source code and documentation described above, within 90 days following final acceptance of the equipment, the Contractor shall also supply:

- A licensed copy of all software tools such as debuggers, assemblers, and compilers, needed to convert the supplied source code into executable form used by the target processors.
- Hardware devices, such as EPROM programmers, with their accompanying software tools, necessary to transfer the executable programs onto the storage device used by any embedded microprocessor.
- Documentation that describes the procedures necessary to convert the supplied source code into executable format.

TP-5.9.1.17 Alternative Delivery to Escrow Agent

Should the Contractor prefer, all deliverables described in TP-5.9.1.16 may, within 30 days following final acceptance of the equipment, be put in escrow with a third party for a duration of not less than 10 years from the end of the warranty period. At the time the escrow agreement is initiated, the Contractor shall prepay the escrow agent to provide escrow services for at least 10 years. The escrow agent and terms of the agreement shall be subject to the approval of the RE. If

an escrow agent is used, a complete inventory of the items deposited shall be supplied to the RE at the inception of the escrow.

TP-5.9.1.18 Types of Training

The following training courses shall be provided.

- **Revenue Servicing** – All revenue service personnel shall be given training to teach the routine service functions of accessing the TVM, collecting monies, replenishing ticket stock and change, clearing basic jams, printing and retrieving audit tickets, and securing the TVM. Approximately 20 hours of training shall be conducted for up to 10 personnel.
- **Field Maintenance and Servicing** – All maintenance personnel who may be required to perform scheduled maintenance and support activities will attend a training course. This course shall provide all knowledge necessary for operation, troubleshooting, maintenance, repair, component change-out, and scheduled maintenance of Ticket Vending Machines
- **Approximately 60 hours of classes shall be conducted for up to 10 personnel.**
- **Shop Repair** – A selection of mechanics and electricians who will perform the periodic overhaul, remedial repair, and adjustment of TVM components, shall be given a comprehensive instruction course in the operation, troubleshooting, maintenance, repair (including printed circuit boards) and overhaul of the equipment. Software flow charts and descriptions of the operational software, including the variables that are programmed for possible changes, shall also be included in the instruction material. Approximately 100 hours of class shall be conducted for up to 10 personnel.
- **Revenue and Maintenance Workstation Operations** – Personnel who will operate the Revenue and Maintenance Workstations shall be trained in the use of all application programs and functions provided by the workstations. Included in this training will be the administration of TVM operating parameters, configuration files, ticket and display text, fare tables, and voice messages. Procedures to download data to TVMs, manually induce data polling, remotely control TVMs, monitor equipment status, and generate queries and reports shall be covered. Specific training how to use HHV reports to assess the productivity of fare inspectors shall be included. Approximately 60 hours of class shall be conducted for up to 5 personnel.
- **Administrative Workstation Operations** – Personnel who will administer the DCIS shall be trained in all aspects of FCNC and DCIS network administration. This course shall provide the fundamentals of administration of the FCNC operating system, application software, and relational database manager. All other functions supported by the Administrative Workstation shall also be covered, as shall the administrative tasks required to maintain communications to the Fare Collection Equipment and the workstations. Approximately 60 hours of class shall be conducted for up to 5 personnel.
- **TVM Accounting and Registration Information** – Those management personnel who will generate and use reports from the FCNC shall be trained to be familiar with report contents and uses. Using sample data created from testing intervals, reports shall be generated from the FCNC and used to explain the resulting data output. Information provided shall include how to use TVM sales reports to estimate ridership and revenue by ticket type. Approximately 24 hours of training shall be provided for up to 10 personnel.
- **IT Training** – Training shall be provided to fully familiarize City personnel with all aspects of the system software, including the structure of the applications, tables utilized, all network communications and settings, plus other similar information.

- The training plan and training documentation shall be approved prior to the training. The trainer for this course shall be technical in nature as the training will be highly technical and not end-user type training. At the conclusion of training, the involved personnel, including the Database Administrators, Programmer Analysts, Administrators, and Network Analysts shall have a thorough understanding of all aspects of the system.
- **Documentation** – The Contractor shall furnish the City with five (5) copies of complete written documentation describing all equipment and software to be furnished, including:
 - Brochures;
 - Product specifications for all computer equipment; and
 - Software descriptions.
 - All documentation described in this section shall be provided in hard copy and electronic formats. The electronic documents shall be delivered in the most current version of MS Word.
- **Functional Description** – A customized Functional Description shall be provided that contains a high-level definition of the hardware, data communications, software, and firmware, and the functions performed by each. The Functional Description shall serve as a complete introduction to the system.

TP-5.9.1.19 Final Design

The following information shall be included in the final design:

- Detail of the hardware configuration showing all major hardware and sub-systems. The overview shall include block diagrams in sufficient detail to show the inter-relationships of major hardware sub-systems and the elements that comprise them.
- A detailed description of the major hardware sub-systems, the elements that comprise them, their inter-relationships, and the functions they perform. Availability, processor performance, spare mass storage, and device redundancy shall be described.
- Detail of the major software sub-systems, describing the software, the inter-relationship of software within a sub-system, and the relationship between sub-systems.

High-level software block/flow diagrams shall be included to enhance the reader's understanding of the overall capability of the system. The sub-systems to be described shall include but not limited to:

- Operating systems
- Network software
- interfaces
- Support utilities
- Database
- Display, and report generation
- Data Communications systems
- A complete description of the software and the individual functions performed by the software. Significant features, concepts, and algorithms pertaining to each function shall be described, with special emphasis on equipment, software, and features unique to the system.

Software Documentation – The Contractor shall provide complete documentation for every aspect of the system

The documentation for each version of each program shall be complete and comprehensive to include, but not be limited to:

- Complete source code listings with fully documented statements
- Comprehensive flow charts

Block diagrams explaining the system as a whole and showing how the individual programs are inter-related. The software documents shall clearly identify what data elements are stored, the source of each data element, how data are structured, transferred and utilized. This shall include the software logic, processing rules, restrictions and exceptions, default conditions, hard and soft wired parameters and the overall process by which each of the reports specified is generated.

Data Flow Diagram and Database Tables – Data diagrams shall be developed. All programs shall be defined and described fully showing all inputs/outputs, samples of reports, logic flows and major functions described, as well as assumptions used during program development. Detailed functional requirements and schema diagrams shall also be provided.

TP-5.9.2 Technical Support

The Contractor shall provide factory technical support during installation and the initial 12 months of LRT revenue service. Technical support shall be provided on-site for at least 90 days following commencement of revenue service. On-site Contractor personnel are subject to the approval of the RE.

The support personnel shall assist in installation and troubleshooting and shall also act as field instructors for the City personnel who maintain, service, and use the Fare Collection Equipment data, and/or software.

From the date of FCNC installation through the expiration of the warranty period (including any extended warranties, if exercised), the City shall, at the Contractor's request, provide a suitable DSL line (VPN/VNC) for use by the Contractor to remotely communicate with the FCNC. The Contractor shall only be given access to this DSL line for limited periods of time as requested, and all activities to be performed by the Contractor shall be approved by the City prior to access being granted. Activities to be performed by the Contractor using the DSL line shall include remote monitoring, software debugging and updating, system administration assistance, and other activities as approved by the City. The Contractor shall supply modems or other communications hardware necessary to access the FCNC via the provided DSL line.

TP-5.9.3 Spare and Replacement Parts

The Contractor shall supply the quantities of spare and replacement parts listed in the Price Schedule.

In addition to the parts listed in the Price Schedule, the Contractor shall submit to the RE a recommended supplemental spare and replacement parts list. The recommended list shall identify supplemental parts necessary to achieve an adequate parts supply for a minimum of ten years from the start of revenue service. These additional parts shall consist of items specific to the Contractor's design that are not specified in the Price Schedule, and those subcomponents that are the most common causes of failure of major components.

Components that are subject to normal wear and vandalism shall also be identified in the supplemental list. The supplemental list of spare and replacement parts shall be supplied at the Final Design Review.

TP-5.9.4 Special Tools and Test Equipment

The Contractor shall supply all special tools, gauges, and test equipment necessary for the proper maintenance, repair, and adjustment of all supplied Fare Collection Equipment. Tools required to service and repair Fare Collection Equipment shall be small enough to fit into a maintenance tool kit that can be comfortably handled by a single individual. Any tool, gauge, or test equipment that is not found in the catalog or showroom of the following companies is considered a specialty tool or gauge:

- ACE Hardware
- Aero Quip
- AMP
- Black & Decker
- Black Hawk
- Grainger
- Hilti
- MAC
- Sears
- Snap-On
- Starrett
- Williams

Other companies will be considered if the Contractor can show that the tool or gauge is readily available within the USA states and such information is agreeable to the RE. Special tools, gauges, and test equipment shall be supplied prior to the commencement of Training. A description of these tools, gauges and test equipment will be supplied as well. These shall include but not be limited to:

Tools and Gauges

Two sets of all special tools and gauges needed for adjustment of the coin and bill acceptors, supplemental coin storage system and hoppers, and ticket and pass-issuing unit. Suggested suppliers for all special tools and gauges shall be provided.

Module Testers

Test equipment shall be provided which includes all necessary power and signal connections for diagnostic test and adjustment of all modules.

The testers may be integrated into the Fare Collection Equipment in the form of self-diagnostic routines, or may be provided as independent hardware, which diagnoses each assembly, or a combination of both configurations.

In either case, the testers shall permit a technician to conclusively determine if all aspects of a module are functioning correctly. The testers shall successfully distinguish between module failure and erroneous inputs, power supply failures, output signal loading, etc. The testing units shall provide all simulated signal inputs.

Printed Circuit Board Testers

Circuit board testers shall be provided for each circuit board contained within the Fare Collection Equipment. Extender boards shall be furnished for circuit board testing/repair if necessary to test a circuit board in place.

Alternately, circuit board test procedures may be incorporated into the module test units above.

Programming Equipment

The Contractor shall supply all necessary equipment and documentation to reprogram the fare collection equipment, or deposit all such material in a secure third-party escrow.

All test equipment shall be accompanied with maintenance manuals to the same level of detail as that supplied for the Fare Collection Equipment. The manuals shall permit the City to maintain and repair all test equipment without assistance from the Contractor.

TP-5.9.5 Maintenance Test Station

The Contractor shall deliver two spare TVMs to the MSF electronics shop. The Contractor shall connect this equipment, together with a Network Interface Unit (if applicable), into a station LAN. The Contractor shall also install the necessary communications equipment to connect the maintenance test station to the FCNC.

This maintenance test station shall appear to the FCNC as a normal station. All data from the test station shall be received by the FCNC and acted on accordingly. Additionally, as with any other station, it shall be possible to download all parameters to the maintenance test station.

Once the system is in revenue service, all TVM software and hardware updates supplied by the contractor shall be tested first in the maintenance test station before being propagated to the in-service equipment.

The Maintenance Test Station shall be installed at the same time as the equipment for the Pilot Station Test. The Maintenance Test Station shall then be used as needed for the training program.

TP-5.9.6 Component Serialization Program

All major parts and equipment are to have nameplates which identify the manufacturer, part nomenclature, part number and serial number. Part numbers and serial numbers shall be permanently stamped or engraved on the nameplate. Duplicate serial numbers shall not be utilized within a type or model series. The nameplate shall have provisions for applying bar coding data to identify the stamped or engraved part number and serial number. With the approval of the RE, a separate identification plate, permanently affixed to each serial numbered component, may be applied below the prescribed nameplate for the bar code data. The location of the nameplate and bar coding data shall be chosen for readability and scanning without disassembly of equipment or components other than normal maintenance access covers or removal of the component.

Serialized identification procedures are to be established by the Contractor for use in identifying part numbers and serial numbers of parts and equipment furnished by the Contractor and all subcontractors. The Contractor shall assign designated codes and blocks of numbers for identification of both Contractor and subcontractor part numbers and serial numbers. The serial numbering scheme to be utilized shall be subject to approval by the RE as part of the Final

Design Review. Within 30 days after the Final Design Review, the Contractor shall furnish for RE review and approval a list of the items to be serial numbered.

TP-5.9.7 Warranty Support

During the warranty period, the Failure Review Board as described in TP-5.9.7.3 shall meet regularly to review system performance and to classify failures. When the FRB determines that a failure is systemic and is caused by a design or manufacturing flaw, the Contractor shall provide suitable corrections in a timely manner.

Major systemic flaws, defined as follows, shall be analyzed and a corrective action plan shall be in place within 7 days of identification. Major flaws are those that cause the TVM to:

- Go out of service or prevent the TVM from issuing tickets.
- Issue incorrect change.
- Fail to issue a ticket without returning deposited money.
- Corrupt or fail to record transaction or event data.

Major flaws of the CDCIS are those that cause:

- The FCNC to cease functioning.
- Corruption of transaction or event data on the FCNC.
- Communications between the FCNC and TVMs to fail.
- Clock synchronization to be more than 5 minutes off.
- On-line alarms to be mishandled or ignored by the Security and Alarm.

Monitoring Application

Systemic flaws of lesser severity shall be corrected in a schedule as agreed upon by the FRB.

Unless deferred by the FRB, if a resolution to a systemic flaw is not identified within the time specified, the Contractor shall dispatch a qualified technician or engineer on-site until a resolution is found.

TP-5.9.7.1 Acceptance

TP-5.9.7.2 Revenue Service Acceptance Testing

The Revenue Service Acceptance Tests (RSAT) shall verify that the fare collection equipment satisfies the City's requirements for reliability, system accuracy, and maintainability.

The Contractor shall submit the procedures to be followed for the resolution of test problems, failure recurrence control and general test rules at least 60 days prior to revenue service. The Resident Engineer shall approve these procedures.

If the reliability, system accuracy, and maintainability requirements specified herein are not attained during the RSAT, the Contractor shall be liable to redesign, provide retrofit kits and furnish labor to correct and/or change the equipment at no additional cost to the City. The corrective action and/or the resolution of the problem(s) shall be subject to RE approval.

The equipment shall not be accepted until the Resident Engineer has approved the RSAT.

TP-5.9.7.3 Failure Review Board

During the first 30 days of revenue service, all normal operations for revenue service shall be carried out with reliability, system accuracy, and maintainability data being recorded and documented. A Failure Review Board (FRB) shall be established during design. The FRB shall include two representatives chosen by the RE and one representative from the Contractor. The FRB shall ascertain what constitutes a failure and what satisfactory corrective actions can be made to prevent recurrence. Failures shall be established in conformance with guidelines specified herein. The FRB shall review all data from this settling period and set ground rules for the Revenue Service Acceptance Tests (RSAT). The RSAT shall then begin and shall be conducted over the next 90 days.

The FRB shall convene weekly during the RSAT to review incident reports, classify failures, assess system accuracy, and calculate maintainability. (The Contractor's representative may attend the meetings via telephone.) The RE shall document results of each meeting. At the end of the 90-day RSAT period, the FRB shall make a recommendation to accept the equipment or to extend the RSAT as necessary.

Once the RSAT is completed and the equipment is accepted, the FRB shall continue to meet on a monthly or quarterly basis for the remainder of the warranty period. During this period, the FRB shall be responsible for monitoring adherence to reliability and system accuracy requirements.

TP-5.9.7.4 Revenue Service Reliability Monitoring

The City shall measure reliability on a continuous basis for the duration of the warranty period for each piece of fare collection equipment. All failures shall be recorded and the machine cycles shall be recorded on a regular basis in order that a continuous measure of relevant failures versus machine cycles and time can be made (MCBF/MTBF). The Failure Review Board shall make classification of failures as relevant or non-relevant.

In the event that the average measured relevant failure rate for any 90-day period during the warranty period exceeds the limits set forth in this Contract, the Contractor shall take corrective action. This corrective action shall be subject to RE approval. After corrective action has been taken and the failure rate and failure records indicate that the action taken was successful for a minimum period of 30 days (even if the reliability monitoring period has ended), the fix shall be deemed satisfactory. If not, the Contractor shall take further action until the failure rate is equal to or better than the specified requirements.

Reliability of the Fare Collection Equipment system shall be evaluated in terms of Mean Cycles Between Relevant Failures (MCBF) or Mean Time Between Relevant Failures (MTBF), whichever condition occurs first. To assure a common basis of comparison, the number of ticket vending cycles shall be used as the reference point for the TVMs. The following definitions of failures shall be used in determining the performance of the equipment:

Relevant Failure – A malfunction that prevents the machine from performing its intended function with the performance criteria specified. Relevant failures include: verified failures including intermittent failures, not excluded under non-relevant failure types; and failures due to design errors or manufacturing defects.

Non-Relevant Failure – A malfunction caused by conditions external to the machine or subsystem. Non-relevant failures include:

- Accident/vandalism, maintenance errors, bent coins, and customer error.

- Failure of expendable items, which have exceeded specified life.
- Dependent or secondary failures resulting from a primary failure.

In addition, the FRB shall review failure data and identify those failures that are systemic due to design flaw or manufacturing defect. Systemic flaws shall be resolved in the manner and time periods defined herein.

TP-5.9.7.5 Reliability Requirements

The following minimum reliability criteria shall be met by the fare collection system and shall become applicable after the first 90 days of revenue service.

TP-5.9.7.6 Ticket Vending Machine Reliability

Ticket vending, including coin and bill acceptance and change making functions, shall meet either the MCBF or MTBF criteria listed below, whichever occurs first:

- MCBF of 10,000 cycles
- MTBF of one failure per TVM per 60 days, calculated as an average of all machines in service over a period of 90 days.

TP-5.9.7.7 Network Interface Unit Reliability

If the Contractor’s design requires a Network Interface Unit, it shall meet the following MTBF criterion.

- MTBF of 1 year taken as an average of all NIUs in service calculated over a period of 90 days.

TP-5.9.7.8 Fare Collection Network Controller Reliability

The Fare Collection Network Controller shall consist of equipment from a major computer supplier. To insure adequate reliability and availability, the Fare Collection Contractor shall provide equipment that includes at least a one-year on-site repair service warranty from the manufacturer or its designated third party representative.

Table 9-2. Reliability, Accuracy, and Availability Requirements

	TVMs	Network Interface Unit	Data Transmission Network and FCNC
Reliability	10,000 MCBF	200 Mean Days Between Failures	3 years from date of purchase
Accuracy	99.5% Aggregate –individual units may have specific Accuracy requirements discussed in the specification	100%	100 %
Availability	99.7%	99.95%	99.95%

TP-5.9.7.9 Maintainability Requirements

Fare collection equipment shall be designed to be easily maintained, repaired, and restored to service.

TP-5.9.7.10 Preventive Maintenance

Fare collection equipment shall require preventive maintenance no more than once per month or 10,000 transactions, whichever occurs first. Each preventive maintenance visit shall be capable of being performed by one technician in less than 60 minutes.

TP-5.9.7.11 Corrective Maintenance

The mean time to repair or replace (MTTR) a defective part or module in the fare collection equipment shall not exceed 45 minutes from the time the maintenance technician opens the door to the device, until the door is closed and the device is returned to fully serviceable operation.