# SECTION 34 50 10

# FARE COLLECTION SYSTEM

## PART 1 - GENERAL

### 1.01 SECTION INCLUDES

A. Fare Media

B. Environmental Requirements

C. Equipment Requirements

D. Software

E. Data Communication Interface

### 1.02 MEASUREMENT AND PAYMENT

A. General: Fare collection system, as specified herein, will not be measured separately for payment but will be paid for as part of the Contract lump sum price for the related item of work in the Bid Schedule of the Bid Form.

### 1.03 REFERENCES

A. International Electronics Commission (IEC)

1. IEC-801-2 Electrostatic discharge

B. Military Specifications:

1. MIL-STD-461C Electromagnetic Emission and Susceptibility Requirements for Control of Electromagnetic Interference, Notice 2

2. MIL-STD-462 Test Methods for Electromagnetic Emission and Susceptibility

C. BART Technical Documents

1. Exhibit B - Contract Data Requirements List

2. Exhibit E - BART Ticket Specifications

3. Exhibit Q - Ticket Encoding and Reading Specifications

4. Exhibit J - Faregate Ticket Processing Requirements

5. Exhibit R - Ticket Data Format

6. Exhibit M - Station Network Interface Specification, Version 3.1, dated 23 Aug. 93

7. Exhibit N - DAS Interface Specifications, Data Format (VEI)

## 1.04 DESCRIPTION

A. General: Automatic Fare Collection items of equipment include the following:

1. Ticket Vending Machines (TVM)
2. Fare Gates
3. Addfare Machines (AFM)
4. Bill to Bill Changers
5. Intermodal Transfer Machines
6. Paid Parking Machines
7. Cash Carts

## 1.05 SUBMITTALS

A. General: Refer to Section 01 33 00 - Submittal Procedures, and Section 01 33 23 - Shop Drawings, Product Data, and Samples, for submittal requirements and procedures.

B. Submit the following:

1. Conceptual Design Submittal

   a. General description of the major sub-assemblies including identification of components supplied by subcontractors for each type of equipment.

   b. Preliminary internal layout of sub-assemblies for each type of equipment.

   c. Preliminary layout of the front operating panels for each type of equipment.

   d. Functional block diagram of the system and equipment.

   e. Catalog cuts of the following modules: Customer Interface Module including Main Display Unit, soft keys and numeric keypad; bill validator, bill escrow, and bill vault; coin system; smart card interface device; credit/debit card module and the equipment CPU.

   f. Outline and format of customer interface messages.

   g. Identification and description of all interfaces between the major sub-assemblies.

   h. Identification and description of all interfaces between the AFC equipment and the existing station equipment including DAS interfaces.

i. Identification and general description of all functions, data elements and messages to be supported by the VEI communications protocol and DAS.

j. Information and decisions required from the District.

k. Physical dimensions of each type of equipment.

l. Power and other facility requirements of each type of equipment.

m. Plans, programs and other data related to management, training, manuals, quality assurance, reliability assurance and configuration control.

2. Preliminary Design Submittal

a. Detailed technical description of operation for all major subassemblies in all units of equipment.

b. Complete customer interface drawings, flow charts, screens graphics, messages and menus, including accommodation of all operating boundary and error conditions.

c. Voice database.

d. Sample tickets with encoded magnetic stripe.

e. Software flow charts down to 3 levels of detail.

f. Hard-wired communication interface.

g. A detailed description of the DAS interface including:

1) Identification and detailed description of all VEI dialogs required to meet the network functionality of the AFC equipment. The description shall include the structure, format and content of the dialogs.

2) Identification and detailed description of all data items, data values, and control functions to be implemented in the VEI communication protocol and DAS to meet the operational and data reporting functionalities of the AFC equipment. The description shall include the format and value of the data elements and control functions.

3) Identification and description of all VEI protocol layers (i.e., Transport, Session) required conforming to the AFC equipment network functionality.

h. Single line power diagrams, control schematics, and functional block diagrams for each subsystem.

i. Evidence of operational and physical compatibility with the existing equipment and equipment installations.

j. Design of the access control to the equipment and to the software menus.

k. Plans, programs and other data as specified in Exhibit B, Contract Data Requirements List, including front panel Human Factors evaluation and draft screen flow charts and display messages.

l. Faregate ticket processing algorithms as specified in Exhibit J, Faregate Ticket Processing Requirements.

3. Final Design Submittal

a. Latest revisions of the drawings, documentation and samples that were submitted at the CDR, PDR and MDR.

b. Complete production drawings for each type of equipment

c. Electrical schematic drawings, down to the individual signal and component level.

d. Complete baseline software and preliminary software documentation for each type of equipment.

e. Fully operating ticket handling mechanism

f. Demonstrated compatibility of BART Blue, BART Plus and Student tickets encoded by the new equipment with existing system.

g. Demonstrated compatibility of new equipment with tickets encoded by existing equipment.

h. List of maintenance service commands, codes and messages.

i. Fully operating smart card components.

j. Plans, programs and other data as specified in Exhibit B, Contract Data Requirements List.

k. Latest revisions of the DAS interface description submitted at PDR.

C. Equipment Mock-up Arrangement.

D. Operations and Maintenance Data: Submit maintenance data and operating instructions in accordance with Section 01 78 23 - Operations and Maintenance Data.

E. Test Reports: Submit certified factory and field test reports.

## 1.06 QUALITY ASSURANCE

A. General: Refer to Section 01 43 00 - Quality Assurance, and Section 01 45 00 - Quality Control, for general requirements.

## 1.07 EXISTING SYSTEM DESCRIPTION

A. General: The existing automatic fare collection equipment is a stored-value, distance-based system. The system is a closed-barrier type which requires a ticket for both entry and exit. Depending on the ticket type, the ticket value can range from $0.05 to $315.00 in $0.05 increments. Fares as of April 1, 1997 range from $1.10 to $4.80 depending on trip length. Statistical, performance and financial data from the AFC equipment are collected via the Data Acquisition System (DAS). The DAS consists of hardware and software: a remote computer at selected stations, a master computer at a central location and additional computers at other District locations. AFC items of equipment are connected within the station by a local area network (LAN). LANs, remote computers, and central computers are connected together by a wide area network (WAN).

B. Ticket/Equipment Process. The fare media is a paper ticket of credit card size, containing all information necessary for passage encoded on its magnetic stripe. The AFC equipment reads and writes information on the stripe, as necessary. Ticket Vending Machines (TVM) are located in the free areas of stations. The TVM accepts coins, bills, and credit and debit card as payment and issues a ticket for the amount selected; it encodes the ticket for entry. Fare gates are located to separate the free and paid areas of stations. The entry gate establishes the station of origin and other control information for a particular trip; it encodes the ticket for exit. The exit gate subtracts the fare from the ticket value based on the entry station. Add fare machines are located in the paid areas of stations. The addfare machine allows value to be added to certain tickets if the remaining value is less than the required fare at exit. The AFC equipment is designed to handle multiple ticket formats. The first and most common format is the "BART Blue" ticket, for adult, not-discounted fare. The second is the BART discount format used for children, seniors, and disabled tickets. The third is the "BART-Plus" ticket that is a combination flash pass on buses and stored-value ticket for use on BART. BART-Plus tickets are sold by TVM in selected stations. The AFC equipment is also designed to process a student ticket and the MUNI Fastpass. Refer to Section 2 and Exhibit R for additional information on ticket types.

C. Generations of Equipment. There are three generations of existing equipment. The first-generation equipment was provided by IBM in 1972-3. The second-generation equipment was provided by Cubic Western Data (Cubic) in 1974-5. The third-generation equipment was provided by Scheidt and Bachmann GmbH (S&B) in 1995-7. Functionally, the Cubic equipment is virtually identical to the IBM equipment, except that change can be returned from the ticket vendors and addfare machines when a ticket transaction is involved. The second-generation equipment was enhanced primarily for treasury activities such as bulk loading coin hoppers and bill stackers. Dedicated money changers located in both the free and paid areas of each station provide change for the IBM equipment. IBM and Cubic TVM and AFM accept bills and coins for payment and issue BART Blue tickets only. The S&B equipment includes TVM, AFM and fare gates in the five recently opened stations, and Credit/Debit Vendors (C/DV) in 20 of the original 34 stations. The S&B TVM accept bills, coins, credit or debit card for payment and give change. The AFM accept bills and coins for payment and give change. The S&B Credit/Debit Vendors accept bills and credit or debit cards for payment. Scheidt and Bachmann's TVM and Credit/Debit Vendors issue BART Blue and BART-Plus tickets.

## 1.08 DESIGN REVIEWS

A. Design reviews will be conducted by the Engineer to evaluate the progress and technical adequacy and conformance of equipment design with Contract requirements. Each design review shall include a design review submittal and a design review meeting. For each design review, a design package shall be submitted that includes all documents listed. The District will review the documents and discuss its comments during the design review meeting. The design review meeting will be scheduled by the Engineer approximately two weeks after the design review submittal has been received by the Engineer. District comments shall be incorporated on the next design review submittal. Design reviews shall occur in the following chronological order:

1. Conceptual Design Review. The Conceptual Design Review (CDR) shall evaluate system concept and design approach and discuss District's comments on the conceptual design package submittal.

2. Preliminary Design Review. The Preliminary Design Review (PDR) shall evaluate further the progress and adequacy of the equipment and contract requirement compliance. District's comments on the preliminary design review package submittal shall also be discussed during the PDR.

3. Mock-up Design Review: The Mock-up Design Review (MDR) shall evaluate the actual layout of the equipment and samples of selected modules and assemblies. The MDR shall include at least the following items:

   a. Mock-ups shall be implemented with real equipment. If real equipment is not available, the mock-ups shall be implemented using full size, colored, and scaled drawings of each piece of equipment, including exterior and interior. The drawings shall be mounted on plywood or foam core panels for "touch and feel" evaluation by the District.

   b. Samples of the following modules: Message Display Unit, numeric keypad, keys, bezels, coin return cup, bill validator/escrow/box, bill dispensing device, bill cassette, coin system, money containers, ticket handling system, credit/debit module, voice module, smart card module, locks. For gates: operating barrier, customer displays.

   c. Presentation of front panel layout and operation, including all screen flow charts and display messages.

4. Final Design Review. The Final Design Review (FDR) shall evaluate the detail design and the production drawings for the equipment. The FDR is the mechanism for determining whether the detailed design has a high probability of meeting all the design requirements, subject only to the results of any following tests or audits such as the pre-production tests, the reliability test during revenue service, and reliability and data accuracy audits.

5. Pre-Production Review. The Pre-Production Review (PPR) shall evaluate actual operation and performance of the pre-production equipment in an in-service environment.

   The PPR shall provide the basis for the Engineer's release of manufacturing of the production equipment. Pre-production equipment approved as noted shall be the Production Configuration Baseline. All changes to the Production Configuration Baseline shall be controlled by an Engineering Change Proposal covered in a Configuration Management Program.

   The PPR shall include at least the following items:

   a. Fully operating units for each type of equipment in the quantities and locations indicated.

   b. All interfaces fully operating.

   c. All software and firmware fully operating.

   d. Customer Interface Finalized.

   e. Cash carts, special tools and test equipment in the quantities and locations indicated.

6. Equipment Placement Details Review: The Equipment Placement Details Review (EPDR) shall be held to evaluate the placement details and resolve issues resulting from the District's review of placement drawings and documents. The EPDR shall evaluate at least the following items:

   a. Physical mounting items, including base plates, lifting procedures, and filler panels for each type of equipment;

   b. Electronic/electrical interfaces; and

   c. Installation/cutover plan.

## 1.09 PACKAGING, HANDLING, TRANSPORTATION, AND DELIVERY

A. Standards. Packaging, handling, transportation, and delivery of AFC equipment shall conform to the following standards:

1. ASTM 3951 Standard Practice for Commercial Packaging.

2. NMFC National Motor Freight Classification.

3. Uniform Freight Classification.

# PART 2 - PRODUCTS

## 2.01 FARE MEDIA

A. Ticket Processing: AFC equipment shall be designed to accommodate magnetic stripe tickets manufactured in accordance with the BART ticket specifications indicated in Exhibit E; and shall process tickets in the same manner as the existing AFC equipment.

B. Ticket Reading and Encoding: AFC equipment shall be designed to process tickets encoded to the specifications indicated in Exhibit Q, Ticket Encoding and Reading Specifications, and shall meet the following requirements:

1. Read and verify data only from track 2 of magnetic stripes that conform to the stripe width specification of ISO 7811-5, international standard for 3-track magnetic stripe ticket.

2. Write full width on magnetic stripes that conform to the stripe width specification of ISO 7811-5.

3. Capable of being easily modified to read/verify and write tickets with data densities of either 120 bits per inch or 190 bits per inch in an intermixed fashion in the same ticket handling mechanism.

4. Write starting at a predetermined position on the magnetic stripe; and

5. Write at a 5-degree angle.

6. The algorithm used by the AFCE to find valid data records from the read-in ticket data shall conform to the method described in Exhibit J, Faregate Ticket Processing Requirements. Supplier shall provide the design details for this algorithm for District review and approval during PDR.

C. Ticket Formats: The encoded information includes such data as station of origin, time, ticket type, and remaining value on the ticket. Ticket formats are summarized in Exhibit R, Ticket Data Format. Detailed information on ticket formats will be provided to the Supplier after Contract Award and upon execution of a confidentiality agreement. The AFC equipment shall process the following types of tickets currently in use in the BART system:

1. BART Blue Ticket: Basic ticket used by the majority of BART customers. It is valid only on BART. The ticket value can range from $0.05 to $79.95 in $0.05 increments. It is not time-limited.

2. BART Red Ticket: Discount ticket for disabled and youth. It has the same encoding format as the BART Blue Ticket except for the ticket type code.

3. BART Green Ticket: Discount ticket for Senior Citizens. It has the same encoding format as the BART Blue Ticket except for the ticket type code.

4. BART Plus Ticket: Joint ticket between BART and several other transit agencies in the San Francisco Bay Area. The BART Plus Ticket is used as a stored-value ticket on BART, and as a flash-pass on nine other transportation agencies. It is time-limited both on BART and the other agencies to a one-half month period with a few days grace period at the end of the period.

5. Muni-Fast Pass Ticket: Monthly pass issued by the San Francisco Municipal Railway (Muni), valid for unlimited travel on BART and Muni within the city limits of the City and County of San Francisco.

6. Student Ticket: Discount ticket for students. It has the same encoding format as the BART-Plus Ticket except for the time-limitation.

## 2.02 ENVIRONMENTAL REQUIREMENTS

A. General: AFC equipment shall be designed to conform to the environmental requirements specified herein. The Supplier shall be responsible for acquiring all data on pertinent conditions that exist at the sites and shall assure by test, analysis, or field records that the AFC equipment operate properly under these conditions. AFC equipment shall be designed in accordance with IEC-801-2, MIL-STD-461C, and MIL STD-462.

B. Electrical Environment. AFC equipment shall be immune from electromagnetic interference and electrostatic discharge. Transmission from the AFC equipment, either radiated or conducted, shall not cause interference to other systems within the BART system or other nearby systems. The Supplier shall provide certification of all tests conducted in accordance with accepted standards and provide details of the test and test results. Existing analysis and data on EMI susceptibility and EMI conductive or inductive radiation of the proposed equipment, properly documented and verifiable applications that are identical may be used for this purpose.

1. Definitions

   a. Electromagnetic Compatibility (EMC) is defined as the proper operation of all AFC equipment and sub-systems in the presence of potentially interfering electromagnetic noise or signals from other sub-systems such as traction power or communications, or from the ambient Electromagnetic environment of the District system.

   b. Electromagnetic Interference (EMI) is defined as interference generated by the AFC equipment on other equipment such as the communications system, signaling system, or any equipment located within the District's stations.

2. EMC Program. An EMC Program shall be submitted for approval during the Final Design Review. The Supplier shall apply the EMC program requirements to all equipment systems and subsystems. All equipment, whether taken individually or in groups, shall comply with the EMC requirements for all modes of operation. The Supplier shall work with the District and other equipment suppliers to resolve any EMC problems discovered during execution of the Contract. The Contractor shall conduct an Electromagnetic Compatibility (EMC) Program consisting of the following elements:

   a. Determination of the District's EMC environment.

   b. Analysis of the EMC design characteristics, emissions, susceptibility, and margin of AFC equipment.

c. Analysis of EMC impacts.

C. Temperature and Humidity. AFC equipment shall function normally between an ambient temperature range of 10°F to 122°F and in a relative humidity range of 5 percent to 95 percent, non-condensing. The equipment shall be tested at the limits of the realistic combinations possible between temperature and relative humidity and at the primary voltage tolerances of plus and minus 10 percent. Performance shall not be affected by any increase in internal temperature caused by the rigors of the test program, such as constant cycling over long time periods.

1. The AFC equipment shall function normally within the ambient maximum temperature while exposed to direct sunlight for up to 8 hours.

2. The AFC equipment shall be sealed and protective compounds used for sensitive internal components to avoid an increase in the humidity or potential damage to the inside of the AFC equipment that could be caused by salt laden fog, water seepage through the concrete from water sprinklers, floor scrubbers and devices existing in the operating environment.

D. Noise. AFC equipment shall not cause a sound pressure level, above the ambient, of more than 65 db on the "C" scale at 3.0 feet in any direction except audible prompts or messages.

E. Seismic Protection. No equipment, rack, assembly, module nor component shall become loose, nor shall it fail to meet operating requirements, after being subjected to a gradually applied force equal to 0.25 times its weight applied in any direction approximately through its center of gravity or seismic loading equivalent to 1.5g horizontal and 1.0g vertical acceleration, whichever is more severe.

F. Shock and Vibration. The Supplier shall verify that the shock and vibration limitations of the equipment or any part of the equipment are not exceeded. The design and construction of the equipment shall be such that the usual shock and vibration levels experienced during transportation by rail, truck or airplane shall have no damaging effect on the equipment. This assumes that no special precautions are taken other than solid anchoring of the cabinet and special packaging internally to prevent damage. After placement, the equipment shall operate normally under the following conditions:

1. Continuous vibration at a frequency range between 0 and 6 Hz and at an acceleration level up to .01g.

2. Intermittent shocks of up to 0.1g, not exceeding 20 millisecond duration, half sine wave, and repeated at intervals of 0.5 to 2.0 seconds.

G. Dust: AFC equipment shall maintain normal operation when exposed to Eolian particles, including brake shoe dust and normal dust present in a rail system environment, both abrasive and non-abrasive, including electrically conductive dust and salt-laden air. Suitable enclosures shall be provided inside the equipment for sensitive components such as printed circuit boards and memory storage device to prevent abnormal operation resulting from dust particles that could be as small as 1 to 200 microns, with a maximum concentration of 0.248 mg/cm3. Where possible, positive air pressure shall be used to reduce the dust intake.

Filters shall be used where positive air pressure is not adequate to block the entry of dust particles as described above.

H. Exposure to Sunlight. Measures shall be taken to minimize the effects of direct sunlight on the ticket vendors, addfare machines, and gate consoles. The use of sculptured buttons, high intensity light, surface grain depth and direction shall be employed to enable easy readability and operation in order to minimize the time for a transaction. In order to minimize problems caused by solar heat or bright light, the Supplier shall consider the following factors in the design: selecting components with a storage temperature range at least 20oF above the maximum working temperature expected; turning on fans automatically; using tilt angled surface orientation, texture, and covers to reduce reflections and glare; using graphics and display types that are readable under all natural and artificial light conditions. Components sensitive to ultraviolet and visible light radiation shall be protected at all times, and the equipment shall be resistive to damaging effects from this type of radiation, including when the front door is open for maintenance and servicing activities.

## 2.03 EQUIPMENT REQUIREMENTS

A. Compatibility: Automatic fare collection equipment shall be compatible with and function as an integral part of the existing AFC system. Compatibility factors shall include, but not be limited to the following:

1. Provisions for purchasing tickets using credit or debit cards.

2. All money collected or used for re-supply shall be contained in locked metal boxes.

3. Increased use of microprocessors for control of individual components, modules, and sub-assemblies, and for menu driven instructions.

4. Increased ability to identify faults with self-diagnostics and self-clearing capability.

5. Strict control of access by the use of keys, codes, and Personal Identification Numbers (PINs).

6. Retaining critical revenue information in memory as backup for later processing if necessary.

7. Statistical, treasury, maintenance, alarm and operating data shall be provided at the equipment and transmitted to DAS.

8. Capability to automatically receive downloaded commands and parameters from the DAS such as fare table changes, gate configuration changes, operating parameters, synchronization of clocks, employee PIN codes, and performance control.

9. Ticket vendors and addfare machines shall have the capability to issue change.

10. Tickets dispensed from a roll.

11. The TVM shall have the capability to dispense a minimum of two ticket stocks, and have the capability to encode and print a minimum of two types of ticket formats,

including not only "BART", but also the "Universal" format used by the BART-Plus and the student tickets, on either stock.

12. Coin recycling (re-circulation) in both the TVM and AFM.

13. All fare gate aisles shall be reversible.

14. Conformance with the American with Disabilities Act (ADA) of 1990 and implementing regulations, the Americans with Disabilities Act Accessibility Guidelines (ADAAG), and the State of California Code of Regulations, Title 24.

15. The TVM, AFM and gates shall process a new regional fare media (TransLink) using a combination contact/contactless smart card technology.

16. Ability to issue a printed receipt that documents credit or debit transactions in accordance with Data Encryption Standard (DES) and financial services industry requirements.

17. Ability to issue a printed receipt that documents the bill and/or coin container and contents removed from a machine during treasury servicing.

18. Ability to issue printed diagnostics of machine parameters and performance.

B. Power and Voltage Requirements: AFC equipment shall operate from a single-phase power source of 277 VAC plus or minus 10 percent, 3-wire, 60Hz plus or minus 1.0 percent and 1000 volt amperes per unit maximum. Primary power shall be available at the base of the equipment. Any conditioning of the primary power or the addition of line interface filters or power supplies shall be the responsibility of the Supplier, and if required, shall be located within the equipment enclosures. The power consumption of each type of equipment shall be provided at the Conceptual Design Review. Two 115V, 15 amp Ground Fault Interrupt (GFI) convenience outlets and power breaker switches shall be provided inside each unit of equipment.

C. Physical Characteristics: The physical characteristics of the new AFC equipment shall be such that equipment can be installed in locations of current AFC equipment on existing bases without vault or floor modifications. Fill-in panels made of like material, strength, and finish shall be provided for new ticket vendors that are physically smaller than the existing equipment. The panels shall be attached to the vendor and designed to fit flush with the station wall and overlap the top and sides of the vault as indicated. Equipment dimensions and clearance requirements shall be as indicated. Supplier shall verify by field measurements actual placement characteristics, prior to Conceptual Design Review.

D. Security Provisions: The equipment shall be designed with features that deter revenue losses from the following:

1. Acts such as altering, copying, or counterfeiting the magnetic stripe tickets;

2. Theft of money or tickets with value from inside the equipment;

3. Theft of money from outside the unit of equipment extending from manipulations, tricks, and counterfeiting and copying of bills and coins to physically breaching into the equipment;

4. Theft from unauthorized changes to the software;

5. Theft from breaking the multi-pin locking concept or circumventing security access controls and PINS;

6. Theft from manipulation of printed circuit boards; and

7. Theft from falsification of records. Provisions shall be made to allow entry at the internal keypad of pre-printed ticket serial numbers to track the ticket supply in order to identify any variances between the tickets dispensed and the tickets used in resupplying the TVMs and the exit gates.

E. Stand-Alone Operation: Individual units of AFC equipment shall be capable of operating in a stand-alone mode. Any breakdown in cabling or communication links between units of equipment or computer installations in stations or at the Central office shall not affect or be noticed by customers using the equipment. The exception shall be credit and debit card transactions that shall be inoperable whenever communications to the bank are lost. In case of a communication system outage, all data that is normally transmitted to DAS shall be stored by the individual units of equipment until they are ready for later automatic transmission when the interruption in communication is corrected. Faregate equipment shall not go out of service due to a full memory condition. Parameters, normally downloaded from DAS shall be loadable locally, directly at the unit using the specified PC Notebook. Upon entry of the proper password, it shall be possible to upload from the unit of AFC equipment to the PC Notebook all of the locally stored information pertaining to access to the machine, maintenance and service event, financial data (money and credit/debit) and individual customer transaction.

F. Modular Design: Modules, subsystems, assemblies, subassemblies and components shall be of modular design for ease of maintenance and interchangeability, and shall conform to the following requirements.

1. Interchangeability: Modules performing identical functions shall be interchangeable. Electrical and mechanical components shall be packaged together in shop repairable and field exchangeable modules according to the function they perform.

2. Maintainability: All components shall be packaged in replaceable and repairable modules. Standard hardware and components shall be used for flexibility and ease of maintenance. Special customized carrying cases shall be provided to avoid damage to sensitive modules, as necessary, in quantities sufficient to support the level of maintenance required. Standardized commercially available hardware and components shall be used to achieve flexibility in use and to facilitate maintenance. There shall be sufficient latitude in the operating tolerances to permit the removal and replacement of modules without the necessity of making any electrical or mechanical adjustments. The use of standardized commercially available hardware and components shall not relieve the Supplier of the requirement to furnish spares for and

to provide training in, the operation, maintenance, documentation, and repair of such hardware and components.

3. Weight Limitation: Modules requiring removal for off-site maintenance shall be limited to 50 pounds. Modules weighing more than 20 pounds and requiring on-site maintenance within the equipment structure shall be provided with hinges or roll-out slides.

4. Categorizing: Because different fare collection equipment require a different mix of modules, the modules shall be categorized as part of an assembly consisting of one module or a number of modules working together to perform a single function. The modules shall be identified as follows:

   a. Central Microprocessor Module;

   b. Coin System Module;

   c. Credit/Debit Card Module;

   d. Power Supply Module;

   e. Ticket Transport Module;

   f. Bill Handling System Module;

   g. Security Module;

   h. Customer Interface Module; and

   i. Smart Card Module.

5. Money Containers: Money containers shall be self-locking upon removal from equipment. Each container shall have a unique electronic ID that shall be automatically recognized when the money container is inserted into the equipment. Containers shall be ergonomically designed with no sharp edges, narrow handles or corners. Containers shall also be bar coded. Currency and coin shall be easily filled and emptied with minimum handling.

G. Maintainability: AFC equipment shall be designed to allow maintenance by BART staff. Preventive maintenance shall be allowed to be performed in the field to enable identification and isolation of a failed replaceable unit. The failed unit will be replaced to correct the failure and the unit will be sent to a BART maintenance facility for further failure analysis to determine the specific cause of failure and appropriate action.

1. Field Maintenance:

   a. The design and fabrication of the equipment shall be such that routine preventive maintenance, diagnostic troubleshooting, minor repairs, and removal and replacement of modules and assemblies can be accomplished in the field. Repairs of modules will be the responsibility of the District's secondary maintenance

personnel. Software diagnostic routines shall be the primary method of isolating failures down to the module level. This shall include self-diagnostics with display of failure codes. Unsoldering shall not be required to remove replaceable modules or consumable items. Disconnection of wires from a replaceable unit shall be accomplished by the use of connectors.

b. The primary objective shall be to reduce equipment downtime by readily removing and replacing the malfunctioning module(s) in the field. In the event replacement cannot be performed immediately and the equipment is able to remain in service, the equipment shall revert to a "degraded" operating mode. In this mode, any openings in the front panel that access the malfunctioning module(s) shall be covered or blocked to permit continued use of the equipment without increasing its susceptibility to damage.

2. Troubleshooting Aids: The primary troubleshooting aid for field diagnosis shall be the use of the failure codes. All possible failures shall be uniquely coded so that the failure can be isolated to the faulty module or subassembly. The Supplier shall demonstrate this capability on each type of equipment in a demonstration test. The Engineer and Supplier will introduce failures at random for this demonstration. Upon request from a technician using the service keyboard, the failure codes shall be displayed on either a flat panel screen or an LCD or LED display. Each displayed failure code shall be accompanied by a brief text description of the failure. A PC Notebook as shall enable cycling of the equipment around a particular set of software instructions to isolate a problem. Failure codes shall be transmitted to DAS with a date and time stamp. The number of failure codes to be provided shall be related to the complexity of the unit of equipment. The ticket vendor, for example, shall have at least 100 failure codes that constitute a level of reference for the other AFC equipment. The most recent 100 error codes shall be stored in local non-volatile memory and shall be retrievable through the PC Notebook and the service keyboard. The failure codes shall be retrievable after a power loss or CPU reset, and shall be comprehensive and detailed and shall include, but not be limited to, such failures as:

a. Decoding error;
b. Ticket jam;
c. Sequence error in handler;
d. No response from subassembly;
e. Check sum error;
f. Full memory;
g. Wrong parameter;
h. Inconsistent header;
i. Record read impossible;
j. Accounting error;
k. Cashbox/coin box removed illegally;
l. Transmission error;
m. Disk error;
n. Not initialized; and
o. File error.

3. Self-Diagnostics and Self-Clearing: Self-diagnostics shall be employed to the maximum extent possible to assure the highest possible availability. Standard

diagnostic programs shall be provided for computer hardware and software programs. Customized diagnostics shall be employed to assure such items as all modules in place, communications link up, non-computer electronics working properly, battery backup ready, and monitoring of wear for signs of deterioration. The Supplier shall indicate in the Operations and Maintenance Manuals how the tests are initiated and provide a complete definition of the results of the tests and ranges of the possible results. A problem detected by self-diagnostics and problems occurring during a transaction shall be subjected to automatic resolution before the offending subsystem or the unit of equipment is removed from service. Automatic resolution shall be peculiar to each subsystem, module, or component and shall be employed in such situations as:

a. TVM ticket invalid on first attempt and sent to the reject bin. Resolution shall be to try two more times to dispense a ticket.

b. Coin jam in hopper. Resolution shall be to attempt to clear by reversing the motor several times.

c. Bill jam in validator, escrow or stacker. Resolution shall be to attempt to clear by reversing motors where possible for less than a second several times and continue trying to move the bill in one direction or the other.

d. Communication session failures. Resolution shall be to automatically restart the session with the host.

e. Computer reinitialization occurs too frequently and requires excessive time to perform. Resolve by reducing the requirements to reinitialize and accomplish reinitialization, when it becomes necessary, in less than 10 seconds.

f. Ticket jam in Ticket Transport. Resolution shall be to attempt to clear jam by reversing motors where possible for less than a second several times and continue trying to move the ticket in one direction or the other.

4. Fingertip Maintenance: AFC equipment shall be designed to facilitate Fingertip Maintenance of jammed bills/coins/tickets. Areas that are susceptible to jams such as the Bill Validator/Escrow, Coin Acceptor/Escrow and ticket handling mechanism shall be easily accessible by the station agent for the purpose of clearing the jammed media.

5. Shop Maintenance: The design and fabrication of equipment modules shall be such that detailed failure analysis of failed modules and repair of such modules can be accomplished by BART maintenance personnel. The Primary Maintenance Test Bench (see Article 7.5) is intended to identify faulty modules and submodules and to check their proper operation after repair at the Secondary Maintenance Test Bench. The Secondary Maintenance Test Bench (see Article 7.6) is intended to be used to isolate module failures to a specific failed component or components on a module or submodule. The equipment and modules shall be designed and fabricated to be completely maintained and repaired at the component level. Shop maintenance to the component level is defined as analyzing and replacing the defective circuit parts to the lowest possible level of an assembly. An example of this would be: in the case of a printed circuit board assembly, removing and replacing integrated circuits, transistors

or resistors. The Secondary Maintenance Test Bench shall assist the technician in diagnosing failures within the printed circuit board assembly.

H. Computer Clock: A quartz clock shall be furnished in each unit of equipment to provide clock and calendar information through at least Year 2038. The clock shall have battery back-up in case of power loss. It shall be possible to synchronize or set the clock remotely from DAS or locally using the AFC equipment's internal service keyboard. The clock shall automatically account for leap year, days of the month, and daylight saving time. The change to daylight saving time shall be made whenever an execution command is received from DAS. The accuracy of the clock shall be plus or minus two seconds per month.

I. Locks and Keys

1. General: Lock and key configurations for all doors and internal components shall retain the present concept of designating a separate key for each of the three categories of Operations and Maintenance, Treasury, and Revenue as described herein.

2. Door Key and Lock Cylinder. The lock cylinder shall be case hardened, steel, maximum security types as manufactured by Abloy, or equal. The lock cylinder combination shall be easily changed on the cylinders already installed. At least 150 different combinations shall be possible. The key combination shall be exclusive to the District. The key and lock cylinder manufacturer shall have provisions to register and control the key combination and its distribution around the world. The key shall not be able to be duplicated on equipment normally found in local Keysmith facilities. The keys shall be registered by means of confidential signature cards. The manufacturer shall not supply or sell key blanks for duplication or any other purpose. The keys shall be shipped separately from the cylinders and by registered mail. Construction cylinders shall be used by the Supplier until final acceptance or revenue service, whichever occurs first. The design and construction of the key shall be strong, rugged, unique, and virtually immune to breaking or deforming under the vigor of every day use. The cylinder drum shall be self cleaning. As an alternative to the construction cylinder, a coded staple, that is irreversible when extracted from the cylinder, and a special key can be used. Cylinder locks and their mounting attachments shall be constructed to comply with UL standard 437.

3. Lock Removal Procedure. The Supplier shall provide a procedure for the removal and replacement of locks which become inoperable due to such conditions as malfunction, key jams, lock openings filled with foreign materials, and damage caused by vandals or persons attempting forced entry. The procedure may include minor alterations to doors, but this should not weaken the security. This procedure shall be considered "Confidential" and delivered exclusively to the District.

4. Key Configuration for TVM and AFM

a. The door key (operation and maintenance) shall open the front door and allow access to the panel that displays maintenance menus, and failure codes. Removal or opening of containers holding money shall not be possible with this key. The front door key shall be different at each station, and 14 keys shall be provided for each station. Removal of equipment without a valid security code

shall result in a separate alarm being transmitted to DAS. Keys shall not be able to be duplicated on equipment normally available at local keysmith facilities.

b. The Treasury Key shall allow the removal and insertion, but not opening, of all the money handling containers, including but not limited to banknote box, coin box, coin hoppers, and coin recycling unit (if used). Keys shall not be able to be duplicated on equipment normally available at local keysmith facilities.

c. The Revenue Key shall open any locked containers holding money such as the banknote box, coin box, and coin hopper which are intended to be emptied and counted or refilled at the Revenue Processing building. All key cylinders controlling access to the money shall be keyed alike and a total of 80 revenue keys shall be supplied. Keys shall not be able to be duplicated on equipment normally available at local Keysmith facilities. The revenue keys shall be shipped separately from the containers via registered mail.

5. Key Configuration for Fare Gates. All doors shall be lockable and the fare gate key shall open all doors on any gate console. There shall be no intrusion alarms associated with the gate consoles. A keypad and an LCD/LED display or equivalent shall be used to gain access to the equipment and to indicate the failure codes and register readings.

6. Access Lock. The access lock in the equipment shall consist of a T-handle embedded in a case hardened steel frame. At the center of the T-handle shall be the cylinder. The top of the T-handle shall be covered by an armored plate for additional protection. The multi-point locking system on the TVM and AFM or the simpler locking system on the gates that are affixed to the backside of the door shall be fully closed or fully opened by no greater than a 180 degree turn of the pop-out T-handle. A crank may be provided in addition to a key operated cylinder to open the door.

J. ADA Compliance: AFC equipment shall comply with the requirements of the Americans with Disabilities Act (ADA) of 1990 and implementing regulations, the American with Disabilities Act Accessibility Guidelines (ADAAG), and the State of California Code of Regulations (Title 24). All instructions and all information for use shall be made accessible to and independently usable by persons with vision impairments by the use of Braille and audible announcements that replicate and expand as necessary all messages displayed on screens.

K. Grounding

1. General: A copper or copper-alloy, corrosion resistant, high-conductivity grounding pad shall be provided within each AFC equipment to ground all conductive materials such as frames and metallic covers, motor frames, trays, and doors in accordance with the National Electric Code.

2. Electrical Equipment, Raceways, and Armor Cable: Exposed, non-current carrying parts of electrical equipment, raceway systems, and metallic cable armor shall be grounded by means of copper conductors. Grounding connections to the equipment shall be made with bolted connectors after the contact surfaces have been cleaned. Nonmetallic raceways shall have green color insulated grounding wire. Ground wires

shall not be smaller than the circuit wires, and the ground resistance from any metallic part to ground shall not be greater than 500 milliohms.

3. Electronic Circuits: Electronic circuits and electrical assemblies shall be grounded through a network of insulated wires and/or printed circuit traces and be grounded at only one point in the cabinet. Leakage current between the equipment common grounding point and the earth with the equipment powered shall comply with all Federal, State and local safety codes, regulations and standards.

4. Certification: The Supplier shall provide certification that its design and installation comply with all Federal, State and local safety codes, regulations and standards that are applicable at the time of certification.

L. Displays: For internal, maintenance and servicing use, such displays as flat panel, medium intensity alpha-numeric LCD, LED readouts, or equal are acceptable. For customer use, displays shall be limited to high brilliance LED, "Active Matrix" LCD, or equal, all of which shall be readable in direct bright sunlight.

M. Cabinet Construction

1. General. Cabinets, having surfaces that are exposed to the public, including all gate console surfaces, all addfare machine surfaces, and the front door of the ticket vendors shall be clad in stainless steel. Stainless steel sheets shall be in accordance with ASTM A167, Type A304L and finished in accordance with ASTM 480, #4 finish, 120 to 150 grit. The direction of the grain shall be parallel to the long dimension of the surface. All bends, forms, joints and seams shall be made as depicted in Federal Standard No. 187. Special attention shall be given to the forming of the individual parts, with undesirable protruding edges and welds removed, and all sharp edges and corners eliminated by a radius or chamfer. The cabinets shall be free of imperfections that affect appearance, function, or serviceability.

2. TVM and AFM Cabinets. The TVM and AFM shall have maximum dimensions as indicated. For vault - mounted equipment, the cabinet door or filler panels shall overlap each of the two sides and top of the vault by two inches. Internal, structural support members that provide rigidity to the cabinet and support for the door and assembly mounting brackets shall be either 300 series stainless or carbon steel, 14 gauge (.078 inch). Unpainted steel, including welds and welding material, screws, bolts and any other mounting hardware shall be stainless steel or carbon steel treated to prevent corrosion and rust by the use of special treatment such as galvanizing, zinc or cadmium plating. The mounting hardware shall conform to ANSI or ISO standards for mechanical fasteners.

   a. Fastenings: Fastenings shall be concealed wherever possible. There shall be no exposed bolt heads or nuts.

   b. Exterior Surfaces: There shall be no sharp corners, non-functional or unnecessary cracks or openings on the outside surfaces. Exposed corners shall be rounded or metered, welded, and ground smooth. Stainless steel shall be formed around corners so that edges are folded and concealed from customers view when doors are closed. Displays, buttons, bezels, trims and labels shall be

aligned parallel to their mounting plate. All weld marks burrs, discolorations or distortions resulting from either fabrication or shipment shall be removed.

c. Panels: The cabinet shall be fabricated with panels and re-enforcing members, all welded together to form a rigid and structurally sound unit. The sides, back and top of the TVM cabinet shall be 18 gauge (0.05 inch) minimum, stainless or carbon steel sheets in accordance with ASTM, #A366, "E" finish. Gaps between panels shall be uniform with not greater than one-eighth inch separation.

d. Design Loads: All ticket vendor and addfare machine cabinets shall be able to sustain a concentrated load of 200 pounds applied to any area of 1.4 square inches through a resilient pad, or a uniformly distributed load over an entire surface of 50 pounds per square foot without causing damage or permanent deformation. The uniformly distributed load shall not deflect the cabinet surface more than 0.02 inches at any point.

e. TVM and AFM Door:

1) Doors shall be constructed of at least .060 inch thick stainless steel lined with at least .080 inch thick carbon steel. Alternate design employing 14 gauge (0.078 inch) stainless steel reinforced by 14 gauge (0.078 inch) stainless steel structural members to provide rigidity will be acceptable.

2) Doors shall be equipped with multi-point locking concept, employing rotating clamps or sliding vertical and horizontal bars or equivalent operated by the T-handle or key lock. A minimum of one locking point on the top, one on the bottom and two on the unhinged side, or equal, shall be used. A minimum of three case hardened steel hinges shall be used which are, or their hinge pins are, entirely within the cabinet. The hinges shall be located on the right side of the door and shall allow the door to open and lock in place at approximately the 90 to 105 degree position. The door shall open and close smoothly with no greater than 10 pounds force applied. The position locking mechanism shall be a simple drop bar or equal, easily released, and installed at a location, preferably near the top, where it does not interfere with access to the modules and sub-assemblies.

3) A compressible seal or equal shall be used around the perimeter of the door to prevent the entrance of dust and liquids. The door for the TVM shall overlay the cabinet and the surrounding wall, as indicated. The door for the AFM shall not exceed the maximum width and height dimensions of the cabinet. Both TVM and AFM doors shall be designed such that devices like pry bars are ineffective in forcing the door open. At the 90o open position, both doors shall be capable of sustaining a force in a plane through the hinges of 300 pounds applied to the top corner, away from the hinge, without incurring any damage including buckling, breaking of displays, permanent deformation, and misalignment.

f. Base Plate

1) Each vault-mounted TVM shall be provided with a base plate that shall be bolted to a steel re-enforced concrete pedestal and to the TVM. It shall be possible to mount the furnished TVM directly or by means of a base adapter to the base plates. Adjustments for leveling shall be provided. The Supplier may re-use the existing base plates where existing TVM are being replaced. The Supplier shall provide base plates as necessary at all new TVM locations and at all locations where existing base plates are missing or are damaged. The base plate shall be constructed of non-corrosive structural, welded members identical in design to the existing base plates.

2) Each AFM and free-standing TVM shall be provided with a base plate, a plinth or both that shall be bolted directly to the finish floor. The base plate or plinth shall not exceed the maximum width and depth dimensions of the AFM nor shall they be less than two inches of each dimension. Construction shall be equivalent to the TVM requirements.

3) Sufficient maintenance access to the power and signal cabling serving the TVM, and AFM, shall be provided. This shall be accomplished with an open-bottom cabinet design, or a base adapter or plinth as indicated.

g. Telescopic Slides: Modules and components that are part of a particular assembly and are located within the TVM and AFM shall be mounted on telescopic slide. Telescopic slides shall be designed to accommodate not less than 200 percent capacity of the weight of the modules and components mounted thereon. The telescopic slide sections shall roll on ball bearings. At its fully extended position, the slide shall not waver horizontally more than one inch or be easily deformed by minor bumping that could be expected during servicing. The slide shall contain detents in the non-extended and fully extended positions to hold the slide in place. A simple pulling or pushing action shall move the slide from its detent position. A shock-absorbing device shall be installed at the rear detent to reduce the shock level, thereby preventing damage to the sub-assembly when it is pushed-in to its "home" position. Slides shall be designed for no less than 500,000 operations.

h. Cabinet Light: Readily accessible fluorescent lighting shall be installed inside the TVM and AFM cabinets to provide sufficient light for the functions to be performed by servicing and maintenance personnel. The opening and closing of the door shall automatically control the power to the lighting arrangement.

3. Gate Console. The external design, material and dimensions of all gate consoles shall be identical to the existing gate consoles, including slope ends, and locations of ticket insertion and return slots as indicated. The base plates and installation except for the cabling shall also be identical. Drawings and other details that are available will be provided to the Supplier upon request. The following requirements shall be met:

a. Outside dimensions as indicated.

b. Welded, reinforced panels of stainless steel, 12 gauge (0.109 inch) minimum on all surfaces including the access doors. Gaps between panels shall be uniform with not greater than one-eighth inch separation.

c. Hinged and removable doors on both sides.

d. The top cover shall open laterally from a side hinge. The cover shall be hinged such that there is no interference with the adjacent aisle in its open position. Top cover shall be held in the open position with a gas strut or equivalent mechanism.

e. Easily changeable barrier locations to suit the installation.

f. Internal metal parts, fasteners, brackets, braces, and channels to be stainless steel.

g. The Supplier shall use existing base plates as available where new gates replace existing gates. The Supplier shall provide additional base plates at new locations and at locations where existing base plates are damaged or missing. The new base plate shall be interchangeable with the existing base plate. New gate consoles shall be able to be installed in place of existing gate consoles without replacing the base plates. The base plates shall be constructed of stainless steel or C1018 carbon steel with 0.0003 inch zinc plating or equivalent.

h. If ventilation is required, the vents shall be located in the longitudinal center of the gate console sides, as indicated.

N. Electronics: Electronics circuits in AFC equipment shall be mounted on printed circuit boards (PCB) for ease of handling and repair. Electronic circuits shall include digital logic, drive circuits, power supply circuits, relays, solenoids, batteries, RAMS, PROMS, EPROMS, communication interfaces, input/output ports, CPU's, drives for floppy disks, hard disks, keyboards, terminal printers, line printers, and discrete electronic components. Computer equipment including the CPU and all peripherals shall be commercially available within the USA and shall be IBM PC compatible. Microprocessors shall be of equivalent quality of IBM PC compatibles and the processor performance shall be of the highest processor performance available as of the final design review. For customized electronics, CMOS circuitry shall be used to the extent possible. The design shall be centered around a microprocessor system consisting of a central processing unit, equivalent to Intel AMD or Cyrix products, various types of memory storage, and access interfaces necessary for access to the software programs, stored information and for communication between other units. Drive circuits such as output ports used to drive lamps and relays, shall employ protective devices as necessary to prevent damage to either the drive circuit or to the load when subjected to continued use such as can be experienced during the cycling tests. Such protective devices shall be easily replaceable without soldering. This protection shall apply to test as well as normal conditions.

O. Printed Circuit Boards (PCBs)

1. General. Customized PCBs shall have copper traces and gold-plated connections and be fungus resistant. PCBs shall be designed for normal handling in the shop without incurring damage. Keying shall be employed such that the PCB cannot be plugged into the wrong connector nor make any type of electrical contact with the wrong

connector upon attempting to insert. PCBs shall be shielded against electrical short circuits and be protected against contact with foreign objects.

2. Test Terminals. Test terminals or connectors shall be provided as necessary in easily accessible and non-critical areas of the PCB for maintenance use.

3. Component Identification. Identification of each discrete component shall match the schematic diagram and shall be placed on the PCB as close to the component as possible. Each PCB shall also be identified by a unique, permanent serial number. In addition, a bar code shall be attached that is identical to the printed serial number.

4. Construction. PCBs shall be constructed with epoxy glass reinforcement with plated through holes and shall meet the following standards: NEMA Grade FR-4 (peel strength load limit of 5), MIL-STD-275C relating to the copper traces, and Federal Specifications #00-S-571 pertaining to the use and application of solder. All circuit sides shall be shielded against electrical short circuits and contact with metal objects.

5. Connections. Components such as EPROMS and others that are intended for frequent replacement, primarily to change the memory contents, shall not be soldered in place and shall be easy to extract and replace without incurring damage to the pins or degrading the electrical contact. Additionally, all microprocessor, micro-controller or programmable array logic devices shall be socketed.

6. Artwork. Artwork for all Supplier-developed PCBs shall be furnished. Excluded from this requirement are commercially available standard OEM-supplied PCB's. The artwork shall be furnished in both camera-ready and electronic formats (Gerber files).

P. Relays: Relays provided shall be electronic solid state relays, sized appropriately, and shall not be ganged-operated in order to share the load. Plug-in relays shall be secured by mechanical fasteners if installed on vertical panels or if employed in equipment subject to vibration. All relays shall be optically isolated from the AFC equipment microprocessor assembly.

Q. Cables, Wires and Connectors

1. Wire and Cable Conductors. Wire and cable conductors shall be American Wire Gauge (AWG) sizes based on copper conductors. Conductors shall be sized on the basis of equipment loads and operating parameters in accordance with the National Electric Code (NEC) and as indicated. All power wiring shall be copper or copper alloy with 600 volt, moisture and heat resistant, thermo-plastic insulation rated for 170 degree F. Minimum size shall be No. 14 AWG. Signal and control wiring shall be minimum No. 18 AWG, NEC type THW moisture and heat resistant thermoplastic insulation, or equal rate for 170 degree F. Cables and wiring shall not support combustion or emit toxic chemical compounds when burned.

2. Raceways. Raceways shall be in accordance with the NEC. Color coding of conductors shall conform to IPCEA 561-402, Part 5, Method 1 or 3.

3. Connectors. Power and control wires shall be terminated with multi-pin plug connectors or on terminal blocks having washer-head screw terminals or the

equivalent to accept "positive" type wire lugs such as the closed ring design. A minimum of 30 percent, but not less than two, spare terminals shall be provided on each terminal block. All connections between each unit of equipment and the cables in the wireways shall be made through connectors located internally at the bottom of each piece of equipment. Connectors shall be factory installed to the extent possible. Connections to or from the equipment shall be made by connectors and not hardwired to terminal boards. Connectors shall be keyed, have quick disconnect fasteners, and be equivalent in quality to industrial grade connectors as manufactured by Amphenol, Winchester, 3M or equal. The mechanical strength of each connection shall be at least 85 percent of the mechanical strength of the wire. The electrical conductivity of each connection shall be at least 95 percent of the electrical conductivity of the conductor. Connectors that are intended to be removed and/or disconnected for Treasury servicing shall be durable and suitable for the service intended. The connectors shall be designed for no less than 5,000 operations, and shall be easily replaced with no cutting or resoldering of existing wires and/or repinning of connectors.

4. Identification. Conductors within a cable, separate wires, and cables shall each be identified by machine printed, permanent plastic identification sleeve, tag, label or equivalent. Cable tags shall identify the source and destination of the cable. All tags shall agree with the identification numbers that appear on the wire lists, schematic diagrams, and cable schedules.

5. Cable Installation. Cables inside equipment shall be supported near terminal points and all along its route to minimize accidental interference and contact. Sufficient length shall be provided to permit removal of modules and withdrawal of sub-assemblies mounted on telescope slides and installed such that cables and ribbon connectors shall fold naturally requiring no special action when, for example, a telescopic slide is returned to its "home" position. For units that telescope in and out, cable dressing shall be provided to prevent damage by handing of the cables and prevent stress on the connectors.

6. Testing. After installation, cables shall be tested to assure that the electrical and mechanical properties of the cables have not been degraded. The test results that shall include a continuity check and identification of all cables and wires shall be recorded and submitted for approval.

R. Safeguards: The safety of patrons and operating personnel using the equipment or performing their duties shall be an essential aspect of the fare collection equipment design and fabrication. The Supplier shall provide appropriate safeguards wherever required by safety regulations and logical considerations. Such safeguards shall include shields or barriers placed to prevent injury, including burns from heated surfaces, or cuts from sharp edges.

1. Electrical Safeguards. Provisions shall be made to prevent electrical shock from harmful levels of voltages. Interlocks shall be provided which disconnect voltages exceeding 150 volts. An interlock bypass shall be provided for servicing, accompanied by an indicator showing the state of the bypass. Guards, safety covers, and warning plates or labels shall be provided for servicing, accompanied by an indicator showing the state of the bypass. Guards, safety covers, and warning plates or labels shall be provided for devices with contacts, terminals, and similar parts

having a potential exceeding 300 volts. Each unit of fare collection equipment shall have an easily accessible circuit breaker within the equipment to open the supply circuit. In the off position, the only power to the machine shall be at the 115 volts, 15A convenience GFI outlets to be provided which shall also be controlled by a circuit breaker.

2. Mechanical Safeguards. Metal or plastic guard plates shall be provided to protect personnel from fan blades, motor shafts, belts, solenoids and other moving parts. Areas of high temperature shall also be protected against injury. Areas that can come in contact with patrons, especially the side and top areas of the gate consoles, shall be given added attention to assure that any kind of injury or snagging of clothing is highly improbable.

S. Painting and Plating

1. Exterior Surfaces. Exterior non-stainless steel surfaces shall be painted using a four-coat system or equivalent. Internal areas, that are painted, can use a two-coat system. Metal surfaces shall be prepared in accordance with the paint manufacturer's instructions. The first coat shall be one coat of an inorganic zinc primer between two and four mils thick, followed by three coats of epoxy enamel or equivalent. The final coat shall have a matte or satin finish. Parts or areas in contact with concrete or masonry walls or floors shall receive a minimum of two coats of rust and corrosion preventive primer and two coats of non-corrosive finish paint.

2. Interior Surfaces. Interior unpainted metal surfaces shall be zinc or cadmium plated or equal applied in accordance with their appropriate standards, such as, Federal Standard QQ-P-416 for cadmium plating.

T. Acrylic: If acrylic is employed, it shall be Rohm and Haas brand high impact, plexiglass #70 or equal. The acrylic material shall meet the requirements of NFPA 101, class A, and UBC Chapter 12, class I.

U. Polycarbonate: If polycarbonate sheets are used for protection of screens, displays, graphics, or surfaces, they shall be mar-resistant, type Lexan MR-5000 as manufactured by General Electric Corp. or equal. The polycarbonate shall meet the requirements of NFPA 101, class A, and UBC Chapter 41, Class I.

V. Sealants: Sealants for use between the base plates or cabinets and the floor shall be a black color, DOW Corning #780 building sealant, polyurethane-based, either one-part elastomeric sealant, complying with FS TT-S-230, Class A, Type I, or two part elastomeric sealant, complying with FS-TT-S-227, Type I or equal. Sealants shall meet the requirements of NFPA 101, Class A, and UBC Chapter 42, Class I.

W. Customer Interface Graphics: Customer interface graphics for the TVM and AFM front panel shall be engraved on stainless steel plates affixed at appropriate locations on the front panel. The graphics shall be engraved into the stainless steel using etched graphics. Graphics shall include all of the pictorial and printed information as indicated.

X. Fare Tables: The faregate and AFM shall be provided with memory space for six faretables. Each faretable shall be configured as a 64 by 64 matrix to accommodate the existing 39

stations and future expansions. Information regarding fare structures will be furnished by the District.

1. Peak Fares: One faretable shall be programmed with the "peak" fares. This faretable (e.g. Faretable 1) shall be used to calculate the fares for all ticket types and shall be in effect at all times unless preempted by other special fare periods or faretable settings.

2. Off-Peak Fares: One faretable shall be reserved for the "off-peak" fares. During the off-peak periods (i.e. 10 AM - 3 PM), the faregates and AFMs shall use this faretable to calculate the "off-peak" fares.

3. Reserve Faretables: The memory space and software programs for the remaining four faretables shall be reserved for future use.

4. Faretable Implementation: For a faretable change, it shall be possible to download the new faretable from the DAS ahead of the implementation date. The only requirement to activate the new faretable shall be a system-wide execution command from DAS, a local execution command from the maintenance terminal, or an automatic control signal initiated by the faregate/AFM clock. All three options shall be provided.

## 2.04 SOFTWARE

A. General: Software programs shall be modular and structured using a hierarchical framework. The work shall be divided into divisions of importance where the work with the highest importance shall be assigned top priority and the next level of importance shall receive the second priority, and so on. Complete software documentation shall be provided. The information supplied shall contain sufficient annotation to enable the District to understand and interpret the software with relative ease and permit changing of any part of the software without the necessity of relying on the Supplier for software changes. All system variables shall be identified and documented. Procedures on how to change these variables shall be supplied. Information to be supplied shall include source codes, disk files, programming statements or lists, subroutines, and operating flow charts applicable to all equipment supplied. The listings provided shall contain an adequate percentage of annotations to help in the understanding of the listing. All comments and annotations shall be in the English language. The information to be supplied shall also include the data stored in each of the EEPROMS or equivalent memory chips, memory maps, object files, Hex files, and source files. All files including schematics and JEDEC files to create PALs, GALs, and FPGAs if used shall also be supplied. The information shall be supplied on MS-DOS compatible diskettes or CDROMs. All hardware and software development tools required for reconfiguring and modifying the software shall be provided. The above documentation shall be provided as part of a Software Manual.

B. Changes to Variables: Changes to AFC Equipment variables such as operational parameters, faretables and display messages shall be accomplished on the Engineering Office Maintenance Equipment Master Workstation and downloaded to DAS or the PC Notebook via disk file transfer or network connection for downloading to the AFC equipment as described below. The changes to variables shall be easily implemented in the equipment without the necessity to modify the application software or to retest the changes extensively.

C. Downloading. Downloading of commands and parameters shall be accomplished remotely from DAS, and locally using the PC Notebook. Downloading locally with the PC Notebook shall be accomplished using standard communications protocols, cables and connectors. All necessary cables and connectors shall be provided. The downloaded information shall include all specified commands and parameters.

D. Software Use and Verification. All software shall be complete and fully tested prior to shipment of the respective equipment. The software shall be fully programmed, debugged and updated with the latest changes prior to the predelivery tests. The Supplier shall provide the latest version of software source code and documentation for use during Supplier-conducted operation and maintenance training. The Supplier shall provide the final software source code and documentation prior to revenue service for the first equipment. All software source code, object code and documentation shall be provided on a floppy disk or CD-ROM in a MS-DOS compatible format. Upon entry of the proper command into the service terminal, the AFC equipment shall generate a printed receipt showing the software part number and version of all installed software.

## 2.05 DATA COMMUNICATION INTERFACE

A. General. A Network interface shall be provided in each unit of equipment to enable communications with the DAS. The interface shall use a TCP/IP protocol and shall conform to the requirements of Exhibit M, the "Station Network Interface Specification" Version 3.1, dated 23 Aug. 93. An Ethernet Network Interface Card and a Ethernet 10 Base FL transceiver, as specified in Exhibit M, shall be installed in each unit of AFC equipment. The interface will be securely mounted inside the communication interface box provided by others at the base of each piece of equipment. The Supplier shall provide connectorized cables from the equipment to the communications interface box. The Network layer of the TCP/IP protocol stack shall conform to the Internet Standards as specified in RFC 1122, RFC 826, RFC 791, RFC 792, RFC 793 as stated in Exhibit M. The Network Interface shall include an SNMP agent with support for MIB II and other appropriate vendor specific MIBS.

B. Data Acquisition System Interface. The microprocessor assembly in each machine shall communicate with the DAS using the VEI protocol specified in Exhibit N, DAS Interface Specifications, Data Format (VEI).

C. Hardwired Communication Interface. A hardwired communication interface shall be provided in each unit of equipment to support the control and status indication functions shown below. The Supplier shall submit a detailed description of this interface for approval during the Preliminary Design Review.

1. TVM and AFM. Relay contact closures rated at 24 VDC shall be provided to annunciate the following machine status conditions:

   a. Out-of-Service

   b. Intrusion Alarm

   c. Loss of Power

d. Credit/ATM Card Function not Available

e. Low Ticket Supply

f. Loss of DAS Communication

g. Front Door Opened

h. Credit/ATM Transaction in Process

2. Faregates. Relay contact closures rated at 24 VDC shall be provided in the faregate and AFG to support the indicated functions.

a. Status Indications

1) Gate Out-of-Service

2) AFG Swing Gate Forced Open (AFG Intrusion Alarm - activated as long as the gate is forced open).

b. SCADA Control Functions - Relay contacts rated at 24 VDC shall be provided that respond to a momentary contact closure command from a remote device to support the control functions listed below. These relay contacts shall be reserved for future SCADA use:

1) Barriers Open (on/off);
2) Barriers Close (on/off);
3) Override Clock Check (on/off);
4) Not Override Clock Check (on/off);
5) Override Entry/Exit Check (on/off); and
6) Not Override Entry/Exit Check (on/off).

Note that the status of the above conditions shall be reported by the faregate to DAS.

3. The relays shall interface via the connectors to mating connectors provided by others. For the faregate, the relay connectors shall be brought out to the end console of each array closest to the station agent's booth.

4. The existing annunciator panel in the agent booth will be retrofitted by others to display the indicated statuses. The Supplier shall design the Hardwired Communication Interface to conform to the electrical characteristics of the panel.

5. Each unit of equipment shall be provided with three spare relays to support future control and data acquisition applications. The spare relays shall be terminated on connectors and connected to the AFC equipment logic.

6. All electronics and power needed to control and monitor the relay contacts shall be provided.

## PART 3 – EXECUTION

Not Used

**END OF SECTION 34 50 10**