Southeastern Pennsylvania Transportation Authority

COMPUTER-AIDED RADIO

DISPATCH SYSTEM TECHNICAL SPECIFICATIONS

Volume 3 of 3

PREPARED BY

Ross & Baruzzini | MACRO

March 2021
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SECTION 13342
CAD/AVL SYSTEM FUNCTIONS

PART 1 - GENERAL

1.1. DESCRIPTION OF WORK

A. The following sections define functional requirements for the CAD/AVL System. The Contractor shall supply all described functions, except for functions designated as options that are not executed by SEPTA and functions designated as “Future”.

B. The CAD/AVL System specified herein shall support fixed-route and Customized Community Transportation (CCT) service operations for SEPTA. The CAD/AVL System shall provide the following major functions:

1. Data communications between CAD/AVL System-equipped revenue and non-revenue vehicles and fixed locations, such as the dispatch offices using SEPTA’s existing cellular communications.

2. Integration with Radio system.

3. Wi-Fi integration

4. Computer Aided Dispatch (CAD) functions to aid dispatchers in managing the fleet

5. Automatic Vehicle Location (AVL) functions that are tightly integrated with the supplied CAD functions to aid dispatchers in managing the fleet

6. Automated, real-time collection and dissemination of operational data on revenue trips

7. Integration of supplied CAD/AVL functions with scheduling system implemented by Trapeze

8. Integration with RouteMatch to retrieve driver and vehicle information.

9. Real-time data collection and management of all operational transit system data for internal analysis

10. Integration of supplied CAD/AVL functions with real-time customer information systems through GTFS, GTFS-RT, and API’s

C. At a minimum, the CAD/AVL System shall support the following types of users:

1. Operations Dispatch
2. Vehicle Operators

3. Customer Service

4. Maintenance – for monitoring mechanical alarms and other maintenance-related functions of the system

5. SEPTA Management – for accessing reports and occasional view-only access to system displays

6. CAD/AVL System Administrators – for managing and monitoring the CAD/AVL System.

1.2. GENERAL REQUIREMENTS

A. CAD/AVL System Scalability - The CAD/AVL System shall initially support the functions specified herein with the quantities of vehicles, devices, workstations, depots, and service parameters defined herein. However, the system shall be easily scalable over its estimated 15-year lifetime to support additional vehicles, users, workstations, and transit facilities without replacement of initially installed components, including both hardware and software components.

1. The CAD/AVL System shall, over its lifetime, interface to the ultimate number of vehicles and users specified herein.

B. Functional Expandability - The CAD/AVL System shall be designed to permit the addition of new functional capabilities over its lifetime without replacement of the initially delivered components. In particular, functions designated in this Technical Specification as “Future” shall be able to be readily added to the CAD/AVL System during its lifetime without rework or replacement of initially delivered system components.

C. Contractor's Standard, Service-Proven Products - Contractors shall provide standard, unmodified, service-proven products of computer and communication equipment manufacturers, established third-party hardware and software suppliers, and their own baseline product offerings where they meet or exceed the functional requirements of this Technical Specification.

D. Adjustable Parameters - Computer programs typically reference a number of variables that must be given specific values during the execution of the program. These variables, or parameters, require adjustment from time to time.

1. All parameters in the CAD/AVL System that may need to be modified to accommodate changes in SEPTA’s service and operations shall be adjustable by authorized CAD/AVL System users. At least three levels of parameter adjustment shall be provided, as follows:
a. Parameters designated in this Technical Specification as “User-adjustable” shall be modifiable by authorized CAD/AVL System users via workstation displays normally accessible to those users.

b. Parameters designated in this Technical Specification as “System Administrator-adjustable” or “Administrator-adjustable” shall be modifiable via workstation displays accessible only by a System Administrator.

c. Parameters designated simply as “adjustable” shall be modified in either of the above ways, depending on the Contractor’s standard approach.

2. Adjustments made to user-adjustable parameters shall become effective immediately without having to restart any part of the system. Adjustments made to System Administrator-adjustable parameters may require a restart of affected system components, but shall not require rebuilding and/or recompilation of programs, or regeneration of databases. SEPTA desires that the requirements for a restart be minimized.

3. All parameters, including periodicities and time intervals, defined in this Technical Specification shall be considered initial values to be used for planning purposes, but all shall be adjustable by authorized CAD/AVL System users. The CAD/AVL System shall log all parameter changes including identification of the user who made the modification, the original value, the modified value, the workstation ID, and the time and date of the modification.

E. Activity Logging - The CAD/AVL System shall log all user actions to an activity log. The activity log shall be real-time and accessible on-line. Each action shall result in an entry in the log that shall include, at a minimum, user ID, workstation ID, record/file ID(s), date/time, module/function ID(s), and other pertinent data associated with the action. The maximum size of activity log storage shall be configurable by the System Administrator in order to conserve storage capacity for critical system functions.

F. Output Requirements - Specific requirements for output of results are defined in this Technical Specification along with the other requirements of each function. Whether or not explicitly specified in the function description, all data and results produced by CAD/AVL System functions shall be accessible for display, printing, and transfer to external computer systems identified elsewhere in this Technical Specification.

G. Reasonability of Data - In order to prevent invalid and unreasonable data from having a harmful effect on the CAD/AVL System or SEPTA operations, data shall be checked for validity and reasonability. All input data and parameters, whether collected automatically or manually entered by a CAD/AVL System user, shall be automatically checked for validity and reasonability before allowing the data to be processed or used by the CAD/AVL System. Data determined to be invalid and/or unreasonable shall be rejected.

1. When invalid and unreasonable input data or results are detected, diagnostic messages clearly describing the problem shall be generated. All programs and the system shall continue to operate in the presence of invalid and unreasonable
data. Calculations using the invalid and/or unreasonable data shall be temporarily suspended or continue to use the last valid and reasonable data.

H. **Data Integrity** - The CAD/AVL System shall be designed to protect CAD/AVL System data integrity in a multi-user and multi-processing environment. Appropriate exclusion methods shall be employed to ensure that collected data is not corrupted from multiple concurrent accesses by different processes. User-entered data shall be protected by appropriate exclusion methods that prevent more than one user from simultaneously editing the same data. In general, users shall be notified and granted read-only access to data that is being updated by another user.

1.3. **ACCESS SECURITY**

A. Access to the CAD/AVL System shall be strictly limited to authorized CAD/AVL System users. Users without proper authorization shall be denied access to all CAD/AVL System functions and data, including all CAD/AVL System resources, such as servers, workstations, etc.

B. **User Authorization** - The CAD/AVL System shall utilize network domain logon credentials for CAD/AVL System user authorization. At a minimum, CAD/AVL System user authorization shall require entry of a valid domain, username, and password combination that determines the user’s level of access to CAD/AVL System functions, data, and resources. Each CAD/AVL System user shall have a unique username that is assigned by the System Administrator. The logon/logoff status of a user shall be unaffected by any automatic failover recovery process in the CAD/AVL System.

C. **User Records** - Each user logon and logoff shall be recorded in the historical event log. The recorded data shall include the user ID, the workstation ID, and the date and time that the logon/logoff was executed. If a logon was unsuccessful, the CAD/AVL System shall record all user-entered login text, workstation ID, and the date and time of each entry recorded.

D. **Functional Partitioning** - Access to CAD/AVL System functions and capabilities shall be based upon each user’s authorization level and not the physical workstation or device being used, though limitations in functional capabilities due to the configuration of the workstation or device may also apply (e.g., no voice equipment). User’s functional access rights to the CAD/AVL System shall be determined based on the user’s domain group memberships. Each user’s authorization level shall be specified as “full”, “view-only”, or “no” access to each identified CAD/AVL System function. A secure method shall be provided for the System Administrator to create and manage functional partitions and their assignment to users and groups. A minimum of 12 distinct authorization levels shall be supported. At a minimum, the levels of functional partitioning that shall initially be supported by the CAD/AVL System include at least the following:

- General User — these users shall have read-only access to CAD/AVL System historical data via the information server, but shall have no access to the CAD/AVL System LAN, functions, and resources.
2. Customer Service — these users shall have all the rights of a General User plus read-only access to selected CAD/AVL System functions (e.g., AVL functions).

3. Dispatcher — these users shall have all of the rights of a General User plus full access to Dispatcher functions and restricted CAD/AVL System functions as determined by the System Administrator.

4. Assistant Director - these users shall have all of the rights of a Dispatcher and shall be able to reopen incidents.

5. Senior Administrator – these users shall have unrestricted access to CAD/AVL System functions.

6. System Administrator — these users shall have unrestricted access to CAD/AVL System functions and shall have special privileges required to administer overall access security and to maintain the CAD/AVL System.

E. Data Partitioning - System Administrators shall be able to define data partitions that specify, via selection criteria or other means, a subset of all CAD/AVL System data, including events that users are permitted to access. User’s data access rights to the CAD/AVL System shall be determined based on the user’s domain group memberships. A secure method shall be provided for the System Administrator to create and manage data partitions and their assignment to users and groups.

1. For each defined data partition, the System Administrator shall also be able to specify the type of access, which shall include at least “full”, “view-only”, or “no” access. Data partitions shall be able to overlap in definition and each data partition shall be assignable to any number of CAD/AVL System users and groups. A minimum of 8 distinct data partitions shall be supported.

2. At a minimum, data partitioning shall be based on any logical combination of the following criteria:

   a. Service — Data associated with a specific service (e.g., bus, CCT, Media-Sharon Hill Line, Trolleys, Norristown High Speed Line)

   b. Vehicle Type — Data associated with a specific vehicle type, such as “Fixed-route”

   c. Route Numbers — Data associated with a list of specific route numbers and from designated ranges of route numbers

   d. Event Type/Sub-Type — Events of specific types and sub-types.

F. CAD/AVL System LAN Access Security - The Contractor shall install a secure CAD/AVL System LAN. The CAD/AVL System LAN shall be secured to prevent unauthorized access, use, and administration of its resources from any networked node, regardless of whether that node is running CAD/AVL System-specific software or some other software (e.g., a general purpose Windows workstation). This security
shall include, but not be limited to, positive user authentication for access to CAD/AVL System file, database, and application servers, as well as workstations, network devices, domain controllers, and other resources that may be used for managing the CAD/AVL System LAN and its configuration. Separate levels of authentication shall be provided to distinguish, at a minimum, user access from administrative access to the CAD/AVL System LAN resources.

G. **WAN Access Security** - Access to any CAD/AVL System resource from the SEPTA WAN shall be strictly controlled to ensure that the system is not corrupted or disabled, intentionally or unintentionally, by any user on the SEPTA WAN. In addition to basic user authorization, WAN access to the CAD/AVL System shall be further secured by enabling the System Administrator to control all access to CAD/AVL System resources via the WAN. All outside access to CAD/AVL System resources shall be denied. Therefore, transfers of data that must take place between the CAD/AVL System and all other systems that are not on the CAD/AVL System LAN shall be initiated by a component from within the CAD/AVL System.

1. In a WAN-connected configuration, local CAD/AVL System users shall have transparent access to external resources on the WAN where the administrators of those external resources have granted such access, including external services for email, agency applications, and printing.

1.4. **COMPUTER-AIDED DISPATCH FUNCTIONS**

A. The CAD/AVL System shall provide a comprehensive set of computer-aided dispatch functions and features that will allow for effective and efficient monitoring and control of revenue and non-revenue vehicles. The basic functional requirements for CAD are contained within the following sections. Norristown High Speed Line and Media-Sharon Hill Line vehicles are operated in single and multiple car consist. The CAD screens shall clearly identify a multiple vehicle consist as a single operational unit yet show the configuration of the consist.

1. **Data Communications** - SEPTA’s existing 4G LTE cellular communications shall be used for all data communications. Vehicle polling cycle shall be between 5 to 10 seconds interval with additional “smart” polling such as when the bus starts a new trip, opens the door to signal arrival at a stop and finishes a trip. The GPS reporting period shall be configurable by the System Administrator.

a. The CAD/AVL system shall receive and process all data received from vehicles, even when the vehicle is not logged in. Each alarm (emergency alarm and other alarm) and other vehicle-initiated and vehicle Operator-initiated actions shall be handled in the same manner as for logged-in vehicles.

B. **Voice Communications** - The CAD/AVL System shall support trunked voice communications via an integrated 700 MHz radio system to be supplied by the Contractor. The System Administrator shall be able to assign a default talk group to each workstation, though workstations shall be able to use any available voice channel in the pool. All voice calls initiated by a CAD/AVL System user at a workstation shall first attempt to utilize the workstation’s default voice channel, if assigned and available;
otherwise, an open voice channel from the pool of voice channels shall be used for the call. All recipients selected by the CAD/AVL System user for a voice call shall be automatically switched to the selected voice channel for the duration of the call.

C. **Fallback Data Communications** - Whenever the CAD/AVL System is unable to perform its assigned data communication functions through primary and backup data paths, the CAD/AVL System shall initiate a fallback communications mode of operation for all affected vehicles and the CAD/AVL System shall generate and present an event to the appropriate CAD/AVL System user(s) in the event queue.

1. The CAD/AVL System shall initiate the fallback communications mode of operation for all vehicles affected by conditions that shall include, but not be limited to, the following scenarios:
   a. Loss of data communication links (e.g., leased line) between SEPTA and the wide area wireless data communications provider
   b. Loss of availability of CAD/AVL System CAD functions due to either software or equipment failure
   c. Vehicle loss of data communications due to equipment failure or out-of-range conditions.

2. When a vehicle enters the fallback mode of operation, an indication of fallback mode shall also appear on the Vehicle Logic Unit (VLU) of every affected vehicle, informing the vehicle Operator that fallback mode procedures are in effect and data communications are not available. When data communications have been restored, all affected vehicles shall automatically return to the normal communications mode.

3. Vehicles that have not lost data communications shall continue to operate in the normal communications mode regardless of the data communications status of other vehicles.

D. **Fallback Voice Communications** - The CAD/AVL System shall support a “fallback” mode of voice communications in the event that normal (voice) communications with one or more vehicles has failed, such as during the failure of a voice channel. In the fallback mode of operation, two-way voice communications between the CAD/AVL System users and the vehicles affected by the failure shall still be possible via alternate voice channels that are assignable by the System Administrator for this purpose.

1. All affected vehicles shall be automatically switched to the fallback mode when a failure of normal voice communications is detected. Vehicles unaffected by the failure shall continue to operate in the normal voice communications mode. The time period between detection of a communications failure by a vehicle and the entering of fallback mode shall be adjustable by the System Administrator.

2. Vehicles in fallback mode shall periodically check for restoration of normal voice communications at an interval that is adjustable by the System Administrator.
When normal voice communications have been restored, all affected vehicles shall automatically return to the normal voice communications mode.

3. During fallback mode, vehicles equipped with silent emergency alarm capabilities shall continue to allow those emergency alarms to be initiated. All such fallback silent emergency alarms shall be immediately annunciated to active CAD/AVL Systems users and shall provide those CAD/AVL System users with at least the vehicle ID of the vehicle that issued the alarm.

E. **Identifier Field Formats** - Vehicle IDs, route numbers, and block numbers shall identify all CAD/AVL System-equipped vehicles. Vehicle Operators shall be identified by badge numbers and run numbers.

1. The formats of the identifiers that shall be supported by the CAD/AVL System are as indicated in Table 13342-1, below.

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<tr>
<td>Run Number</td>
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<tr>
<td>Operator Name</td>
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<tr>
<td>Operator Badge Number</td>
</tr>
<tr>
<td>Vehicle ID Bus, Trolley, MSHL, NHSL</td>
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<td>Vehicle ID CCT</td>
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2. Fewer digits may be utilized than the maximum lengths to be supported by the CAD/AVL System as indicated above. Where the actual number utilized is shorter than the maximum lengths defined above, the CAD/AVL System shall not require the entry of leading zeros.

F. **Events** - The CAD/AVL System shall support the gathering, processing, storage, and presentation of events relating to vehicles, vehicle operators, and the status of the CAD/AVL System. The following sections define requirements for events and event gathering. Requirements for event presentation to users are defined in Section 13343.
I. **Event Types and Priorities** - The CAD/AVL System shall support multiple event types and subtypes. Events shall be available within the CAD/AVL System for presentation, processing, and storage within specified maximum time delays relative to the actual creation of the events in the field under the peak loading conditions defined herein. All events shall include sufficient identifying and descriptive data necessary for CAD/AVL System users to properly interpret the event.

a. Event types shall have pre-defined priorities that are assignable by the Senior Administrator and System Administrator. A minimum of eight (8) priority levels shall be supported. However, the emergency alarm event type shall be assigned the highest priority.

b. The Senior Administrator and System Administrator shall be able to enable and disable event types and subtypes.

c. The CAD/AVL System shall include the following minimum set of event types and subtypes:

   - **Emergency Alarm (EA)** – a signal from a vehicle Operator that an emergency condition is occurring. This event shall have priority over all other events.

   - **Priority Request To Talk (PRTT)** – a high priority request from an Operator to talk with a Dispatcher. This event shall have priority over all other events except for EA events.

   - **Request To Talk (RTT)** – a normal request by an Operator to talk with a Dispatcher.

   - **Canned Text Message** – a pre-defined text message selected by an Operator to a CAD/AVL System user. Each canned text message shall be distinguishable as a unique message subtype and shall be configurable.

   - **Schedule Adherence Violation** – an event indicating that a revenue vehicle is off schedule (early and late). The message shall indicate the amount of deviation from schedule in minutes. Early and late schedule adherence events shall be configurable to different priorities. Initially, schedule adherence violations having an early deviation from schedule shall be assigned a higher priority than those having a late deviation from schedule.

   - **Route Adherence Violation** – events indicating that a fixed-route vehicle is off route. Initially, these events shall have the same priority as early schedule adherence violation events.

   - **Turn-back** – events indicating that a vehicle has performed a turn-back (short turn).
- **Fill-in Service Start/Stop** – events indicating starting and stopping of fill-in service for a specified route.

- **Vehicle Movement Alarm** – events indicating that a vehicle has left a depot without a valid Operator log-on.

- **Invalid Logon** – events indicating a failure of an Operator logon. An invalid logon event shall be reported after three (3) consecutive failed logon attempts and include a reason of the invalid logon.

- **Operator Logon/Logoff** – events indicating successful Operator logons and logoffs.

- **Operator Late Logoff** – events indicating an Operator didn’t logoff within the Senior Administrator and System Administrator configure time after the expected logoff.

- **Open Block Alarm** – events indicating that a Block has been without service (i.e., no active vehicle) for more than a pre-defined and configurable time period.

- **Relief Events** – events indicating that an Operator relief has started, ended, and missed.

- **Fallback** – event indicating the vehicle is in the fallback mode for data communications.

- **CAD/AVL System Alarm** – events indicating a failure or restore within the CAD/AVL System itself, such as communications errors and failures, fixed-end component failures (e.g., servers, workstations, and network devices), on-board vehicle component failures, etc.

- **Detour Expiration** – events indicating that a detour or curtailment/turn-back is scheduled to expire soon. Alert shall identify the detour, curtailment/turn-back and the beginning and ending dates and times. Include the ability to change the end date or expiration date of these events.

- **Information Message** – a data message that is logged for historical purposes, but is not normally presented to a CAD/AVL System user.

  d. EA events shall be displayed in the event queue within five (5) seconds from the time that the event is created. All other events shall be displayed in the event queue within 10 seconds of creation.

2. **Event Recording** - All events shall be recorded by the CAD/AVL System and, if appropriate, shall be presented to the appropriate CAD/AVL System users according to their functional and data partition assignments. The CAD/AVL
System shall be designed with sufficient processing and storage capacity to record all events without loss of system performance under the peak load conditions defined herein.

a. All recorded events shall be accessible via the Historical Data Storage and Retrieval functions. Recorded events shall include at least the following data:
   • Event type/sub-type(s)
   • Event parameter data, if any (e.g., message text)
   • Date/time of creation (at the source location of the event)
   • Date/time of receipt (at the fixed end)
   • Date/time of selection (by user)
   • Identification of selecting user
   • Data regarding the disposition of the event (e.g., incident report generated).

G. Incidents - The CAD/AVL System shall enable authorized users to create, maintain, track, and print incident reports that provide an official record with additional details concerning specific event occurrences. Incident types and subtypes shall be configurable by the Senior Administrator and System Administrator enabling modification of existing and creation of new incident types and sub-types. The following sections define basic requirements for incidents.

1. Incident Types - The CAD/AVL System shall support at least 16 different types of incidents. Each type of incident shall be associated with a unique incident report format that provides the information required for that particular incident type. The types of incidents and incident reports to be initially supported shall include the following:
   a. Emergency Alarms
   b. Priority-Request-to-Talk
   c. Request-to-Talk
   d. Districts/Operating areas
   e. Phone
   f. Text message

2. The Contractor shall work with SEPTA to develop the final list of incident types and subtypes and reports during the CAD/AVL System design phase, following
Contract Award. The Senior Administrator and System Administrator shall be able to add, modify, and delete incident types and incident sub-types. Up to 16 sub-types shall be definable for each incident type. The same “type” form shall be used for all sub-types of the “type”.

3. **Incident Recording** - The general information common to all incidents shall be recorded and shall include, but not be limited to, the following:

- Creation time and date of incident record
- Incident number
- Time and date of the incident
- Incident location
- Incident type
- Incident subtype (if applicable)
- Incident description
- Event(s) associated with the incident
- Vehicle ID
- Route number and direction
- Block number
- Operator name and badge number
- Dispatcher number
- Incident disposition
- Bus switch out (yes/no)
- Replacement bus ID
- Change location
- Change time
- Passenger(s) name (passenger related incidents)
- Notes
• Time lost
• Responding Supervisor name and badge number
• Incident status (open/closed)
• CAD/AVL System user who opened the incident
• CAD/AVL System user who modified the incident
• CAD/AVL System user who closed the incident
• Time and date the incident was modified
• Time and date the incident was closed
• CAD/AVL System user comments.

4. Additional information particular to each type of incident shall be supported by the CAD/AVL System and shall be defined as part of the design process following Contract Award. The System Administrator shall be able to add, modify, and delete data fields from the incident database.

1.5. AUTOMATIC VEHICLE LOCATION

A. The CAD/AVL System shall include an Automatic Vehicle Location (AVL) function. The AVL function shall provide tracking and reporting of the locations of CAD/AVL System-equipped vehicles with a positional accuracy of four meters or less, regardless of whether the vehicles are moving, on-route, off-route, have no assigned route; and whether or not the vehicles are logged in. All vehicle movement on AVL maps and displays shall be based upon actual vehicle location reports and shall not be simulated. Norristown High Speed Line and Media–Sharon Hill Line vehicles are operated in single and multiple car consists. The AVL maps shall clearly identify a multiple vehicle consist as a single operational unit yet show the configuration of the consist.

B. The AVL implementation shall provide both the vehicle Operators and CAD/AVL System users with accurate and timely position, schedule, and route adherence data while minimizing the use of data communications for the transmission of vehicle location data. Design approaches such as on-board calculation and display of route and schedule adherence (RSA) information, with only schedule and route deviation and occasional on-demand RSA reporting to the fixed-end system, shall be utilized.

C. Vehicles shall report the vehicle location whenever a timepoint is encountered, schedule or route adherence thresholds are exceeded, a communications request is transmitted, any vehicle alarm is transmitted, and whenever the vehicle responds to poll requests.
D. **AVL Coverage** - It is likely that there will be locations of momentary GPS signal blockage and/or distortion, especially in downtown areas. Accordingly, the CAD/AVL System shall include a Dead Reckoning functionality that will effectively maintain AVL accuracy requirements under the varying conditions of GPS satellite coverage that are likely to be encountered throughout SEPTA’s service area. Momentary loss of GPS signal less than a few minutes, which shall be Administrator-adjustable, shall not result in loss of vehicle position accuracy and shall not present unnecessary events and alarms.

E. **AVL Map and Overlays** - The CAD/AVL System functions shall utilize a current GIS base map. The Contractor shall supply all software, scripts and procedures necessary for successful importation of the base map into the CAD/AVL System, so that SEPTA can perform similar imports in the future without assistance from the Contractor and without an additional license fee.

1. In addition, the CAD/AVL System shall be able to import data for route shapes (route overlay data), timepoints, bus stops, and other location-based service data maintained in the scheduling system. It shall be possible to obtain route overlay data required for the CAD/AVL System from the scheduling system using the scheduling system software export abilities. See also Section 13342, Article 1.24 for further requirements concerning the scheduling system interface.

2. Initialization of the CAD/AVL System’s AVL map shall be the responsibility of the Contractor. The Contractor shall be responsible for all refinements, updates, format conversions, adjustments, processing, and handling of the GIS data supplied to them by the scheduling system or otherwise obtained as necessary for successful incorporation of the data into the AVL map and the proper operation of all CAD/AVL System functions that directly and indirectly use this data.

3. All functions necessary for successfully entering and maintaining map data in the CAD/AVL System shall be provided as part of the system. These functions shall enable the System Administrator to perform regular updates to, and replacement of the AVL base map and map overlays used by the CAD/AVL System without requiring extensive or complex manual operating procedures and without requiring manual data entry. Selective updates of the base map and to any selected overlays shall be possible without re-importing the entire map and all overlays and without loss of prior map edits. Where minor edits or data entry are required to import map data, such edits, entries and corrections shall be stored (e.g., as a script) for re-application in subsequent imports. The System Administrator shall be able to reapply these edits, entries and corrections on subsequent imports via a minimal set of commands.

1.6. **BULK DATA TRANSFER**

A. The CAD/AVL System shall support automated and secure wireless transfer of large amounts of data to and from all CAD/AVL System-equipped vehicles. This function shall eliminate the need for SEPTA personnel to physically visit each vehicle to perform updates to or download data from each vehicle.
B. Wireless bulk data transfers shall occur when the vehicles enter SEPTA’s depots through cellular or WLAN if available. The posting of data for transfers shall be supported at any time. The bulk data transfer function shall enable authorized CAD/AVL System users to post data for transfer to vehicles and to monitor the progress of all transfers on a per-vehicle basis. No user intervention shall be required to handle transfers once they are posted. Suitable interactive facilities shall be provided for the CAD/AVL System Administrator to manage the bulk data transfer function.

C. The bulk data transfer function shall detect interrupted transfers, such as for a vehicle that leaves the access zone prior to completion of a data transfer. In this case, the transfer shall resume from the interruption point when the affected vehicle returns to any access zone.

D. In order to expedite completion of large transfers, the bulk data transfer function shall continue to operate without interruption following vehicle power down while within range of any access point. This mode of operation shall be limited in duration as necessary in order to avoid excessive vehicle battery drain.

E. Bulk data supported by this function shall include, but not be limited to, the following types of data:

1. **Fixed-route Schedule Data** – Provide for the transfer of schedule data including routes, schedules, blocks, trips, runs, time points, arrival and departure times, map data, and other data required by the vehicles as dictated by the Contractor’s design approach. The bulk data transfer function shall permit all such updates to occur over a period of at least two weeks prior to the effective date of the new data and without disrupting current operations using the existing data. In addition, the CAD/AVL System shall include the ability to download short-term changes to the route definition data (e.g., re-routes or detours) to vehicles operating in the field.

2. **Vehicle Equipment Software Updates** – The download of software and configuration updates to any and all vehicle types.

1.7. **DAILY SCHEDULE SELECTION**

A. For fixed-route service, the CAD/AVL System shall support a minimum of two (2) complete sets of service schedules (bookings) – (1) the booking currently in effect and (2) the next booking to become effective at some future date. The daily schedule of trips for each service day shall be automatically selected by the CAD/AVL System based upon the date, service schedule in effect, day of the week, and any special schedules applicable to particular days. The CAD/AVL System shall support SEPTA’s current Weekday, Friday, Saturday, Sunday, and Holiday schedule types. Each schedule type includes trips that only pertain to certain days of the week or particular dates. The CAD/AVL System shall recognize such day-to-day variations in the schedules and only display and use the scheduled trips that apply to the particular service date. For each service schedule, the CAD/AVL System shall support at least
10 schedule types in addition to the current SEPTA schedule types. All schedule types and associated service dates shall be definable by SEPTA.

B. The CAD/AVL System shall support service days that cover time periods over 24 hours in duration and which end after midnight, at the time of the last pull-in. At midnight, the new day's schedule shall be utilized for vehicles that pull out after midnight. Those vehicles that pulled out before midnight shall continue to operate under the schedule of the day they pulled out until they complete their scheduled block, even if the block completion occurs after midnight. Therefore, for a time period after midnight, the CAD/AVL System shall allow two schedules to be in effect concurrently.

1.8. VEHICLE AND OPERATOR ASSIGNMENTS

A. The CAD/AVL System shall include all functions and displays to facilitate the manual entry of operators, vehicles, block assignments, and run assignments for the current and the next period of service in accordance with the associated pick. Functions and displays shall be provided that will enable dispatchers to easily confirm operator and vehicle assignments with operators reporting at the start of their work day and to make changes in assignments that might be required for the service day (e.g., change of vehicle or operator). The system shall issue a warning message and require a confirmation from the CAD/AVL System user before a duplicate vehicle or operator assignment is made. All changes shall become effective immediately, shall be included in all CAD/AVL displays and functions, and logged.

B. The system shall retain the data set of at least two picks, one representing the current pick and another representing the pick for the next period of service. The next pick data shall also include a start date and time when the new data will become effective.

1.9. SCHEDULE ADHERENCE MONITORING

A. The CAD/AVL System shall accurately monitor the schedule adherence of all fixed-route revenue vehicles that are operating on defined schedules. Fill-in vehicles (extra vehicles placed on a route) and special event/service vehicles that are without defined schedules need not be monitored for schedule adherence.

B. Schedule adherence shall be calculated for each defined timepoint and accurately estimated between defined timepoints. Schedule deviations beyond pre-defined, Senior Administrator and System Administrator-adjustable early and late thresholds shall produce an event.

C. Schedule adherence to defined timepoints shall be based on the scheduled departure time at each timepoint, with the exception of those specific stops that have only an arrival time or have both arrival and departure times. The CAD/AVL System shall handle any number of timepoints per route direction. Timepoint arrivals and departures shall be determined to an accuracy of ±15 seconds. For timepoint departures, determination to an accuracy of ±15 seconds shall be regardless of whether the vehicle stops at the timepoint or passes the timepoint without stopping.
D. Additionally, schedule adherence shall be predicted for deadhead portions of vehicle movements before the start and following the end of scheduled trips. A vehicle that is predicted to be late for the start of a trip or returning from the end of a trip by a Senior Administrator and System Administrator-adjustable amount of time shall be reported to the dispatcher.

E. A vehicle's schedule adherence status shall be used for display to the Operator, and for generation and display of schedule adherence deviation events to CAD/AVL System users. To minimize data transmission requirements under non-emergency conditions, a report-by-exception scheme is required, whereby schedule adherence information is maintained on-board each vehicle.

1.10. ROUTE ADHERENCE MONITORING

A. The CAD/AVL System shall accurately monitor the route adherence of all fixed-route revenue vehicles, including fill-in vehicles and special event/service vehicles that are operating on defined routes. Route deviations that are beyond pre-defined, Senior Administrator and System Administrator-adjustable thresholds shall produce an event.

B. A vehicle's route adherence status shall be used for display to the Operator, and for generation and display of route adherence violation events to CAD/AVL System users. To minimize data transmission requirements under non-emergency conditions, a report-by-exception scheme is required, whereby route adherence information is maintained on-board each vehicle.

1.11. TURN-BACK OR SHORT TURN MONITORING

A. The CAD/AVL System shall detect and adjust for fixed-route vehicle turn-backs (short turns) within an assigned block. The system shall issue a specific turn-back event when a vehicle has executed a turn-back before the end of its current trip and proceeds along the route in the opposite direction for a subsequent trip within the same block. Following the turn-back, the CAD/AVL System shall automatically determine which trip within the assigned block the vehicle has jumped to, based on the current time, the vehicle's new geographic location, the vehicle's direction, and the vehicle's schedule. The CAD/AVL System shall then resume RSA monitoring for the vehicle based on the new trip assignment. Missed trips and partially missed trips shall be identified and presented to CAD/AVL System users in associated schedule-related displays, and recorded by the CAD/AVL System for reporting purposes.

B. The Senior Administrator and System Administrator shall be able to enable and disable the turn-back function. Initially, the turn-back function shall be turned off.

1.12. INTERLINING

A. The CAD/AVL System shall insure the proper handling of interlined blocks by all fixed-route CAD/AVL System functions. Additional user actions, selection criteria, and displays from those required to handle non-interlined routes shall not be required. CAD/AVL System functions that shall properly handle interlining shall include, but not be limited to, the following:
1. Group messages to a route
2. Store and forward messages to a route
3. Internal and external audio and visual announcements
4. Destination sign changes, with and without an intermediate deadhead
5. Correlation of RSA data to the proper routes
6. Display of interlined routes on the AVL map
7. Display of vehicles on interlined routes on the AVL map
8. Data messages, text messages including store and forward messages, reroutes, and RSA functions through the selection of one or more routes via “rubber-banding”.

B. The Senior Administrator and System Administrator shall be able to enable and disable the interlining function. Initially, the interlining function shall be turned off.

1.13. SHIFT TRIPS

A. The CAD/AVL System shall include functions to shift a trip forward or backward in time, changing the scheduled time as needed.

B. The Senior Administrator and System Administrator shall be able to enable and disable the shift trips function. Initially, the shift trips function shall be turned off.

1.14. DETOURS

A. Detours planned in advance using the scheduling system shall be downloaded to the CAD/AVL System from the scheduling system by the System Administrator. New detours shall be enterable by the Dispatchers. All downloaded and Dispatcher-entered re-routes shall be displayed in the same detour display and all detours, regardless of their source, shall be listed in the same list according to the route number and detour notice numbering sequence. The Dispatcher-entered detours shall be distinguished from the downloaded detours in a visually distinctive manner, such as by using bolding, color, background changes, or similar approaches. Dispatchers shall be able to add an unlimited number of new detours notices and to modify and delete any Dispatcher-entered detour. Detour shall be able to use recurrent event detours, i.e. snow day, Made in America event, Broad Street Run etc.

B. The detour description field shall be up to 500 characters in length and the reason field shall be at least 50 characters in length. The detour entry screen provided for Dispatcher entry of detour notices shall be the same character width as the display on the VLU, so that the Dispatchers may format the detour notices for proper display on the VLU. The CAD/AVL system shall also allow Dispatchers to retrieve an existing
detour notice, modify it, and store the revised detour under the same or a new detour name.

C. In many cases, a detour notice will apply to more than one route. In these situations, the Dispatcher shall only be required to enter the detour definition once. The CAD/AVL System shall allow the Dispatcher to specify the applicable routes and the CAD/AVL System shall automatically store the detour definition under each specified route with a unique, sequentially assigned detour notice number.

D. Dispatchers shall be able to select a detour description for transmission and display on-board one or more vehicles. The Dispatchers shall be able to specify the routes and/or vehicles that are to receive the re-route notices. If route numbers are specified, the CAD/AVL System shall send the detour notice to all vehicles operating on those routes.

E. The CAD/AVL map shall highlight detours and allow dispatchers to highlight and save a graphic/map view of the detour to be forwarded to customer service and other users via E-mail

F. Customer Service shall be able to view all current and past detours.

1.15. BUS BRIDGE

A. The CAD/AVL System shall insure the proper handling of new trips or routes by all fixed-route CAD/AVL System functions in real time.

B. The CAD/AVL System shall recommend replacement vehicles and drivers taking into consideration status of the potential replacement driver (full/part time, regular, Extra Board, vehicle schedule, vehicle maintenance required, operator assignments, etc.)

C. The CAD/AVL System shall support the ability to identify the number and location (garage) of available vehicles for assignment to Bus Bridges, service restorations (e.g. fills or trades), and other ad hoc service adjustments (e.g. gap filling to restore consistent service headways)

D. The CAD/AVL System shall support different classifications of Bus Bridges, including: planned and unplanned and within both, major or minor

E. The CAD/AVL System shall identify available and appropriate vehicles for unplanned bus bridge if vehicles need to be pulled from service, factors shall include vehicle capacity, driver experience, minimizing impact on other routes (interlining, transfer, etc.)

F. The CAD/AVL System shall be able to denote high priority bus routes with color-coding or other means to address rail stoppage needs

G. The CAD/AVL System shall assist the dispatcher with route management of the line(s) where buses have been removed from service for the bus bridge. This could include turning-back some buses and putting the line on headway management
H. The Senior Administrator and System Administrator shall be able to enable and disable the bus bridge function. Initially, the bus bridge function shall be turned off.

1.16. OPERATOR RELIEF STATUS

A. The CAD/AVL System shall monitor the status of scheduled reliefs for vehicle Operators. A complete schedule of reliefs for the current service day shall be provided that shows the status of each scheduled relief. Possible status indications for reliefs shall include whether the relief has started, is completed, and has been missed.

B. The Senior Administrator and System Administrator shall be able to enable and disable the operator relief status function. Initially, the operator relief status function shall be turned off.

1.17. CAD/AVL SYSTEM USER FUNCTIONS

A. The CAD/AVL System shall provide functions to support CAD/AVL System users as specified in the following sections. All user functions shall be available to both local and remote/shared users. Local users are defined as those users on the SEPTA LAN/WAN who require continuous or regular access to the CAD/AVL System. Remote users are defined as users with workstations whose network interconnection to the CAD/AVL System LAN is via a WAN infrastructure with limited bandwidth. Shared users are defined as users who will only intermittently access the CAD/AVL System and do not require a dedicated CAD/AVL workstation installation at their work position. Simultaneous access by a minimum of 12 remote/shared users shall be supported by the CAD/AVL System.

B. Event Handling - CAD/AVL System users shall be permitted access to events to the extent permitted by their assigned data partition(s). CAD/AVL System users with read-only access to specific events shall be able to view the events, but they shall not be permitted to respond to (i.e., acknowledge, open incident, reply, log, etc.) the events. CAD/AVL System users shall not be permitted to view events to which they do not have at least read-only access.

   1. The CAD/AVL System shall always ensure that emergency events are promptly presented to all active (i.e., logged on) CAD/AVL System users. In this special case, the CAD/AVL System users receiving the emergency event shall have full access to the event. Events not assigned to a data partition and events in data partitions without a current active user shall be routed to at least one active CAD/AVL System user, regardless of the data partition assignment(s) of that user. The System Administrator shall be able to define which users or groups of users shall receive the emergency events and the events not assigned to a data partition or assigned to a data partition without a current active user.

C. Event Presentation - The CAD/AVL System shall enable CAD/AVL System users to rapidly and efficiently detect and respond to events. Events shall be presented to CAD/AVL System users in a manner that emphasizes the most urgent events requiring response. However, all events within a CAD/AVL System user’s data partition(s) shall be accessible.
1. Redundant events shall be eliminated in order to reduce the presentation of unnecessary events. In cases where multiple EA events are present from the same vehicle, only the first-received, highest priority, unanswered (i.e., to which a CAD/AVL System user has not responded) event shall be presented. Where different mechanical alarms are being reported for the same vehicle, the most recent unacknowledged or return-to-normal alarm of each unique alarm subtype shall be presented. Where multiple Route and Schedule Adherence (RSA) violations are being reported for the same vehicle, only the most recent event of each type shall be presented.

2. CAD/AVL System users shall be able to inhibit or change the display reporting thresholds of selected events in order to reduce the volume of events being reported during peak operating periods and during service disruptions. In particular, CAD/AVL System users shall be able to inhibit the display of RSA violations and to modify the display thresholds in order to control the number of RSA violation events displayed to the user.

3. Some events supported by the CAD/AVL system might not initially be used. The CAD/AVL System shall enable the Senior Administrator and System Administrator to inhibit and re-enable the reporting of selected events.

4. All events, including redundant events, shall be stored in the historical log regardless of how they are filtered or otherwise handled for user presentation. For example, inhibiting and changing of display reporting thresholds by a user shall not affect the historical recording of the filtered events.

D. Event Selection - The CAD/AVL System shall enable CAD/AVL System users to quickly locate and select an event. A convenient mechanism shall be provided for the automatic selection of the oldest (first received) event in the highest event priority level and the most recent (last received) event in the queue, regardless of the event’s priority level.

1. Upon selection of an event by a CAD/AVL System user, the CAD/AVL System shall enable the following functions:

   a. **View** – examine all information concerning the event

   b. **Edit** – insert, delete and modify information concerning the event

   c. **Incident** – create and edit an incident report for the event

   d. **Answer** – respond to an event requiring a response, including a request for voice communications, returning a text message, and acknowledging alarms

   e. **Show Location** – Show the current location of the vehicle associated with the event on the AVL map display

   f. **Transfer** – transfer control of the event to another authorized CAD/AVL System user.
2. The CAD/AVL System shall manage access to events by multiple CAD/AVL System users in order to avoid conflicts and loss of data that may otherwise occur from multiple operations on the same event.

3. In addition, the CAD/AVL System shall support the ability to sort incidents by route, block, time, status or type.

E. **Event Removal** - Authorized CAD/AVL System users shall be able to remove events from display regardless of their current status. The ability to select multiple events for removal with a single command shall also be provided. Authorized CAD/AVL System users shall also be able to specify that all events of a particular type be removed with a single command; for example, to remove all schedule adherence messages or all data messages of a particular type with a single command. Removal of emergency alarms shall require additional confirmation from the CAD/AVL System user before the request is executed. Removal of events shall affect only their presentation to CAD/AVL System users and shall not affect the historical log, which shall record and retain all events.

F. **Map-Based Vehicle Location and Status** - The CAD/AVL System’s AVL map functionality shall provide CAD/AVL System users with a detailed geographical map of the SEPTA service area showing the current locations and RSA status of all vehicles within a user’s assigned data partition(s). This functionality shall be provided at all workstations equipped for the display of the AVL map.

1. Vehicle positions on the AVL map shall be represented by vehicle symbols depicting SEPTA’s various fleet vehicles. Vehicle positions shall be accurately located and aligned with the streets and rail lines on which the vehicles are operating. There shall be no visible offsetting of vehicle positions from the displayed streets and rail lines. If necessary, the CAD/AVL System shall correct for map and positional inaccuracies and automatically position the displayed vehicle symbols onto the proper streets and rail lines. Vehicle locations shall be updated on the map overlay each time valid vehicle position data is obtained from the vehicle.

2. For the trolley, MSHL, and NHSL separate AVL map layers showing the track layout, including switches and turnarounds, shall be provided. CAD/AVL System users shall be able to quickly enable or display the track layout layer on a route-by-route basis.

3. When the on-board AVL equipment is not operational and when data communications is disrupted, vehicle locations shall remain at the last reported location. For such vehicles, the last reported location shall be depicted on displays with appropriate highlighting to indicate to a viewer that AVL data is not available and the vehicle location is the last known position.

4. Vehicle status information conveyed by this function shall include, but not be limited to, the following attributes:

   a. Vehicle ID assignment
b. Schedule status (early, on-schedule, or late)

c. Emergency alarm conditions

d. Route status (on or off-route)

e. Type of vehicle (e.g., fixed-route)

f. Non-Scheduled - logged on (e.g., fill-in, tripper, special event vehicles)

g. Not logged on

h. Operator badge number and name

i. Direction of travel

j. Vehicle speed

k. AVL data not available.

5. CAD/AVL System users shall be able to quickly and easily configure their map view to display all or selected attributes.

G. Service Status - The CAD/AVL System shall provide tabular information to users for determining the status of specific routes, schedules, and vehicles within the users' assigned data partition(s) without the use of geographical maps. The CAD/AVL System user shall be able to filter and sort the data presented using common selection criteria, such as date, time, vehicle, Operator, route, block, run, etc.

1. At a minimum, the following types of information shall be provided:

a. A searchable listing of blocks that provides the scheduled times at timepoints and, if data is available, at bus stops

b. A searchable listing of runs that provides the scheduled operator work piece(s)

c. A searchable listing of routes that provides the scheduled times of vehicles at timepoints and, if data is available, at bus stops

d. A listing of vehicles currently in violation of schedule adherence limits with the early/late status in terms of minutes, current route, block, and run assignment

e. All blocks for the current service day and the current status of each block, including an indication of active blocks that are currently un-served (e.g., due to an overdue Operator log-on)

f. A listing of the currently active (logged on) vehicles and vehicle Operator for each block
g. All runs for the current service day and the current status of each run, including an indication of active runs that are currently un-served (e.g., due to an overdue Operator log-on)

h. A listing of currently active (logged on) vehicles for each run

i. All routes that currently have tripper and fill-in vehicles active and the number of tripper and fill-in vehicles on each of those routes.

H. Vehicle and Route Selection - The CAD/AVL System shall enable users to quickly identify, through selection, a set of vehicles and routes for the purpose of directing specific voice and data communications to/from the selected set of vehicles and routes. Available vehicle and route selections shall be based on the CAD/AVL System user’s assigned data partition(s).

I. Basic Selection Methods - The basic methods of vehicle and route selection that shall be supported are as follows:

a. Select one or more vehicles by specifying vehicle IDs

b. Select one or more vehicles by specifying vehicle assignment attributes, including Operator badge numbers, currently assigned block numbers, and currently assigned run numbers. The CAD/AVL System shall automatically maintain the correlation between vehicles, vehicle Operator names, vehicle Operator badge numbers, block numbers, and run numbers based on the current schedule and log-on data received when Operators log in.

c. Select one or more specified routes by route numbers. Since the set of vehicles associated with a route may change frequently during the service day, the selection of routes shall resolve to the corresponding vehicles only at the time the selection is actually used and not during the selection process itself, which may have occurred at an earlier time. For example, route selections for the text message store and forward function shall pick up new vehicles as they log onto a route during the service day.

d. Select all vehicles of a particular type (e.g., fixed-route revenue vehicles and non-revenue vehicles).

e. Select all vehicles. The CAD/AVL System shall provide a dedicated command for executing this type of selection. CAD/AVL System users shall not be required to make multiple selections to select all CAD/AVL System-equipped vehicles.

f. Re-use the selection with which the CAD/AVL System user previously communicated, or tried to communicate. The CAD/AVL System shall support this type of selection without requiring the CAD/AVL System user to explicitly re-select the vehicles and routes involved. The CAD/AVL System user shall be able to name and save selection criteria for re-use.
g. Any combination of the above selection methods shall be applicable interactively in order to construct the desired final list of vehicles and routes. The system shall automatically filter out duplicate vehicle entries that may occur as a result of the selection process.

2. **Map-Based Selection Methods** - The following map-based selection methods shall be provided from the AVL map display:

   a. Select one or more vehicles and routes that are individually picked from the AVL map display.

   b. Select all displayed vehicles within a dynamically selected geographical area on the AVL map display. A "rubber-band" type of graphical selection shall be supported for defining the desired geographical area. The CAD/AVL System shall generate a list of all vehicles that are currently located within the selected area. Vehicle IDs and block numbers shall identify the selected vehicles. Once a list of vehicles is generated, the CAD/AVL System user shall be able to add, delete, and modify entries in the list prior to using it.

   c. Select all displayed routes within a dynamically selected geographical area on the AVL map display. A "rubber-band" type of graphical selection shall be supported for defining the desired geographical area. The CAD/AVL System shall generate a list of all routes that pass through the selected area. Once a list of routes is generated, the CAD/AVL System user shall be able to add, delete, or modify entries in the list prior to using it.

3. CAD/AVL System users shall be able to use a combination of both basic and map-based methods to make a selection.

I. **Emergency Alarms** - When a CAD/AVL System user selects an Emergency Alarm (EA) event in the event queue, the CAD/AVL System shall provide a subtle (i.e., not observable by passengers on the vehicle) and silent indication back to the initiating vehicle Operator's VLU that the emergency alarm has been received and that covert monitoring has been initiated.

   1. The CAD/AVL System user shall also have the ability to terminate an emergency alarm without communication from the vehicle Operator. However, the system shall issue a warning message and require a confirmation from the CAD/AVL System user before the emergency alarm is actually terminated.

   2. The CAD/AVL System user selection of an emergency alarm shall automatically generate an incident report.

J. **Text Messaging** - A major goal of the CAD/AVL System is to greatly reduce the need for voice communications and to streamline the dispatching function through the extensive use of text messaging between Operators and Dispatchers. To this end, the CAD/AVL System shall be designed to efficiently support text messaging to and from the vehicle fleet.
1. The CAD/AVL System shall enable authorized CAD/AVL System users to send text messages to one or more selected vehicles and routes using any of the specified selection methods. Free-form text messages and a set of pre-defined text messages shall be supported. Pre-defined text messages shall be configurable by authorized CAD/AVL System users and shall be available for rapid selection. The CAD/AVL System shall support at least 60 pre-defined messages. Text messages shall be up to 250 characters in length.

2. CAD/AVL System users shall be able to specify a response requirement for each free-form text message that is issued. Response requirement options supported by the CAD/AVL System shall include: “no response”, “acknowledgment of receipt”, and “yes/no”. For messages requiring a response, the CAD/AVL System shall request a response from each vehicle to which the text message is directed. The default response requirement for free-form text messages shall be “no response”. Pre-defined text messages shall each have a pre-defined default response requirement.

K. Text Messaging with Response - The CAD/AVL System shall track the status of responses to text messages that require a response. Responses shall not be displayed in the event queue. Rather, a separate display shall be used for displaying and managing these responses. The CAD/AVL System user shall be able to display the status of all required responses grouped by message. For each message, a listing of the receiving vehicles shall be presented, along with the assigned block and run numbers, with an indication of those that have responded and the response received. Vehicles that have not responded shall be listed at the top of the list. The text of the original message and the time it was sent shall be displayed at the top of each list.

   a. The CAD/AVL System shall support situations where multiple messages requiring a response are active at the same time for the same CAD/AVL System user. In this case, the CAD/AVL System shall associate the responses with the proper message. The active messages and the status of responses for each shall be preserved when a CAD/AVL System user logs off and automatically transferred to a new CAD/AVL System user who logs on and takes over the responsibility of the CAD/AVL System user who initiated the active messages. Alternately, a CAD/AVL System user shall have the capability to manually initiate a transfer of the lists to another CAD/AVL System user who may not be logged on yet or to whoever assumes the responsibility of the CAD/AVL System user who initiated the messages.

   b. CAD/AVL System users shall be able to choose the message responses to be displayed from a list of active messages for which responses have been required. Authorized CAD/AVL System users shall be able to delete a message from the active list even if all of the responses have not been received.

   c. All detour and text messages shall default to no response with an option to request a response.
L. **Text Messaging – Store and Forward** - The CAD/AVL System shall enable authorized CAD/AVL System users to send text messages that are designated as “store and forward” messages.

1. CAD/AVL System users shall be able to address “store and forward” messages to selected vehicles in a manner similar to normal text messaging and shall be able to designate a bounded (start/end) delivery time period. A “store and forward” message shall be delivered to the selected vehicles that are logged on and also to those that logon or interline to one of the addressed routes at any time during the user-designated delivery time period. In no case shall a store and forward message be delivered more than once to the same vehicle Operator while operating the same vehicle and block (or route) number.

2. A store and forward message shall remain available for delivery until the user-designated delivery time period has ended, until the message is deleted by the CAD/AVL System user, whichever occurs first.

3. All Store and Forward messages shall default to no response.

M. **Voice Communications** - Voice calls to one or more selected CAD/AVL-equipped vehicles shall be supported using any of the selection methods specified. In this normal mode of operation, the CAD/AVL System shall automatically select an available and open voice talk group.

N. **Route and Schedule Adherence (RSA) Status** - The CAD/AVL System shall monitor the Route and Schedule Adherence (RSA) status of all revenue vehicles. All vehicles that are off-route or off-schedule by more than pre-defined threshold values indicated below shall be presented to CAD/AVL System users who are assigned to the corresponding data partition(s). RSA status data shall be presented in terms of minutes early or late and the distance off-route.

1. The threshold values for declaring a vehicle off-schedule and off-route shall be Senior Administrator and System Administrator-adjustable. The CAD/AVL System shall support multiple categories of threshold values.

   a. Schedule Adherence: Initially, vehicles that deviate from their schedules greater than one minute early and more than five minutes late for fixed-route vehicles, shall be treated as schedule adherence violations. Additionally, schedule adherence shall be predicted for deadhead portions of vehicle movements before the start and following the end of scheduled trips. A vehicle that is predicted to be late for the start of a trip or returning from the end of a trip by a System Administrator-adjustable amount of time (initially greater than 5 minutes) shall be reported to the dispatcher as a schedule adherence violation.

   b. Route Adherence: Initially, vehicles that deviate from their scheduled routes by more than 1,000 feet for fixed-route vehicles or that miss a bus stop shall be treated as route adherence violations.
2. **RSA Disable and Enable** - Assistant Directors, Senior Administrators, and System Administrators shall be able to disable route and schedule adherence violation events for selected vehicles, for all vehicles on selected routes, for all vehicles while they are located within a specified geographic area, and for all vehicles. The objective of this functionality is to minimize nuisance alarms presented to the CAD/AVL System user; for example, when vehicles are forced to detour or are delayed due to a known traffic problem. Assistant Directors, Senior Administrators, and System Administrators be able to disable route and schedule adherence violations events for a user-adjustable specific time period. These disabled conditions shall be identified in a list available to Assistant Directors, Senior Administrators, and System Administrators for review and for the re-enabling of the RSA violation events. All disabling and enabling of RSA violation events shall be logged.

O. **Incident Forms** - The CAD/AVL System shall provide authorized CAD/AVL System workstation users the ability to create, maintain, track, view, and distribute incident forms. The creation of incident forms shall be triggered automatically for some event types and sub-types (e.g., an emergency alarm), on user demand for all other event types and sub-types, and for incidents not linked to events. CAD/AVL System workstation users shall be able to request a full menu listing of all open and closed incident forms for the current day for selection and display of the desired form.

1. Upon creation of an incident form, the CAD/AVL System shall automatically fill in all data for the form that is available to the system, such as vehicle IDs, Operator name and badge number, block number, dispatcher number, route, RSA status, current date and time, and vehicle location. The automatically filled in location shall be a reverse geo-coded street address or, if applicable, transit location (e.g., timepoint or bus stop) based on the vehicle’s reported lat/long position. CAD/AVL System users shall be able to edit all data fields and fill out any additional data fields defined for the incident form. CAD/AVL System users shall be able to edit incident form data until the incident form is closed. Incident form reports shall automatically be distributed to designated locations on SEPTA’s LAN/WAN to selected management. Assistant Directors, Senior Administrators, and System Administrators shall have the ability to re-open an incident form to add and/or modify data. Incident shall add the modification date, time and account number of the assigned user that re-opened the incident.

2. SEPTA requires an approach to incident management that permits multiple events to be linked to a single incident form.

3. The CAD/AVL System shall provide functions to enable the Senior Administrator and System Administrator to specify which events will automatically trigger incident forms and the incident form format to be used, create new incident form formats, edit existing form formats, and integrate new form formats into the system. These incident form maintenance functions shall be available on-line without interrupting current system operation.

P. **Surface Snow App.** – The CAD/AVL System shall provide a standalone webbased application showing a map view of all vehicles with an open CAD/AVL Incident Report
using specific SubCodes, for example 070 for Send Service Truck, 071 for Send Wrecker, and 075 for Line Standing/Icy Conditions.

1. The System Administrator shall be able to define which SubCodes shall be used for this application and what color the vehicle icon is displayed e.g. red for Send Service Truck and blue for Line Standing/Icy Conditions.

2. The application shall include a legend with the vehicle icon and Incident Report SubCode description.

3. The application shall include a listing of all vehicles with the same Incident Report SubCode and include the time the Incident was opened, the elapsed time (in minutes), the location, the SubCode, and the route, block and vehicle number.

4. The elapsed time, map view, and vehicle listing shall update automatically and not require a web browser refresh.

5. Closing an Incident Report with a specified SubCode shall remove the vehicle from the map and vehicle view.

Q. **Playback** - The CAD/AVL System shall include a playback functionality that enables CAD/AVL System users to quickly recreate and observe the exact conditions that existed within the system at a previous time for the purpose of analyzing incidents. The playback function shall permit users to rapidly and selectively retrieve data for any time period where online historical data is available without requiring the loading of archival data from removable media. A means shall be provided to restore data from removable media and play back data from time periods prior to the online history. All playbacks shall use the Information Server data. There shall be no limit to the duration of the playback period defined by the CAD/AVL System users.

1. The playback shall recreate the exact conditions that existed during the particular time frame selected by the user. Observation of the conditions that were present at the time shall be supported and allow presentation of all displays, including AVL displays and production of all reports via the normal CAD/AVL System displays and reports at the requesting user’s workstation. The actual displays that were originally present on each workstation monitor do not need to be recreated; only the system conditions need to be recreated. These system conditions shall include all:

   a. Application program generated outputs

   b. Alarms

   c. Events, including schedule and route adherence events

   d. Incidents

   e. Vehicle locations
f. Instantaneous speed

g. Information on reroutes in effect

h. Data communications

i. User-entered data and commands that initiate communications, initiate actions, and modify the database.

2. The AVL presentation for playback shall include a means of determining the average speed of vehicles.

3. The ability to play back the conditions that existed at a previous time shall be unaffected by database, display, and report changes that have occurred since that time. The normal online operation of the CAD/AVL System at other user workstations shall not be affected by the playback function.

4. Playback functionality shall enable users to start a playback beginning at any selected date and time. Users shall not be required to play back data for an extended duration in order to properly initialize the system conditions at the beginning of the playback period specified by the user. Users shall be able to control the speed and execution of the playback and shall be able to start and stop the playback, fast forward, reverse, pause and resume, and play back in slow motion. While in pause mode, no further data updates shall occur, but users shall be able to view and move among all displays and produce all reports.

5. It shall be possible to save a recording in a standard multimedia format as .avi, .wmv, and/or .mpg. for later review and analysis.

6. The same display formats and conventions shall be utilized for playback as for actual operations, except that a clear, distinguishing attribute such as a colored border or other means shall be provided to distinguish displays presented during playback from those presented during actual operations.

1.18. SYSTEM ADMINISTRATION FUNCTIONS

A. Access to the following CAD/AVL System user functions shall be restricted to System Administrators.

   1. **Schedule Data Maintenance** - The CAD/AVL System shall enable authorized System Administrators to manually initiate retrieval and maintenance of all defining data for the fixed-route schedules. Schedule data required for proper operation of the CAD/AVL System shall be retrieved from SEPTA’s fixed-route scheduling system (Trapeze-FX). This data shall include, but not be limited to, route shapes and descriptions, trips, runs, time points, stops and block definitions. The retrieved data shall be used by all functions within the CAD/AVL System, including Route and Schedule Adherence Monitoring.
a. Retrieval of route definition data shall occur directly via the external system rather than through manual handling of physical media. In addition, functions shall be provided to enable the user to validate, test, repair and, if necessary, discard a retrieved data set prior to its cutover to online operation. These functions shall be supported without interfering with online operation of the CAD/AVL System using the currently active data set.

b. The cutover to online operation for a new and validated schedule data set shall be coordinated within the CAD/AVL System to ensure schedule data is consistent between the fixed-end servers and the vehicles. The distribution of destination sign data to vehicles shall be according to the requirements specified for bulk data transfer. The cutover process shall minimize any interruption to online operations and in no event shall such an interruption exceed 10 minutes.

c. The CAD/AVL System shall enable System Administrators to make manual adjustments and corrections to the CAD/AVL System active schedule data for use on an interim basis. Adjustments and corrections shall be visually distinguishable by users from the original data. All such manual changes shall be immediately available to all affected CAD/AVL System functions. A means shall be provided to restore the schedule data to its original state without having to manually re-enter the data.

B. GIS Data Import and Maintenance - The Contractor shall supply all functions, software, licenses, scripts, procedures, and training necessary for successful import of the base map GIS data into the CAD/AVL System so that SEPTA can perform similar imports in the future without assistance from the Contractor. The CAD/AVL System shall enable System Administrators to manually initiate the import of base map data, including addition of map layers and other spatial data without affecting current system operation and, once complete, shall permit a controlled and rapid switchover to the new data. The import process shall enable input, validation, and correction of new and updated map data without requiring extensive or complex manual operating procedures and without requiring significant manual data entry.

1. The CAD/AVL System shall enable System Administrators to make corrections and additions to the map. The CAD/AVL System shall store these corrections and additions so they can be re-applied on subsequent retrievals of newer versions of the base map without requiring re-entry of any of the changed data. A simple means of reverting to a prior map shall also be provided.

2. A means of switchover to new map data shall be provided that minimizes system disruption while updates are being distributed to all components of the system that require map data, including map-enabled workstations. All distribution shall be automatic and shall not require the System Administrator to physically access each component.

3. Regardless of the method used, system downtime shall not exceed 10 minutes for incorporation of new GIS data.
C. **System Configuration Monitoring and Control** - The CAD/AVL System shall provide System Administrators with the ability to review and modify the CAD/AVL System configuration and parameters. The ability to monitor the status of all CAD/AVL System components shall also be provided. Functions to control system performance monitoring, and to display and analyze server and workstation processor resource utilizations shall also be provided.

1. Control operations that shall be supported shall include, but not be limited to, failover switching, server and LAN administration, management of interfaces, and control of CAD/AVL System components.

2. The CAD/AVL System shall provide System Administrators the ability to log out any user in the system and provide a log event of this action.

1.19. **REVENUE VEHICLE FUNCTIONS**

A. The CAD/AVL onboard system shall provide revenue vehicle functions as specified in the following sections. CAD/AVL System-equipped revenue vehicles shall provide all required functions while operating anywhere within SEPTA’s defined service area and without requiring manual reconfiguration of any kind.

1. A logon through a Smart Card and at the Vehicle Logic Unit (VLU) shall automatically logon or all onboard system equipment, including destination signs, Clever Devices IVN or DR 500C/600/700, and the farebox/Key payment device. However, the CAD/AVL System shall verify that all logon data is valid before accepting the logon. The validity checks to be performed on each data field are as follows:

   - **Operator badge number** - Verify that the Operator badge number entered is a valid number in the current employee list, that the employee is permitted to perform a vehicle logon, and that the same employee is not already logged onto another vehicle.

   - **Vehicle ID** - Verify that the Vehicle ID is a valid number in the current vehicle list.

   - **Block number** – Verify that the entered block number is valid for the current day and time, and that it is not already logged on to another vehicle.

a. Invalid logons shall be rejected. The CAD/AVL System shall log an event after three consecutive invalid logon attempts that includes all relevant information about the invalid logon attempts, including the badge number used, the vehicle ID, block number, and date and time.

b. All valid logons and logoffs shall be logged as events that indicate all relevant information about the logon and logoff, including the Operator badge number, block number, vehicle ID, and date and time. A successful logon shall trigger
the delivery of any relevant store and forward text messages to the vehicle (e.g. detours).

c. If an Operator fails to log on prior to pull-out, the CAD/AVL System shall issue an audible alarm to the Operator and shall prompt the Operator to logon. Dispatchers shall be able to logon and logoff Operators remotely. A successful logon shall not be required in order to use any of the CAD/AVL System vehicle communications functions.

d. The CAD/AVL System shall retain an Operator’s logon status during layovers and other temporary hold conditions for which the vehicle ignition may be turned off. The Operator’s logon status shall not be affected by subsequently restarting the vehicle engine upon resumption of service. An Operator shall be logged off automatically after a System Administrator-adjustable period of time following turn-off of the vehicle ignition.

2. **Operator Changes** - The CAD/AVL System shall support enroute changes in the assigned Operators for cases such as mechanical breakdowns and Operator substitutions. The Operators shall be required to perform an Operator logoff/logon when the change takes place.

3. **Text Messaging** - The CAD/AVL onboard system shall enable Operators to send pre-defined text messages to CAD/AVL System users with a minimum of interaction with the VLU. Pre-defined messages shall be selected and transmitted by Operator selection. For each vehicle type (e.g., fixed-route), the CAD/AVL System on-board system shall support at least 30 pre-defined messages of at least 80 characters in length. Operator-initiated messages shall be handled as events and shall be subject to all of the requirements of events, including event priority and event data partitioning.
   
a. The CAD/AVL System shall allow System Administrators to define and revise the set of pre-defined messages, and to schedule the automatic transfer of the revised messages to all vehicles via bulk data transfer.
   
b. Operators shall be able to review recently received messages at any time with a minimum of interaction with the VLU. The CAD/AVL on-board system shall retain at least the last eight received messages for Operator review. The received messages shall be ordered chronologically with the most recently received message presented first. Retained messages shall be deleted from the VLU upon vehicle operator logoff.
   
c. Messages requiring a response shall be clearly indicated to the Operators. Operators shall be able to respond by selecting the appropriate response on the VLU. Message responses shall be routed to the Dispatcher currently responsible for handling the responses.

4. **Text to Speech** - The VLU shall provide Text-to-Speech functions to limit interaction of the vehicle operator with the VLU while the vehicle is in motion. The Text-to-Speech function for playing a new text message shall start by a
single Operator action. A text message shall not be removed after the message has been played. It shall be required that text messages are read by the Operator (displayed in text form on the VLU) before they can be removed. The System Administrator shall be able to enable and disable the function that text messages are read by the operator before they can be removed by vehicle type.

B. **Silent Emergency Alarms** - The CAD/AVL System shall enable Operators to issue a silent emergency alarm (EA) for which activation is not observable by passengers on the vehicle. Activation of this alarm shall result in an emergency alarm event that is reported to all appropriate CAD/AVL System users.

1. CAD/AVL System user selection of an emergency alarm event shall provide a subtle, non-obvious indication to the Operator that the emergency alarm has been received and acknowledged.

C. **Covert Monitoring** - CAD/AVL System user selection of an emergency alarm shall automatically initiate covert monitoring (i.e., a one-way voice call from the vehicle to the selecting CAD/AVL System user). CAD/AVL System user initiation of covert monitoring without an associated emergency alarm shall not be permitted.

1. Covert monitoring shall enable the CAD/AVL System user to monitor sound from the vehicle that is in an emergency alarm state.

2. The voice channel number selected by the system for covert monitoring shall be made available to the CAD/AVL System user at the workstation. The CAD/AVL System shall be support simultaneous covert monitoring sessions with at least two vehicles.

3. While covert monitoring is active at a workstation, all other workstations shall continue to operate normally, including support for all two-way voice and data communications with other revenue and non-revenue vehicles. The CAD/AVL System user who selected the emergency alarm, thus initiating a covert monitoring session, shall be able to end the covert monitoring session (but not the emergency alarm) at any time. During covert monitoring, periodic interruptions to the covert monitoring transmission that are required to avoid overheating of the mobile transmitter are acceptable, provided these interruptions are kept as short as possible.

D. **Vehicle Location Reporting** - Reporting of vehicle locations based upon on-board GPS equipment shall be provided by the CAD/AVL System. Only valid GPS data received from the vehicle shall be processed by the CAD/AVL System. Location data shall always be reported as part of all data messages. Dead reckoning shall be used to enhance the GPS-based location reporting by providing position reports when GPS-based position reports are unavailable.

E. **RSA Status** - The CAD/AVL on-board system shall automatically display RSA (Route and Schedule Adherence) status to the Operator. The CAD/AVL on-board system shall display schedule adherence status to the Operator in units of minutes early and late. The ability to independently turn the Operator’s display of route adherence status
and early and late schedule adherence status on and off shall be configurable by the System Administrator.

F. **Fixed Route Schedule Display** - The Operator shall have an VLU display available that shows the next stops of the current route. The stops shall be displayed in colors that represent the type of stop (e.g., time point stop, non-time point stop, etc.).

G. **Navigation Aid/Turn by Turn directions** - The CAD/AVL system shall provide route navigation assistance/Turn by Turn directions to fixed-route Operators, based on the vehicle’s schedule. The System Administrator shall be able to enable and disable route navigation assistance/Turn by Turn directions by vehicle type.

H. **Navigation Aid Map** - The base map and applicable overlays used for navigation aid on the vehicle VLU shall be the same or similar map as used for the system AVL functions. The Contractor shall be responsible for supplying any associated licenses.

I. **KEY/Farebox Interaction** - The CAD/AVL System shall include an interface with the current farebox system. The CAD/AVL System shall support all functions necessary to fully implement the interface supported by the farebox. The supported functions shall include supplying log-on/log-off data from the farebox to the CAD/AVL System after Operator logon/log-off at the farebox either manually or with a smart card (enabling single-logon). The CAD/AVL System shall verify the logon and provide such verification to the farebox. A separate CAD/AVL System VLU logon shall not be required. The CAD/AVL System shall also support manual logon/logoff directly from the VLU as a backup to the logon/logoff process from the farebox.

J. **Fallback Mode** - The CAD/AVL on-board system shall provide a “fallback” mode of operation that preserves normal operation of revenue vehicle functions to the greatest extent possible whenever it is determined that the CAD/AVL System fixed-end is unavailable. The primary objective of fallback mode is to help ensure that the vehicle Operators can continue with their assigned routes regardless of the status of data communications.

1. When it is determined that the CAD/AVL System fixed-end is not available, the CAD/AVL on-board system shall notify the vehicle Operator through an audible tone and shall continue to operate in a fallback mode. Momentary loss of signal and other minor and brief interruptions to data communications shall not be considered failures and shall not be reported to the vehicle Operator. Data communications error reports to the vehicle Operators shall be minimized and shall not interfere with normal use of the CAD/AVL System vehicle functions.

2. While in fallback mode, the CAD/AVL System vehicle functions shall continue to operate normally, except that all data communications messages shall be queued for later transmission. The CAD/AVL on-board system shall buffer queued data messages for at least a full service day.

K. **Safe VLU Usage Enforcement** - The CAD/AVL System shall limit permitted Operator interaction with the VLU while the vehicle is in motion. Functions that require significant Operator attention, such as text messaging, shall be inhibited while the vehicle is...
moving. This function shall not inhibit functions that do not require Operator interaction, such as location reporting, and automatic mechanical alarms. Additionally, Operator initiation of a text message in audio form shall be permitted if the optional text-to-speech function is provided. This function also shall not inhibit emergency alarm functions or other static button functions of the VLU that do not require display interaction.

1. SEPTA requires a design that enables the System Administrator to select from a set of specific functions to be inhibited during vehicle movement and also to set any applicable thresholds for determining when a vehicle is moving. Other possible configurable actions may also include designating a specific display to be shown whenever the vehicle has begun moving.

L. **Pre-Trip and Vehicle Condition Inspection System** – The CAD/AVL System shall provide a Pre-trip and Vehicle Condition Inspection System (PVCIS). This PVCIS shall replace the current paper system in terms of operations and reporting and shall be backwards compatible with current electronic inspection systems.

1. Upon completion of the pre-inspection process the information from the check shall be stored on the bus and can be called up upon operator request in view only mode. In addition, upon completion of the pre-trip inspection the system shall push the information through WLAN.

1.20. **SUPERVISOR VEHICLE FUNCTIONS**

A. The CAD/AVL system shall provide an App to be installed on existing SEPTA laptops with all required CAD/AVL system application and utility software to provide CAD/AVL system user functions in a vehicle in support of field supervision activities. The Supervisor App would support the following CAD/AVL system user functions:

1. View of CAD queues. Data partitioning shall be supported in order to limit the amount of data required for this function.

2. Display of current service schedules

3. View of existing Incident Management forms.

4. Map-based AVL tracking and vehicle status monitoring functions. Data partitioning shall be supported in order to limit the amount of data required for this function

5. Other information such as routes, turnsheets, emergency book information etc.

B. **Vehicle Location Reporting** - The CAD/AVL system shall perform Supervisor vehicle location reporting the same as specified in the revenue vehicles section.

C. **Downloading of infrequently updated data** such as schedules and route and service area maps shall be performed through cellular or wireless LAN if available.
1.21. MAINTENANCE AND SUPPORT VEHICLE FUNCTIONS

A. Vehicle Location Reporting - The CAD/AVL system shall perform maintenance and support vehicle location reporting through the radio system (location data and Vehicle ID).

1.22. REMOTE DISPATCH FUNCTIONS

A. The CAD/AVL system shall provide a Remote Dispatch solution to be installed on laptops with all required CAD/AVL system application and utility software to provide all dispatch functions described in this Technical Specification. This shall include but is not limited to the integrated CAD and AVL functions.

1.23. ACTIVE DATABASE ACCESS FUNCTION

A. The CAD/AVL System shall provide read access to a replicated active database for various integrations as needed by SEPTA

B. All available operational CAD/AVL data shall be stored in this database for a maximum of 24 hours.

C. The replicated active database shall be hosted in a Demilitarized Zone (DMZ).

1.24. HISTORICAL DATA STORAGE FUNCTION

A. The CAD/AVL System shall provide an historical data storage function to record and store all collected operational data for the purpose of later retrieval and analysis. The operational data to be recorded and stored by the CAD/AVL System shall include, but not be limited to, records of all events, all data messages to and from Operators and other personnel, all data transmitted from the vehicle fleet (e.g., Operator log-on data, communications requests, emergency alarms, mechanical alarms, data messages, text messages, RSA data, location data, timepoint collection data, data transmitted from other equipment on-board the vehicles, data collected from the vehicles via bulk data transfers), all user-entered data, all user log-ons/ log-offs, and all reports generated by the CAD/AVL System.

B. The stored data shall be time and date tagged and shall contain sufficient information to enable the selective retrieval and sorting of the data based on user-specified selection criteria. Stored historical data for each service day shall properly account for the service day exceeding 24 hours in duration and shall also properly handle the extra hour day and missing hour day resulting from Daylight Savings Time changes. Data latency between the time when real-time data is collected by the CAD/AVL real-time functions and the time it is stored as historical data shall not exceed 5 minutes. All historical data shall be immediately accessible to authorized users.

C. The historical data storage function shall support storage of all data ranging from present time to at least the past seven (7) years. Data older than 7 years shall be periodically purged from the database via an automatically scheduled function. The
system shall enable a System Administrator to manually archive selected data before it is purged.

1.25. HISTORICAL DATA RETRIEVAL FUNCTION

A. The CAD/AVL System shall provide an historical data retrieval function that enables CAD/AVL System users to selectively retrieve historical data for playback, reporting, export, and other analyses. The historical data retrieval function shall be designed to ensure that potentially large ad-hoc (i.e., unpredictable) data retrievals will not adversely affect the performance of online CAD/AVL System functions.

B. The historical data retrieval function shall provide access security that is configurable by the System Administrator. The security features shall enable restriction of data access to view-only and shall permit further access restrictions to the data at both the table and field levels. The security provided for this function shall also support safeguards against unauthorized access to historical data by other outside users on the SEPTA LAN/WAN.

C. Selection criteria for data retrieval shall include text string matches on selected or all portions of fixed-format or free-format entries, or combinations of these criteria. Definition of selection criteria shall support the use of "wild card" and partial match entries. At a minimum, the following specific criteria shall be supported for accessing all historical data:

1. Operator Name
2. Operator badge number
3. Route number
4. Block number
5. Run number
6. Trip number
7. User ID
8. Date and time
9. Type of data, message, and event
10. Vehicle ID
11. Vehicle type
12. Schedule adherence (exceptions)
13. Service schedule elements, including route, direction, timepoint, and bus stop.
D. It shall be possible to combine any number of the above selection criteria with logical operands ("and" and "or") such that all data meeting the combined criteria can be retrieved. Additional selection and sorting criteria for data shall include date and time ranges, status values, text string matches on selected data fields, and combinations of these criteria. Criteria for number fields shall not require the user to enter special alpha representations of the numbers, such as requiring leading zeros or blanks, in order to obtain correct sort order or to properly filter the data on numeric fields.

E. All data shall be retrievable in a fully decoded format. The user shall not be required to interpret coded messages in order to determine the meaning of the retrieved data.

F. Retrieved historical data for a service day shall properly account for the service day exceeding 24 hours in duration and shall also properly handle the extra hour days and missing hour days resulting from Daylight Savings Time changes. Retrieval of such data shall not require manual manipulation of the data in order for it to properly represent the chronological data for each service day.

G. All vehicle operational data shall be available for a minimum of seven (7) years.

1.26. INTERFACES WITH EXTERNAL SYSTEMS

A. The CAD/AVL System shall support interfaces to external systems in order to provide all required functions of this Technical Specification. It shall be the responsibility of the Contractor to determine each interface ability and to promptly report to SEPTA any deficiencies that may prevent full compliance with the functional requirements of this Technical Specification.

B. The Contractor shall be responsible for the design and implementation of a highly secure means of data exchange for all interfaces to external systems that prevent access by unauthorized users to the CAD/AVL System LAN. These interfaces shall utilize, to the fullest extent, the abilities already present in the external systems to minimize the need for modifications to those systems.

C. External interfaces shall be fully designed and documented by the Contractor in sufficient detail for third parties to implement and/or modify the external side of the interface. Designs shall employ ODBC and support direct data access using SQL; and use standard file formats for file-based data exchange interfaces. CAD/AVL System performance shall not be affected by the level of data transfer activity to and from external systems.

D. In addition to correctly developing the system interfaces, the Contractor shall be responsible for initializing the CAD/AVL System with all data needed for the proper operation of the CAD/AVL System in accordance with this Technical Specification. This shall include, but is not limited to, all GIS map and spatial data, Operator and CAD/AVL System User IDs, vehicle IDs, service types, and destination sign data. As part of the system data initialization, the Contractor shall work with SEPTA in identifying any data-related issues that need to be resolved within the originating external systems.
E. Specific external interface requirements are contained in the following sections. Also identified are “future” external interface requirements for the CAD/AVL System; these future interfaces shall be supported without major replacement of initial system components and software.

F. **GIS System Interface** - The CAD/AVL System shall include a base map and all associated layer data. GIS data to be made available to the CAD/AVL System includes location and shape data for jurisdictional boundaries, major roads, all roads, street addresses, physical barriers (e.g., water), and landmarks.

1. Updates to the GIS data will occur in the future and shall be supported by the CAD/AVL System on an as-required basis without requiring Contractor assistance.

G. **Fixed-Route Scheduling System Interface** - The CAD/AVL System shall interface with SEPTA’s Trapeze® scheduling system for schedule data using the Trapeze Standard Data Exchange (TSDE) ICD. The Trapeze® scheduling system server is located at SEPTA’s 1234 Market Street facility and is accessible via the SEPTA LAN/WAN.

1. The CAD/AVL System shall automatically convert, reformat, and filter data acquired from the scheduling system as is necessary to support CAD/AVL System functions. Operation of the scheduling system interface shall not impact other functions of the CAD/AVL System and shall not require the CAD/AVL System to be shut down or disabled in any way. The CAD/AVL System shall not require manual manipulation of acquired scheduling system data in order for it to be usable by the CAD/AVL System. Manual entry and maintenance of transit service data within the CAD/AVL System be supported, but shall not be required for proper CAD/AVL System operation if that data is available in any form within SEPTA’s scheduling system. The abilities of the interface shall be as necessary to support all CAD/AVL System fixed-route functions specified elsewhere in these specifications.

2. SEPTA requires that the CAD/AVL System utilize the standard Trapeze interface protocol and format. The design and implementation of the interface shall be the sole responsibility of the Contractor. If the CAD/AVL System design will require modification to the standard Trapeze interface or additional Trapeze hardware or software, the Contractor shall be responsible for supplying all such modifications, hardware, software, and any associated licenses.

3. It shall be the sole responsibility of the CAD/AVL System Contractor to coordinate with the fixed-route scheduling system vendor to obtain the information necessary to implement this function as specified, even if such coordination necessitates that the CAD/AVL System Contractor enter into a separate sub-contractor agreement with the fixed-route scheduling system vendor. SEPTA involvement for coordination and management of any agreement between the CAD/AVL System Contractor and Trapeze concerning the scheduling system interface shall not be required.
4. The delivered CAD/AVL scheduling system interface shall support the transfer of data for the anticipated ultimate capacities, as defined elsewhere in this Technical Specification. Further details concerning the interface to SEPTA’s scheduling system are described in the sections that follow.

5. **Geographic Data** - The CAD/AVL System shall use geographic data that is required to support the proposed CAD/AVL System implementation. Geographic data available to the CAD/AVL System from the fixed-route system includes location and shape data for routes, stops, timepoints, transit centers, and major transfer points. Updates to the scheduling system geographic data will occur and shall be supported by the CAD/AVL System on an as-required basis.

6. **Service Changes** - The CAD/AVL System shall acquire from the scheduling system any and all available service changes that are required to support the proposed CAD/AVL System implementation. Service changes available to the CAD/AVL System from the scheduling system include attribute data on route patterns, stops, timepoints, blocks, runs, trips and Operator data. The CAD/AVL System shall support at least two service change versions, one current and one future, so that the loading of new service changes for a future date do not interrupt current CAD/AVL System operations.

H. **Real-Time Passenger Information Interfaces** - SEPTA requires that the CAD/AVL System utilize the standard GTFS and GTFS-RT interface protocol and format and RESTful APIs. The design and implementation of the interface shall be the sole responsibility of the Contractor. If the CAD/AVL System design will require modification to the standard Trapeze interface or additional Trapeze hardware or software, the Contractor shall be responsible for supplying all such modifications, hardware, software, and any associated licenses.

1. It shall be the sole responsibility of the CAD/AVL System Contractor to coordinate with the passenger information software systems vendors to obtain the information necessary to implement this function as specified, even if such coordination necessitates that the CAD/AVL System Contractor enter into a separate sub-contractor agreement with passenger information software system vendor. SEPTA involvement for coordination and management of any agreement between the CAD/AVL System Contractor and Trapeze concerning the passenger information interface shall not be required.

2. **RESTful APIs:**
   a. TransitView
   b. Routes
   c. Routes Direction
   d. Bus Stops
   e. Bus Detours
f. NTA Bus

g. Shapes

h. Estimation Arrival

i. Estimation Departure

j. Service Alert

3. Data latency returned by the GTFS-RT feeds and RestFull APIs shall not exceed 10 seconds.

4. All APIs shall return results

5. See Section 13352 for interface details.

I. System Time Interface - The CAD/AVL System shall include Universal Coordinated Time equipment to obtain accurate time from GPS. The CAD/AVL System shall ensure that all CAD/AVL System network, server, workstation, and vehicle functions utilizing time are synchronized with the time obtained from the GPS time reference equipment. In the event of a failure to synchronize with the time reference, the CAD/AVL System shall generate an alarm to the System Administrator, discontinue use of the reference time, and begin using its own internal clock.

J. Vehicle Management Information System (VMIS) Interface – The CAD/AVL System shall push all relevant vehicle and operational data to the existing Vehicle Management Information System (VMIS) System. This data push shall be triggered in real time by incident problem and problem subcodes. The Senior Administrator and System Administrator shall be able to add, modify, and delete incident problem and problem subcodes. See Section 13352 for interface details.

   I. The CAD/AVL System shall interface with existing Vehicle Management Information System (VMIS) to retrieve vehicle information to keep the vehicle listing within the CAD/AVL System current. This interface shall be in real time or an automatic overnight process.

K. Mainframe Interface – The CAD/AVL System shall interface with existing Mainframe to retrieve SEPTA employee information. A csv file with SEPTA employee information is exported at midnight in the csv format. The CAD/AVL System shall import this file automatically every night. See Section 13352 for interface details.

L. RouteMatch CCT Interface - The CAD/AVL System shall interface with the existing RouteMatch system to retrieve driver and vehicle information. RouteMatch exports two files to CARD at midnight in the csv format. The CAD/AVL System shall import these files automatically every night. See Section 13352 for interface details. File exports:

   M. Processed_Export_Drivers.csv. Exports the driver information.
N. Processed_Export_Vehicles.csv Exports the vehicle information.

O. **TransitView Interface** - The CAD/AVL System shall interface with existing TransitView See Section 13352 for interface details.

P. **APC Interface** - The CAD/AVL System shall interface with existing infoDev Automatic Passenger and People Counting (APC) system to allow dispatchers to view the bus loading through the CAD/AVL system. This interface shall be on the backend. APC equipment on the bus shall not be connected to the CAD/AVL system.

Q. **ITS Architecture** - It is a goal of SEPTA that the CAD/AVL System follow the guidelines and intent of the Regional and National ITS Architecture. While it is understood that some aspects of the ITS architecture have not been fully designed or implemented by proposers of systems like the CAD/AVL System, SEPTA strongly desires that all elements that can be reasonably achieved be included in the CAD/AVL System implementation. In order to achieve compliance and understand the extent to which the CAD/AVL System meets the architecture, the Contractor shall:

1. For internal data exchanges between CAD/AVL System elements (i.e., between vehicle systems and the fixed-end system), the Contractor shall utilize the appropriate ITS architecture.

2. For data exchanges between the CAD/AVL System and external systems, the Contractor shall utilize the appropriate ITS architecture guidelines.

R. **External Access to CAD/AVL System Historical Data** - Historical data collected by the CAD/AVL System is potentially of significant value to different departments within SEPTA. Those users and systems would typically not interact directly with the CAD/AVL System, but would instead utilize CAD/AVL System data for analysis and for integration with other available data. The CAD/AVL System shall allow extraction of CAD/AVL System historical data in common machine-readable formats that can be used by other external systems. All such access shall be via the CAD/AVL System Information Database rather than requiring direct access to the CAD/AVL System LAN.

S. **Other Transit Operators (Future)** - The CAD/AVL System shall be able to add, in the future, external interfaces to other transit operator systems, for such purposes as the exchange of service information and automatic coordination of transfers, where possible and such information is available.

T. **Other External Interfaces (Future)** - It is a goal of SEPTA that the CAD/AVL System follow the guidelines and intent of the Regional and National ITS Architecture, including following the System Engineering Process. While it is understood that some aspects of the architecture have not been fully designed or implemented by proposers of systems like the CAD/AVL System, SEPTA strongly desires that all elements that can be reasonably achieved be included in the CAD/AVL System implementation.

1. In addition to the current and future external interfaces identified in previous sections, the CAD/AVL System shall also be able to permit information exchange
with other systems in the future. It is anticipated that such future interfaces will require compliance with the Regional ITS Architecture NTCIP standards, including possible certification to those standards.

PART 2 – PRODUCTS – NOT APPLICABLE

PART 3 – EXECUTION – NOT APPLICABLE

END OF SECTION
SECTION 13343

CAD/AVL SYSTEM USER INTERFACE

PART 1 - GENERAL

1.1. DESCRIPTION OF WORK

A. The CAD/AVL System shall provide a modern, state-of-the-art User Interface (UI) for supporting all CAD/AVL System fixed-end and mobile users. The class of CAD/AVL System user shall determine the required access and abilities of the UI. Regardless of the class of user, however, the UI shall be convenient to use and be responsive to user requests.

1.2. USER INTERFACE GENERAL FEATURES

A. Rapid and reliable selection and performance of user actions is crucial to the successful implementation of the CAD/AVL System and acceptance by its users. The Contractor's system and UI must be user-friendly and allow all user actions to be completed as quickly and conveniently as possible. Any user functions, especially frequently performed functions, requiring user actions that are confusing, awkward, or are too time-consuming will be deemed unacceptable and shall be corrected by the Contractor. To further avoid user confusion, the systems and functions accessible by users shall be integrated to minimize the number and diversity of system interfaces and discrete display devices that are presented to each class of user. The UI design shall be subject to SEPTA approval and shall be in conformance with accepted human-factors design criteria. Web-based standards-compliant UI may be used, provided all CAD/AVL System requirements are met, including redundancy and availability.

1. The following features shall be included in the CAD/AVL System UI. Unless specified otherwise, these features shall apply to both fixed-end and mobile users. Alternatives may be offered, but shall be functionally equivalent to the features specified.

B. Windows (Workstations) -

1. The simultaneous display of at least eight windows on each screen of a workstation shall be supported. The windows shall be individually selectable by the user using the keyboard and mouse, with the currently selected window being the focus for all user input.

2. All windows shall be re-configurable by the user as follows:

a. Quickly displayed in overlapping and tiled configurations at the user’s option

b. Easily resized to any dimension up to the full dimensions of the screen
c. Easily moveable to any position on the screen, including across and between screens on a multi-screen workstation.

d. Quickly reduced to an icon and subsequently restored to the previously configured size and position.

3. Window configurations (including locations, sizes, and display configurations) shall be defined on a per-user basis, and shall be retained between user sessions. For multi-screen workstations, default window and dialog positions shall not be initially positioned across more than one screen. Default fixed locations for taskbars, time and date display, pop-up windows, and fixed windows shall be configured by the Contractor so that they are not obstructed by the boundaries between multiple screens.

C. **Element Highlighting** - Highlighting techniques shall direct the user to critical data on displays. The display attributes of color and intensity, blinking, background and character inversion, line texture, and appended symbols shall be provided. These attributes shall be used to highlight alarms, data entry locations, user selections, status conditions, and to convey other information to the user. The use of element highlighting shall be consistent throughout all displays of the CAD/AVL System for each class of user.

D. **User Guidance** - The CAD/AVL System shall respond to all user input actions indicating whether the action was accepted, was not accepted, or is pending. For multi-step procedures, the CAD/AVL System shall provide feedback at each step. Indications such as text messages and element highlighting shall provide this feedback. User guidance messages shall not require the user to select, close, or move them in order to perform subsequent actions or read their contents.

1. User guidance messages shall be unabbreviated English text and shall not require the use of a reference document for interpretation. The use of mnemonics is prohibited.

2. User guidance messages for system errors that occur during normal system use shall not include diagnostic or other complex data or descriptions intended for maintenance personnel. This type of data shall instead be recorded in a log or in the CAD/AVL System database for later retrieval by authorized users.

3. Critical actions initiated by a CAD/AVL System user, such as a deletion, shall be performed only after a warning message and request for confirmation are issued to the initiating user and the confirmation of the intended action is received from the initiating user.

E. **Cursor Positioning** - Multiple methods of rapid and convenient cursor positioning shall be provided, including forward and backward tab keys, cursor control keys, touchscreen, and a mouse (on workstations). Tab stops shall be provided on displays at the first character of enterable data fields, at controllable devices, and at all other cursor targets. Cursor targets on displays shall be sufficiently sized to permit rapid selection of the target and shall be sufficiently spaced apart to minimize the possibility
of incorrect target selections. Cursor positioning techniques shall be consistent for all displays for each class of user.

I. In addition to positioning the cursor on a screen, the CAD/AVL System shall provide a means for continuously moving the cursor across screens on multiple-screen workstations and for enabling selection of a desired window within a specific screen.

F. **Function and Display Selection** - CAD/AVL System users shall be able to rapidly initiate the most common functions and display requests at any time by a variety of means, depending on the user's preference. These means shall include the selection of items from menu bars, pop-up menus, tool bars, and function keys (if applicable) using cursor-positioning techniques.

G. **User Interface Configuration** - To the greatest extent possible, reconfiguration of the CAD/AVL System UI, such as changes to element highlighting techniques, user messages, and displays, shall not require reprogramming or re-compilation of program code.

1. User-configurable settings and preferences of the workstation UI shall be retained between user sessions and shall be uniquely defined for each user and retrieved upon the user's logon to the CAD/AVL System. Suitable defaults shall be provided for all settings and preferences. A means to restore all settings and preferences to the defaults shall be provided. A means to store multiple sets of settings and preferences for each user shall be provided.

H. **Data Entry** - The CAD/AVL System shall determine if proper authorization exists for the user requesting data entry. All data fields where data entry is not authorized shall be uniquely identified and shall not accept data entry. All enterable data fields shall be highlighted. Fields where data entry is mandatory shall be uniquely highlighted from fields where data entry is optional. The CAD/AVL System shall validate all entered data. Invalid entries shall be detected, rejected and reported to the user as user guidance messages.

1. The CAD/AVL System shall allow users to initiate data entry by selecting the desired data field in which the value is to be entered. Users shall be able to enter the desired data value anywhere within the data entry field. If only a portion of a data value needs to be changed, the CAD/AVL System shall require only that portion of the value be changed. Full-display data entry shall be provided that allows users to make multiple data entries before requesting that the data be recorded in the database. All valid entries shall be recorded unless the CAD/AVL System requires all entries be valid and an invalid entry is detected. In that case, the invalid entry shall be clearly identified and the user shall only be required to correct the invalid entry and shall not be required to re-enter any valid entries.

2. The amount of data users are required to enter shall be minimized. The CAD/AVL System shall automatically insert any data that is already known (e.g., date, time, user identification, vehicle identification, vehicle Operator). Default values shall
also be inserted where defined. Users shall be able to override any CAD/AVL System-inserted known and default values.

3. When data entry of a field is limited to a set of known values, the list of values shall be presented to the user in the form of a scrollable list from which the user shall be able to select the desired value and/or use autocomplete initiated by typing the first characters.

4. Users shall be able to end data entry at any time by selecting a cancel function or requesting a different display or window. These actions shall cause the process to be terminated and any entered data discarded. Except for an explicit cancel request, user confirmation shall be requested in order to avoid accidental loss of data.

I. **Spell Check** - The contractor shall provide a spell check. The spell check shall work in real-time, and underline, highlight, or otherwise clearly indicate to the user when it flags a word. The spell check system shall provide an option to require users to review flagged words before submitting forms.

J. **Context-Sensitive Help Facility** - The Contractor shall provide a comprehensive, context-sensitive help facility to aid users in interpreting displayed information and to guide users, at their option, through all the control, data entry, selection, and other user action processes supported by the CAD/AVL System. The help information displayed to users shall provide assistance and information pertaining to the particular actions being performed by the user at the time help was requested.

K. **Time and Date** - The CAD/AVL System current time and date shall be displayed to users at a fixed location on the screen and not on a display basis. This information shall not be present on all displays.

1.3. **USER DISPLAYS**

A. The Contractor shall provide all standard displays that are normally included with the Contractor’s base CAD/AVL System product. The Contractor shall also provide all displays and display features defined below. These specific displays and display features are not intended to define the entire set of displays and display features necessary to meet the full functional requirements of this Technical Specification. As such, the Contractor shall provide any additional displays necessary to support the Contractor’s design approach and to meet all CAD/AVL System functional requirements defined in this Technical Specification.

1. Alternative approaches to the displays and display features defined below may be offered, provided the functional requirements of the Technical Specification are satisfied.

B. **General Display Features** - Each display shall have the general features described below:
1. **Display Heading** - Each display shall include a heading at the top of the display consisting of a title showing the unabbreviated name of the display. For multi-page displays, the current page number and the total number of pages shall be presented (e.g., Page 2 of 3).

2. **Display Content** - It shall be possible to present any item in the CAD/AVL System database on a display. Tabular displays shall support the use of grouping, sorting, and filtering techniques to present displayed data in the manner desired by the user. Status of vehicles, devices, and other dynamic entities shall be displayable using combinations of symbols, colors, descriptions, and blinking.

3. **User Guidance Message Area** - A means for presenting CAD/AVL System-generated user guidance messages on a display shall be provided. User guidance messages shall not obstruct the view of the display or prevent the user from performing additional actions within the display.

4. **Display Scrolling** - If the display is larger than the viewable area of the window, scroll bars shall be used to enable rapid viewing of all display content. Horizontal and vertical scroll bars shall include direction arrows indicating that additional data can be viewed by scrolling in the direction of the arrow.

   a. For tabular displays, row and column headings shall be displayed such that these headings are viewable regardless of the scroll position.

C. **AVL Map Display** - A geographical map display of SEPTA’s service area shall be provided on CAD/AVL System workstations and shall support all functional requirements for vehicle location status tracking, vehicle and route selection, and other supplied functions that require the use of a geographical map. The CAD/AVL System shall provide specific AVL map display features and functionalities defined below in order to enable CAD/AVL System users to efficiently interact with the map.

1. **Map Views** - CAD/AVL System users shall be able to set up a particular view of SEPTA’s service area on the map display and store it for future selection and display. The ability to define, store, and retrieve up to 30 specific views of portions of the service area shall be supported. Each stored view shall include the defining parameters of the view including the area center point, scale/zoom level, map layers (themes) and routes to be displayed, and other parameters that define what and how the map view information is displayed.

   a. Each stored view shall be uniquely identified and rapidly selected for display by the CAD/AVL System user. When a stored view is selected, it shall be displayed as per the defining parameters for the particular view. All map functions, controls, and real-time vehicle updates shall be active when these stored views are being displayed.

2. **Map Attributes** - The AVL map shall support a variety of map attributes, including all roads, major roads, prominent geographical features (e.g., rivers, major bodies of water, mountains), important landmarks (e.g.: bridges, airports,
fire and police stations, shopping centers, schools, etc.), labels, SEPTA-specific spatial data (e.g., rail lines, trolley track layout, transit centers, timepoints, bus stops, etc.), and other map attributes required to meet the functional requirements of this Technical Specification.

3. **Geographic Boundaries** - The AVL map shall support defined boundaries within the SEPTA fixed-route service area that may be used to classify location-based data. Users shall be able to display defined boundary types on the map using overlays. Specific boundaries supported shall include, but not be limited to, Municipal and county boundaries.

4. **Vehicle Overlays** - The location of each CAD/AVL System-equipped vehicle shall be indicated by a special symbol that is overlaid on the AVL map display. Up to twelve distinctive vehicle symbols shall be provided that represent each of SEPTA’s vehicle types. Vehicle symbols shall also clearly show the vehicle state and status using combinations of symbol colors and shapes and, if necessary, text. The symbols shall be reviewed by SEPTA and shall be easily modified by the System Administrator.

   a. At a minimum, the following vehicle types shall have a distinctive vehicle symbol:

   - Bus Revenue Service
   - Trolley Revenue Service
   - Media Sharon Hill Line Revenue Service
   - Norristown High Speed Line Revenue Service
   - Paratransit (CCT)
   - Maintenance
   - Supervisor
   - Transit Police
   - Wildcat
   - Non-Revenue
   - “Contract Service”

   b. Each vehicle symbol shall include the specific vehicle information for the vehicle represented by the symbol, which shall uniquely identify the vehicle. For revenue vehicles, the vehicle information shall include the vehicle type (e.g., bus), vehicle number, run number, roster number, trip name, block number, and vehicle Operator badge number and name. For non-revenue
vehicles, the vehicle information shall include the vehicle number, work number, and Operator badge number and name. The vehicle information to be displayed with the vehicle symbol shall be configurable by the user and initially set to display the vehicle block number. CAD/AVL System users shall be able to call-up the additional information pertaining to a vehicle by selecting the vehicle’s symbol on the map display. This additional vehicle information shall be displayed in a pop-up window.

c. When multiple vehicles cannot be displayed without overlapping at the selected zoom level, the CAD/AVL System shall provide a means for the user to see the individual vehicle identities for the overlapped vehicles.

5. **Map Navigation** - The following navigation functions and features shall be provided to support CAD/AVL System users when they are working with the AVL map:

a. Rapidly select a specific map area for viewing by using a graphical map overview

b. Locate and center a vehicle on the map by vehicle ID, Operator badge number, run number, or block number

c. Locate and center a selected landmark on the map

d. Center the map display on any selected point of the currently visible map

e. Center the map display on a selected vehicle and automatically pan the display as the vehicle progresses to keep the vehicle centered on the map

f. Calculate the distance between two selected points on the map and accumulate the distance along the path formed by a series of points

g. Course and fine panning of the map display to bring any non-displayed portion of the map into view.

6. **Map Scaling** - CAD/AVL System users shall be able to zoom in and out on the AVL map display to view specific areas of the service area at different levels of detail. The range of display shall extend from displaying SEPTA’s entire service area at an overview level of detail to displaying a small portion of the area in fine detail. CAD/AVL System users shall be able to zoom in to a map scale that allows at least six vehicles lined-up within a 200-foot distance to be clearly distinguished without overlap of the vehicle symbols.

a. Map attributes shall be automatically added and removed from the map display at specified zoom (scale) levels as the view is zoomed in and out, respectively. The System Administrator shall be able to specify the scale associated with each zoom level, as well as the map attribute information that will appear at each level. Map labels such as road names, vehicle identities, route names, and landmark names displayed at each zoom level shall be clearly readable.
7. **Map Attribute Filtering** - In order to avoid unnecessary cluttering of the display, the CAD/AVL System shall enable users to configure the AVL map display as desired by selecting specific attributes for display. All user configuration options for the map shall be unique to each CAD/AVL System user and shall be retained for each user between sessions.

8. **Vehicle Overlay Filtering** –

   a. A CAD/AVL System user shall be able to restrict the display of CAD/AVL System-equipped vehicles on the AVL map to any combination of the following criteria:
      
      - All vehicles of a transit provider
      - All vehicles of a service type (e.g., fixed-route bus, trolleys, CCT, etc.)
      - All revenue vehicles
      - All revenue vehicles on selected routes
      - Revenue vehicles assigned to the workstation user’s area of responsibility
      - Maintenance/Service vehicles
      - Strategic vehicles
      - All vehicles
      - A single vehicle.

   b. The mechanism for selecting the routes (and the associated vehicles) to be displayed shall be convenient and shall not be solely dependent on the manual entry or individual selection of the specific route numbers. Other mechanisms, such as allowing CAD/AVL System users to conveniently select one or more pre-defined groups of routes for display shall be supported.

   c. Users shall be able to set filtering options that enable them to see vehicles outside of their assigned data partition(s). Vehicles reporting an emergency alarm shall always be visible on the AVL map display regardless of the user’s current filtering criteria and data partition assignments. These filtering options shall be implemented on a demand basis, and the System Administrator shall be able to enable or disable the filtering.
D. **Emergency Alarm Tracking** - The generation of an EA by a Vehicle Operator shall automatically display a separate EA tracking window on the AVL map display with the associated vehicle centered within the tracking window. The EA tracking window shall automatically pan such that the vehicle remains centered as the vehicle location changes. The EA tracking window attributes (e.g., title bar and colors) shall clearly distinguish the EA tracking window from other AVL windows and the emergency state of the vehicle.

E. **Event Queue Display** - A tabular display shall be provided on CAD/AVL System workstations that addresses the functional requirements of user event handling. The types and partitioning of events supported by this event queue display shall be such that each user sees only those events that pertain to his/her area(s) of responsibility. The following additional features of the event queue display shall be provided with the CAD/AVL System.

1. **Priority** - Color coding and spacing shall be used to distinguish events of different priority levels. The System Administrator shall be able to define the color to be used for each priority level. Events that are unanswered (i.e., those which a CAD/AVL System user has not yet selected) shall be clearly distinguishable from all other events.

2. **Event Ordering** - Events in the event queue display shall be ordered by decreasing priority, and ordered chronologically (oldest first) within each priority as the default mode of presentation. The CAD/AVL System shall enable users to re-order the events in the event queue display by sorting on any displayed field. A means shall be provided to quickly return the display to the default ordering.

3. **Scrolling** - Scrolling of the event queue display shall be supported when there are more events in the queue than can be displayed in the viewing area.

4. **Display Fields** - The fields (columns) to be presented for each event shall include the type of event, time of occurrence, block number, route number, run number, vehicle ID, vehicle Operator name and badge number, a text description of the event, event status (e.g., unanswered), and any important event attributes (e.g., schedule deviation amount). The System Administrator shall be able to define the order in which the event queue fields are displayed. The time of occurrence shall be displayed in a 24-hour format showing hours, minutes, and seconds. Clearly descriptive text and/or abbreviations shall be used for identifying each event type. The full set of attributes for an event shall be viewable by selecting the event.

5. **Text Descriptions** - The text description shall uniquely describe each type of event such as emergency alarm, request-to-talk, schedule and route deviations, and text for pre-canned text messages received from vehicles. In the case of lengthy data messages, at least the first 20 characters of each data message shall be displayed in the event queue. For messages longer than 20 characters, the full text of the message shall be displayed to the user when the particular
event is selected. Numeric and cryptic alphabetic codes shall not be used for the event descriptions.

6. **Audible Annunciation** - An audible tone shall sound if a user's event queue contains no unanswered events and a new event is added to the user's event queue. This audible tone shall consist of a single short beep. When unanswered events already exist in the event queue, a new event added to the user's event queue shall not be audibly annunciated.

7. **Emergency Alarms** - For emergency alarm events, the above paragraph shall not apply. Instead, all emergency alarm events shall be audibly annunciated with a unique and distinctive tone when the emergency alarm is added to the event queue. This audible annunciation shall continue until all emergency alarm events are selected (answered) or otherwise acknowledged.

8. **Event Selection** - The event queue display shall provide for the convenient selection of events in the queue and for initiating follow-up actions pertaining to the selected event(s). Once an event is selected, all information pertaining to that event and other pertinent data including the vehicle ID, vehicle Operator name, schedule adherence status, complete text of a data message, and fields for initiating follow-up actions shall be displayed. The ability to select multiple contiguous and non-contiguous events in the display shall be provided to support rapid event removal.

F. **Service Performance Display** - A tabular display, or integrated set of displays, shall be provided that enables CAD/AVL System users to quickly monitor the current service performance. Status information shall be organized such that the most critical service issues are displayed first followed by less critical service issues and finally, if included in the display, all service that is within normal operating thresholds. In addition to basic identifying information, such as block number, route, vehicle ID, Operator badge number, run number, etc., the following specific types of information shall be presented:

1. **Late logon** – The scheduled logon time shall be displayed for each block where the Operator is late logging on.

2. **Off-route status** – For fixed route service, the distance off route, the time that the vehicle went off route, and the next scheduled timepoint shall be displayed for each off-route vehicle.

3. **Off-schedule status** – The early or late schedule deviation and the next scheduled event shall be displayed for each vehicle that is off-schedule.

4. **Late pull-out** – The scheduled pull-out time and the associated vehicle status, if logged in, shall be displayed for each block with a late pull-out.

5. **Late pull-in** – The scheduled pull-in time and the associated vehicle status, if logged in, shall be displayed for each block that is late pulling in.
G. **Reference Information Displays** - The CAD/AVL System shall provide reference information displays that present transit operations information routinely needed by the Dispatchers. The information displayed to CAD/AVL System users shall be images or copies (e.g., Acrobat PDF) of existing SEPTA data obtained from various sources. Using this data as-is, the Contractor shall develop the CAD/AVL System import procedures and software applications necessary to support these displays. SEPTA will not repackage, rework, or otherwise change its reference data to suit the needs of the Contractor’s CAD/AVL System input requirements. The CAD/AVL System shall provide the capability for the System Administrator to create reference information displays as SEPTA uses the system and identifies other needs. The types of displays to be provided shall include:

1. **Paddle Displays** – These displays shall present copies of the fixed-route Operator's schedules (paddles).

2. **Headway Displays** – These displays shall present a list of buses by block number that service a particular route including time points along the route, the pull-out/pull-in times, and the departure times of each fixed-route vehicle.

3. **Destination Sign Displays** – These displays shall present fixed-route destination sign messages and corresponding codes.

4. **Phone Numbers Displays** – These displays shall present the telephone numbers needed by the Dispatchers.

5. **Route Displays** – These displays shall provide detailed descriptions, including any notes, for each fixed service route.

6. **Vehicle Listing Display** – This display shall show a listing of all revenue vehicles. The information presented in this display shall include the vehicle number, vehicle type, manufacturer, license plate number, registration information, and other pertinent vehicle-specific information. The finalization of the information to be included in this display shall be decided on by SEPTA as part of the FDR (Final Design Review) process.

H. **Actual Versus Scheduled Headway** - A display shall be provided that graphically and numerically compares the scheduled headways between vehicles on each fixed route with the actual headways. CAD/AVL System users shall be able to specify the route whose headways are to be displayed. All vehicles operating on a route shall be displayed, separated according to the direction of travel along the route. In cases where the actual route topology includes a split or similar diversion, these features can be "compressed" into a simplified linear presentation format. The on-time performance of each vehicle shall also be displayed. The spacing displayed between vehicles shall be proportional to the scheduled and actual headways between the vehicles so that users may visually recognize bunching and excessive gap situations. The spacing used between vehicles on this display shall also be based on the expected travel time separation, not the distance between vehicles. Display selection buttons shall be provided on this display to allow users to directly request the desired headway displays and direction for the route.
I. **Pull-Out Display** - A display shall be provided that lists pull-out information for revenue vehicles. The vehicles shall be listed chronologically and shall be identified according to block number. The scheduled pull-out time and actual pull-out time shall be displayed for each block number. In addition, for vehicles that are logged-in, the block number, vehicle ID, route, vehicle Operator badge number, and run number shall be displayed. Vehicles that are late pulling out shall be highlighted on the display along with the number of minutes late. The actual pull-out time shall be determined automatically by the CAD/AVL System by tracking the vehicle location and determining when the vehicle actually leaves SEPTA’s depots. The vehicles listed on this display shall be all those that are late in pulling-out, have pulled-out within the past 30 minutes, and those scheduled to pull-out within the next 60 minutes from the current time.

J. **Pull-In Display** - A display shall be provided that lists scheduled pull-in information for all revenue vehicles. The vehicles shall be listed chronologically and shall be identified according to block numbers. The display shall list the time and location where each vehicle is scheduled to complete its revenue run before returning to a SEPTA bus depot, the block number, vehicle number, route number, run number, and Operator badge number. The vehicles listed on this display shall be all those late in pulling-in, have pulled-in within the past 30 minutes, and those scheduled to pull-in within the next 60 minutes from the current time.

K. **Detour Display** - A display shall be provided that lists all detours that are currently in effect. Each detour shall be listed according to a unique identifier consisting of the route number and a sequentially assigned detour notice number for each detour notice. In addition to the detour identifier, each detour notice shall include a full description of the detour, the reason for the detour, the applicable direction, and the date and times the detour is in effect.

1. Dispatchers shall have the option to see a list of routes and/or vehicles that are currently affected by a detour in time order by the next affected vehicle in one or both directions

L. **System Configuration Monitoring and Control Displays** - CAD/AVL System configuration monitoring and control displays shall be provided that enable the System Administrator to review and manage the CAD/AVL System configuration. These displays shall show the current configuration and status of the CAD/AVL System servers and workstations, CAD/AVL System LAN, communications links, and peripherals. The status of the data communications network shall also be included on this display to the extent that this equipment status is known to the CAD/AVL System. The following control operations shall be supported on these displays:

1. Failover, switching, and monitoring of each CAD/AVL System server
2. Monitoring of each CAD/AVL System workstation, LAN, and device, including interfaces to the data communications facilities and other computer systems
3. Controlling the performance monitoring function and displaying processor resource utilization.
M. **System Parameter Displays** - Many CAD/AVL System functions defined in this Technical Specification require System Administrator-adjustable parameters in order to allow the System Administrator to configure those functions to meet the specific needs of SEPTA and to best support the present operating conditions. The CAD/AVL System shall provide convenient access to each of these adjustable parameters via system parameter displays.

1. System Administrators shall be able to display the current and default state or setting of each parameter and adjust the parameters as necessary, subject to the valid range of adjustability of the parameter. The parameters shall be logically grouped and clearly identified as to their function and purpose. All adjustable parameters shall be arranged on as few CAD/AVL System displays as possible, rather than scattered among numerous CAD/AVL System displays.

1.4. **REPORTS**

A. The CAD/AVL System shall support production of pre-defined and ad-hoc (user defined) reports, which may be requested immediately and on user-defined schedules using the latest version of SAP Crystal Reports. Report schedules shall support one-time production of reports at specific dates and times, and recurring report production at user-defined intervals. Supported intervals shall include daily, weekly, monthly, quarterly, yearly, and fiscal year. In addition, the reporting function shall permit the definition of pre-defined collections of reports that can be conveniently referenced and produced as a group.

B. The destination of report output shall be user-selectable and shall include routing the output to the user’s display (for immediate requests) and any user-selected printer(s) on SEPTA’s LAN/WAN. Reports directed to the user display shall appear the same as the corresponding report when printed. Report production shall also support storage of report output into files at a user-designated location on any accessible network file server. Report output file formats shall include ASCII text format, HTML, Excel, and Acrobat PDF formats.

C. The Contractor shall provide all standard reports and standard report templates that are normally included with the Contractor’s base product offering, as well as all reports specified in these specifications.

D. In addition to the above reports, the report features and specific reports defined in the following sections shall be provided. In general, the format of the reports specified below may be the Contractor’s standard, provided that all required information is presented. If required information is not presented or not properly presented, the Contractor shall update the report(s) to satisfy the SEPTA required information.

E. **General Report Features**

1. **Report Access and Distribution** - Authorized CAD/AVL System users shall be able to display and print any and all reports supported by the CAD/AVL System. The CAD/AVL System shall permit users to define the desired report content and configuration, including, but not limited to, defining the report content, changing
the paper size, utilizing different printers, and reorienting the printed pages from landscape to portrait. The CAD/AVL System shall provide the ability to automatically generate and distribute reports electronically.

2. **Report Headings and Footers** - All reports shall include headings and footers on each page that include at least the report title, page number, total number of pages, and the date and time that the report was generated. Information displayed in columns shall have header labels. If a printed column length exceeds one page, all successive pages shall have the column headers repeated. For displayed reports, columns and row headings shall remain visible and not scroll outside of the viewable window area.

3. **Report Parameters** - All reports shall support default and user-specified parameters that constrain the report content to SEPTA’s fiscal year, year-to-date, month-to-date, specific calendar date/time periods, service date/time periods, vehicle types, etc. as appropriate to the purpose of the report. Report parameters shall also include appropriate pre-configured defaults that reflect current system parameters, where applicable, that are used to generate the report if the user does not otherwise specify different parameters.

   All parameters, both default and user-specified, shall be printed with the report on a report cover page, or equivalent, that lists all parameter settings that were used to generate the report. Alternatively, the title and sub-title of the generated report may be used to indicate parameters used to generate the report; (e.g., a time period).

F. **Report Content** - It shall be possible to present any data in the database on a report as well as any data stored via the Information Server. All reports shall be generated from the data stored in the Information Server unless data required by the report is resident only in the on-line database and has not yet been replicated to the Information server.

1. Any report that includes a threshold value or a status condition based on a threshold value (e.g., a report including late schedule deviations, where the threshold is the definition of how many minutes behind schedule is defined as a “late” status) shall utilize the defined threshold value that was in effect at the time the data was collected, not the current threshold value.

2. The Contractor shall be responsible for assuring that each report contains the correct information and nomenclature regardless of the nomenclature used in their existing standard reports. Unless otherwise noted or instructed by SEPTA to keep existing wording, SEPTA's nomenclature shall be correctly used in all reports. SEPTA approval on the content and formatting of all report types shall be a requirement for the completion of the FDR.
1.5. BUSINESS INTELLIGENCE (BI)

A. The CAD/AVL System shall include a web based business intelligence tool to provide authorized users with real-time information to proactively support operational decisions.

1. Business Intelligence (BI) tool Features:
   a. BI tool shall include Key Performance Indicators (KPIs) to track and trend metrics in real-time.
   b. BI tool shall include customizable dashboards.
   c. BI tool shall include alerting of key quality data by Email and text.
   d. BI tool shall display data on a map for a geographical reference
   e. BI tool shall include “what if” scenarios functions.

1.6. USER INTERFACE PERFORMANCE REQUIREMENTS

A. The following sections specify the performance required of the user interface for CAD/AVL System workstations. Averaged or other statistically processed response and update times will not be accepted as a measure of Contract conformance.

B. Workstation UI Performance Requirements

1. Display Response Time - When a new display is requested by the user, the new display complete with data values shall appear on the local workstation screens (i.e., workstation screens within the SEPTA facilities) within two seconds and within two seconds plus the communications channel transmission delay time at remote workstations (i.e., Supervisor App. on laptop computers), under the peak load conditions defined herein. For this requirement, display response time is defined as the elapsed time required to show current database data on a display.

a. SEPTA realizes that a complex geographical map display may require a longer initial response time than other system displays. Due to the complex nature of geographical map displays, an additional two seconds shall be allowed to the response time listed in the above paragraph for the presentation of a new geographical map display. The additional two seconds shall not apply to the panning or zooming of a geographical map already displayed.

b. When data entry is performed on a display, the data entry operation shall be completed and the newly entered value(s) displayed on workstations within one second and within one seconds plus the communications channel transmission delay time at remote workstations, under the peak load conditions defined herein.
2. **Display Update Rate** - Once a requested display containing dynamic data has been presented to the user, the display shall be updated to ensure a data latency of no more than one second. To achieve this, these display types shall be updated on a periodic basis of at least every one second or updated within one second of any change to the data. All displays containing dynamic data shall be updated within one second regardless of whether or not the display is presented in the currently active window. The maximum allowable data latency for remote workstations shall be two seconds.

3. Geographical Map Display Zoom Response Time - The level of detail presented on the Geographical Map Display shall be according to the zoom levels defined herein. A user request to zoom the Geographical Map Display within a different zoom level shall update the display within three seconds.

4. Geographical Map Display Pan and Rotate Response Time - The Geographical Map Display shall support smooth panning and rotation. There shall be no user-discernable delay to refresh the display during map panning and rotation operations.

5. Report Response Time - Requests for reports shall be acknowledged immediately with an indication that the report is being processed. Printing of a report shall begin within one minute of its scheduled time or on-demand request, regardless of the level of CAD/AVL System activity.

C. **MDT UI Performance Requirements**

1. **Vehicle Operator Actions** - All vehicle Operator actions performed via the MDT shall be completed within one second when entirely processed by the CAD/AVL System on-board equipment.

2. **Sent Data Messages** - When a user enters a request on the MDT to send an event, the CAD/AVL System shall provide immediate feedback to the user that the request has been accepted and is being processed, and when the message has been sent. The message shall be available at the fixed-end within the maximum event delay times specified herein.

3. **Received Data Messages** - When the CAD/AVL System on-board equipment receives a data message, the MDT user shall be notified by both visual and audible means, and the message available for display on the MDT within one second after it is received.

**PART 2 – PRODUCTS – NOT APPLICABLE**

**PART 3 – EXECUTION – NOT APPLICABLE**

**END OF SECTION**
PART 1 - GENERAL

1.1. DESCRIPTION OF WORK

A. This section describes the required characteristics of the CAD/AVL System fixed-end software. It is neither intended nor possible to list all software and all characteristics of the software required. The Contractor shall, however, provide all software necessary to satisfy the CAD/AVL System functional requirements described in this Technical Specification.

1.2. GENERAL SOFTWARE CHARACTERISTICS

A. The Contractor shall provide standard, field-proven software products wherever possible. SEPTA will consider changes in the software requirements and characteristics if it can be shown that a proposed alternative approach using the Proposer’s standard, field-proven software will meet the functional needs of the CAD/AVL System in a reliable and cost-effective manner. Newly developed software, or where software code has been modified and re-compiled to satisfy the requirements of this Technical Specification, will be considered specially designed for this project and, as such “custom software”. SEPTA reserves the right to review the design of such custom software without relieving the Contractor of the responsibility to meet the functional requirements of this Technical Specification.

B. All operating system, database, utility, and network software shall be products that are commercially available, standard, unmodified, and off-the-shelf products produced by well-established and reputable suppliers. The most recent version of each product that is available at the time of the Factory Acceptance Test (FAT) shall be provided, subject to SEPTA approval. For all third-party software, the Contractor shall install all applicable vendor patches and service packs until final acceptance of the CAD/AVL System by SEPTA. Local third-party support and training shall be available for all standard commercially available software.

C. The following subsections specify the required general characteristics applicable to all software provided with the CAD/AVL System.

D. Conformance to Standards - The software provided with the CAD/AVL System shall comply with SEPTA’s standards. In addition, the software provided with the CAD/AVL System shall comply with industry standards produced by national or international standards organizations.

1. Application software shall use industry-standard programming languages and databases, and shall run under the provided operating systems using the standard and documented APIs of the operating system(s). Each programming
language used within the CAD/AVL System shall include libraries for accessing all operating system services.

E. **Expandability** - All software shall be easily expandable to accommodate the anticipated growth of the CAD/AVL System in terms of users and vehicles as defined in this Technical Specification. Reassembly, recompilation, or replacement of the software shall not be necessary to accommodate the specified growth. The size and configuration of the system shall be expanded by easily modified parameters contained in centralized system parameter files.

F. **Modularity** - All software shall be designed with sufficient modularity to minimize the time and complexity involved in making a change to any program. The modularity shall include the separation of hardware interface modules from other software modules.

### 1.3. OPERATING SYSTEM SOFTWARE

A. The system-level software provided shall include operating systems supporting the functional, performance, and response requirements of the CAD/AVL System. The most recent versions of the Windows Server and Workstation operating systems that are available at the time of the Factory Acceptance Test (FAT) shall be provided, subject to SEPTA approval.

B. The provided operating systems shall not be modified or patched by the Contractor in a manner that is not approved by the operating system vendor.

C. The file management services shall maintain a record of the mass storage allocation of all programs and data. This record shall be available for display and printing upon request.

D. **Graphical User Interface** - Operating systems supplied for the CAD/AVL System workstations and servers shall utilize the Microsoft Windows graphical user interface. This graphical user interface shall be used to provide all user interaction within the CAD/AVL System.

E. **Time and Calendar Functions** - The date and time of day shall be maintained for use by other CAD/AVL System software, as specified in the following sections.

F. **Daylight Savings Time/Leap Years** - The time of the day shall be maintained in 24-hour format in hours, minutes, and seconds. The timekeeping function shall include the ability to correct for the local time zone, including adjustments to reflect Daylight Savings Time (DST), observance and leap years, or the lack thereof. Orderly adjustments for time changeovers between standard and DST on event processing, historical files, system reports, and all other time-oriented functions shall be made. Adjustments shall automatically be made for both 23-hour and 25-hour days without disruption to any CAD/AVL System function and without any data ambiguity. The System Administrator shall be able to pre-define the date and time when each of the time changeovers are to occur.
G. **Date and Time Correction** - The CAD/AVL System shall use a time standard to keep all components of the CAD/AVL System synchronized, including the time base used on all servers, workstations, passenger information signs, mobile devices, and other equipment hosting time-oriented functions. In the event of failure to communicate with the time standard, the CAD/AVL System shall generate a system alarm. A Network Time Server is the required source of standard time for the system.

1. Devices installed in vehicles shall be synchronized to the CAD/AVL System fixed-end time standard so that all fixed and mobile components of the system reflect the same standard time within a maximum error of 3 seconds.

2. The System Administrator shall be able to manually correct the CAD/AVL System date and time in a single action that results in all components of the CAD/AVL System being automatically synchronized with the new date and time. The alteration shall be immediately accepted by all system components and shall not corrupt data files, such as the historical logs, nor adversely affect the state of other currently running programs.

H. **Network Software** - The CAD/AVL System shall include network software that supports the data communications within the CAD/AVL System. Software for network communications, security, network services, and network management shall be provided. This software shall consist of standard off-the-shelf products, included as part of the supplied operating system(s).

I. **Diagnostic Port Access Security** - Remote diagnostic ports shall be highly secure; use of encrypted VPN required. The CAD/AVL System Administrator shall be able to enable each port for either a single terminal session or until disabled by the System Administrator. The System Administrator shall have the option of being notified periodically by the CAD/AVL System, via an alarm or event message, that the diagnostic port is enabled; and of being notified of each log-in and log-out on a diagnostic port.

J. **System Performance Monitoring Software** - Software shall be provided to continuously monitor hardware and software performance and gather performance statistics in real-time with a minimum of interference with the normal CAD/AVL System functions. The time period over which the statistics are gathered and saved shall be adjustable by the System Administrator, and the accumulated statistics, after storage in a save file, shall be reset at the start of each time period.

1. The system performance monitoring function shall include processor resource usage monitoring, application program resource usage monitoring, and network resource usage monitoring. The CAD/AVL System shall include on-line services that permit the System Administrator to individually enable, disable, and reinitialize each performance monitoring function.

2. The supplied performance monitoring software shall be suitable for evaluating the performance of the CAD/AVL System against specified requirements during factory and field testing. Performance monitoring capabilities are not required for terminals that do not run application software.
K. **Error Monitoring** - The CAD/AVL System servers shall employ on-line error monitoring. CAD/AVL System devices shall be monitored for both recoverable and non-recoverable errors at all times using SNMPv3, even if a backup device is available. The CAD/AVL System shall monitor all devices and types of errors normally monitored by the operating system software. Error monitoring statistics shall not be lost upon device failover or restart.

1. The CAD/AVL System shall enable the System Administrator to configure notification alarms for specific error events. The alarm notification shall provide an alarm message to the logged-in System Administrator(s). In addition, other notification options, including pager, SMS, and email notifications shall be supported by the error monitoring software.

2. Alarm notification shall be provided for, but not limited to, the following events:
   a. UPS alerts
   b. Network device failures
   c. Network devices failover and restarts
   d. Application process failures
   e. Workstation and server failures
   f. Server disk failures
   g. Server failover and restarts
   h. Workstation and server high memory usage
   i. Workstation and server high CPU utilization
   j. Workstation and server high Ethernet utilization
   k. Workstation and server high Disk utilization.

3. All server references above as it pertains to alarm reporting and events shall include storage servers, associated storage drives and storage networks.

1.4. **DATABASE SOFTWARE**

A. All supplied database management system software shall not be modified or patched by the Contractor in any manner that is not approved by the software’s vendor.

B. The supplied database management system software shall support all functional, performance, and response requirements of the CAD/AVL System at the ultimate user and fleet size requirements described in this Technical Specification.
C. **Online Database** - The CAD/AVL System shall include an online (i.e., continually updated and accessible) database that maintains comprehensive current and historical information on the CAD/AVL System operating state, including, but not limited to, data on communications status, system status, route and schedule information, incidents, events, data required for displays and reports, data retrieved from the revenue and non-revenue fleets, data entered by CAD/AVL System users, and data retrieved from other computer systems.

1. If a separate real-time (i.e., memory-resident) database is used, the Contractor shall provide all necessary API documentation and associated libraries for accessing this database from a program. All information maintained by a supplied real-time database shall also be accessible via the provided database facilities defined above, though possibly with greater latency.

2. The delivered CAD/AVL System database software shall be sized to accommodate the ultimate user, fleet, and service area requirements described in this Technical Specification, and shall be expandable so that data for future functions can be readily included.

D. **Replicated Online Database** – The CAD/AVL System shall provide a separate, dedicated online database. The online database shall replicate all data to the replicated online database. Data latency between the time when real-time data is collected by the CAD/AVL real-time functions and the time it is replicated shall not exceed 3 seconds. All replicated online data shall be immediately accessible to authorized real only users.

1. User access to the database via API’S to transmit XML or JSON, industry-standard SQL (ISO 9075 or later) and via third-party ODBC compliant front-end application software shall be supported. Facilities shall be provided to convert retrieved data to common export formats, including a comma-delimited ASCII and MS Excel file formats, for transfer and subsequent use in external office applications.

E. **Historical Information Database** - The CAD/AVL System shall provide a separate, dedicated Historical Information database. The online database shall replicate all data to the Historical Information database in addition to any other data that may be required to satisfy CAD/AVL System functional requirements for playback and reporting. The CAD/AVL System shall monitor the replication process and ensure that the Historical Information database is synchronized with the online database. The Contractor shall provide all tools necessary, including documented procedures, to resynchronize the databases if a replication error is detected.

1. User access to the database via API’S to transmit XML or JSON, industry-standard SQL (ISO 9075 or later) and via third-party ODBC compliant front-end application software shall be supported. Facilities shall be provided to convert retrieved data to common export formats, including a comma-delimited ASCII and MS Excel file formats, for transfer and subsequent use in external office applications.
F. GIS Map Database - The CAD/AVL System shall include a Geographic Information System (GIS)-based database of the entire SEPTA service area. The GIS database shall support all of the functions and features required by this Technical Specification, such as layering to permit separation of complex mapping information based on its type and/or function. The GIS database shall be used by all map-related functions within the CAD/AVL System. The programming APIs for interfacing with the GIS database shall be provided along with all relevant programming documentation on their use.

1.5. SOFTWARE MAINTENANCE TOOLS

A. The Contractor shall provide all software necessary for the continued maintenance of the CAD/AVL System software following installation. One copy of all such software maintenance tools used by the Contractor during development shall be provided, regardless of whether all source and object code required by the tools has been supplied to SEPTA. Further, to ensure that SEPTA can maintain the software and firmware source and/or object code in escrow, all tools not otherwise required by SEPTA for continued maintenance of the CAD/AVL System shall be placed in escrow along with the code.

1. Contractor-supplied updates to CAD/AVL System software provided after initial installation shall also include any necessary updates to the software maintenance tools in order to keep the maintenance tools valid and usable for the currently installed version of the CAD/AVL System software. This requirement shall apply regardless of whether the tools have been supplied to SEPTA or have been placed in escrow.

2. Access to maintenance software shall be password-protected to prevent unauthorized usage. All maintenance software shall execute without interfering with the online operation of the CAD/AVL System. All updated objects such as displays, reports, and programs shall be able to replace the current copy of the object without significant interference with online system operation. and distribute updated objects on-demand to all affected workstations with a single command.

3. Requirements for specific types of software maintenance tools are contained in the following sections.

B. Display Generation/Editing Software - The Contractor shall provide means for generating new displays and editing existing displays. The Contractor's documentation shall describe the procedures required to build and integrate new displays and to modify existing displays. The Contractor shall use this same display generation software to construct all Contractor-provided displays.

C. Report Generation and Editing Software - The CAD/AVL System shall provide authorized CAD/AVL System users the ability to generate new report formats and edit existing report formats. SAP Crystal Reports, software shall be used and provided with the CAD/AVL System. The Contractor shall use this same report generation and editing software to develop all Contractor-provided CAD/AVL System reports.
1. The report generator shall enable an authorized user at any workstation to develop ad-hoc queries and define reports for any CAD/AVL System data via interactive procedures that do not require knowledge of SQL. Formatting of reports for both display monitors and printers shall be provided.

2. Executing the report generation and editing software shall not interfere with the on-line functions of the CAD/AVL System.

D. **Programming Languages** - The Contractor shall provide the programming languages used for all software supplied with the CAD/AVL System. The CAD/AVL System shall be written entirely in high-level languages conforming to industry-recognized standards. All languages shall include their associated compilers, assemblers, and loading facilities needed to add new programs written in the language. All libraries, class libraries, and individual classes shall be included, as used by the Contractor. Where feasible, the commercial software vendor’s class libraries and development tool kits shall be used. All custom software shall be written using high-level languages conforming to industry-recognized standards and shall be easily transportable to other SEPTA-owned computer systems and workstations that use the same standard language. Data access and data manipulation facilities in each language shall provide complete access to, and control of, the CAD/AVL System data.

E. **Source Editor** - One or more source editors shall be provided for creation and modification of program source code. All editors shall be the same as used by the Contractor’s programming staff for work on the CAD/AVL System.

F. **Code Management** - A code management facility shall be used for documenting and controlling revisions to all CAD/AVL System programs. This facility shall maintain a library of all Contractor-provided and SEPTA-developed source, object, and executable image code, and provide a controlled means for changing library files containing this code. It is desirable that the utility also supports revision management of system documentation.

1. The code management utility shall include inventory, version, and change control and reporting features. Program module inter-dependencies shall be included in the library for user reference. The description of inter-dependencies shall be compatible with the object code and program building facilities, such that dependent programs may be rebuilt automatically whenever a program, module, or library is changed. The code management facility shall retain a complete history of additions, deletions, and modifications for all programs, program modules, and program libraries.

G. **Software Tester/Debugger** - The software shall include one or more on-line, interactive software test and debugging utilities to assist in the testing of new and revised programs. Security checks shall be built into the software testing monitor to prevent the program under test from affecting the operation of the online CAD/AVL System functions. The test/debug utility or utilities shall be the same as that used for the Contractor's work on the CAD/AVL System.
H. **Software Integration** - Software integration services shall be provided for adding new programs to the set of active software after the programs have been tested. These services shall include commands to substitute one program for another, to set up or modify operating system tables, and to schedule and activate a new program with a minimum of interference with the normal running of the CAD/AVL System. Restoration of the CAD/AVL System to its status prior to the new program integration shall be provided.

I. **System Build** - All required software elements and tools (including libraries, compilers, linkers, loaders, etc.) shall be provided with the CAD/AVL System to enable SEPTA personnel to rebuild portions of the system, or the entire system, using only the elements supplied. SEPTA shall be able to perform all system build functions and generate an executable object of all software and database structures (excluding third-party software, such as operating systems and database systems) at SEPTA offices, without the necessity of returning to the Contractor's facility and without requiring Contractor engineering or programming support. The procedures necessary to accomplish a complete system build on the CAD/AVL System shall be provided as part of the system documentation.

J. **Third-Party Software Libraries** - All third-party source and/or object libraries required to build the CAD/AVL System shall be provided, including the necessary documentation for programming with these libraries. All Contractor modifications to these libraries, if any, shall be clearly documented in the material supplied to SEPTA.

K. **Database Maintenance** - The CAD/AVL System shall include all administrative and maintenance tools and facilities associated with the online real-time and historical information databases. Tools of this type shall include, but not be limited to: performance monitoring and tuning; backup, restoration and recovery; and facilities for modifying, extending, documenting, and adding database structures.

L. **GIS Database Maintenance** - The CAD/AVL System shall support GIS database updates made by importing externally supplied (external to the CAD/AVL System) map data. Import functionalities shall enable import of new base map data acquired from external sources, while allowing the user to selectively retain existing map overlays (e.g., routes and bus stops) within the GIS database. Import functionalities shall support a variety of common GIS map interchange formats, including ESRI Shape file, ArcView, MapInfo, and Enhanced TIGER formats.

1.6. **SOFTWARE UTILITIES**

A. Efficient, reliable, well-documented, user-oriented software utilities shall be provided. All utilities shall be subject to a common design methodology and common standards in order to provide a similar look and feel among the utilities. All user-interactive utility software shall provide a graphical user interface.

1. The utility software shall operate without jeopardizing other CAD/AVL System on-line functions running concurrently. Utility software shall be accessible from workstations and server terminals, and from command files on mass storage.
Multiple users shall have concurrent access to each utility program, provided there are no conflicts in the use of data files and peripheral devices.

2. All utility software required to maintain the CAD/AVL System software shall be provided.

B. **Backup Software** - A backup utility shall be provided that can backup and restore all mass storage, and selected portions thereof, from and to other storage and input/output media and verify the transfer. The backup utility shall support a full system restoration, including all operating system software.

C. **Archive Utility** - An archive utility shall be provided that can migrate selected online data to offline removable media for historical storage. The same utility shall support the temporary restoration of offline historical data to the CAD/AVL in order to enable user access via CAD/AVL functions, such as reporting and playback.

D. **Virus Protection** - The Contractor shall install virus protection software on all servers and workstations.

1.7. **CONTRACTOR’S FUTURE SOFTWARE CHANGES**

A. SEPTA shall be placed on the Contractor’s regular mailing list to receive all software announcements, including announcements of new software releases and other improvements that could be made to the software furnished with the CAD/AVL System. Solutions to problems with Contractor-supplied software, whether discovered and corrected on SEPTA’s CAD/AVL System or elsewhere, shall be documented and supplied to SEPTA without additional charge. This service shall include announcements and fixes pertaining to Contractor-produced software for fifteen (15) years after final system acceptance, and shall include announcements pertaining to software produced by third-party suppliers for the life of the CAD/AVL System warranty.

1.8. **LICENSES**

A. The Contractor shall provide to SEPTA perpetual, nonexclusive, irrevocable, fully paid-up licenses for system software, operating systems, system generation software, and application programs. Contractor software licenses shall also remain applicable when processor/server and network hardware is replaced, upgraded or purchased by SEPTA during the life of the system. Enterprise software licenses shall permit SEPTA to use the software without restrictions, in whatever manner is necessary for the operation of SEPTA’s transit system. Enterprise licenses shall be provided for all Contractor-developed software. Contractor-supplied third party software licenses shall also be perpetual, nonexclusive, irrevocable, and fully paid-up, but may be limited in quantity. The quantity of third party licenses provided shall be sufficient to support all specific functions from the ultimate quantity of workstations (local and remote). SEPTA shall be able to load and utilize, without restrictions, the total quantity of licenses purchased for the CAD/AVL workstation software on any SEPTA owned hardware.
PART 2 – PRODUCTS – NOT APPLICABLE

PART 3 – EXECUTION – NOT APPLICABLE

END OF SECTION
SECTION 13345

CAD/AVL HARDWARE REQUIREMENTS

PART 1 - GENERAL

1.1. DESCRIPTION OF WORK

A. This section describes the hardware equipment characteristics for the CAD/AVL System. Characteristics are discussed within the context of the design approach presented in this Technical Specification.

1.2. GENERAL REQUIREMENTS

A. All hardware shall be manufactured, fabricated, assembled, finished, and documented with workmanship of the highest production quality and shall conform to all applicable quality control standards of the original manufacturer and the Contractor. All hardware components shall be new and suitable for the purposes specified. All hardware provided shall be commercially available, standard, off-the-shelf products manufactured by well-established and reputable manufacturers and be best available at the time of purchase. Servers, workstations, and network devices shall have remote management functionalities and shall have simple network management protocol (SNMPv3) agents for network and device status monitoring and alarming.

B. Delivered hardware shall include all applicable engineering changes and field changes announced by the equipment manufacturer since it was produced. As part of the field performance test, the Contractor shall certify that all supplied equipment can be placed under a maintenance contract by the local service offices representing the equipment manufacturers.

1.3. SERVERS

A. The Contractor shall provide and install rack-mounted servers with redundant power supplies, plus all necessary racks, mounting hardware, cabling, and other components necessary for a complete and fully operating installation of the servers. Blade server technology and virtualization technology may be used, provided all CAD/AVL System requirements are met, including redundancy and availability and all management and monitoring tools to support this technology are provided, including training.

B. All servers shall be current models selected for efficient operation of a real-time system. SEPTA shall be able to replace or upgrade the servers with future server offerings to obtain increased computational power and system expansion with no required system or application software changes, and no software license modifications for Contractor-developed software.

C. Additional server requirements are contained in the following paragraphs:
1. **Processors and Cache** - The CAD/AVL System servers shall support all functions described in this Technical Specification utilizing no more than 40% of the total processing capability of each server under the peak loading conditions defined in Section 13351.

2. **Main Memory** - Each server shall be equipped with sufficient memory to meet all performance requirements of this Technical Specification. The main memory of each supplied server shall be expandable in the field to at least two (2) times the size of the delivered memory. This expansion shall be possible solely by the addition of memory modules and shall not require the replacement of any existing server components. The delivered memory shall include all memory installed in the server at the time of Final Acceptance, whether or not the memory is needed to meet the requirements of this Technical Specification.

3. **Server Terminals** - The Contractor shall provide one or more shared server terminals for managing all supplied server equipment. Shared server terminals shall be quickly and conveniently switched among associated servers without unplugging or re-attachment of cables and without adversely affecting the operation of the servers. A server utilizing a shared terminal shall boot up without the shared terminal being switched to that server.

   a. All server terminals shall be rack mounted in a location that is easily accessible by the System Administrator from a seated or standing position and within close proximity to the front panels of the associated servers. All server terminals shall consist of a color flat-panel monitor with at least a 19-inch diagonal screen, a QWERTY keyboard, and a mouse or trackball. The server terminals shall be packaged to utilize a minimum of rack space and shall be retractable for storage when not in use.

1.4. **WORKSTATIONS**

   A. All Contractor-supplied workstations shall consist of computer hardware that is compliant with Intel/Microsoft PC2001, or later, design guidelines. Monitors, keyboards, and cursor-positioning devices supplied with workstations shall be connected via plug-detachable cords, and shall be manually interchangeable between all workstations. The Contractor shall provide all CAD/AVL System workstations equipped as specified herein.

   B. Additional workstation requirements are described in the following subsections.

   1. **Processors and Cache** - The CAD/AVL System workstations shall support all functions described in this Technical Specification utilizing no more than 40% of the total processing capability of each workstation under the peak loading conditions defined herein.

   2. **Main Memory** - Each workstation shall have sufficient memory to meet all performance requirements of this Technical Specification. The main memory of each supplied workstation shall be expandable in the field to at least two (2) times the size of the delivered memory. This expansion shall be possible solely
by the addition of memory modules and shall not require the replacement of any existing workstation components. The delivered memory shall include all memory installed in the workstation at the time of Final Acceptance, whether or not the memory is needed to meet the requirements of this Technical Specification.

1.5. WORKSTATION LAN

A. Local CAD/AVL System workstations shall be connected to servers and any other necessary external devices via the Contractor-supplied CAD/AVL System LAN.

1.6. WORKSTATION HUMAN-MACHINE INTERFACE

A. Each workstation shall be equipped with one keyboard and mouse. Where the Contractor’s design requires multiple computers at a workstation position, a means shall be provided for the user to quickly and conveniently switch control among the workstation’s computers.

B. Keyboard - Each workstation keyboard shall include a QWERTY key layout and a minimum of 12 function keys that initiate specific functions or display requests. The function keys shall be arranged in logical functional groupings. All workstation keyboards shall be identical.

C. Mouse - Each workstation mouse shall be equipped with at least two pushbuttons and a scroll device. The mouse shall produce cursor movement along any axis and at a speed proportional to the motion of the mouse. A means to adjust the proportionality of the mouse to cursor movement shall also be provided.

D. Monitors - All workstations shall include one or more identical, freestanding LCD monitors, each with at least a 24-inch diagonal viewing area. The number of monitors to be provided for each workstation position shall be as specified herein. Multiple monitor configurations shall be configured such that the combined display area of all monitors serves as a single, contiguous desktop under the operating system. Explicit user switching among monitors in a multiple monitor configuration shall not be required. On-screen menu operation for control of all monitor video tuning shall be provided.

1. Monitor native resolution shall be at least 1920 by 1200 pixels at 75 Hz vertical scan rate (non-interlaced) supporting at least 16.7 million colors, at a dot pitch of 0.26mm or less. The monitors shall be capable of accepting input signals within a scanning frequency range of 30 kHz to 80 kHz horizontal scan, and 50 Hz to 77 Hz vertical scan. The provided monitors shall support standard DVI video inputs and have DisplayPort interfaces.

2. The contrast ratio shall be at least 700:1 and the backlight shall provide 300 nit (cd/m2) brightness. All monitors shall be supplied with tilt and swivel stands with a tilt range of at least 5° downward (measured from a plane perpendicular to the face of the flat panel screen in relation to a horizontal plane) to 30° upward. The horizontal swivel shall range at least ±30° from a nominal centered position.
3. The nominal horizontal viewing angles shall be 160 degrees (80 degrees right/80 degrees left), and the nominal vertical viewing angles shall be 160 degrees (80 degrees up/80 degrees down). Minimum viewing angles shall be 140 degrees horizontal (70 degrees right/70 degrees left), and 140 degrees vertical (70 degrees up/70 degrees down). The monitor screen surface shall be abrasion resistant and anti-glare.

4. Monitors shall be designed for 24 hours per day, 7 days per week usage in a typical office environment. Nominal backlight life under these conditions shall be at least 50,000 hours. The monitors shall be capable of operating within a temperature range of 41 to 86 degrees F (5 to 35 degrees C), and humidity levels of up to a maximum of 80%. Power requirements shall be 100 to 120 VAC at 60 Hz. All monitors supplied must meet the following regulatory standards: UL 1950, C-UL, FCC Rules Part 15 Class B, CFR 21 DHHS, MPRIII (level B), TUV/GS, TCO, and VESA DPMS/Energy Star.

E. **Audible Alarm** - Workstations requiring audible alarms shall be equipped with Contractor-supplied audible alarm equipment that is capable of sounding repetitively for a System Administrator-adjustable time period. The audible level shall be adjustable by the user for each workstation, but be restricted to a minimum level so that the audio can always be heard (i.e., turned down at night but never off). At least four different audible alarm sounds shall be provided. The audible alarm shall not use the internal speaker of the workstation.

F. **Desktop CAD/AVL Equipment** - SEPTA will provide the desktop space for all CAD/AVL equipment. Console furniture is not required.

1. Contractor shall supply the physical and space dimensions of its equipment for all CAD/AVL users (i.e., dispatchers with voice communications, local and remote read-only users without voice communications, system administrators, etc.).

2. Quantities and types of CAD/AVL users and the workstation equipment for each type of user are provided in the contract drawing package.

3. SEPTA will provide AC power for workstations and other CAD/AVL equipment; however, all other components required for a complete CAD/AVL workstation and user environment shall be supplied by the Contractor, including the workstation, UPS, connectors, cables, and other associated electronics.

4. Voice radio communications equipment for each dispatcher workstation shall be supplied as part of this contract. This equipment shall be located on the dispatcher console along with the CAD/AVL equipment supplied by the Contractor.

5. The Contractor shall be fully responsible to ensure that all CAD/AVL user and workstation equipment fits in its intended location, can be adjusted for use by the intended users, and can be powered via the provided power outlets.
1.7. PRINTERS

A. The Contractor shall provide printers for use by authorized CAD/AVL users. The types of printers to be provided and installed by the Contractor are identified in the contract drawing package. All supplied printers shall support a direct LAN interface for network printing that does not require direct attachment to a server or workstation, and shall be fully compatible with Microsoft Windows print services.

B. The following sections describe specific printer requirements by printer type.

   1. Color Laser Printer
      a. Color laser printers shall produce an exact color copy of any CAD/AVL display and report. All color laser printers shall have the following characteristics and features:
         b. A minimum resolution of 600 dots-per-inch
         c. Landscape and portrait output orientation
         d. Paper input tray capacity of at least 250 sheets
         e. Paper output tray capacity of at least 250 sheets
         f. Desk-top enclosure
         g. Use untreated paper and accommodate A-size (8.5" by 11") paper
         h. Postscript support
         i. Color calibration facilities
         j. Minimum print speed of 10 pages per minute for color prints.

1.8. SYSTEM LAN

A. A LAN shall be supplied to interconnect CAD/AVL System servers, workstations, and other local network devices. The supplied LAN shall be Ethernet conforming to the IEEE 802.3 series standards and shall support all CAD/AVL System performance requirements. Wireless LAN technology shall not be used for the System LAN network.

B. The LAN design shall preclude LAN failure if a server, workstation, network device, or LAN interface fails. The LAN design shall also allow reconfiguration of the LAN and the attached devices without disrupting on-line operation of the CAD/AVL System. All equipment, cabling, and installation required for the CAD/AVL System LAN shall be the responsibility of the Contractor.

C. No more than 15% of the available access and transfer capacity of the supplied LAN shall be utilized under the peak loading conditions defined herein. The CAD/AVL
System LAN server backbone shall be at least ten Gigabit Ethernet. Local workstation connections to the CAD/AVL System LAN shall be at least one Gigabit.

D. The CAD/AVL System LAN shall also provide network connectivity to the SEPTA LAN/WAN. The interconnection to the SEPTA LAN/WAN shall be secured with a Contractor-supplied firewall device that blocks all unauthorized users and systems on the SEPTA LAN/WAN from accessing CAD/AVL System LAN resources. The Contractor shall integrate the firewall device(s).

E. The Contractor shall supply all necessary LAN segmentation and interconnection devices (e.g., hubs, routers, firewalls, switches, bridges, etc.) to provide secured connectivity among all supplied servers, workstations, and other supplied network devices. All supplied devices shall be remotely manageable, shall be from the same scalable family of devices, and shall be comparable in quality to equipment currently in use by SEPTA.

F. **Routers, Firewalls, and Switches** - Router, firewall, and switch devices shall have simple network management protocol (SNMPv3) agents for network management and shall support remote terminal configuration of programmable filters.

1. **Routers** - Routers shall automatically build routing tables and shall include mechanisms (such as spanning tree algorithms) to prevent loops when multiple paths are possible. Routers shall be supplied with redundant hot swappable power supplies. Where multi-port routers are employed to interconnect more than two LANs, the multi-port routers shall be configured such that no single failure of an interface card will result in the loss of communications with more than one LAN. Router throughput shall be sufficient to take full advantage of the available channel bandwidth.

2. **Firewalls** - Separate, independent device-level firewalls shall be supplied at each and every point of entry to the systems from connection points to the SEPTA systems, to include, but not be limited to, all wired, wireless, dedicated fiber connectivity or any other form of connection that constitutes a route into, or from, a system external to the CAD/AVL systems.

   a. Firewalls shall also be installed between the primary and backup offices and the SEPTA systems field devices, for prevention of harmful accidental or malicious access to the offices from a field site. If a single chassis firewall device with multiple fire walls is proposed, it shall be acceptable only upon demonstration, to the sole and complete satisfaction of the SEPTA CAD/AVL Project Manager, that no single point of failure in any component of the device, to include power supplies, shall permit the failure of more than one protected external connection or that any device shall “fail open”.

   b. Firewalls shall limit access at the packet, circuit, and application levels. Firewalls shall provide the following features:

      - Authentication – The firewall shall require authentication of the user. The firewall shall enforce password construction rules such as minimum
length, inclusion of non-alphanumeric characters, and maximum validity period.

- **Access Control** – Based on the identity of the user, different levels of access shall be provided, including none, read only, read/write, and execute. The types of access that users on the CAD/AVL System LAN have to the external services, such as to the Internet, shall also be configured.

- **IP Spoofing** – The firewall shall guard against IP spoofing - an attack in which a would-be intruder outside the firewall configures its machine with IP addresses on the CAD/AVL System LAN.

- **Prevention of Denial of Service** – The firewall shall protect against denial of service attacks. These attacks are characterized by attempts to deny service through overrunning buffers, filling the firewall disk, or overrunning the log files. Such attacks shall result in rejection of packets where they can be recognized. Where such packets are not recognized, the firewall shall respond by shutting down or denying external access when overruns occur rather than continuing to operate with partial capability.

- **Packet Filtering** – Packet filtering shall be provided by a screening router to restrict access based on both source and destination IP addresses.

- **Stateful Inspection** – Each packet shall be inspected to determine which port numbers are used by which connections. When a connection closes, access to the port by that connection shall be shut down until another authorized user establishes a new connection.

- **Proxy Servers** – An application-layer proxy functionality shall be provided to control access to the Internet to meet performance and security requirements. The firewall shall include suitable application proxies, including at least HTTP, FTP, Gopher, Telnet, Mail, News, DNS, generic UDP and TCP, and other proxies needed for the CAD/AVL System functions. Access to these services shall be customizable based on the user ID and IP address. Application-layer gateways for HTTP shall identify executable content downloaded from a Web site, including ActiveX and Java, and block transfer onto the CAD/AVL System LAN.

- **Network Address Translation** – The firewall shall perform network address translation (NAT) to permit the hiding of IP addresses used on the CAD/AVL System LAN from external view.

- **Notification** – All break-in attempts shall be recorded in a log file and notification issued to the System Administrator.
3. **Switches** - Switches shall support mechanisms (such as spanning tree algorithms) to provide path redundancy and to prevent loops when multiple paths are possible. One-second convergence shall also be supported to provide for the addition of new nodes to the network, switch failures, uplink failures, and indirect failures. The provided switches shall support all Layer 2, Layer 3, and security access control functions to meet the requirements of this Technical Specification.

   a. Switches shall be supplied with redundant hot-swappable power supplies, shall have Power over Ethernet (PoE) ports, and shall be configured such that no single failure will result in the loss of communications with more than one LAN.

   b. Switch throughput shall be sufficient to take full advantage of the available channel bandwidth.

1.9. **MASS STORAGE**

   A. The mass storage supplied with each server and workstation shall have sufficient storage capacity to satisfy the requirements of all CAD/AVL System functions under the peak conditions defined herein. Seventy five percent of the delivered mass storage for each server and workstation shall be spare capacity, completely free and available for SEPTA use. The delivered mass storage for each server and workstation shall also be expandable in the field within the provided enclosures to at least two (2) times the delivered capacity, where the delivered capacity includes the spare capacity provided in accordance with this Technical Specification and spare capacity in excess of specified requirements.

   B. Information server mass storage units shall be sized to provide a minimum of seven (7) years of operational data. Where the data stored on mass storage is distributed among multiple storage units, the requirements for mass storage spare capacity and expansion shall apply separately to each mass storage unit, or set of units allocated to one data type.

   C. For servers, all mass storage units shall utilize Storage Area Network (SAN) and RAID 6 technologies, be hot-swappable, and have dual power supplies. Mass storage access and transfer times must be sufficient to serve the current and future needs of SEPTA. No more than 60% of the available access and transfer capacity shall be utilized under the peak system loading conditions defined herein for both server and workstation mass storage units.

1.10. **BACKUP STORAGE**

   A. The CAD/AVL System shall include a high-density backup storage system that is configured for backing up all SEPTA system servers and workstations. The backup storage system shall support backup of system software, applications, and data on a periodic basis. The backup system shall support full system recovery for each SEPTA system server and workstation, including all operating system and application software. The backup storage device shall have sufficient capacity to allow unattended daily backup operations for a period of at least seven (7) contiguous days without requiring replacement of backup media. The backup media shall be rewriteable so that...
SEPTA may reuse the backup media. Sufficient media shall be provided to support a backup scheme incorporating multiple backup generations as well as offsite storage.

1.11. REMOTE DIAGNOSTIC PORT

A. The CAD/AVL System shall include a connection for use as a remote diagnostic port by the Contractor and by SEPTA. Diagnostic access shall be performed via a secured Internet connection utilizing VPN, rather than a separate, dedicated communications facility. The diagnostic port shall be protected by a name and password entry, and shall be enabled and disabled by the System Administrator.

1.12. NETWORK TIME SERVER

A. A Network Time Server shall be provided and installed by the Contractor to meet the AVL functionality and requirements specified.

1.13. TIME DISPLAYS

A. Digital LED or LCD time displays shall be provided and installed by the Contractor. The displays shall be synchronized with the CAD/AVL system time and shall be updated every second. The time shall be presented in a 24-hour format in hours, minutes, and seconds. Display characters shall be sufficiently large and bright to be clearly readable from a distance of 50 feet with ambient room lighting levels of 75 foot candles.

1.14. WIRELESS LAN

A. The CAD/AVL System shall be able to use the Wireless LANs at the depots for bulk data transfers if available.

B. **SEPTA LAN/WAN Interface** - The CAD/AVL System shall be interfaced to the SEPTA LAN/WAN for exchanging data with other systems and for workstation access by some SEPTA CAD/AVL System users. The Contractor shall provide all necessary hardware to interface to the SEPTA LAN/WAN. The Contractor shall provide all necessary security protection, including a firewall, to ensure that unauthorized personnel cannot access CAD/AVL System LAN resources. The connection of the SEPTA LAN/WAN to the CAD/AVL System shall be in a manner that isolates the CAD/AVL System LAN from SEPTA LAN/WAN traffic and prevents failures or other disturbances on the SEPTA LAN/WAN from affecting the operation of the CAD/AVL System.

1. The interface to the LAN/WAN shall support the following access and data exchange:

   a. Download revised GIS base maps to the CAD/AVL System.

   b. Access CAD/AVL functions by SEPTA users with workstations on the SEPTA LAN
c. Remote/Shared access by SEPTA users with workstations on the SEPTA LAN/WAN

d. Provide Information Users on the WAN with read-only access to the CAD/AVL System Historical Information Database, while otherwise restricting their access to the CAD/AVL System

e. Transfer of vehicle data to and from the bulk data transfer equipment at SEPTA’s facilities.

2. The Contractor shall provide and configure all necessary hardware to complete the logical and physical connectivity to all specified LAN/WAN components. All such devices used in the CAD/AVL System shall be from the same manufacturer, and if practical, from the same scalable family of devices.

1.15. VEHICLE EQUIPMENT

A. SEPTA considers the ability to readily interface to a wide variety of on-board devices manufactured by various suppliers as a crucial element in providing the facilities and services required to meet future regulatory and passenger demands. To help meet these demands, SEPTA requires on-board equipment designs that support accepted industry standard vehicle area network (VAN) interface designs and protocols, such as SAE J1708/J1587 and \textbf{SAE AS6802}, for communications between the on-board devices and subsystems.

B. The bus VAN design and protocol shall support the ultimate fleet size specified herein.

C. The types of vehicle equipment to be provided and installed by the Contractor are identified in the contract drawing package. The vehicle equipment shall be designed, built, and installed for the harsh environment in which this equipment is to operate, including conditions pertaining to temperature, humidity, power variations, shock, vibration, altitude, and EMI/RFI interference. All equipment housings shall be water proof, and dust proof, and prevent damage from water directed on equipment while cleaning the inside of the revenue vehicles.

D. All vehicle equipment and displays provided by the Contractor shall be designed for, and operate properly under the following minimum conditions:

<table>
<thead>
<tr>
<th>Operating Parameters</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating Voltages</td>
<td>11-15 VDC, negative ground</td>
</tr>
<tr>
<td>Operating Temperature</td>
<td>-25 degrees C to +60 degrees C (vehicle storage includes outside areas)</td>
</tr>
<tr>
<td>Humidity</td>
<td>per SAE 1455</td>
</tr>
<tr>
<td>Shock</td>
<td>30g of 6 milliseconds</td>
</tr>
<tr>
<td>Vibration</td>
<td>Operating: 1.5g RMS, 5 to 150 Hz</td>
</tr>
<tr>
<td></td>
<td>Endurance: 8g RMS, 100 to 1,100 Hz</td>
</tr>
<tr>
<td>----------------------</td>
<td>-----------------------------------</td>
</tr>
<tr>
<td>EMI/RFI</td>
<td>FCC part 15 subpart J Class B</td>
</tr>
<tr>
<td>Boot time</td>
<td>2 minutes or less</td>
</tr>
</tbody>
</table>

E. During engine startup, the voltage may drop to 0 VDC for several seconds, particularly in cold weather.

F. If internal batteries are used to support information stored in the vehicle equipment, these batteries shall provide an 8-year minimum life under normal operating conditions, shall be readily available, and shall have a low battery indicator included with the battery enclosure. Removal of all primary power to any or all of the vehicle equipment shall not cause any loss of stored information.

G. The installation details and placement of vehicle equipment shall be subject to SEPTA review and approval during the design phase of the CAD/AVL System project. The availability and location of space for equipment installation will vary according to the various types of vehicles in the fleet.

H. In addition to the vehicle equipment that the Contractor is explicitly required to furnish by this Technical Specification, the Contractor shall provide any other equipment that is required to install and operate the Contractor-provided equipment on SEPTA vehicles.

I. All Contractor-installed vehicle equipment shall be easily accessible, modular, and easily removable to facilitate maintenance and repair of the equipment. The vehicle equipment (e.g., MDT) shall be programmable using a personal computer, via a USB interface, and via a wireless link. All necessary field programming shall be possible without disassembly of the MDT enclosure. Programming and other routine maintenance shall not require removal or replacement of internal devices of any kind.

J. **Mobile Data Terminals** - The CAD/AVL System shall provide interfaces to existing MDTs on all CAD/AVL System-equipped vehicles.

1. The Contractor shall provide and install MDTs for all CAD/AVL System-installed vehicles. Requirements for the MDT are described below in terms of two major MDT components; the VLU and the IVCU. MDTs that package the VLU and IVCU in a single device and MDTs that consist of two separately packaged devices are both acceptable.

2. For MDTs consisting of separately packaged devices, the VLU shall be the only device required to access all CAD/AVL System vehicle Operator functions. All other devices of the MDT shall be securely mounted behind vehicle panels or in designated vehicle equipment compartments.
3. **Vehicle Logic Unit** - The Contractor shall provide VLUs that shall serve as the interface between the vehicle Operators and the CAD/AVL System. The VLUs shall be securely mounted on rigid Contractor-provided support brackets. The brackets shall be customized by the Contractor as needed for each type and variation of vehicle within the SEPTA fleet, shall be easily adjustable for individual Operator’s seating position, and shall be secure to minimize vibration and prevent rattles. SEPTA and the Contractor shall jointly decide the placement and mounting of each VLU. Each VLU shall be mounted and positioned within convenient reach of the vehicle Operator’s seated position, where the vehicle Operator can easily read the VLU digital display and numeric/function keys, where there will be no interference with the Operator's view through front and side windows, and where there will be not interference with the operation of the vehicle blinds and other equipment. The user interface for each VLU shall be the same, though the hardware may differ depending on available space per bus.

a. The VLU shall provide the following:

- The VLU shall be 100% solid state.

- The VLU housing shall be of rugged construction. SEPTA requires that the VLU housings be of a light color to minimize heat absorption by the VLU when exposed to direct sunlight.

- Provide a digital display that can display a minimum of 200 alphanumeric characters concurrently. For example, displays with 5 lines of 40 characters each, or similar configurations, would be acceptable. The display shall be easily read by the vehicle Operator in lighting conditions ranging from bright sunlight to darkness, and by vehicle Operators wearing conventional types of sunglasses, (e.g., polarized, un-polarized, "blue-block", etc.). The display shall be designed to minimize reflective glare from the front surface of the display. Operator-accessible controls for the display brightness and contrast shall be provided. Adjustment of the display brightness and contrast over the useful range of settings shall be possible. Adjustment of display brightness and contrast to settings where the display is unreadable shall be prevented.

- The VLU display characters shall be at least ¼" in height. Larger VLU display characters shall be utilized as necessary to meet accepted human factor design criteria for personnel with 20/20 vision at the distance and angle of the seated vehicle Operator from the mounted VLU. In the event the mounting location of the VLU varies between the types of vehicles in the SEPTA fleet, the character height shall meet these requirements for the most severe mounting location.

- Provide at least 16 backlit keys for vehicle Operator entry of data, selections, commands, and control functions. Alternatively, a fewer number of context sensitive soft keys shall be provided. If fixed keys are proposed, at least 10 shall be assigned to functions commonly required...
by the vehicle Operators. SEPTA shall be able to assign functions pertaining to their operations to these keys.

- The functions assigned to each key shall be listed or displayed immediately above, below, or adjacent to the key. If the text describing the key's function is placed on the key, it shall be in a manner that precludes the text from being worn-off by repeated use by the vehicle Operators. The keys shall be durable, wear-resistant, and large enough for convenient selection. The keys shall be spaced sufficiently far apart to minimize inadvertent selection of adjacent keys. Color-coding of the keys and/or areas around the keys is required to help logically group keys according to their assigned functions. The backlighting of the keys shall be adjustable by the vehicle Operator. An audible tone or detent shall occur each time a button is pressed so that the Operator receives feedback that the action was successful. The backlighting of the keys shall return to the default value after an Operator logon.

- The VLUs shall produce audible tones when a new text message has been received and is available for display on the VLU. The audible tones shall have the ability of being heard over normal bus ambient noise levels. The audio output level shall be adjustable by the vehicle Operator within a restricted range that prevents audio output from being inaudible. The audio output level shall return to the default value after an Operator logon.

- The VLU shall display the current CAD/AVL System time to the vehicle Operator.

b. In addition to the equipment, features, and functionalities listed above, the Norristown High Speed Line and Media–Sharon Hill Line vehicles shall be provided with the following:

- Double ended vehicles shall be equipped with two VLU's.
- One VLU shall be active and the other shall be inactive. The inactive VLU shall be powered, but not provide operator functionality. The inactive VLU shall clearly indicate it is in standby mode.
- The IVCU shall determine which VLU shall be active based on Active Cab and End of Train signals.
- The IVCU shall automatically determine if a switch over to the inactive VLU is required. A switchover process shall take 5 seconds or less.

c. In addition to the equipment, features, and functionalities listed above, all CCT vehicles shall be provided with a Digi Router TX64.

4. **Intelligent Vehicle Control Units** - The Contractor shall provide IVCUs to support the functional and device interface requirements defined herein. The
IVCU shall also interface to the Contractor's proposed industry-standard vehicle area network (VAN) for performing processing related to the on-board functions (e.g., mechanical alarms), and for interfacing to the vehicle's data communications equipment. IVCUs may be packaged as part of the VLU or as an independent device, and shall have sufficient spare resources and I/O ports to support SEPTA's future requirements. The IVCUs shall store the vehicle ID and shall automatically transmit the vehicle ID as part of any data transmission, such as Operator logons. Encoding the vehicle ID shall not require manual programming of the MDT when the unit is replaced in a vehicle.

5. **Other Device Interfaces** - The MDT shall also be interfaced to a number of other on-board devices that do not reside on the VAN. The Contractor shall provide the inputs and input functionality required to connect these devices to the CAD/AVL System on-board equipment. The types of equipment to be interfaced shall include the following:

   a. Wheelchair lifts/ramps (status contacts)

   b. Spare RS232 and status contact inputs.

K. **Vehicle Area Network** - The Contractor shall provide and install a VAN on all installed vehicles. The VAN shall be based on the latest versions of the Society of Automotive Engineers (SAE) J1708 and J1587 standards.

   1. On revenue vehicles, the Contractor shall provide and install the VAN wiring, connectors, and the device access boxes to the extent necessary to interface to the farebox.

L. **Vehicle Wiring and Connectors** - In addition to the J1708 VAN specified above, the Contractor shall provide and install all other vehicle wiring and connectors required for the Contractor-provided equipment and for interfacing to the existing vehicle equipment listed in this Technical Specification. All cables shall be sufficiently protected from damage within a harness covering and shall adhere to the guidelines and requirements of the SAE J1455 and SAE J2202 standards. All connectors and cables shall include appropriate environmental seals to ensure that they are water resistant. Cables shall be supported at least every five feet with insulated clamps. Maintenance service loops shall also be provided. Connectors shall be assembled according to the guidelines in SAE J2030 and J2202. All connections shall be securely crimped. Cable designs for the vehicles shall not have exposed cabling wherever possible. Cabling that must pass through the passenger area of the vehicle shall be concealed behind panels. All vehicle wiring designs shall be submitted to SEPTA for approval prior to installations.

M. **Power-Off Delay Timer** - Unless the equipment is disconnected for maintenance purposes, the CAD/AVL System vehicle equipment shall remain powered on for a defined time period after the vehicle has been powered off to allow the CAD/AVL System to upload all collected data at the end of the day and to prevent Operators having to re-logon during short layovers.
1. It shall be possible for the System Administrator to set and adjust the power off delay timer to a new time period without touching each vehicle. Time periods ranging up to 4 hours delay shall be supported and shall initially be set to power off the CAD/AVL System vehicle equipment 45 minutes after the vehicle is powered off.

N. GPS Receivers and Antennas - The Contractor shall provide the GPS receivers, antennas, and all necessary connections required to monitor the location of CAD/AVL System-equipped vehicles if the existing GPS system doesn’t meet positional accuracy requirements. The GPS receivers shall be parallel (dedicated channel) tracking receivers and shall be able to simultaneously track at least eight GPS satellites in the best geometry for a position fix. The GPS receivers shall report latitude, longitude, speed, time, direction of travel, and satellite tracking station to the IVCU. The provided receivers shall also provide date/time signals to all Contractor-provided and existing on-board equipment, as necessary to support the required CAD/AVL System functions.

1. The GPS receivers shall support all Block I, Block II, and Block IIR GPS satellites that are operational at the time the GPS equipment is delivered. The accuracy of GPS location tracking functions shall be unaffected by GPS “week number rollover” events. Velocity measurements provided by the GPS equipment shall be accurate to within 0.1 meters/second when operating in the clear (non-selective availability) mode.

2. The GPS receivers shall have a cold start time to first fix (TTFF) solution time of two minutes or less and a signal reacquisition time of 15 seconds or less following the loss of the signal for at least one minute. The GPS equipment shall include multi-path rejection to eliminate spurious signals caused by reflections off of buildings and other structures.

3. The GPS receiver shall store the GPS almanac in non-volatile RAM.

4. The provided GPS antennas shall support the number of channels tracked by the GPS receivers and shall be low-profile units housed in rugged, weather tight, roof-mounted enclosures.

O. Additional Navigation Equipment - The CAD/AVL System shall include and utilize any additional navigation equipment required to meet the CAD/AVL System positional accuracy requirements. At a minimum, the dead reckoning methods shall be used to back-up the GPS-based navigation. It is expected that additional navigation equipment is required within the tunnels.

P. Emergency Alarm Switches - The Contractor shall install new emergency alarm switches on all CAD/AVL System-equipped revenue vehicles. The emergency alarm switch shall also trigger the onboard video surveillance system to tag the recording thereby eliminating the need for an Operator to press a separate button. All installed switches shall be identical. The switch configuration and location for new emergency alarm switches shall be subject to SEPTA approval.
Q. **Smart Card** – The Contractor shall install Smart Card readers on all CAD/AVL System equipped revenue vehicles for Operator login.

R. **Odometer Interface** - The Contractor shall interface to the odometer on all CAD/AVL System-equipped vehicles. This interface shall support the collection of accurate mileage data for each vehicle, navigation, and other functions as necessary to meet the Contractor’s design. All SEPTA vehicles have and use a J1939 interface and the Contractor shall obtain odometer data/pulses via the VAN.

S. **Farebox Interface** - All SEPTA buses have GFI CENTSaBill #M161S0-SM fareboxes with a KEY subsystem. The Contractor shall install all required wiring necessary for connection to the fareboxes.

T. **Voice/Data Controller** – The Contractor shall install voice/data controllers on all CAD/AVL System equipped vehicles. The voice/data controller shall be able to connect the IVCU to the current radio system, the new 700Mhz radio system, and provide VoIP functionality using the existing Digi Router. The voice/data controller shall support primary and backup voice/data paths without the need of a manual transfer to a different voice/data path.

1.16. **VEHICLE OPERATOR TRAINING HARDWARE (Bus In a Box (BIB))**

A. The Contractor shall provide training equipment for training revenue and non-revenue vehicle Operators on the proper use and operation of the CAD/AVL System on-board vehicle equipment in a classroom environment.

B. Vehicle operator training shall be held at SEPTA’s facilities. The training equipment shall be fully operational and identical to the equipment being provided and installed by the Contractor in SEPTA’s revenue and non-revenue vehicles. At a minimum, the on-board vehicle devices to be provided for each set of equipment shall include a MDT, SEPTA-provided mobile radio, cellular data modem, emergency alarm switch, covert microphone, speaker, handset, USB port, Ethernet port to connect to the SEPTA LAN, and the ability to simulate various vehicle status inputs (e.g., mechanical alarms).

C. Each set of training equipment shall be mounted in a rigid frame that is portable and suitable for temporary placement on a desktop during training. The equipment sets shall be powered from the SEPTA-provided 120 VAC, 60 Hz power supply.

D. The Contractor shall provide all hardware, software, and cabling required to interface to all the devices in each set of training equipment and to provide a realistic simulation of all operations, functions, and features of the CAD/AVL System on-board equipment. The training equipment shall allow vehicle Operators to be trained on the following functions:

1. Logon and logoff sequences
2. Use and meaning of all buttons, indicators/lights, menus, and any other information displayed on the VLU
3. Sending, receiving, and responding to text messages including displaying and controlling all messages in the MDT’s message per

4. Emergency alarm and covert monitoring scenarios

5. Understanding the meaning of and proper actions to be taken in response to all vehicle Operator prompts and error messages displayed on the VLU.

E. A dedicated CAD/AVL System training workstation shall be provided to allow SEPTA training personnel to interact with the vehicle Operators, over-the-air, in the same manner as actual operation. SEPTA training personnel shall be able to perform all CAD/AVL System dispatch functions so that the training can be as realistic as possible.

F. One of each type of training equipment shall be tested as part of the factory testing. All sets of equipment shall be delivered to SEPTA in time for vehicle Operator instructor training.

1.17. Remote Dispatch Laptops

The Contractor shall provide remote dual screen dispatch laptops with all software installed to perform all dispatch functions described in this Technical Specification. The remote dispatch laptops shall adhere to the workstation requirements described in this Technical Specification. Voice radio communications equipment for each remote dispatch laptop shall be supplied as part of this contract.

1.18. EXPANDABILITY

A. All expansion capacity defined in this Technical Specification shall be satisfied within the existing enclosures by the addition of circuit boards only. All power supplies and chassis space for the expansion shall be supplied with the delivered system. Expansion requirements shall include, but not be limited to, main memory, mass storage, and the ultimate device quantities as described herein.

1.19. OVERLOAD AND SURGE WITHSTAND CAPABILITY

A. The Contractor shall ensure that all communications facilities and interconnections among CAD/AVL System components are adequately protected from voltage overload and surge conditions (e.g., static discharge). The CAD/AVL System shall operate under minor overload conditions, recover to normal operation after other overload conditions, and limit damage caused by other, more severe, overload conditions. Facilities and interconnections requiring overload and surge protection at their interface to the system shall include telephone and T1 lines, antennas, and metallic cable runs.

B. The Contractor shall provide vehicle equipment that maintains normal operation under all operating conditions in which the equipment is installed, in accordance with the latest SAE J1455 guidance and requirements. The vehicle equipment shall be designed to withstand all transient voltage variations including load dump, inductive
switching, and mutual coupling. For 24 VDC systems, the vehicle equipment shall be able to operate in the presence of input voltage excursions of 38 VDC for up to 1.5 seconds. The Contractor shall provide the necessary cable and component shielding to prevent any inductive switching and mutual coupling errors from being introduced over I/O circuits and conductors.

1.20. POWER SUPPLY REQUIREMENTS

A. The CAD/AVL System shall operate with the following power inputs and the following conditions.

1. **Facility Power Supply and Cabling** - SEPTA will provide unconditioned, single phase 120 VAC, 60 Hz power to the Contractor-supplied UPS equipment that supports the CAD/AVL System equipment. Power to the UPS equipment will be supplied from utility power sources. Input voltage may vary ±10% and frequency may vary ±0.5% from nominal. Each circuit shall include a circuit breaker typed and sized in accordance with the equipment manufacturer’s recommendation. The Contractor shall supply all power cabling to the equipment locations, racks, workstations, enclosures, and other CAD/AVL System equipment. Power supply connections shall be located within the enclosures. The Contractor shall distribute power within the system enclosures, peripherals, and other CAD/AVL System components. The Contractor shall connect all equipment in accordance with the National Electric Code and applicable local electrical codes.

2. **Uninterruptible Power Supplies** - Contractor-installed servers, network equipment, and all other CAD/AVL System equipment located at SEPTA’s facilities and other locations where CAD/AVL System equipment is installed shall use the facilities provided Uninterruptible Power outlets.

3. **Hardware Protection** - Excluding the AC power main circuit breakers to be provided by SEPTA, all fusing, switches, and surge protection necessary at all locations to protect the hardware supplied as part of this Technical Specification shall be supplied by the Contractor.

1.21. TEMPERATURE/HUMIDITY/HEAT LOAD

A. All equipment provided under this Contract and located within the SEPTA server rooms and at workstation locations shall operate over an ambient temperature range of 50 degrees F to 110 degrees F, with a maximum rate of change of 15 degrees F per hour and with relative humidity ranging from 20% to 80% non-condensing.

1.22. GENERAL CONSTRUCTION REQUIREMENTS

A. All CAD/AVL System equipment shall be constructed in accordance with the following requirements.

1. **Cabinets** - The Contractor shall provide standard 19” cabinets for the CAD/AVL System equipment located in the Server rooms. Cabinet height shall not exceed
80 inches and shall have a solid roof and wheels. All equipment cabinets shall meet the following requirements:

2. **Finish** - The cabinets shall be finished inside and out. All cabinet metal shall be thoroughly cleaned and sanded, and welds chipped to obtain a clean, smooth finish. All surfaces shall be treated to resist rust and to form a bond between the metal and the paint. The finish colors of all enclosures shall be the Contractor’s standard.

3. **Accessibility** - Floor mounted cabinets shall have front and rear access to hardware and wiring. All cabinet doors shall be perforated for ventilation and be secured with keyed locks with all locks being keyed alike. Keys shall be removable in both the locked and unlocked positions. Moving assemblies within the cabinet, such as swing frames or extension slides, shall be designed such that full movement of the assembly is possible without bending or distortion of the cabinet or the moving assembly. Cabinets shall not require fastening to the floor to preclude tipping of the cabinet when the moving assembly is extended.

4. **Cabling and Wiring** - Cable entry shall be through the top or bottom, of the cabinet, such that no cables shall be visible from the front of the cabinet. All cables running above drop ceilings shall be rated as NEC Class 2 Plenum cable and tested to NFPA 262-1985 Test for Fire and Smoke Characteristics of Wires and Cables to a maximum peak optical density of 0.5, a maximum average optical density of 0.15, and a maximum allowable flame travel distance of five feet.

   a. Wiring within cabinets shall be neatly arranged and securely fastened to the cabinet by non-conductive fasteners. Wiring between all stationary and moveable components, such as wiring across hinges or to components mounted on extension slides, shall allow for full movement of the component without binding or chafing of the wire.

   b. Except for fiber-optic cables, all wiring shall use copper conductors. Conductors in multi-conductor cables shall be individually color-coded.

5. **Cooling** - Cooling air shall be drawn from the conditioned air within the room. Ducted or directed cooling air to the cabinets will not be supplied by SEPTA. Cabinets shall be equipped with replaceable filters to minimize the accumulation of dust and other particulates on internal equipment. Filters shall be a standard, readily-available size. Cabinets shall not be equipped with cooling fans.

6. **Construction Materials** - All materials used in the cabinets, including cable insulation or sheathing, wire troughs, terminal blocks, and cabinet trim shall be made of flame retardant material and shall not produce toxic gasses under fire conditions. Any use of PVC shall be allowed only with specific permission of SEPTA.
7. **Anchoring** - The Contractor shall ensure that the equipment, materials and installation comply with all local seismic requirements for the area in which the equipment is to be installed.

8. **Grounding** - A safety ground in accordance with the National Electrical code shall be provided within each cabinet and shall connect to the ground (green) wire of the AC power input. Cabinet grounding shall also be provided and shall be subject to SEPTA approval.

9. **Assembly and Component Identification** - Each assembly in the system, to the level of printed circuit cards, shall be clearly marked with the manufacturer's part number, serial number, and the revision level. Changes to assemblies shall be indicated by an unambiguous change to the marked revision level. All printed circuit card cages and all slots within the cages shall be clearly labeled.

10. **Interconnections** - The Contractor shall supply all signal cabling between component units of the CAD/AVL System. The connectors shall be polarized to prevent improper assembly. Each end of each interconnection cable shall be marked with the cable number and the identifying number and location of each of the cable's terminations; this information shall agree with the drawings and be descriptive, so that maintenance personnel can easily identify which cables connect to which equipment. Each cable shall be continuous between components; no intermediate splices or connectors shall be used. Terminations shall be entirely within the cabinets.

11. **Equipment Space** - The Contractor shall provide a plan view of the location where the CAD/AVL System equipment is to be installed. Floor plans shall be used to determine lengths of interconnecting cables. An additional 20 feet shall be provided for cables crossing room boundaries.

**PART 2 – PRODUCTS – NOT APPLICABLE**

**PART 3 – EXECUTION – NOT APPLICABLE**

**END OF SECTION**
SECTION 13347

CONFIGURATION CHARACTERISTICS AND AVAILABILITY

PART 1 - GENERAL

1.1. DESCRIPTION OF WORK

A. This section describes system configuration requirements, presents the functions required to monitor and manage the CAD/AVL System hardware and software, and quantifies the CAD/AVL System availability requirements. The ability of the CAD/AVL System to perform its specified tasks under normal conditions and under conditions of hardware and software failure is of paramount importance to SEPTA.

1.2. SYSTEM CONFIGURATION REQUIREMENTS

A. The CAD/AVL System shall accommodate the system configuration and network topology requirements described below and in other sections of this Technical Specification.

B. **System Configuration Major Elements** - The CAD/AVL System configuration shall include the following major elements:
   1. Redundant CAD/AVL System application servers
   2. Redundant CAD/AVL System on-line database servers
   3. Redundant data communication servers/devices
   4. Replicated Online Database
   5. A redundant, dedicated Information Server
   6. Dispatcher workstations located in the primary and backup Control Centers
   7. Redundant server rooms
   8. All other users' workstations (e.g., System Administrator, Customer Service, etc.)
   9. Network Time Server
   10. Interfaces to the following external systems:
       a. SEPTA LAN/WAN
       b. Trapeze FX
       c. GTFS-RT
d. Vehicle Management Information System (VMIS)

e. RouteMatch

f. Mainframe

g. Real-Time Passenger Information

C. All interfaces to the above external computer systems shall be secure and shall prevent unauthorized users and data traffic from impacting the performance or security of the real-time CAD/AVL System functions.

D. **Server/Device Interconnections** - The Contractor-provided CAD/AVL System LAN shall provide interconnections between the major system elements listed above, and other necessary server and device interconnections for:

1. The exchange of data among servers and workstations for the purpose of executing all required CAD/AVL System and user functions

2. The exchange of data between servers for the purpose of populating and maintaining all CAD/AVL System databases

3. The exchange of server and device state information for the purpose of monitoring and controlling the CAD/AVL System configuration

4. The data communications between the CAD/AVL System and the wide area wireless data communications provider

5. The voice communications between the CAD/AVL System and the voice communications provider

6. Access to peripheral devices.

E. **Backup Databases** - A backup copy of all required databases shall be maintained so that the CAD/AVL System operation may continue in the event of server, workstation, device, or software failure. The backup databases shall be updated with the current contents of the primary databases, such that all changes to a primary database are replicated to the backup database.

F. **Error Detection and Failure Determination** - All CAD/AVL System servers, workstations, devices, and on-line and background functions shall be monitored for fatal and recoverable errors. All errors shall be recorded for review by the System Administrator and shall be included in the error statistics displays and reports. Each type of error for each device (for example memory access violation, device reply time-out, or message checksum error) shall be recorded separately.

1. Configuration of errors and failures to also issue an alert to the System Administrator via, SMS, email, etc.,.
G. **Server Redundancy and Failure** - Unless specifically identified as redundant herein, servers may be configured as redundant or non-redundant, as necessary to meet availability requirements. Redundant servers shall be provided in a primary and backup server configuration, where the backup server is in a hot standby mode of operation.

2. When a failure of a primary server is detected, the CAD/AVL System shall invoke the appropriate failover actions so that all functions assigned to the failed server are preserved and available. In the event of a primary server failure, the assigned backup server shall assume all functions performed by the primary server and take responsibility for the continued operation of the CAD/AVL System. The transition of the backup server to the primary role shall take no longer than 60 seconds. This transition shall be considered complete when all system functions are completely operational on the new primary server.

3. Failures of servers operating in the backup state shall not initiate failover actions.

4. All server failures shall be annunciated by alarms. The alarms shall identify the failed server(s), all server state changes, and the success or failure of any restart and failover operations.

H. **Device Redundancy and Failure** - Unless specifically identified below as redundant, devices (including LANs and interfaces) may be configured as redundant or non-redundant, as necessary to meet the specified availability requirements. In addition, the following device redundancy and failure recovery requirements shall be met:

1. **LANs**: LAN components that represent a single point of failure shall be avoided. LAN components present in the Contractor’s design shall be equipped with redundant power supplies and, at a minimum, shall allow immediate manual reconfiguration with a Contractor-supplied replacement component to correct the problem. Replacement components shall be installed in the same enclosure as the online device and shall be pre-wired for power. The routing and dressing of LAN cabling shall allow for the rapid rerouting of cables to the replacement component. Recovery from a LAN failure shall not require server failover.

2. **Workstations**: When a Dispatcher workstation fails, the CAD/AVL System shall assure that all of the partition assignments (e.g., route and fleet) of the user who was logged in at that workstation are assigned to at least one user logged in at another Dispatcher workstation. If one or more partition assignments are not covered, the partitions shall be assigned to the current user of another Dispatcher workstation and an alarm shall be generated at that workstation.

I. **Server Room Redundancy and Failure** - Redundant server rooms shall be provided in a primary and backup system configuration, where the backup server is in a hot standby mode of operation.

1. When a failure of a primary and backup server is detected in the primary server room, the CAD/AVL System shall invoke the appropriate failover actions so that all functions assigned to the failed computer room are preserved and available.
In the event of a primary server failure, the assigned backup computer room shall assume all functions performed by the primary computer room and take responsibility for the continued operation of the CAD/AVL System. The transition of the backup computer room to the primary role shall take no longer than 60 seconds. This transition shall be considered complete when all system functions are completely operational on the new computer room.

2. Failures of servers operating in the backup server room shall not initiate failover actions.

3. **Backup storage:** Any function using a backup storage device shall be able to use any other backup storage device if the primary device is not available. Substitution of a backup storage device for a failed device shall be at the direction of the System Administrator.

4. **Printers:** Where there is more than one network printer at a CAD/AVL location, the printers shall be backed-up by other printers. If a printer fails and no other assigned backup device is operational, the system shall retain the print files on-line until the primary printer or a backup device is available. When the primary printer is returned to service, the assigned printouts shall again be directed to the primary printer.

   a. Processor failover shall not be required to recover from printer failure. Printer failover logic shall include a time delay to allow the user to temporarily take a printer off-line to load or adjust paper without failover, and shall preclude the loss of information transferred to a buffered printer but not printed at the time of the printer failure.

5. When a failure of a redundant device is declared, the CAD/AVL System shall automatically invoke the appropriate device failover actions so that functions assigned to the failed device are preserved. Backup devices may be identical to, or different from, the primary device provided that the functions of the failed device can be performed. The ability for the System Administrator to assign specific backup devices to replace failed primary devices shall be supported.

6. Except as specified above, server failover, as specified herein, may be allowed as the means of recovering from the failure of a redundant device crucial to the CAD/AVL System operation, and shall be subject to SEPTA approval.

7. When a failure of a non-redundant device is declared, the CAD/AVL System shall not invoke failover or restart actions. Functions assigned to a failed, non-redundant device may be lost until the failed device is restored to service.

8. All device failures shall be annunciated by alarms. The alarms shall identify the failed device(s), all device state changes, and the success or failure of any failover operations.
1.3. Remote Communications

A. As may be necessary for emergency backup or other functions, the system shall have the ability for remote operations, including dispatch, from full-function user workstations at a remote location. To support this requirement, the Contractor shall be responsible for verifying that the implementation of the communication facilities provided by SEPTA meet the remote communications requirements of the proposed system. The Contractor shall demonstrate to SEPTA any problems encountered with the network communications implementation provided by SEPTA and shall assist SEPTA as necessary to resolve the problem(s).

B. The Contractor shall provide the necessary equipment for the CAD/AVL System to interface to the existing communications equipment. The Contractor shall perform all interconnections and testing such that all CAD/AVL System functions are provided and performed as specified.

1.4. STANDARDS AND PUBLICATIONS

A. The following standards and publications are incorporated herein by reference to the extent applicable. References to these standards shall imply the latest version of the standard, including revisions, in force at the date of Bid submission.
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1.5. **AVAILABILITY**

A. The CAD/AVL System shall have a total calculated availability, including functional availability (See below) and hardware availability (See below), of 99.98%. That is, the ratio of total time minus downtime to total time shall be equal to or greater than 0.9998.

B. The failure of any single Contractor-provided server, device, or other component shall not render the system unavailable.

C. The following subsections identify the functions and equipment required for the CAD/AVL System to be considered available. Section 13348, describes the requirements, responsibilities, and definitions for an Availability Test that shall demonstrate conformance with the availability criteria described in this section.

D. **Functional Availability** - All CAD/AVL System functions shall execute as specified, without degradation in response times, for the system to be considered available.

   1. Functional availability shall also include the execution of the Contractor-provided data communications interface and associated functions. For the purposes of the Availability Test, failure to meet this criterion due to failure of SEPTA-supplied communications circuits or components will not be measured as downtime, and will be considered Holdtime.

E. **Hardware Availability** - For the CAD/AVL System hardware to be considered available, the fixed-end availability requirements defined below must be met. For purposes of the availability testing, software and firmware in the Contractor-provided data communications interface equipment will be considered as part of the hardware.

   1. **Fixed-end Hardware Availability** - The following minimum complement of fixed-end hardware must be operational for the CAD/AVL System to be considered available:

      a. Sufficient servers, with all main memory, server interconnections, mass storage, and peripheral device access to execute all CAD/AVL System functions at the scheduled periodicities and response times.

      b. Sufficient LAN facilities to execute all CAD/AVL System functions at the scheduled periodicities and response times.

      c. At least 99.5% of all CAD/AVL System workstations shall be operational. A workstation shall be considered operational when the keyboard, mouse, all monitors, and computer are operational, and when it can support all required CAD/AVL System functions while meeting all performance requirements. Additionally, each failure of the workstation application software that requires a program restart or reboot shall count as 15 minutes of downtime for that workstation.
2. **Data Communications Availability** - Sufficient Contractor-provided hardware to execute data communications must be operational for the CAD/AVL System to be considered available. For the purposes of the Availability Test, failure to meet this criterion due to failure of SEPTA-supplied communications circuits or components will not be measured as downtime, and will be considered Holdtime.

F. **Individual Device Availability** - In addition to meeting the system hardware availability requirements, each Contractor-supplied device, including but not limited to servers, workstations, and network and communications equipment shall individually exhibit a minimum calculated hardware availability of 99.5%.

1. For the purposes of the Availability Test, equipment consisting of an assembly of individual components shall be considered a single device (e.g., a server, router, etc.). Also, during the course of the Availability Test, each device shall experience no more than one hardware failure.

PART 2 – PRODUCTS – NOT APPLICABLE

PART 3 – EXECUTION – NOT APPLICABLE

END OF SECTION
PART 1 - GENERAL

1.1. DESCRIPTION OF WORK

A. All materials furnished and all work performed under this Technical Specification shall be inspected and tested. Deliverables shall not be shipped until all required inspections and tests have been completed, all deficiencies have been corrected as required to the satisfaction of SEPTA.

B. If any inspections or tests indicate that specific hardware, software, or documentation does not meet the Technical Specification requirements, the appropriate items shall be replaced, repaired, upgraded, or added by the Contractor, as appropriate, to correct the noted deficiencies at no cost to SEPTA. After correction of a deficiency, all necessary retests shall be performed to verify the effectiveness of the corrective action.

C. For all testing specified in the following sections, no adjustments, modifications, or substitutions are to be made by the Contractor to the CAD/AVL System software and equipment, except by approval of SEPTA.

1.2. Inspection

A. Access to the Contractor's facilities while system manufacturing and testing are taking place, including any facility where hardware or software is being produced for the CAD/AVL System, shall be available to SEPTA representatives at any time.

B. In conjunction with scheduled project meetings at the Contractor's facilities, SEPTA representatives shall be allowed to review and verify the functional implementation of all operational CAD/AVL System software in an informal, hands-on demonstration of the operation of each software function, even though software debug and integration activities may not have been completed. No special documentation is required to support these informal software demonstrations.

C. Inspections performed by SEPTA will include but not be limited to visual examination of hardware, cable dressings, and equipment and cable labeling. Contractor documentation may also be examined to verify that it adequately identifies and describes all hardware and software, and is in accordance with the documentation requirements specified herein.

D. SEPTA shall have the right to inspect the Contractor's hardware and software quality assurance standards, procedures, and records that are applicable to the CAD/AVL System. Documents identified in the Contractor's hardware and software quality assurance documentation shall also be available for inspection.
E. The inspection rights described above shall not apply to subcontractors supplying standard items, such as COTS computer or peripheral equipment and third-party software products. Standard COTS hardware and software products shall be tested as part of the formal tests and activities specified herein. However, inspection rights shall apply to subcontractors that are developing new hardware or software for inclusion in the CAD/AVL System.

1.3. TEST PLANS AND TEST PROCEDURES

A. Test plans and test procedures for both factory and field tests shall be provided by the Contractor to ensure that each factory and field test is comprehensive and verifies all functions and devices to be delivered as part of the CAD/AVL System. Test plans and test procedures for application software shall place special emphasis on comprehensively testing each function and feature, checking error conditions, and documenting and verifying the validity of all simulation techniques used. The test procedures shall be modular to allow individual test segments to be repeated as needed.

B. Together, test plans and test procedures shall provide a two-step description of each factory and field test. Test plans shall provide a high-level summary of the methods used for verifying each function and feature of the hardware, software, and firmware to be delivered. Test procedures shall include detailed, step-by-step procedures associated with each test segment. All test plans and test procedures shall be submitted to SEPTA for approval, subject to the review and approval process. No factory and field testing shall commence without a reviewed test plan and the reviewed test procedures associated with each test.

C. Test Plans - The test plans for factory and field tests shall be submitted to SEPTA 30 days in advance to allow for review and approval before Contractor submittal of the associated test procedures. The following information shall be included in the test plans:

1. Test schedule
2. Responsibilities of SEPTA and Contractor personnel
3. Record-keeping procedures and forms
4. Procedures for monitoring, correcting, and retesting discrepancies
5. Procedures for controlling and documenting all changes made to the CAD/AVL System after the start of testing
6. Block diagram(s) of the hardware test configuration, including Contractor-supplied equipment, equipment supplied by SEPTA (if any), communications equipment, revenue and non-revenue vehicle equipment, external communication channels, and any test or simulation hardware
7. A list of individual tests to be performed, the purpose of each test segment, and references to the applicable sections of the Technical Specification

8. Identification of special hardware, software, tools, and test equipment to be used during the test

9. Techniques and scenarios to be used to simulate ultimate system sizing, processor utilization, and performance, especially during the peak loading test

10. Copies of any certified test data (e.g., environmental data) to be used in lieu of testing for certain approved equipment.

D. **Test Procedures** - Test procedures that are based upon, and consistent with, the reviewed test plan shall be submitted to SEPTA for review and approval. Test procedures shall be submitted only after the test plan has been reviewed by SEPTA. Testing shall not commence without reviewed test procedures. SEPTA will only review test procedures if they are comprehensive and thoroughly test each CAD/AVL System component, both independently and collectively. Test procedures shall include the following items:

1. Function or feature to be tested, with appropriate reference to the Technical Specification section(s) that prescribes the requirement(s) being tested.

2. Purpose of each test segment

3. Set-up and conditions for testing

4. Descriptions of all simulation tools and techniques used during the test

5. Detailed, step-by-step procedures to be followed

6. All inputs and expected results for each test segment.

1.4. **TEST RECORDS**

A. The Contractor shall maintain complete records of all factory and field test results. The records shall be keyed to the steps enumerated in the test procedures. A test report shall be provided by the Contractor upon completion of each test. The test reports shall include the following:

1. Reference to the appropriate section of the test procedures

2. Test results for each test segment, including a passed/failed indication and any modifications made to the procedures during the test

3. Identification of the Contractor's test engineer and of the SEPTA representatives witnessing the test

4. Date of the test
5. Provision for comments by SEPTA representatives

6. List of all discrepancies generated and their status

7. Copies of all discrepancy forms generated

8. System logs or printouts saved as part of the test.

B. Discrepancy Forms - A discrepancy form shall be prepared by the Contractor personnel and SEPTA representatives each time a deviation from Technical Specification requirements, test procedures, or the Contractor's design is detected during any formal or informal CAD/AVL System testing. The form shall include a complete description of the discrepancy, including the following:

1. A sequential identifying number assigned to the discrepancy

2. The date and time the discrepancy was detected

3. Discrepancy priority (see below)

4. Discrepancy status (e.g., open, ready for retesting, closed)

5. Appropriate references to the test procedures, Specification, or design documentation

6. A description of the test conditions at the time the discrepancy was detected

7. Identification of Contractor and SEPTA witnesses

8. A sign-off by both Contractor and SEPTA representatives when the correction of the discrepancy has been verified.

C. Discrepancy Priorities - Discrepancy priorities shall be assigned by SEPTA. Each discrepancy shall be assigned one of the following four priorities, depending on its severity:

1. Priority 1: Critical – a failure or deficiency that results, or would result, in SEPTA being unable to use critical functions of the CAD/AVL System to an extent that may affect the safety of the public and/or SEPTA personnel (e.g., a failure resulting in a complete loss of data communications and/or an extended inability to locate vehicles would be considered a Priority 1 discrepancy).

2. Priority 2: Major – a failure or deficiency of lesser severity than a Priority 1 that does not substantially reduce the ability of the CAD/AVL System to accomplish its primary system functions, such as vehicle communications, CAD and AVL. Priority 2 discrepancies indicate functional and/or performance deficiencies, but the CAD/AVL System can still accomplish its primary system functions with a satisfactory degree of safety and effectiveness (e.g., deficiencies in
performance, such as response times, may be considered Priority 2 discrepancies). Also, Priority 1 discrepancies for which an acceptable workaround has been established may also be reassigned to Priority 2.

3. **Priority 3:** Minor – a failure or deficiency of a minor function, minor performance issues, and documentation errors. Priority 2 discrepancies for which an acceptable workaround has been established may also be reassigned to Priority 3.

4. **Priority 4:** System Enhancement – requests for functions, features, or devices not presently required or part of the CAD/AVL System software or hardware suite.

**D. Discrepancy Tracking and Reporting** - The Contractor shall track all discrepancies and document actions taken to correct each discrepancy. Sufficient information shall be provided to enable SEPTA representatives to determine the need for retesting the function, for testing interaction with any previously tested function, and for updating appropriate documentation as a result of the corrective action. Discrepancy corrections that would result in a change to a reviewed document must be reviewed by SEPTA prior to their implementation by the Contractor. Each discrepancy shall be addressed by the Contractor and closed when a Contractor and SEPTA representative acknowledge, by signatures, correction of the discrepancy. Discrepancies shall be available to SEPTA at all times.

1. The Contractor shall maintain and periodically distribute (frequency of distribution based on testing activity) a discrepancy summary that lists for each discrepancy, the discrepancy number, a brief description of the discrepancy, date opened, priority, current status, date closed (if closed), and a brief description of the resolution of the discrepancy. The Contractor shall distribute a current discrepancy summary at the completion of each test, just before a new test, and when requested by SEPTA. The discrepancy summary shall be distributed to SEPTA in Microsoft Access- or Excel-compatible electronic formats.

2. A closed discrepancy shall be removed from the discrepancy summary after the closed status and resolution of the discrepancy has been reported on one version of the discrepancy summary and distributed to SEPTA. Upon request, a comprehensive listing of all discrepancies (open and closed) shall be provided to SEPTA.

**E. Disposition of Discrepancies** - All Priority 1 and 2 discrepancies detected during factory testing shall be corrected and reviewed by SEPTA, and no more than fifteen Priority 3 discrepancies shall remain open, prior to shipment of the CAD/AVL System to SEPTA.

1. All Priority 1 and 2 discrepancies found during field testing shall be corrected and reviewed by SEPTA, and no more than ten Priority 3 discrepancies shall remain open, prior to any portion of the CAD/AVL System being phased-over to revenue operation.
2. Any Priority 1 discrepancies that are detected during phase-over shall require the cessation of any revenue use of the CAD/AVL System. SEPTA may choose to waive these restrictions in specific instances, depending on the nature of the discrepancies.

3. All Priority 1, 2, and 3 discrepancies shall be corrected before the start of the Availability Test.

4. All Priority 1, 2, and 3 discrepancies shall be corrected before final acceptance of the CAD/AVL System by SEPTA.

1.5. FACTORY ACCEPTANCE TEST

   A. The Contractor shall perform a Factory Acceptance Test that shall demonstrate the required functional, software, and hardware operation of the fully integrated CAD/AVL System, including all consoles and related equipment, and a subset of all fixed-site and on-board vehicle equipment (see below). All tests shall be performed “over-the-air”, using the cellular equipment that will be used for implementation in the field. The FAT shall consist of a Contractor-performed dry run of the factory tests, a Functional Performance Test, and a System Stability and Availability Test. Unstructured testing may be performed by SEPTA.

   B. The CAD/AVL System shall not be shipped to SEPTA until all factory acceptance tests are completed to the satisfaction of SEPTA. SEPTA is under no obligation to accept the CAD/AVL System for shipment if any uncorrected functional, hardware, or software problems exist, except as provided for herein.

   C. The FAT configuration shall include all server, workstation, and network equipment; all communication equipment; one of each type of passenger information sign; and a complete set of on-board vehicle equipment for each type of revenue vehicle. Each set of vehicle equipment shall include all equipment and interfaces supplied by the Contractor under the CAD/AVL System project, including any optional equipment selected by SEPTA for inclusion under this project. The FAT configuration shall also include all test equipment required to simulate system loading activity, vehicle movements, and data signals to and from devices supplied by others, such as fareboxes.

   D. The Contractor-provided data communications equipment shall be used by the Contractor to simulate the data communications between the CAD/AVL System fixed-end and vehicle equipment via the wide area wireless data communications provider. Common carrier interconnections between the CAD/AVL System communications equipment and the wide area wireless data communications provider may also be simulated. Both individual and group data communications shall be tested.

   E. All equipment that will be supplied by the Contractor, but not exercised as part of the factory test configuration, such as the remaining vehicle equipment, shall be tested using standard manufacturer’s testing procedures and criteria. This testing may be conducted at another location, but the manufacturer’s test results shall be supplied to...
and reviewed by SEPTA prior to the start of the FAT. SEPTA representatives shall have the opportunity to witness these tests.

F. The FAT shall include a comprehensive simulation test of AVL functions using the actual SEPTA service area base maps, including all route and map overlays. The simulation testing shall include playback of previously recorded AVL data associated with a minimum of two vehicles simultaneously traversing a set of actual routes. The previously recorded AVL test data shall include all patterns that a vehicle could expect to encounter to comprehensively test the CAD/AVL System’s AVL and RSA functions. SEPTA requires that the simulation test of AVL and RSA functions exercise vehicle subsystems in addition to the fixed-end components by simulating the GPS data feed to the vehicle subsystems that are being staged at the FAT.

G. Communications facilities for supporting communications between the CAD/AVL System at the Contractor’s factory and SEPTA local systems, if needed by the Contractor for implementation and testing, shall be supplied by the Contractor. Testing of data exchanges shall be conducted as part of the factory testing. Tests of data exchanges that are not required in real time (e.g., a new service schedule) may be conducted using suitable storage media for transport of the test data.

H. The following conditions shall be satisfied prior to the start of the FAT:

1. Final design review completion and subsequent SEPTA approval of the Contractor’s design.

2. All applicable hardware and software engineering design changes shall be incorporated into the CAD/AVL System.

3. CAD/AVL System documentation, including drawings, list of deliverables, software functional description document, factory test plans and test procedures, and all user manuals shall have been reviewed and reviewed by SEPTA.

4. All action items related to approval documents, system performance, and test simulation techniques shall be resolved.

I. All test hardware, software, and special test and calibration equipment required to demonstrate the acceptable operation of the CAD/AVL System shall be provided by the Contractor, including data communications with the vehicles, and the simulation of processor loading based on the ultimate system size and conditions specified herein. The Contractor shall not substitute any equipment and software during the entire factory test period without prior SEPTA authorization.

J. The FAT shall be considered successfully completed only when all tests have been performed, all discrepancies have been resolved to the satisfaction of SEPTA, all test records have been issued to SEPTA, and SEPTA acknowledges, in writing, successful completion of the FAT.

K. **Dry-Run Testing** - Prior to the start of the Functional Performance Test, the Contractor shall conduct a complete and formal dry run of the entire Functional
Performance Test and System Stability and Availability Test to verify that the CAD/AVL System is ready to be tested by SEPTA. The Contractor shall follow the reviewed test plan and procedures, and record and correct all discrepancies found during the dry run testing, including test procedure errors. Written certification that the dry run has been successfully completed and a report identifying the discrepancies found and resolutions implemented shall be provided to SEPTA by the Contractor at least two weeks prior to the start of the Functional Performance Test. At the option of SEPTA, one or more SEPTA representatives may witness and participate in all, or portions of, the dry run testing.

L. **Functional Performance Test** - The Functional Performance Test shall completely verify that all the specified and Contractor-proposed features and functions of the CAD/AVL System hardware, software, and firmware have been properly designed and implemented. SEPTA representatives might witness all tests and may perform hands-on actions of the test procedures, at SEPTA discretion. If SEPTA elects to perform hands-on actions of the test procedures, knowledgeable Contractor representatives shall be present at all times to assist the SEPTA representatives with the testing.

M. The following items, at a minimum, shall be included in the Functional Performance Test:

1. Inspection of all equipment for conformance to drawings, specifications, and applicable standards, and for satisfactory appearance

2. Testing of the proper functioning of all hardware by thoroughly exercising all devices, both individually and collectively

3. Testing of the proper functioning of all software and firmware features and functions, including test cases with normal and exception data

4. Testing of the proper functioning of all data communication features and facilities

5. Testing of all revenue and non-revenue vehicle functions, using actual equipment items supplied as part of the CAD/AVL System.

   a. Input and output signals from devices supplied by others or already installed on the vehicles shall be simulated by the contractor if SEPTA cannot provide actual devices for testing.

6. Testing of AVL functions using a mobile test vehicle, or simulated vehicles, using the appropriate test map, schedule data, and geographic information for the routes that will be traversed

7. Testing of all vehicle functions

8. Testing of all bulk data transfer functions

9. Verification of all data transfers and interfaces with external systems, including Trapeze systems
10. Testing of all UI functions

11. Simulation of hardware failures and failover of each CAD/AVL System server, device and server room that has a backup unit

12. Simulation of data communications failure, including the subsequent transition to fallback mode of operation and the transition back to normal operation mode when data communications has been restored

13. Verification that spare capacity and ultimate sizing requirements have been met, including all expansion requirements

14. Verification of the accuracy of the system performance monitoring software

15. Verification that the processor loading and system response time requirements have been met while performing the Peak Load Performance Test as defined in Section 13351.

16. Verification of device and system recovery from AC power failures

17. Verification of the accuracy of hardware and software documentation via random checks

18. Testing of the display generator/editor, report generator/editor, and software and database maintenance functions

19. Verification of all reports provided with the system, including ad hoc reports.

N. If SEPTA representatives believe the quantity and/or severity of the CAD/AVL System discrepancies warrant a restart of the Functional Performance Test, the test shall be halted, remedial work shall be performed by the Contractor, and the complete test shall be rerun at a time agreed upon between the Contractor and SEPTA.

O. Unstructured Testing - Periods of unstructured testing shall be permitted to allow SEPTA representatives to verify proper operation of the CAD/AVL System under conditions not specifically included in the reviewed test procedures. Unstructured testing shall be conducted in compliance with the following conditions:

1. A minimum of 25% of the time allotted testing shall be reserved for unstructured exercising of the CAD/AVL System by one or more SEPTA representatives. Unstructured testing shall be allowed, at SEPTA’s discretion, at the end of each structured test segment and at the end of the Functional Performance Test.

2. The Contractor’s test representative(s) shall be present and other Contractor’s technical staff shall be available for consultation with SEPTA representatives during unstructured test periods.
3. All simulation software and hardware, test cases, and other test facilities used during the structured portions of the FAT shall be made available for SEPTA use during unstructured testing.

P. **System Stability and Availability Test** - The stability and availability of the CAD/AVL System hardware and software shall be tested after the successful completion of the Functional Performance Test. All CAD/AVL System functions shall run concurrently and all Contractor-supplied equipment shall operate for a continuous 48-hour period. All Priority 1 and 2 discrepancies that have been detected must be corrected prior to the start of this test.

1. The System Stability and Availability Test shall assure SEPTA that the CAD/AVL System is free of problems caused by interactions between software and hardware while the CAD/AVL System is operating as an integrated whole. SEPTA will not accept the CAD/AVL System for shipment if any unexplained restarts or failovers have occurred. The test will be extended by 24-hour increments until these requirements are satisfied.

2. The test procedures shall allow for both structured and unstructured testing under normal conditions according to procedures based in the reviewed Contractor documentation.

1.6. **FIELD TESTS**

A. The Contractor shall perform field testing that shall demonstrate the required functional, software, and hardware operation of the fully integrated CAD/AVL System under actual field conditions at SEPTA’s facilities and on SEPTA’s revenue and non-revenue vehicles. The field testing shall consist of a Field Installation Test and a Field Performance Test. Unstructured testing may be performed by SEPTA in the same form and manner as with the FAT.

B. Before field testing begins, the capability of SEPTA to purchase maintenance contracts for all equipment shall be confirmed by the Contractor and certified to SEPTA. If any updates or maintenance is necessary for SEPTA to procure maintenance contracts, the Contractor shall immediately perform the necessary work.

C. **Field Installation Test** - The Field Installation Test shall be conducted after the CAD/AVL System has been installed at all SEPTA sites and all of the CAD/AVL System vehicle equipment is installed on the Mini-Fleet Test vehicles. All discrepancies shall be corrected prior to the start of the test.

1. The purpose of the Field Installation Test is to ensure that the CAD/AVL System, as installed in the field, works properly as an integrated and installed system. This testing shall include, but not be limited to, the verification of proper network (LAN and WAN) connectivity, hardware startup and operation, software startup and operation, interface connectivity between the CAD/AVL System and other external SEPTA systems, interface connectivity between the CAD/AVL System
and the wide area wireless data communications provider, and other communication path connectivity.

2. The Contractor shall be responsible for conducting the Field Installation Test. SEPTA representatives will, at SEPTA’s discretion, witness all or part of the installation testing.

D. **Field Performance Test** - Following the successful completion of the Field Installation Test and correction of all discrepancies generated during the Field Installation Test, and SEPTA’s acceptance of the mini-fleet test vehicle installations, a comprehensive test of the CAD/AVL System shall be conducted with the mini-fleet test vehicles.

1. The purpose of the Field Performance Test is to ensure that the CAD/AVL System functions properly as a fully installed and integrated system, including test vehicles and external interfaces. This testing shall encompass the full range of CAD/AVL System functionality; however, it shall concentrate on areas of CAD/AVL System operation that were simulated or only partially tested in the factory, as well as on areas where discrepancies were generated. Testing of other areas shall be repeated as necessary to ensure the proper functioning of the complete CAD/AVL System.

2. The Contractor shall be responsible for conducting the Peak Load Performance Test defined in Section 13351.

3. The Contractor shall be responsible for conducting the Field Performance Test, including documenting and correcting any discrepancies. SEPTA representatives will witness all tests and may perform the hands-on actions of some or all test procedures, and perform unstructured testing. Contractor representatives shall be present at all times to assist SEPTA representatives with such testing.

1.7. **MINI-FLEET TEST**

A. A comprehensive Mini-Fleet Test (MFT) shall be conducted following the successful completion of the Field Performance Test and the correction of all discrepancies. The MFT shall be conducted using ten fixed-route vehicles, one Supervisor vehicle, and one maintenance vehicle from the SEPTA fleet. The MFT vehicles shall be equipped with all of the vehicle equipment to be installed on each vehicle type, including all of the SEPTA-selected optional equipment.

1. The MFT vehicles shall all be simultaneously operated in actual and simulated revenue service to fully test schedule and route adherence, AVL, text messaging, voice communications, emergency alarm processing, and the other CAD/AVL System equipment and functions under actual service conditions. The MFT vehicles shall be operated on a subset of the service routes selected by SEPTA. These selected routes shall encompass the entire service area and allow testing under all of the operational and functional conditions expected to be encountered throughout the service day for each of SEPTA’s service types.
2. The Contractor shall provide on-site support during the MFT to assist in testing, to help identify and document discrepancies, and to correct any discrepancies. The duration of the MFT will depend on the number of problems encountered and the need for additional testing. At a minimum, the MFT shall take place over a period of two weeks. The MFT shall continue until SEPTA is satisfied that the CAD/AVL System is operating properly.

1.8. PHASE-OVER TO REVENUE OPERATIONS

A. Following successful completion of the MFT and correction of all discrepancies, the Contractor shall begin the CAD/AVL System vehicle equipment installation and gradual phase-over of the remainder of the fleet into revenue service, in accordance with the reviewed installation and phase-over plan. During the phase-over to revenue operations, SEPTA will monitor the performance of the CAD/AVL System and notify the Contractor of any failure or degradation of the system and its components. Likewise, the Contractor shall notify SEPTA of any failure or degradation of the system discovered by the Contractor’s representatives. Such failures or degradation shall be promptly corrected by the Contractor at no cost to SEPTA.

1. No adjustments, modifications, or substitutions are to be made by the Contractor to the CAD/AVL System equipment and software during the phase-over to revenue operations, except by approval of SEPTA.

1.9. AVAILABILITY TEST

A. Following the phase-over of CAD/AVL System-equipped vehicles to revenue operation, a 720-hour (30-day) test shall be conducted to verify the ability of the CAD/AVL System to meet its availability requirements. Prior to the start of the test, all discrepancies shall be corrected and all hardware and software documentation shall have been received and reviewed by SEPTA. During this test, no adjustments, modifications, or substitutions shall be made to the CAD/AVL System by the Contractor, except by approval of SEPTA.

B. Availability Requirements - The total CAD/AVL System availability requirements specified herein shall be exhibited by the CAD/AVL System in accordance with the specified availability criteria. Individual device availability shall also be measured over the Availability Test Period in accordance with the availability criteria.

C. Test Responsibilities - Contractor will be responsible for conducting the Availability Test. The test shall consist of normal CAD/AVL System revenue operations without special test equipment or procedures. SEPTA will operate and maintain the CAD/AVL System according to procedures in the reviewed Contractor documentation. Discrepancy forms and test records defined in the Test Plan will be generated and maintained by SEPTA personnel and the Contractor for subsequent correction. Corrected discrepancies shall be promptly reported to SEPTA for verification and, if verified, closing of the discrepancy forms.
1. The Contractor shall provide CAD/AVL System maintenance on an on-call basis, as needed, via either consultation or on-site assistance. When on-site maintenance support is needed, qualified Contractor personnel shall arrive at the site within the time specified herein.

D. **Test Definitions** - The following definitions of downtime and Holdtime shall apply to the Availability Test.

1. **Downtime** - Downtime occurs whenever the criteria for successful operation are not satisfied. Downtime shall be measured from the start of diagnostic procedures until full service is restored. In the event of multiple failures, the total elapsed time for repair of all problems shall be counted as downtime.

2. **Holdtime** - During a test of this nature, certain contingencies may occur that are beyond the control of the Contractor and of SEPTA. These contingencies may prevent successful operation of the CAD/AVL System but, at the same time, are not considered to be downtime for the purpose of measuring CAD/AVL System availability. Such periods of unsuccessful operation may be declared "Holdtime" at the sole discretion of SEPTA. These periods will not be considered in availability statistics for availability calculation purposes. Specific instances of Holdtime contingencies are as follows:

   a. **Scheduled Shutdown**: During scheduled shutdowns, or if an equipment failure occurs while its backup device is scheduled out-of-service, the resulting system outage shall be considered Holdtime, provided that service can be restored according to Contractor-specified procedures within 30 minutes.

   b. **Power Interruption and Environmental Excursion**: Loss of commercial power, or manual shutdown in the event of loss of environmental control, shall be considered Holdtime, provided the CAD/AVL System is operated during periods of power or environmental conditions beyond those specified.

   c. **Service Response Time**: Holdtime will be allowed for the Contractor to respond to each call for maintenance support. This Holdtime will be limited to no more than the specified service response time. The time between detection of a failure and the start of diagnostic procedures shall also be considered Holdtime when performed by SEPTA personnel.

   d. **Corrected Design Defect**: Holdtime may be declared by mutual agreement to ensure against similar future occurrences if a failure occurs due to a defect in the CAD/AVL System design and the Contractor defines corrective measures. Holdtime may be declared while the Contractor is implementing and testing the corrective measures.

E. **Test Satisfaction** - After 720 hours of cumulative test time, test records shall be examined to determine conformance with availability criteria. If test objectives have not been met, the test shall continue until the specified availability is achieved, based on one of the following time periods:
1. Total elapsed test time – required availability is achieved over an extended test period that exceeds 720 hours (the test window is extended).

2. Consecutive 720-hour period of test time, exclusive of Holdtime – required availability is achieved over a 720-hour period different from the initial test period (the test window is moved).

F. In order to establish that all failures have been satisfactorily repaired prior to the end of the Availability Test, no downtime or any un-commanded restart or failover shall have occurred within 240 hours of the test's conclusion and no more than one un-commanded restart or failover shall have occurred during the entire 720-hour test period. The test shall be extended, if necessary, to satisfy this requirement.

G. After the 720-hour Availability Test period has been reached, the availability of each CAD/AVL System device shall be evaluated and measured against the specified device availability criteria. If one or more CAD/AVL System devices do not meet the defined criteria, or if any device failed more than one time during the Availability Test, SEPTA approval of the Availability Test shall be delayed until SEPTA representatives and the Contractor mutually agree that corrective action has been completed for those devices. Corrective action shall include performing all necessary procedures to test and verify proper operation to SEPTA satisfaction.

PART 2 – PRODUCTS – NOT APPLICABLE

PART 3 – EXECUTION – NOT APPLICABLE

END OF SECTION
SECTION 13349

TRAINING, SUPPORT SERVICES AND MAINTENANCE

PART 1 - GENERAL

1.1. DESCRIPTION OF WORK

A. Requirements for Contractor-supplied training of SEPTA personnel, for Contractor-supplied support services, and for maintenance of the CAD/AVL System are described in this section.

1.2. TRAINING

A. The Contractor shall provide a comprehensive training program that prepares SEPTA personnel for operation, administration, and troubleshooting of the CAD/AVL System. Training may be conducted by, and all training requirements shall apply to, the Contractor, the Contractor's subcontractors, third-party software suppliers, and original equipment manufacturers (OEMs). The Contractor shall provide to SEPTA all training credits supplied to the Contractor by the subcontractors, third parties, and OEMs and shall provide a list of subcontractor, third-party, and OEM training courses for which these credits can be used.

B. For the Preliminary Design Review, the Contractor shall provide a list of training courses including the title of each course, a list of topics covered, duration, prerequisites, and training site.

C. Hardware Basic Maintenance Training - CAD/AVL System hardware basic maintenance training courses shall be provided for all Contractor-provided CAD/AVL System equipment. The hardware basic maintenance training shall provide SEPTA personnel with a working knowledge of the CAD/AVL System hardware including its control, operation, interfaces with other SEPTA computer systems and devices, interfaces with data communications hardware, and the operation of diagnostic tools. The courses shall provide SEPTA support personnel with an overall knowledge of the installation, preventive maintenance, troubleshooting, repair, and expansion procedures. The courses shall provide sufficient understanding in the above topics so that trained SEPTA personnel may perform maintenance tasks and assist maintenance contractors with more detailed troubleshooting, as well as oversee the work performed by maintenance contractors.

D. Vehicle Equipment Maintenance Training - Vehicle equipment maintenance courses shall be provided that enable qualified SEPTA maintenance personnel to troubleshoot, replace, and configure CAD/AVL System vehicle equipment at the replaceable module level. Removed equipment would be returned to the maintenance contractor for component level repair. Equipment covered by the courses shall include the vehicle CAD/AVL equipment, the Contractor-provided data communications equipment, vehicle wiring, and other associated equipment and sub-systems that are installed by the Contractor on the vehicles. The vehicle training course shall include
theory of operation, vehicle configuration, vehicle wiring and interfaces, diagnostics, and special procedures that must be observed, such as device/module replacement procedures and disconnection of power or fuses when other vehicle maintenance could affect the CAD/AVL System vehicle hardware.

E. **System Administration Training** - The system administration training course shall provide training on the procedures necessary to configure, operate, and maintain the CAD/AVL System in an efficient, controlled, well-documented manner. This training course shall include, but not be limited to, the following:

1. The structure, interfaces, and functions of the CAD/AVL System software and databases
2. The configuration settings and maintenance of operating systems, third party software, and network devices using the operating system(s) and network administration facilities
3. System backup and restoration procedures, including disaster recovery procedures
4. Configuration and maintenance of all fixed-end hardware (e.g., servers, workstations, mass storage devices, etc.)
5. Managing system security and user access
6. Generating, deleting, modifying, and installing reports in the real-time environment, including the use of ad hoc queries
   a. Linkages to the database and application software shall be described. Generation and modification of typical reports shall be included in this course.
7. Generating, deleting, modifying, and installing displays in the real-time environment
   a. Linkages to the database and application software shall be described. Generation and modification of typical displays shall be included in this course.
8. Installing software updates provided by the Contractor and third-party software suppliers
9. Using the software configuration management and administration tools
10. Failing over to backup servers and devices, and restoration procedures
11. Interpreting and responding to error and warning messages generated by system and device monitoring software
12. Maintaining and tuning the databases using database management tools
13. Data import and updating of fixed-route schedules and other data imported into the CAD/AVL System

14. Updating the AVL map database including base maps, routes, bus stops, etc.; and distributing these map updates to all map-equipped workstations

15. Managing the historical data archive facility

16. Modifying application program configuration parameters

17. Configuring and modifying the data set sent/received over links to external systems

18. Performing maintenance of route, schedule, vehicle, bus stop, timepoint, and vehicle Operator data within the CAD/AVL System

19. Performing updates to the destination signs, including recommended guidelines for properly defining destination sign codes.

20. System troubleshooting procedures

21. Management, definition, and maintenance of data and text messages

22. The steps necessary to create new messages, define the triggering conditions for each message, and to add, delete, modify, and download the messages to the vehicles shall be explained.

F. The System Administration course also shall include overview level training on the structure, organization, and functionality of the system software, application software, and database to allow SEPTA administrative and system administrator personnel to effectively support maintenance contracts for this software.

G. Dispatcher Training - The Contractor shall train SEPTA fixed-route and CCT Dispatchers in the functional abilities of the CAD/AVL System and in the operation of the CAD/AVL System workstations. The course shall provide a thorough understanding of the UI and operation of all CAD/AVL System functions, and shall familiarize the Dispatchers with general CAD/AVL System design concepts and features. It shall include hands-on training using the actual hardware and software being delivered to SEPTA. Training aids for this course shall include the CAD/AVL System Dispatcher Manual.

H. Revenue Vehicle Operator Instructor Training - The Contractor shall train selected SEPTA personnel to be qualified instructors in the operation of the CAD/AVL System fixed-route and CCT revenue vehicle equipment supplied by the Contractor. This course shall provide a thorough and clear presentation of the UI of the vehicle equipment and shall include hands-on training using the actual vehicle hardware and software being delivered to SEPTA. This course shall also instruct SEPTA instructor personnel on the setup, operation, and configuring of the vehicle Operator training
hardware and any simulation hardware and software provided for vehicle Operator training. Training aids for the course shall also include the Operator Manual.

I. Non-Revenue Vehicle Operator Training - The Contractor shall train SEPTA non-revenue vehicle Operators in the operation of the non-revenue vehicle equipment supplied by the Contractor. This course shall provide a thorough and clear presentation of the UI of the vehicle equipment and shall include hands-on training using the actual vehicle hardware and software being delivered to SEPTA. Training aids for the course shall also include the non-revenue vehicle Operator Manual.

J. General System User Training - The Contractor shall provide a high-level course for general system users like management staff to give them an overview of the CAD/AVL System configuration, functions, UI, reports, and report generation capabilities. It is the intent of this course to inform the general system users of the types of data that the CAD/AVL System will acquire and store, and the accessibility of that data for reports and analysis. The detailed content of this course shall be jointly developed by the Contractor and SEPTA.

K. Supplemental Training

1. The Contractor shall provide extended, duplicate, and additional training for the CAD/AVL System as deemed necessary by SEPTA because of the following occurrences:

a. Major modifications to CAD/AVL System hardware and/or software that is implemented by the Contractor after completion of the scheduled training courses and that impacts the content of those courses

b. Delays in placing the CAD/AVL System into revenue service for which the Contractor is responsible and that result in more than two months elapsing between completion of one or more training courses and the placing of the CAD/AVL System into revenue service.

2. Supplemental training shall be supplied at no cost to SEPTA. SEPTA will determine the time, location, and extent of any supplemental training in consultation with the Contractor.

L. Training Course Requirements - The following sections describe general requirements that apply to all training courses.

1. Class Size - The Contractor shall provide training as identified in in the contract drawing package.

2. Training Schedule - The Contractor shall conduct training in a timely manner that is appropriate to the overall CAD/AVL System schedule. One session of the System Administrator and Dispatcher training courses shall be conducted prior to the start of the Functional Performance Test so that these trained personnel may more effectively participate in the CAD/AVL System FAT. The System Administrator and Dispatcher training courses shall be repeated, as necessary,
so that the SEPTA-selected personnel all receive training within 1 month prior to the start of the Field Performance Test. Vehicle Operator Instructor training shall be completed no later than 1 month prior to the start of the Field Performance Test. All other training shall be completed prior to the phase-over to revenue operations. The Contractor shall finalize the training schedule in consultation with SEPTA after Contract Award.

3. **Training Location and Classrooms** - All training shall be conducted at SEPTA supplied facilities. SEPTA will provide classroom facilities for all training conducted at their facilities.

4. **Instructors** - The principal instructors provided by the Contractor, subcontractors, third-party software suppliers, and OEMs shall have had previous formal classroom instructor training and relevant experience with the CAD/AVL System hardware and software. The instructors shall also demonstrate a thorough knowledge of the material covered in the courses and familiarity with the training documentation, tools, and training aids used in the courses.

   a. When prerecorded lectures are part of a training course, the lecturer or a qualified substitute shall supplement the recorded material. All SEPTA-specific material shall be presented in person by a qualified instructor.

5. **Training Documentation and Equipment** - The Contractor shall provide editable training documentation in a digital format and detailed agendas, including the training instructor for each training course, to SEPTA for review prior to the start of classroom instruction. SEPTA requires that training materials specifically prepared for use as training aids be used as the primary training document; but system documentation such as reference manuals, maintenance manuals, and user manuals may also be used. Materials used for training shall be tailored to reflect all SEPTA hardware, software, terminology, and user requirements. If system documentation is used for training, the quantities of documentation provided for training shall be in addition to the quantities otherwise required in Section 13350.

   a. Upon completion of each course, instructor's manuals, training documentation, and training aids shall become the property of SEPTA. As part of the delivered system documentation and the final documentation, the Contractor shall supply SEPTA with all changes and revisions to the training documentation. SEPTA reserves the right to copy all training documentation and aids for use in SEPTA-conducted training courses.

   b. The Contractor shall furnish for use during training courses all special tools, equipment, training aids, and any other materials required to train course participants. The number of special tools and other training equipment shall be adequate for the number of participants attending the course.

6. **Video-Based and Computer-Based Training** - The Contractor may use standard prerecorded lectures and workbooks and/or computer-based interactive courses as training material, subject to prior approval by SEPTA. All
such courses shall be supported by the availability of qualified personnel to answer questions and provide in-depth discussion of difficult topics. The Contractor shall provide SEPTA with copies of all such training course material for retention and playback by SEPTA as reference documentation and training aids. SEPTA reserves the right to record all training courses using its own recording equipment.

1.3. SUPPORT SERVICES

A. Throughout the design, implementation, testing, and field installation phases of the CAD/AVL System project, the Contractor shall supply engineering data and services, as required by SEPTA, regarding the necessary site preparations, communication facilities, field installation of equipment, and solutions to technical problems related to the CAD/AVL System. These support services shall apply to CAD/AVL System hardware, software, and operational needs.

B. Installation and Cutover Plan - During the design phase of the CAD/AVL System, the Contractor shall meet with SEPTA personnel to discuss and develop the steps, procedures, and schedule for system installation and cutover. Based on the results of these discussions, the Contractor shall prepare a CAD/AVL System Installation and Cutover Plan. The Installation and Cutover Plan shall be submitted to SEPTA sufficiently in advance for two review cycles and approval before shipment of the CAD/AVL System to SEPTA.

1. The Installation and Cutover Plan shall describe a smooth and secure transition between the existing CAD/AVL equipment and the new CAD/AVL System, with no loss of control over dispatching operations. The Installation and Cutover Plan shall allow for parallel operation of current operations and operations using the CAD/AVL System. The Contractor shall be responsible for implementing all software and hardware required to support system cutover.

2. The Installation and Cutover Plan shall describe in detail the design and procedures used to support the parallel operation, to test and verify the functionality of the CAD/AVL System, and to transition between current operations and use of the CAD/AVL System. The initial CAD/AVL System installation, Field Installation Test, Field Performance Test, Mini-Fleet Test, and vehicle installations to be performed during the installation and cutover period shall be described in this plan.

3. The Installation and Cutover Plan shall provide detailed information concerning site preparation and equipment installation and shall be based on a clear understanding of SEPTA’s existing communications equipment, computer system equipment, buildings and building facilities, building renovation plans, operational requirements, CAD/AVL System equipment, and schedule requirements. It shall be the responsibility of the Contractor to conduct any site visits that may be necessary to ensure a complete understanding of SEPTA facilities, existing equipment, and systems.
4. The Installation and Cutover Plan shall include detailed vehicle installation plans that define how the vehicle installation work will be performed, the sequence in which vehicle installation work will be performed, the schedule for installing equipment on the vehicles, installation forms and checklists, and the support and facilities expected from SEPTA.

C. System Setup - The Contractor shall be responsible for initially setting up the CAD/AVL System and for entering and loading all required data into the system, which shall include, but not limited to, the following:

1. Defining the hardware and software configuration
2. Defining the user accounts and user functional partitions
3. Defining all data required for the system databases
4. Defining the routing of event queue entries
5. Defining the pre-defined text messages
6. Downloading all schedules from the SEPTA fixed-route scheduling system (Trapeze FX) as required for full system operation
7. Setting the initial values for all System Administrator- and user-adjustable parameters
8. Setting the initial schedule and route deviation reporting thresholds
9. Entering all communications parameters
10. Configuring all network devices for the required security and accessibility
11. Loading the AVL map, including all overlays and GIS information
12. Loading all information for Dispatcher reference information displays
13. Programming for the control of destination signs.

D. System Preparation, Packing, and Shipment - The Contractor shall prepare, pack, and ship the CAD/AVL System equipment in a manner that is consistent with OEM recommendations, and shall do nothing that invalidates any manufacturer’s warranty or prevents the purchase or continuation of a commercially-available maintenance contract.

E. Preparation for Shipment - The CAD/AVL System shall be prepared for shipment to avoid damage in transit and to facilitate installation. The equipment shall also be refurbished, as necessary, prior to shipment. All external surfaces shall be thoroughly cleaned, and all paint chips, broken parts, and other signs of use shall be repaired. The CAD/AVL System equipment shall be shipped in an "as-new" condition.
F. **Packing** - All material and equipment shall be packed, crated, or otherwise suitably protected to withstand shipment to its destination. Equipment shall be shipped assembled and completely wired wherever possible.

1. Site accessibility and the size and nature of available doors, bays, and hallways needed for access to SEPTA control rooms, equipment rooms, offices, and any other locations where CAD/AVL System equipment is to be installed shall be inspected by the Contractor. The CAD/AVL System shall be shipped in modules that can be moved into place without requiring structural alteration of any SEPTA facility.

2. Each package, crate, and part shall be clearly marked with the name of the consignee, shipping destination, contract number and other such markings as appropriate. Complete packing lists shall be supplied showing the contents and identity of each package. One copy of the list shall be securely attached to the outside of each shipping unit.

G. **Shipment** - The components of the CAD/AVL System shall be shipped, FOB destination, to the following address:

Southeastern Pennsylvania Transportation Authority  
1234 Market Street  
Philadelphia, PA 19107-3780

1. The Contractor shall notify the SEPTA Project Manager two weeks prior to any shipment, and again 48 hours prior to arrival of equipment. The equipment shall be delivered Monday through Friday between 9:00 AM and 3:00 PM local time.

2. The Contractor shall be responsible for unloading the equipment, moving the equipment to its installation site, unpacking and uncrating the equipment, and verifying that no equipment was damaged during shipment.

3. Insurance on all deliverables shall be obtained and maintained by the Contractor during shipment, during unloading at the SEPTA premises, and while the equipment is in storage prior to installation.

H. **Installation** - The Contractor shall install all Contractor-provided equipment and the wiring required to properly connect all equipment to other new or existing equipment, and to power sources. The logistics of the installation activities will be resolved between SEPTA and the Contractor in the course of developing the Installation and Phase-Over Plan.

1. **Fixed-End Equipment Installation** - The Contractor shall install all Contractor-provided fixed-end equipment at SEPTA’s facilities, along with the wiring, antennas, mountings, connectors, cable management, and all hardware required to connect each device to other Contractor-provided equipment, existing equipment, and the power supplies. The specific Contractor equipment includes, but is not limited to:

b. CAD/AVL System workstation locations – CAD/AVL System User workstation locations as specified herein.

c. Bus Depots – Network equipment

2. **Vehicle Equipment Installations** - The Contractor shall install all Contractor-provided vehicle equipment on SEPTA revenue and non-revenue vehicles along with the wiring and connectors required to connect each device to other Contractor-provided equipment, existing vehicle equipment, and the vehicle power supplies.

   a. The final installation details for each type of vehicle will be determined after contract award, once the physical dimensions, mounting requirements, and other details of the Contractor-provided equipment are known. As a part of the Installation and Cutover Plan, the Contractor shall provide vehicle equipment installation procedures and checkout forms for each type of vehicle. Checkout forms for each vehicle shall be completed by the Contractor before and after installation of the CAD/AVL System equipment to verify the condition of the vehicle and proper installation of the vehicle equipment. SEPTA, personnel and Operator personnel will work jointly with Contractor personnel to ensure that the vehicle installations are acceptable to SEPTA.

   b. In order to allow for a smooth cutover from the existing vehicle equipment to the CAD/AVL System, some or all of the Contractor-provided vehicle equipment and wiring may have to be installed on the SEPTA vehicles prior to the removal of the existing vehicle equipment and wiring. It may also be necessary to either temporarily or permanently move existing vehicle equipment and devices in order to properly install the Contractor-provided equipment and wiring. Any such parallel installations, relocations of equipment, and the eventual removal of the existing equipment that is being replaced shall be the responsibility of the Contractor.

   c. The Contractor shall perform the vehicle installation work during nights and weekends, when vehicle availability will be the greatest. Equipment storage containers and enclosed facilities for vehicle installations shall be supplied by the Contractor. Specific vehicle installation requirements are as follows:

   - All installations shall be completed in the same manner within a type of vehicle.

   - Connections to existing vehicle equipment (e.g., door sensors) shall not tap into bus control lines. If such connections are shown to be the only way that the required signals can be obtained, specific written approval shall be obtained from SEPTA and suitable isolation shall be installed to
prevent any control action initiated from the CAD/AVL System equipment.

- Installation of vehicle equipment shall minimize the exposure to and possibility of damage due to abuse, vandalism, and theft. Theft-resistant fasteners and mountings shall be used. Cables shall be run in hidden and protected spaces. Screws shall be installed such that they do not penetrate other wires, cables etc. during or after installation.

- If new mounting trays are necessary, they shall be fabricated to use the same mounting holes as the existing trays, or otherwise attached so as to obviate the need to drill new holes.

- SEPTA reserves the right to require replacement of any Contractor and subcontractor installation personnel due to poor workmanship, excessive time spent in installation, and for unacceptable work at the expense of the Contractor.

- A qualified Contractor’s engineer shall be present on site at SEPTA during the entire period of vehicle equipment installations to coordinate installation activities and needed resources with SEPTA and supervise the installation work. The Contractor’s engineer shall also coordinate with SEPTA management so as to be aware of the local safety plan and OSHA and SEPTA safety rules.

- The Contractor shall be responsible for providing and installing the interfaces between the Contractor-provided equipment and the following existing equipment:
  - Radios
  - Cellular Data Equipment
  - Emergency Alarm Switches
  - Cover Microphones
  - Odometers
  - Fareboxes

- To facilitation of the installation of vehicle equipment will be discussed during the design period.

I. General Installation Standards

1. The workmanship and appearance of work throughout the CAD/AVL System shall be of the best commercial quality and adhere to all applicable standards and codes. Work shall adhere to the highest standards of safety for personnel
and property. Work shall be performed only by qualified personnel, and shall be supervised on-site at SEPTA by technically competent, trained, and experienced Contractor supervisory personnel. Installation shall comply with all Universal Building Code (UBC) and State seismic requirements for the Philadelphia, Pennsylvania area.

a. Installation work shall exactly follow equipment manufacturers' instructions for grounding and all other installation details.

b. All equipment racks shall be securely attached to the floor and/or wall. If applicable, the first rack in each row shall be securely anchored to the wall, and additional racks shall be bolted to the adjacent rack at the top of the rack. Racks and cabinets shall be shimmed to plumb alignment.

c. The Contractor shall supply all necessary installation materials, such as fasteners, cable ties, bushings, and brackets.

d. All equipment and components shall be easily accessible for adjustment and service.

e. Equipment rack spacing shall allow not less than three (3) feet clear working space. All equipment shall have full access front and rear, except that equipment mounted on swing-out racks is permissible.

f. The Contractor shall be responsible for any damages caused by its negligence during installation, acceptance testing, and the Contractor's maintenance period.

g. Cabling and equipment exposed to the weather shall be adequately protected from wind, rain, and dust. Seals, gaskets, packing, sheathing, finishes, mountings, and all other exposed items shall be designed for maintenance-free performance under long-term exposure to weather, including ultra-violet radiation.

h. Equipment and cabling installed inside buses shall be adequately protected from water and dust, which are present during both normal operations and bus cleaning operations.

i. Controls, adjustment points, displays, connectors, terminal strips, and circuit boards shall be labeled to indicate the function.

j. Legends on control panels and other equipment shall be permanent and easily legible, resistant to fading or peeling, and capable of withstanding repeated cleaning without degradation or loss of legibility.

k. Legends shall be applied to equipment by silk-screening, etching, engraving, or other reviewed method. Stencil transfer letters, hand-applied letters, or embossed plastic strips are not permitted.
l. One original key and two copies shall be provided for each type of lock supplied. Each set of keys shall be assembled on a heavy-duty, double-loop key ring, and equipped with a permanent tag indicating the associated lock.

m. All vehicle equipment shall be keyed alike.

2. **Wiring Standards** - Wiring and cables shall be installed in accordance with the following practices:

a. Except for fiber optic cables, all conductors shall be copper of not less than 98% conductivity. Aluminum conductors are not acceptable.

b. Conductors shall be continuous between terminals, without splices.

c. Conductor gauge, insulation, and shielding shall be adequate for the intended purpose.

d. Cable and wire shall be run neatly with adequate lacing or clamping.

e. The manufacturer's minimum bending radius of cables shall not be exceeded at any point during installation.

f. Consistent cable and wire color-coding shall be used throughout.

g. All applications requiring physical movement and access shall use stranded conductors.

h. Ring-type, crimped or soldered lugs shall be used with stranded wires terminated on screw-type terminals. Connections shall be made only with crimping tools that meet the connector manufacturer's specifications.

i. Interfaces to carrier communication lines (e.g., telephone, T1, etc.) shall be terminated on industry-standard "66-type" punch blocks, with pre-wired telephone-type connectors.

j. Shielded wiring, or other means of signal isolation, shall be used wherever necessary to avoid cross-talk, hum, pops, clicks, whine, and other forms of interference. The Contractor shall provide an interference-free system.

k. Unless installed in conduit, wiring within cabinets, in ladder racks, beneath raised floors, and from outlet boxes to freestanding or desk-mounted equipment shall be neatly installed, bundled with appropriate tie-wrap devices, and tied to supports if practicable. Adhesive-Backed mounts shall not be used.

l. Horizontal cable runs longer than the manufacturer's recommended self-support distance shall be tied to a rigid support, at intervals not greater than three feet. Vertical cable runs shall be supported at intervals not greater than six feet. All cables shall be dressed appropriately, and run parallel to each other.
m. Signal and control wiring, and connection of devices shall be installed beneath raised floor (where available), in conduits, or concealed, and shall be included as part of the work to be performed by the Contractor. Wiring shall be accessible for maintenance. At unattended sites and the server room, cable shall be routed through appropriate vertical and horizontal cable managers.

n. Cables and wiring shall be “plenum” rated where required by the most restrictive applicable code.

o. The insulation on interconnect cabling used in areas where the wiring will not be installed in metallic conduit, shall be of heat-resistant material to minimize pyrolysis and fire hazard.

p. Cable and wiring penetrations through metal cabinets shall be protected with dielectric grommets.

q. Cable and wiring installed in modular furniture shall be run in trays or channels designed for that purpose.

r. Extra wiring necessary for equipment movement shall be neatly coiled, tied, and concealed.

s. Wiring in dropped ceiling areas shall be mounted with J-hooks and shall not lie on top of light fixtures or ceiling tiles, nor be attached to existing cables, conduits, or ceiling wires.

t. Cable penetrations through building outside walls shall be thoroughly packed and waterproofed.

u. Cables, wiring forms, and terminals shall be identified by permanent labels, tags, or other appropriate means. Cables shall be identified at both ends with indications of the source and destination of that cable run. The cable identification shall agree with the wiring and interconnect diagrams.

3. **Interference** - As used in this section, “interference” means any interference from such causes as intermodulation, transmitter noise, etc. It includes interference either conducted or radiated to and from microprocessors, computers, and all associated equipment including, but not limited to, I/O devices, displays, terminals, printers, network devices, and protocol converters.

a. The performance of Contractor-provided equipment shall not be degraded by radiated and conducted interference. Also, CAD/AVL System equipment shall not cause interference that degrades the performance of existing devices.

b. Synthesizer circuits used in mobile units shall not cause, or be affected by, interference to or from existing electronic and electrical systems in vehicles and other installations.
J. **Decommissioned Equipment** - At an appropriate time as determined by SEPTA, the Contractor shall remove all decommissioned equipment that was replaced by the CAD/AVL System, both at fixed site locations and on-board vehicles. The Contractor shall inventory the removed equipment, prepare and package the equipment (i.e., palletize, pack in containers) for disposal according to federal requirements, and shall move it to a location to be specified by SEPTA.

K. **Technical Support** - The Contractor shall offer continuing technical support on an as-needed, per-diem basis for a minimum of 10 years after final acceptance. Consultation with knowledgeable Contractor technical support personnel and trained field service personnel shall be readily available to assist SEPTA personnel in maintaining, expanding, and enhancing the CAD/AVL System. Technical support and consultation shall include cooperation with, and assistance to, SEPTA in implementing interfaces with other systems for the exchange of information between the systems.

L. **Change Notification Service** - SEPTA shall be informed of all alterations or improvements to the hardware, software, and documentation supplied under this Technical Specification. SEPTA shall be placed on the Contractor's mailing list to receive announcements of the discovery, documentation, and solution of hardware and software problems, as well as other improvements that could be made to hardware and software provided with the CAD/AVL System. The service shall begin at the time of contract award, and shall continue for 10 years following final acceptance. The Contractor shall also include a subscription to hardware and software subcontractors' change notification services from the time of contract award through the warranty period, with a SEPTA-renewable option for extended periods.

1.4. **SYSTEM MAINTENANCE**

A. In this section, system maintenance requirements prior to shipment and during installation, field testing, warranty and after warranty are described. All maintenance performed by the Contractor, subcontractors and OEMs shall be in accordance with procedures and schedules recommended by the equipment OEMs.

B. **Maintenance Records** - Software maintenance activities shall be recorded via the Code Management System specified herein, beginning with the start of software integration. Hardware preventive and corrective maintenance activities shall be recorded in a hardware maintenance log. The hardware maintenance log shall be submitted to SEPTA when the Field Performance Test is completed and shall be available for SEPTA inspection throughout the project.

C. **Maintenance Prior to Shipment** - The Contractor shall be responsible for performing repairs and preventive maintenance on all Contractor-provided equipment and software during development, integration, and factory testing of the CAD/AVL System.

D. **Maintenance During Installation, Field Test, and Warranty** - The Contractor shall be responsible for maintenance and support of all Contractor-provided equipment and software, including all fixed-site and vehicle equipment, until successful completion of the warranty period. The warranty period is stated in Section 01400 “Quality Control and Warranty Requirements”. During the startup, field testing, and Warranty period,
the Contractor shall provide the following maintenance and support for Contractor-supplied equipment and software:

1. For critical system, hardware, and software failures, qualified Contractor maintenance personnel shall arrive on site within two hours of notification to begin troubleshooting activities, and remain on site until the problem is resolved. The two-hour response shall be provided twenty-four hours a day, seven days a week. Critical hardware and software failures shall include:

   a. Failure of critical CAD or AVL functions that affect the ability of the Dispatcher to communicate with, or track the location of, vehicles.

   b. Server hardware failures or server-resident software that cannot be corrected by a restart of the server. If after a successful restart, the failure re-occurs within twelve (12) hours, the second failure shall be considered a critical failure.

   c. Failures that affect the proper operation of Contractor-provided data communications equipment, including communications servers and communications interface equipment.

   d. Any other hardware or software failure that affects CAD/AVL System functionality at more than one workstation or affects communications with more than one vehicle.

2. For all other hardware and software failures, qualified Contractor maintenance personnel shall arrive on site within twelve hours of notification to begin troubleshooting activities, and remain on site until the problem is resolved. The twelve-hour response shall be provided eight hours a day, five days a week.

E. **Maintenance After Warranty** - After expiration of the warranty, SEPTA plans to maintain the CAD/AVL System with a combination of SEPTA, Contactor, and third party services. SEPTA shall have up to 30 days following System Acceptance to select and execute the maintenance agreement option, if any, that best meets its objectives and needs. The proposed price for these options shall remain firm up to 30 days following System Acceptance.

1. **Base Maintenance Agreement** - SEPTA shall have the option of purchasing a one-year, renewable maintenance agreement for the Contractor-provided maintenance services, or purchase the maintenance services as a single multi-year agreement as described below.

   a. SEPTA Responsibilities:

      - **Procure spare parts** for Contractor-supplied vehicle equipment and any unique fixed-site hardware that is generally not available as COTS computer system and network equipment.

      - **SEPTA will perform first level maintenance activities** for Contractor-supplied vehicle equipment, including troubleshooting, identification of
the failed equipment at the replaceable module level (e.g., VLU) and replacement and configuration of the failed module. SEPTA will return all removed Contractor-supplied vehicle equipment to the Contractor for repair. The Contractor shall permit participation of SEPTA’s subcontractor personnel in vehicle maintenance training classes purchased under this Contract, or purchased separately specifically for the purpose of supporting SEPTA’s fleet maintenance.

- SEPTA, via third-party contracts, time and material, or via in-house maintenance, will maintain COTS computer, network, and peripheral equipment, and associated third-party off-the-shelf software.

- SEPTA personnel who are trained by the Contractor as CAD/AVL System Administrators will perform system administration.

b. Contractor Responsibilities:

- The Contractor shall provide hardware, system, and software maintenance services as defined below. System-level maintenance services shall include all system-level troubleshooting necessary to identify the failed hardware or software component, regardless of whether the Contractor or SEPTA is responsible for repairing the failed component that is identified.

- The Contractor shall repair or replace all Contractor-supplied vehicle equipment returned by SEPTA for repair. The Contractor shall be responsible for all shipping costs in both directions. Turn-around time for repairs shall not exceed 21 calendar days.

- The Contractor shall provide overnight delivery of parts if spare parts on-site are not available.

- The Contractor shall provide a contact phone number for SEPTA to notify the Contractor of any CAD/AVL System problem. The contact phone number shall be staffed 24-hours a day, seven days a week.

- For critical system and software failures (as defined herein), qualified Contractor maintenance personnel shall begin remote troubleshooting activities within 30 minutes of notification by SEPTA and continue troubleshooting activities until the problem is resolved, a workaround has been identified that restores the CAD/AVL System to full operation, or a hardware failure is identified in CAD/AVL System equipment maintained by SEPTA (refer to item a above). The 30 minutes response shall be provided twenty-four hours a day, seven days a week.

- For all other system, hardware, and software failures, qualified Contractor maintenance personnel shall begin remote troubleshooting activities within four hours of notification, and continue troubleshooting
activities during normal working hours until the problem is resolved, a workaround has been identified that restores the CAD/AVL System to full operation, a hardware failure is identified in CAD/AVL System equipment maintained by SEPTA, or agreement is reached that the problem is a low priority issue and has minimal impact on operations. The four response shall be provided twenty-four hours a day, seven days a week. Low priority problems shall be resolved within 7-calendar days.

- The Contractor shall coordinate with SEPTA’s System Administrator prior to modifying or installing any software on the CAD/AVL System. The Contractor shall inform SEPTA when a reported problem is resolved and what was done to resolve the problem.

- The Contractor shall provide monthly reports identifying the status of all unresolved problems and equipment that has been returned for repair.

1.5. SPARE PARTS AND TEST EQUIPMENT

A. The Contractor shall provide spare parts and test equipment for the CAD/AVL System as specified herein. If it becomes necessary at any time prior to acceptance of the CAD/AVL System to modify the supplied hardware that is to be maintained by SEPTA (such as the use of a different type, size or configuration of equipment) to meet the requirements of this Technical Specification, the Contractor shall provide all additional spare parts and test equipment that SEPTA needs to maintain the modified hardware at no cost to SEPTA.

B. Equipment Supported by Maintenance Contract - All spare parts, special test equipment, and other special devices necessary to troubleshoot and repair the equipment that is supported via maintenance contracts shall be the responsibility of the maintenance contractor.

C. Equipment Maintained by SEPTA - All spare parts, special test equipment and other special devices necessary to troubleshoot and repair the equipment to be maintained by SEPTA shall be supplied by the Contractor and delivered with the CAD/AVL System. For multiple devices of the same type the quantities of spare parts and test equipment provided shall be sufficient to maintain the devices even if multiple failures occur simultaneously. In lieu of a kit of spare parts for each subsystem or component, fully assembled additional devices shall be supplied.

1. The spare parts shall include a total of 10% of all the furnished and installed active vehicle equipment.

2. The Contractor shall provide spare parts for the CAD/AVL System Fixed Infrastructure. The spare parts shall include a total cost of 7% of the total cost of all furnished and installed active equipment including but not limited to; servers, workstations, printers, and network devices. Spare parts for CAD/AVL Vehicle equipment shall be based on the quantities shown in the Contract drawings. The Contractor shall provide a spare parts list of all CAD/AVL spare parts with a unit price for each item that shall be valid for the duration of the project.
SECTION 13350

PROJECT MANAGEMENT, SCHEDULE AND DOCUMENTATION

PART 1 - GENERAL

1.1. DESCRIPTION OF WORK

A. This section describes the interface between SEPTA project personnel and the Contractor, and the schedule, quality assurance, and documentation requirements for the CAD/AVL System project.

1.2. PROJECT SCHEDULE

A. The CAD/AVL System project development shall be scheduled to meet the following requirements:

1. The detailed project schedule that shall not be different from the high level proposed schedule, a list of training deliverables, and a documentation status table, shall be provided within one month after Contract Award.

1.3. USE OF CONSULTANTS

A. No limitations shall be imposed on SEPTA’s use of consultants in any activity related to the CAD/AVL System project. The consultants, at the direction of the SEPTA Project Manager, shall be accorded the same access to facilities and participation in project activities as any member of the SEPTA project team. Involvement of consultants may include, but shall not be limited to, progress and technical meetings, conference calls, document review, installation review, and system testing.

B. SEPTA shall have the option of adding consultants to the distribution list to receive all correspondence initiated by the Contractor. SEPTA shall also be able to add consultants to the distribution list to receive all or selected system documents. The consultants will be bound by the same confidentiality restrictions imposed on SEPTA personnel.

1.4. QUALITY ASSURANCE

A. The definition, design, development, integration, testing, field installation, and documentation activities of the CAD/AVL System project shall be conducted in accordance with the Contractor’s approved hardware and software quality assurance plans.

B. Standard Document Review - Documentation of the Contractor's standard hardware, software, and firmware shall be furnished for SEPTA review, but approval shall be limited to the content of the document. Specifically, SEPTA reserves the right to determine that:
1. All standard hardware, software, and firmware are in full conformance with the Technical Specification.

2. The documentation accurately and completely describes all features and options of the hardware, software, and firmware that pertain to the SEPTA CAD/AVL System.

C. **Modified and Custom Documents Approval** - In some cases the Contractor's standard hardware, software, or firmware may need to be modified to fully conform to the requirements of this Technical Specification. In other cases, selected portions of the hardware, software, or firmware may be completely custom. In both instances SEPTA shall have, in addition to the approval rights described above, full approval rights over the portions of the document's content and format pertaining to the modified or custom hardware, software, and firmware. The following conditions shall be satisfied for this approval:

1. Hardware, software, and firmware shall be in full conformance with Contract requirements.

2. Changes and modifications shall be documented in a complete and clear manner in accordance with the Contractor's established documentation standards.

3. Features, equipment, and options pertaining to SEPTA shall be clearly distinguished from those that do not pertain.

4. The Contractor shall follow its established quality assurance plan for design, implementation, and integration of the affected hardware, software, and firmware.

D. **Functional Requirements and Test Document Approval** - SEPTA shall retain full approval rights over all Software Functional Requirements, Test Plan, and Test Procedures documentation regardless of the standard, modified, or custom classification. In addition, SEPTA shall have full approval rights over the format of displays and the UI pertaining to CAD/AVL System functions developed for SEPTA.

1.5. **DOCUMENTATION**

A. Complete documentation of the CAD/AVL System shall be provided. SEPTA reserves the right to reject documents not conforming to the standard. All documentation shall be clearly written in the English language. SEPTA reserves the right to reject any document that is not clear due to incorrect grammar, poor document or sentence structure, and/or significant spelling errors. All documents that are rejected by SEPTA shall be promptly corrected by the Contractor and shall be resubmitted to SEPTA for review and approval according to procedures outlined above.

B. All documentation shall exactly reflect the configuration of hardware and software supplied under this Contract. Any changes as a result of latent defects and design changes shall result in all affected documentation being updated within 30 calendar days of correction.
C. All documentation shall follow the SEPTA document and drafting standards.

D. Each document shall be identified by a Contractor document number and the SEPTA project number. Where a document is revised for any reason, each such revision shall be indicated by a number, date, and subject in a revision block, along with an indication of official approval by the Contractor's project manager.

E. The numbers of preliminary documentation and final documentation copies to be submitted for review is listed in Table 13350-1.

F. Electronic copies of selected documents also shall be provided to SEPTA in Adobe Portable Document Format (PDF). For all documents, a PDF-format copy is required for each submittal. PDF copies of each document shall be delivered or emailed to up to five SEPTA designated personnel.

G. The Contractor shall provide a CAD/AVL System Documentation Index, identifying all documents to be provided with the system. The index shall describe each document and the document's purpose to help the user locate the appropriate document in the set of all CAD/AVL System documentation.

H. The Contractor also shall provide an updated documentation status table for each Progress Report. The documentation status table shall include the following information for each document:

   1. Title
   2. Contractor's document number
   3. Scheduled and actual dates for initial submission, reviews by SEPTA, and resubmissions
   4. Revision number for each submission
   5. Indication of being preliminary or final document.

I. The documents in the documentation status table shall be grouped by type of document (hardware, software, user, etc.).

J. System Functional Description - A customized System Functional Description shall be provided that contains a high-level definition of the CAD/AVL System hardware, software, and firmware, and the functions performed by each. The System Functional Description shall serve as a complete introduction to the CAD/AVL System and to the more specific documents defined in the following Sections. The information to be provided in the System Functional Description shall include the following:

   1. An overview of the hardware configuration showing all major hardware subsystems
2. The overview shall include block diagrams in sufficient detail to show the interrelationships of major hardware subsystems and the elements that comprise them.

3. A description of the major hardware subsystems, the elements that comprise them, their interrelationships, and the functions they perform.

4. System availability, processor performance, mass storage, and device redundancy, shall also be described.

5. An overview of the major software subsystems, describing the software, the interrelationship of software within a subsystem, and the relationship between subsystems.

6. High-level software subsystem block/flow diagrams shall be included to enhance SEPTA's understanding of the overall abilities and capabilities of the CAD/AVL System. The subsystems to be described shall include: CAD software, AVL software, operating systems, network software, system interfaces, support utilities, database software, and display, map, and report generation software.

7. A complete description of the software and the individual functions performed by the software

8. Significant features, concepts, and algorithms pertaining to each function shall be described, with special emphasis on equipment, software, and features unique to the SEPTA CAD/AVL System.

9. System interfaces

10. Over the air data protocols

11. Communication modes

12. Site connectivity

13. List of all hardware to be acquired.

K. Hardware Documentation - Documentation for all CAD/AVL System hardware shall be provided to SEPTA. All drawings shall conform to the SEPTA drawing standards. In addition to the documentation specifically identified below, the Contractor shall provide SEPTA with all documentation originally supplied with standard OEM hardware devices purchased from others.

1. Inventory, Floor Plans, Wiring, and Block Diagrams - The Contractor shall provide the following items:

   a. An inventory of all hardware to be supplied, including the manufacturer's name, model number, serial number, nameplate data, SEPTA identification tag number, overall dimensions, and quantities
b. **Floor plan** drawings for each CAD/AVL System equipment location, showing rack, cabinet, workstation position, and peripheral device locations and sizes

c. Detailed **installation, wiring diagrams and cabling diagrams** for fixed-site locations

- Any special precautions associated with cabling shall be clearly identified. All SEPTA cable and wiring terminations shall be shown on drawings, and all terminal markings, cable connector markings, and cable lengths shall be clearly indicated.

d. **Configuration block diagrams**.

2. **Site Preparation Manuals** - Site preparation manuals shall be provided for all locations where CAD/AVL System hardware is to be installed. The manuals shall contain:

a. Drawings of all racks, cabinets, enclosures, power supply equipment, computer equipment, communications equipment, auxiliary and other equipment

b. Mounting details, clearance requirements, and environmental restrictions

c. Device installation requirements, including distance and clearance restrictions

d. Electrical power supply and grounding requirements

e. Heat dissipation specifications.

3. **Enclosure Assembly Documentation** - Enclosure assembly drawings shall be provided that show the location of all major subassemblies, such as power supplies, printed circuit card chassis, and components comprising the subassemblies to the level of printed circuit cards, in each enclosure, including, but not limited to, equipment racks, cabinets, and vehicle equipment enclosures.

a. The drawings shall identify each subassembly and component by part number and revision level. The drawings shall include interconnection wiring diagrams showing all interconnecting cables, including signal, grounding, antenna, and power distribution cables. Drawings shall be provided for each enclosure. A copy of the appropriate drawing(s) shall be stored inside each enclosure.

4. **Custom Hardware Design Documentation** - The Contractor shall provide hardware design documentation for each hardware device that is built specifically for, or is highly customized for, the CAD/AVL System. This documentation shall include, but not be limited to, functional description, specification data (e.g., features, capacity, performance parameters, power requirements, dimensions, weight, and environmental limits), physical drawings, mounting details, and schematics.
5. **Reference Manuals, User Manuals, and Instruction Books** - Reference manuals and instruction books shall be provided for all hardware. These manuals shall include documentation relating to CAD/AVL System hardware, including descriptions, specifications, theory of operation, installation information, and drawings. The Contractor shall include an attachment to each document outlining those portions of the document, if any, that do not apply to the SEPTA hardware. Hardware user manuals also shall be provided where available.

6. **Maintenance Manuals** - Manuals and other descriptive material shall be provided for all Contractor-provided equipment, regardless of whether it is manufactured by the Contractor or another supplier. This documentation shall include descriptions, specifications, theory of operation, printed circuit module schematics and layout drawings (showing component types and positions), motherboard schematics (showing inter-module connections), backpanel and assembly wiring diagrams, pin lists, and other electrical, electronic, and mechanical hardware data.

   a. Instructions shall be provided for preventive maintenance procedures that include examinations, tests, adjustments, and periodic cleaning. The manuals shall provide guidelines for isolating the causes of hardware malfunctions and for localizing faults.

   b. Complete parts lists and breakdowns with sufficient descriptions to identify each field-replaceable component shall be provided.

   c. Manuals shall be easily updatable. Manual updates shall be made by the Contractor and distributed to SEPTA as long as the System is under a maintenance contract.

7. **Diagnostic Program Manuals** - Diagnostic program user manuals shall be provided with complete instructions on the loading and operation of all hardware diagnostic programs required for the equipment to be maintained by SEPTA. The text shall include guides for locating faults, symptoms, possible causes of trouble, and suggested remedial action. Sample printouts from the diagnostic programs shall be included.

8. **Software Documentation** - Documentation for all CAD/AVL System software shall be provided to SEPTA. In addition to the documentation specifically identified below, the Contractor shall provide SEPTA with all documentation originally supplied with standard OEM software purchased from others. The Contractor shall also provide a **Software Inventory** listing all software to be supplied, along with version, status, and license information.

9. **Standard Software** Documentation - Existing documentation and user manuals for standard software shall be provided. Standard software is defined as field-proven software purchased from third-parties and software developed internally as a base for all projects that fully satisfies the requirements of this Technical Specification without modification for the CAD/AVL System. Typical examples
include operating systems, compilers, software development utilities, software diagnostic programs, network managers, and window managers.

10. Interface Control Documents - An Interface Control Document (ICD) shall be provided for each required interface to an external system and computer. An ICD shall also be provided for each interface to an external vehicle system. The ICD shall contain sufficient detail to enable a third party to fully implement the external side of the interface. ICD content shall include, but not be limited to, detailed descriptions of protocols, message structures, and individual record and field formats. Contractor-provided ICDs shall include the following:

a. Fixed-route Scheduling System (Trapeze FX) Interface

b. Mainframe interface for operator and dispatcher information

c. GIS Interface

d. Route trace file interface

e. Farebox Interface

L. Firmware Documentation - If the Contractor implements certain functions in firmware, that firmware shall be documented in conformance with the software documentation requirements.

M. Database Documentation - Database documentation shall be provided that describes each CAD/AVL System database. Database documentation shall describe the configuration, individual elements (files, tables, fields, records, etc.), relationships, and security settings for each CAD/AVL System database. Documentation content shall include, but not be limited to, an Entity Relationship Diagram (ERD) and a complete listing of the data dictionary for each database. Portions of the databases developed, modified, or enhanced specifically for SEPTA shall be explicitly identified. Complete administration documentation for the database management system(s) utilized by the CAD/AVL System shall also be supplied.

1. All data in the CAD/AVL System databases that is supplied by SEPTA or generated from SEPTA operations shall be solely-owned by SEPTA. The Contractor shall have no ownership rights to this SEPTA-supplied or SEPTA operations-generated data. There shall be no restrictions on SEPTA's rights or ability to access and use its data.

N. CAD/AVL System User Manuals - The Contractor shall provide user manuals that contain detailed operating instructions and procedures to be used by CAD/AVL System users. Each user manual shall be customized for SEPTA and shall be based on the delivered CAD/AVL System. It is not acceptable to describe the Contractor's standard system and then identify differences between the standard product and the delivered system; the user manuals shall not include standard or optional descriptions that do not apply to the CAD/AVL System; the user manuals shall not include standard or optional descriptions that do not apply to the delivered equipment.
1. User manuals shall not be written as a programmer's document. Procedures shall be explained step-by-step with an explanation of how each step is performed, which parameters can be adjusted, and the effects obtained by varying each parameter. All user guidance and error messages shall be described, along with the steps necessary to recover from errors.

2. Information in each user manual shall be presented in terms that are meaningful to the specific SEPTA personnel for whom the manual is written.

3. Specific user manuals to be provided are described below.

a. **Dispatcher Manuals** - A fixed-route Dispatcher Manual shall be provided that contains detailed operating instructions and procedures to be used by the associated Dispatchers. The manual shall include a description of the operation of the CAD/AVL System (hardware, software, and vehicle equipment) as it relates to the Dispatcher's tasks.
   - The Dispatcher Manual shall describe each function defined herein and all other functions accessible to each of the Dispatchers, and how it is used. The manuals shall also include a copy of each type of display and report used in the CAD/AVL System, along with a description of each data field. User instructions for each display and report shall be provided.
   - The Dispatcher Manual shall describe procedures to be followed as a result of computer system restarts, failures, failovers, and failures of elements of the vehicle equipment subsystem.

b. **Vehicle Operator Pamphlet** - A Vehicle Operator Pamphlet shall be provided that contains the related detailed operating instructions and procedures on all of the Contractor-provided vehicle equipment to be installed on SEPTA's vehicles.
   - The Vehicle Operator Pamphlet shall describe each related revenue vehicle functions and how it is used. The manuals shall also include a copy of each type of display used in the related MDT, along with a description of the display. User instructions for each function associated with the display shall be provided.
   - The Vehicle Operator Pamphlet shall describe all user guidance and error messages, along with the steps necessary to recover from errors. Procedures to be followed as a result of CAD/AVL system vehicle equipment restarts and failures shall also be provided.
   - The Pamphlets shall be bound in a book-like form.

c. **System Administrator Documentation** - User-oriented documentation shall be provided to guide the SEPTA System Administrator in the operation and procedures required to maintain and update the CAD/AVL System, including
system software and firmware, database, application software, and other elements of the CAD/AVL System. System Administrator documents shall be specifically geared to the delivered CAD/AVL System and include, but not be limited to, the following items:

- Software code management
- Programming language compilers and assemblers
- Network communications management, including firewall and switch configuration, and system IP addresses
- Server configurations and build
- Workstation configurations and build
- System performance monitoring and tuning
- System restart and failover management
- Diagnostic programs and procedures
- System generation and management
- Database generation and management
- Display generation and management
- Report generation and management
- Base map interface/loading procedures
- Schedule data interface/loading procedures
- Audio/Visual Announcement management including definition, trigger points, and loading procedures
- Software utilities
- System and application software configuration
- System and data backup, restoration, and images
- System security
- GIS data importation management
- Other Contractor-supplied system software not included above.
O. Test Documentation - Documentation for all system Factory, Field, Mini-Fleet, and Availability tests shall be provided in accordance with the requirements defined herein and include Test Plans, Test Procedures, Test Records, and Dry Run Certification.

P. Training Schedule and Manuals - Training documentation shall be provided in accordance with the requirements defined herein.

Q. Installation and Cut-Over Plan and Maintenance Record – Installation and Cut-Over Plans and Maintenance Records shall be provided in accordance with the requirements defined herein.

R. Program Listings and Code - The Contractor shall provide SEPTA with a machine-readable copy of all source code and other program files developed for SEPTA, including those developed for interfacing the CAD/AVL System to external systems and for all displays and reports developed specifically for SEPTA. The machine-readable files provided shall contain all the data required to enable SEPTA to add, modify, and remove any SEPTA-specific displays, reports, and interfaces.

1. For the remainder of the CAD/AVL System software and firmware, the Contractor shall provide an escrow agreement that guarantees SEPTA access to the source code and other files of the CAD/AVL System software and firmware, if the Contractor be unwilling or unable to perform future system software/firmware maintenance or modifications required by SEPTA. The software and firmware retained in escrow shall be updated each time the CAD/AVL System software or firmware is updated such that the version in escrow matches the version in use by the CAD/AVL System. The Contractor shall be responsible for all escrow related costs.

S. Review and Preliminary Documentation - Review documents shall be submitted to SEPTA so that they may review the Contractor’s design. After reviewing a document, SEPTA submit comments for inclusion in the next update. If SEPTA submits comments for inclusion in the next update, the Contractor shall revise the document and submit the revised document as another review version. When SEPTA reviews a document, the reviewed version shall be considered the preliminary document; and if the Contractor has not already submitted a quantity of copies greater than or equal to the number of preliminary copies shown in Table 9-1, the Contractor shall provide to SEPTA the requisite number of additional copies.

1. The preliminary documentation will be used by SEPTA personnel for system testing and for operating the CAD/AVL System until Final Acceptance. All preliminary documentation shall be received by SEPTA at least 6 weeks prior to the start of factory tests unless specifically directed otherwise in this Technical Specification.

T. Final Documentation - Final documentation shall consist of preliminary documentation that is updated to include all subsequent changes made to the CAD/AVL System up until Final Acceptance. Documentation revisions or changes necessitated by inaccuracies, installation requirements, omissions determined by
usage, and design or production alterations to the CAD/AVL System shall be supplied. All changes shall be issued in the form of replacements for the affected drawings, diagrams, charts, graphs, tables, lists, and written pages in the documentation. Where appropriate, the complete document shall be re-issued.

1. All Contractor-supplied final documentation shall be easily reproducible by SEPTA, and SEPTA shall be granted the rights to reproduce any document supplied under this contract for its own use.

2. In addition to properly bound and assembled hardcopies of all final documentation, SEPTA requires a copy of all final documentation produced by the Contractor on electronic media in commercially available word processing format and, where necessary, graphics formats. This media will be used by SEPTA to maintain the accuracy of the documentation as future changes to the system are implemented. Standard documentation produced by others is not required in an electronic format unless it is routinely available from the vendor as a standard or optional item for on-line accessibility. This standard OEM vendor documentation need not be editable by SEPTA.

3. All drawings shall conform to the SEPTA AutoCAD standards provided as part of this specification.

U. Document Quantities - The quantities of documents to be supplied for review, preliminary, and final documents are enumerated in the contract drawing package. All documents shall be provided to SEPTA in PDF format in addition to the specified number of printed copies for each submittal, including each time a review, preliminary, or final document is updated.

PART 2 – PRODUCTS – NOT APPLICABLE

PART 3 – EXECUTION – NOT APPLICABLE

END OF SECTION
SECTION 13351

CAD/AVL SYSTEM PEAK LOAD PERFORMANCE TESTS

PART 1 - GENERAL

1.1. DESCRIPTION OF WORK

A. This section defines the one hour peak load performance testing conditions that shall be applied during the factory and field tests to prove that the CAD/AVL system meets all specified processing utilization, spare capacity, and timing requirements when it is supporting all CAD/AVL functions and CAD/AVL Users, and monitoring and communicating with the peak number of revenue that it will be required to support.

1.2. CAD/AVL SYSTEM PEAK LOAD PERFORMANCE TESTS

A. All specified timing requirements shall be met during this peak load testing including, but not limited to, the CAD/AVL display response times, event message availability times, vehicle data reporting rates, CAD/AVL display update times, and CAD/AVL passenger sign update rates. The CAD/AVL system processing load to be performed during the one-hour peak load performance tests is defined in Table 13351-1.

B. The peak load performance test conducted during FAT shall utilize all the CAD/AVL hardware and software installed in the factory. The loading imposed by the CAD/AVL hardware and software not installed in the factory shall be simulated.

C. The peak load performance test conducted during the Field Performance Test shall utilize all the CAD/AVL hardware and software being implemented at that time. The loading imposed by the CAD/AVL hardware and software not installed at that time shall be simulated using the same techniques used at FAT.

D. The peak load performance test shall include the loading of the maximum number of revenue and non-revenue vehicles that are to be supported by the configuration being tested. The loading associated with vehicles that have not been installed at the time of the testing shall be simulated.

E. Test Configuration - All peak load performance tests shall be conducted with all the CAD/AVL hardware and software operational and all installed CAD/AVL workstations connected and operational. The CAD/AVL system shall be initialized as follows in preparation for the peak load performance test scenario:

1. Verify that all equipment and all the CAD/AVL functions are operational.

2. Verify that the peak load performance testing correctly reflects the required configuration.

3. Install all test hardware and software necessary to simulate loading for the required peak number of revenue and non-revenue vehicles.
4. Install all test hardware and software necessary to simulate loading from all required data exchanges, system interfaces, and functions that are not yet implemented.

5. Install all test hardware and software necessary to simulate CAD/AVL workstations loading for the ultimate number of workstations.

6. Provide all hardware and software required to measure update times of the CAD/AVL displays, response times to the CAD/AVL User actions such as display requests, times from detection of events to the availability of the events for display and storage, vehicle reporting periodicity, and other specified performance parameters.

7. Define procedures, personnel assignments and associated activities required to conduct the peak load performance testing.

F. The CAD/AVL displays requested and actions performed throughout the peak load performance testing shall be a mixture of different displays and actions that will reflect actual workstation use. For multi-monitor workstations, the geographic map display shall be presented on one monitor and the remaining monitor(s) shall be used for requesting all other displays and performing any actions not requiring the use of the geographic map display.
1.3. ONE HOUR PEAK LOAD PERFORMANCE TEST LOADING

A. Table 13351-1 defines the peak level of CAD/AVL system activity expected during a typical morning rush hour. This level of loading shall be executed during the one-hour peak load performance test to demonstrate that the CAD/AVL system meets all specified performance, utilization, capacity, and timing requirements. The term “As Specified/Designed” means that the function listed shall be performed in accordance with the specified requirements and the reviewed design implemented by the Contractor. The term “As Required” means that the function listed shall be performed as necessary to accomplish all other actions or events that occur during the peak load performance tests.

Table 13351-1
PEAK LOAD TEST LOADING

<table>
<thead>
<tr>
<th>TASK DESCRIPTION</th>
<th>Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating System</td>
<td>As Required</td>
</tr>
<tr>
<td>Restart/Failover</td>
<td>As Required</td>
</tr>
</tbody>
</table>

**Interfaces**

| Data Exchanges with all implemented computer systems | As required by application, but at least once |

**Dispatcher Initiated Actions and Communications**

<table>
<thead>
<tr>
<th>Dispatcher Logout and Dispatcher Login</th>
<th>25 logins and 25 logouts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data message transfer to individual vehicles and responses from these vehicles (the average data message length shall be 100 characters)</td>
<td>500</td>
</tr>
<tr>
<td>Data message transfer to a group of 25 vehicles and responses from these vehicles (the average data message length shall be 100 characters)</td>
<td>20</td>
</tr>
<tr>
<td>Reference data retrieval: route schedule lookup</td>
<td>20</td>
</tr>
<tr>
<td>Reference data retrieval: display an employee list</td>
<td>20</td>
</tr>
</tbody>
</table>

**Bus Operator Initiated Communications**
<table>
<thead>
<tr>
<th>TASK DESCRIPTION</th>
<th>Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bus Operator Log-ins</td>
<td>All vehicles</td>
</tr>
<tr>
<td>Emergency Alarms</td>
<td>10</td>
</tr>
<tr>
<td>Bus Operator and Vehicle Equipment Initiated Data Communications</td>
<td>500</td>
</tr>
</tbody>
</table>

**Other CAD/AVL Functions and User Actions**

<table>
<thead>
<tr>
<th>Task</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>User Logins/Logoffs (other than Dispatchers)</td>
<td>20 logins and 20 logouts</td>
</tr>
<tr>
<td>Automatic Vehicle Location Monitoring</td>
<td>Track and report location and status of all revenue and all non-revenue vehicles at the required reporting interval. Ten percent of the revenue vehicles shall be off-schedule and two percent shall be off-route.</td>
</tr>
<tr>
<td>CAD/AVL User Display Requests</td>
<td>30 per workstation</td>
</tr>
<tr>
<td>Geographic Map Display Scaling and Translation Operations</td>
<td>12 per workstation</td>
</tr>
<tr>
<td>Display Updates</td>
<td>As required for events, user actions and specification requirements</td>
</tr>
</tbody>
</table>

**Reports**

<table>
<thead>
<tr>
<th>Task</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recording and entry of data required for reports</td>
<td>As Required</td>
</tr>
<tr>
<td>Reports</td>
<td>Generate 1 report per workstation</td>
</tr>
<tr>
<td>Incident Reports</td>
<td>Open, complete the data entry for, and close 5 incident reports per Dispatcher workstation.</td>
</tr>
</tbody>
</table>

**Data Storage and Retrieval**

<table>
<thead>
<tr>
<th>Task</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Storage</td>
<td>Collect all historical data generated during the performance test.</td>
</tr>
<tr>
<td>User retrieval requests involving queries of 3 or more tables</td>
<td>50 total</td>
</tr>
</tbody>
</table>
## CARD System

### 13351-5 CAD/AVL Peak Load Performance Tests

### TASK DESCRIPTION

<table>
<thead>
<tr>
<th>TASK DESCRIPTION</th>
<th>Loading</th>
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<tbody>
<tr>
<td>Playback</td>
<td>Playback of a 15 minute segment of historical data for at least 4 vehicles using the Playback function.</td>
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### PART 2 – PRODUCTS – NOT APPLICABLE

### PART 3 – EXECUTION – NOT APPLICABLE

END OF SECTION
1.1. Description of work

A. The following describes the interfaces and interface details to external systems that the SEPTA CAD/AVL System shall interface with. The CAD/AVL System provided by the Contractor shall support each of the defined interfaces and all other interfaces required under these specifications.

1.2. VEHICLE MANAGEMENT INFORMATION SYSTEM (VMIS)

<table>
<thead>
<tr>
<th>problem_code</th>
<th>problem_description</th>
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<tbody>
<tr>
<td>DI</td>
<td>District Incident</td>
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<tr>
<td>EA</td>
<td>Emergency Alarm</td>
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<td>PH</td>
<td>Phone Call</td>
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<td>PR</td>
<td>Priority Radio Call</td>
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<td>RT</td>
<td>Request to Talk</td>
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<tr>
<td>TM</td>
<td>Text Message</td>
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<td>WS</td>
<td>Wildcat Service</td>
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** The problem_subcode is per problem_code for each one of them.
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<tr>
<th>Problem subcode</th>
<th>Problem subcode description</th>
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<tbody>
<tr>
<td>R10</td>
<td>Route 10 (WC Shuttles)</td>
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<td>R11</td>
<td>Route 11 (WC Shuttles)</td>
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<td>Order Service from Shop</td>
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<td>Relief to take out a Vehicle</td>
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<td>Col btw Septa Veh with Injuries</td>
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<td>Passenger incident with Injuries</td>
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<td>Scrubber Car Operation</td>
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<td>Sink or Pot Hole</td>
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<td>Sick (Control Center or Supervisor)</td>
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<td>SOR</td>
<td>Operator sick off the street</td>
</tr>
<tr>
<td>SPAK</td>
<td>Suspicious Package</td>
</tr>
<tr>
<td>SPS</td>
<td>Special Public Service</td>
</tr>
<tr>
<td>SREQ</td>
<td>Signal request</td>
</tr>
<tr>
<td>SRKI</td>
<td>Strike Incident</td>
</tr>
<tr>
<td>STN</td>
<td>Stanchion bar</td>
</tr>
<tr>
<td>STO</td>
<td>Single Track Operation</td>
</tr>
<tr>
<td>STR</td>
<td>Steering/Front End Problems</td>
</tr>
<tr>
<td>SVT</td>
<td>Stolen vehicle</td>
</tr>
<tr>
<td>SWT</td>
<td>Switch</td>
</tr>
<tr>
<td>TALT</td>
<td>Turn Alert System</td>
</tr>
<tr>
<td>TCK</td>
<td>Time Check</td>
</tr>
<tr>
<td>TIME</td>
<td>SMDT with clock problems</td>
</tr>
<tr>
<td>TNT</td>
<td>Trenton Line (WC Shuttles)</td>
</tr>
<tr>
<td>TRAK</td>
<td>Track Problems</td>
</tr>
<tr>
<td>TRS</td>
<td>Third Rail Shoe</td>
</tr>
<tr>
<td>TRPS</td>
<td>Trespassers</td>
</tr>
<tr>
<td>UAP</td>
<td>Unauthorized person in Track area</td>
</tr>
<tr>
<td>UDT</td>
<td>Unannounced Drug Test</td>
</tr>
<tr>
<td>VAC</td>
<td>Vacation Day</td>
</tr>
<tr>
<td>VTAG</td>
<td>VTAG Problem</td>
</tr>
<tr>
<td>WATR</td>
<td>Water leaking into bus (Heavy Rain)</td>
</tr>
<tr>
<td>WCL</td>
<td>Wheel Chair Lift Problem</td>
</tr>
<tr>
<td>WCP</td>
<td>Wheel Chair Passenger Pick Up</td>
</tr>
<tr>
<td>Problem subcode</td>
<td>Problem subcode description</td>
</tr>
<tr>
<td>-----------------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td>WCPA</td>
<td>Wheel Chair Passenger fell off Ramp and claimed injury</td>
</tr>
<tr>
<td>WCPF</td>
<td>Wheel Chair Passenger fell off Ramp</td>
</tr>
<tr>
<td>WCPU</td>
<td>Wheelchair psgr pass up</td>
</tr>
<tr>
<td>WFI</td>
<td>Won’t display numbers</td>
</tr>
<tr>
<td>WIN</td>
<td>Window/Windshield Problem</td>
</tr>
<tr>
<td>WOT</td>
<td>Working Other</td>
</tr>
<tr>
<td>WRM</td>
<td>Warminster Line (WC Shuttles)</td>
</tr>
<tr>
<td>WTN</td>
<td>West Trenton Line (WC Shuttles)</td>
</tr>
<tr>
<td>WWP</td>
<td>Wiper problems</td>
</tr>
<tr>
<td>XGTE</td>
<td>Crossing Gate Problems</td>
</tr>
</tbody>
</table>

**Supervisor Codes**

<table>
<thead>
<tr>
<th>Problem subcode</th>
<th>Problem subcode description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000</td>
<td>Emergency- All units clear the air</td>
</tr>
<tr>
<td>10-1</td>
<td>In Service</td>
</tr>
<tr>
<td>10-2</td>
<td>Out of Service</td>
</tr>
<tr>
<td>10-3</td>
<td>Contact a Person</td>
</tr>
<tr>
<td>10-4</td>
<td>Checking, on location (out of car)</td>
</tr>
<tr>
<td>10-5</td>
<td>Rest Room</td>
</tr>
<tr>
<td>10-6</td>
<td>In the District</td>
</tr>
<tr>
<td>10-7</td>
<td>Lunch</td>
</tr>
<tr>
<td>10-8</td>
<td>Special Assignment</td>
</tr>
</tbody>
</table>

1.3. MAINFRAME INTERFACE

File export sample

Employee_id, Last_name, First_name, , , Job_Id, Job_num#, . , . , . , .0, . . .,

01435,MILLER,JOHN H, , , 5,7014, , , 1, , , , , . , . , . , .0, . . .,

01629,AGARD,RICHARD H, , , 5,9075, , , 1, , , , , . , . , . , .0, . . .,

01836,TROY,KEVIN F, , , 5,9075, , , 1, , , , , . , . , . , .0, . . .,

05005,GREGOR III,STEVE J, , , 5,9075, , , 1, , , , , . , . , . , .0, . . .,

1.4. ROUTEMATCH CCT INTERFACE
1.5. **GTFS RT FEED**

The 3 GTFS-RT feeds below shall include at a minimum all the field list below and meet the GTFS-RT standard as publish and maintain by Google.

**Trip Updates:**

- **entity**
  - **id**
  - **trip_update**
    - **trip**
      - **trip_id**
      - **route_id**
    - **stop_time_update**
      - **stop_sequence**
      - **arrival**
        - **delay**
      - **schedule_relationship** (if applicable)
    - **vehicle**
      - **id**
    - **timestamp**
Service Alerts:

- entity
  - id
  - alert
    - active_period
      - start
      - end
    - informed_entity (for each affected route)
      - route_id
    - cause
    - effect
    - url
      - translation
        - text
        - language
    - header_text
      - translation
        - text
        - language
    - description_text
      - translation
        - text
        - language

Vehicle Position:

- entity
  - id
  - vehicle
    - trip
      - trip_id
      - route_id
      - schedule_relationship
    - position
      - latitude
      - longitude
      - bearing
    - vehicle
1.6. RESTful APIs

TransitView

Parameters:

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>RouteName</td>
<td>Comma separated list of route names.</td>
<td>Route names are alphanumeric, for example, 22, 23, BLVDDIR, XH.</td>
</tr>
<tr>
<td>VehicleID</td>
<td>Comma separated list of vehicles ids.</td>
<td>Vehicle IDs are numeric.</td>
</tr>
</tbody>
</table>

Results:

Returns realtime data: lat, lon, vehicle id, route id, block id, direction, destination, GTFS trip id, minutes late of each revenue vehicle on the specified routes, next upcoming StopID estimated arrival time.

Routes

Parameters:

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>RouteName</td>
<td>Comma separated list of route names.</td>
<td>Route names are alphanumeric, for example, 22, 23, BLVDDIR, XH.</td>
</tr>
</tbody>
</table>

Results:

Returns static information for the specified routes (direction, destination) or returns information on all routes if ‘all’ is specified. The data shall include the list of stopID available for each direction list in the order of stop occurrence on the route/direction.
Routes Directions

Parameters:

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>RouteName</td>
<td>Comma separated list of route names. 'all' will request every route in current schedule.</td>
<td>Route names are alphanumeric, for example, 22, 23, BLVDDIR, XH.</td>
</tr>
</tbody>
</table>

Results:

Return static information of the possible route destination for a route

Bus Stops

Parameters:

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>RouteName</td>
<td>Comma separated list of route names.</td>
<td>Route names are alphanumeric, for example, 22, 23, BLVDDIR, XH.</td>
</tr>
</tbody>
</table>

Results:

For the specified routes, returns all bus stops, including stop id, stop name, lat, lon, and handicap accessibility.

Bus Detours

Parameters:

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>RouteName</td>
<td>Comma separated list of route names. 'all' will request every route in current schedule.</td>
<td>Route names are alphanumeric, for example, 22, 23, BLVDDIR, XH.</td>
</tr>
</tbody>
</table>

CARD System 13352-12 CAD/AVL System Interfaces March 2021
Results:

Returns available information on the detours, but not limited to: route id, detour start, detour message, detour end (if known), start location, end location, reason, direction, affected stop ids.

**NTA Bus**

Parameters:

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>StartStopID</td>
<td>Starting stop id</td>
<td>GTFS Stop IDs are numeric</td>
</tr>
<tr>
<td>EndStopID</td>
<td>Ending stop id</td>
<td>GTFS Stop IDs are numeric</td>
</tr>
<tr>
<td>RouteName</td>
<td>Optional. Filter results to</td>
<td>Route names are alphanumerical.</td>
</tr>
<tr>
<td></td>
<td>specified route</td>
<td></td>
</tr>
<tr>
<td>NumOfResults</td>
<td>Number of results to return</td>
<td></td>
</tr>
</tbody>
</table>

Results:

Results will be all active and upcoming scheduled trips that will travel from StartStopID to EndStopID. Returns the realtime data, where possible: lat, lon, vehicle id, route id, block id, direction, destination, GTFS trip id, minutes late.

**Shapes**

Parameters:

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>RouteName</td>
<td>Comma separated list of route names.</td>
<td>Route names are alphanumerical, for example, 22, 23, BLVDDIR, XH.</td>
</tr>
</tbody>
</table>

Results:

Returns a GeoJSON object containing the LineStrings that traces all the paths along the specified route.
Estimation arrival:

Parameters:

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>StopID</td>
<td>Stop ID to show scheduled times.</td>
<td>GTFS Stop IDs are numeric</td>
</tr>
<tr>
<td>RouteName</td>
<td>Route name of specific route</td>
<td>The unique ID of a route can include more than one route</td>
</tr>
</tbody>
</table>

Result:

Return the next arriving bus a specific stopID including the estimated arrival time

Estimation Departure:

Parameters:

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>VehicleID</td>
<td>Vehicle ID of a vehicle</td>
<td>Actual vehicle ID</td>
</tr>
</tbody>
</table>

Result:

Return the next upcoming stops arrival time for a specific vehicle. The data shall include 1 or more StopID and the estimated arrival at each stop ID. The data shall also return the TripID of the vehicle.

Service Alert

Parameters

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>RouteName</td>
<td>Comma separated list of route names.</td>
<td>Route names are alphanumeric, for example, 22, 23, BLVDDIR, XH.</td>
</tr>
</tbody>
</table>
Results:

Provide a list of service disruption information for a specific route included vehicle IDs affected, StopIDs affected. The service alert feed shall return data such as bus cancellation, Delay information service disruption.

PART 2 – PRODUCTS – NOT APPLICABLE

PART 3 – EXECUTION – NOT APPLICABLE

END OF SECTION
SECTION 13353

CAD/AVL SYSTEM REPORTS

PART 1 - GENERAL

1.1. DESCRIPTION OF WORK

A. The Contractor shall provide all standard reports and standard report templates that are normally included with the Contractor’s base CAD/AVL System product offering, as well as all reports specified in these specifications, including the reports identified below that are generated under SEPTA’s existing CARD System.

B. The format, organization, data content, terminology, report generation time, time period covered by a report, and distribution of the existing SEPTA CARD System reports shall be maintained under the Contractor-provided reports, unless revisions are reviewed by SEPTA.

C. Reports shall be webbased and accessible outside the control room by authorized users.

1.2. EXISTING REPORTS

A. Existing SEPTA CARD Daily Reports – The following reports shall be generated by the CARD System on a daily basis:

1. Major Incidents report
2. Light rail morning report
3. Shop equipment failure report
4. Light rail pass up report
5. Employee injury report
6. Major incident report
7. Wildcat shuttle report
8. District delay report
9. Service delay report
10. Daily missed trip report no details
11. NCC failure report
12. Daily pass up report
13. WCL failure report
14. CTBC report
15. Accident report

B. Existing SEPTA CARD Weekly Reports - The following reports shall be generated by the CARD System on a weekly basis:

1. Fume report
2. Leak report
3. Cal - route and schedule adherence by Acct No
4. Com - route and schedule adherence by Acct No
5. All - route and schedule adherence by Acct No
6. Cal - route and schedule adherence by operator
7. Com - route and schedule adherence by operator
8. All - route and schedule adherence by operator
9. Route and schedule adherence by Acct No
10. Route and schedule adherence by operator
11. Missing trips subcode report
12. Fume summary
13. Blocked trolley report in process
14. Operator Assault (OPA) report
C. Existing SEPTA CARD Monthly Reports - The following reports shall be generated by the CARD System on a monthly basis:

1. Missed trip report
2. Accident report
3. Passenger pass-up report
4. Wheel chair passenger pass up
5. Wheel chair passengers accommodated
6. Operator assault/operator threatened
7. Fume report
8. Leak report
9. Major/minor incident report
10. Provide information for the monthly highlights report
11. Provide information for the monthly elevator and escalator reliability
12. Daily shop failure report
13. Daily district delay report
14. Daily failure report
15. Monthly scheduled, missed and shuttle trip report
D. Existing SEPTA CARD Daily, Weekly and Monthly Reports - The following reports shall be generated by the CARD System on a daily, weekly and monthly basis:

1. Operator Activity Log
2. Dispatcher Activity Log
3. Call Summary
4. Dispatcher Activity Log
5. Current Status Report
7. Services Detail Report

E. Existing SEPTA CARD District Logon Reports - The following District Logon reports shall be generated by the CARD System:

1. Bus detour history
2. CAD Data messages to busses
3. Code weekday
4. Code Saturday
5. Code Sunday
6. RTTs over 5 minutes
7. RTTs over 9 minutes
8. Total incidents
9. Total incidents PRTT
10. PRTTs over 2 minutes
11. EA over 1 minute
12. Subcode report
13. Any type over 9 minutes
14. Any type over 5 minutes
Notes:

- District Logon Reports run daily. They capture the logon history from the previous day. It is also possible to go back in the history if need be.
- Reports #’s, 3, 4 and 5 track On-Time-Performance in increments of time.
- Reports #’s 6, 7 (RTT) and 10 and 11 track the response time from the Control Center Managers when answering Requests to Talk (RRT), Priority (PRTT) or Emergency Alarms (EA) initiated by the Operators.

PART 2 – PRODUCTS – NOT APPLICABLE

PART 3 – EXECUTION – NOT APPLICABLE

END OF SECTION
PART 1 - GENERAL

1.1. DESCRIPTION OF WORK

1.2. System Design Requirements

A. The 700 MHz Radio System shall be a separate distinct radio system from the existing VHF Radio System. It shall not be combined with the VHF System in any way. The two systems can share the same backhaul as required by the Contractor’s design, but each system shall use separate IP networks and subnets. Networks shall not overlap or interfere in any way. Connection to other systems or networks shall be by firewall as stated in the cyber security section of these specifications.

B. SEPTA currently utilizes an audio logging system manufactured by Verint, The Contractor is responsible to interface the 700 MHz Radio System as specified in this specification to the existing audio logging system.

C. The 700 MHz P25 Phase II Trunked Simulcast Radio System furnished and installed shall include, but not be limited to, the requirements of this Section.

D. The 700 MHz system shall be configured to receive incoming and outgoing telephone lines for display uses on the dispatcher consoles. The lines shall be POTS lines or traditional dial tone. The quantity of POTS line interfaces shall be no fewer than 200.

E. The Contractor shall be fully responsible for providing a complete and workable final design, and all equipment required by the design for this 700 MHz Radio System. All designs, all materials to be used and the means and methods of constructing the new system shall require the approval of the SEPTA Project Manager. The Contractor is advised that no materials shall be ordered without first obtaining SEPTA’s prior approval. The Contractor is to understand that any work not specifically mentioned in this Specification, but which is necessary, either directly or indirectly, for the proper performance of the Work, shall be required and completed, and be performed just as if it were particularly delineated or described in this Specification.

F. The design shall include but not be limited to the following:

2. 18-channel voice and data P25 Phase II trunked IP linear simulcast RF infrastructure. The Radio system shall provide for fallback CAD/AVL data functions as described in Division 13342.

3. Remote Site Mini Base Control Stations - SEPTA utilizes standalone base stations at fixed field locations for local communications. The Mini base stations shall be used on the desktop or under cabinet mounted, programmable with all frequencies and talk groups as required by SEPTA, palm microphone, adjustable output power to 40 watts, power source shall be 120 VAC. The Contractor shall supply to SEPTA a Mini Base Station kit comprised of the following: 700 MHz programmable radio (based on Supervisor/Maintenance Vehicle Mobile Radio requirements in these specifications), radio mounting bracket, Omni directional antenna including 50’ of coaxial cable with connectors and antenna mounting brackets. Contractor shall program each Mini Base as per project manager direction and turnover to the SEPTA Radio Shop. Reference contract drawings for additional details.

4. SEPTA Fiber Network Core Node connectivity - Each of the existing SEPTA fiber node core sites have fiber connectivity utilizing Wave Division Multiplexing (WDM). The Contractor shall provide a fiber switch/router/multiplexor for connection into the fiber / WDM network to be utilized as the backhaul system and connectivity between the core node Sites. The fiber core node site are located at 200 Wyoming Ave, Auxiliary Control Center at the Frankford Transportation Center and 1234 Market St. Each subsystem (CAD/AVL System, 700 MHz System) shall be configured as a separate backhaul network, utilize a separate fiber mux at each site for each system, and each fiber mux system shall include a network management computer.

a. The Contractor shall provide and configure PacketLight SFP/SFP+ optical modules for the WDM Core interface connection.

b. The Contractor shall provide and configure an Extreme-Switch X465 with two (2) 10 Gigabit Ethernet interfaces, SFP/SFP+, and redundant power supplies.

5. Auxiliary transceiver / receiver infrastructure at SEPTA facilities.

a. SEPTA has an extensive wayside fiber optic network along its right of way (ROW) comprised of OTN fiber Optic multiplexors, Wave Division Multiplexing and dark fiber. These existing network locations are available to the Contractor to augment the coverage area.

b. The Contractor shall install the radio equipment at the local communications houses along the ROW as needed to meet the RF coverage requirements of this specification detailed in 13704. The equipment shall include but not be limited to: Antenna System; Antenna mast, transceiver, network switch, cabling etc. for a turnkey solution. SEPTA shall supply rack space and limited 24/48VDC for the equipment.
6. Two above ground locations are deemed critical to SEPTA’s Operations. These locations shall be required to have reliable radio coverage as specified in paragraph 1.2 F. 11. below. Both sites shall be designated as a remote RF base station site and are to be included in the overall design, regardless of their contribution to any RF design or coverage predictions maps. The locations are Frankford Transportation Center and 69th St Transportation Center (103 Victory).

7. SEPTA’s identified list of critical locations including yards and depots requiring both outdoor and in building mobile and portable coverage includes; Fern Rock, Bridge St, 69th Street Transportation Center complex including: Platforms & Boarding areas, 69th St, MFSE, 69th NHSL, 69th St MSHL, Midvale Bus Depot, Comly Bus Depot, Frankford Bus Depot, Allegheny Bus Depot, Frontier Bus Depot, Southern Bus Depot, Callowhill Bus Depot, Victory Ave. Bus Depot, Germantown Bus Depot, Wyoming Bus Garage, Elmwood Trolley garage, Woodland Trolley Garage. The Contractor shall be responsible for furnishing an In-Building Coverage Solution providing 95% reliability and 95% coverage for areas above grade where the outdoor signal penetration does not meet the requirements.

8. SEPTA Subway Tunnels - SEPTA recently installed a Distributed Communications System (DCS) supporting the Market Frankford Line, Broad Street Line, Subway Surface Line & Regional Rail Commuter Tunnel. The DCS system is comprised of two Master Sites feeding remote Bidirectional Amplifiers (BDA) located throughout SEPTA’s Subway and Regional Rail tunnels. The Contractor shall install two trunked remote 700MHz Tx/Rx Remote sites one each at the 15th Street passenger station (Broad Street Line) & Fairmount passenger station (Broad Street Line) to interface to the DCS system. The existing DCS underground system is capable of accepting two distinct 700 MHz combined inputs for SEPTA’s use at both 15th St and Fairmont. The Contractor shall simulcast the SEPTA 700 MHz transmissions below ground on the DCS System.

a. The Contractor shall perform an Interference and intermodulation study to determine the potential of any new or modified signals interfering with existing signals, and plan to design the sites accordingly so interference can be minimized. Currently SEPTA has operating frequencies within the 218 MHz, 500 MHz, 700/800 MHz & 160 MHz bands, and other frequencies not specifically accounted for that may pose interference issues but shall be the responsibility of the contractor to address and minimize the interference/intermodulation issues as a result of simulcasting the SEPTA 700MHz. Contractor shall note that the 450/500MHz frequencies are legacy System frequencies that are to be replaced under this specification but may be in use during the transition period.

9. The Contractor shall test and interface to SEPTA’s existing Fiber backhaul from existing sites along the ROW to 1234 Market St and 2nd & Wyoming. The Contractor shall test each backhaul link to verify that the performance meets the Contractors design requirements.
10. The Contractor shall program all new and existing portables, mobile and mini base stations as part this project. Existing radio system ID's and frequency information for all radio programming shall be provided by SEPTA. SEPTA has purchased six hundred (600) Motorola APX 8000/8500 portable and mobile radios for SEPTA Police use on the City of Philadelphia Motorola trunked radio system. The Contractor shall reprogram these radios to add additional new talk groups or frequencies required by the new SEPTA trunked radio system. These radios are currently in use and critical to the life safety nature of Police Operations, the Contractor shall include a plan to update the radios with minimal impact to the SEPTA Transit Police in the overall Transition Plan. The SEPTA Police radios shall operate on the new P25 Phase II 700 MHz system with all features currently in use and shall comply with APCO P25 common air interface.

a. Current configurations of APX8000 portables include:
   - ASTRO Digital CAI Operation
   - Smartzone Operation
   - P25 9600 Baud Trunking
   - OTAP
   - Radio Packet Data
   - Advanced System Key – Hardware Key
   - DVRS Operation
   - ASTRO P25 OTAR with Multikey
   - DES, DES-XL, DES-OFB Encryption

b. Current configurations of APX8500 mobiles include:
   - ASTRO Digital CAI Operation
   - Smartzone Operation
   - P25 9600 Baud Trunking
   - OTAP
   - Advanced System Key – Hardware Key
   - DVRS Operation
   - P25 & MDC OTAR
- DES, DES-XL, DES-OFB Encryption
- RS232, IV&D Packet Data
- O5 Control Head

11. 95% RF coverage Service Area reliability for all outdoor areas as defined in Division 13704 designed and tested in accordance with the latest revision of the TSB-88 standard.

   a. SEPTA has identified a number of critical service locations that shall require 95% RF coverage within the specified area. These locations shall be coverage tested individually to the same standards as outdoor areas. SEPTA shall deem the entire Radio System Coverage Test Acceptance “Failed” if any of these critical areas do not pass individually, even if the Contractor is able to demonstrate meeting “Pass” requirements for the overall Service Area defined in Div 13704. These critical locations are further defined within these specifications.

12. Replacement of existing Alcatel MDR8000 T1 Microwave backhaul system with a hybrid T1/Ethernet Microwave backhaul system.

13. Replacement of existing Motorola and L3Harris Consoles at 1234 Market St Dispatch with Motorola MCC 7500e dispatch consoles in accordance with the requirements in 13708 1.1 A and equipped with applicable software.

14. Integration of the Radio System with on-board, back office and dispatch console CAD equipment for CAD/AVL functionality as described in Volume 3 Division 13 CAD/AVL System.

15. Integration of existing interoperability and as a minimum supply the interoperability functionality on the replacement MCC 7500e Consoles as described within this specification and contract drawings.

16. Provision of Motorola MCC7500e consoles at Frankford Transportation Center Auxiliary Control Center.

17. Provision of Motorola MCC7500e Consoles at 2nd & Wyoming into the new dispatch system.

18. Provision of Motorola MCC7500e laptops configured for remote dispatch solution as described in the contract drawings.

19. Provision of Motorola APX900 Model 2 Portable radios

20. Provision of Motorola APX4500 Mobile radios

21. Provision of Motorola APX8500 Mobile radios
22. Provision of Motorola APX6500 Mini-Base Control Stations.

23. Provision and integration of existing Motorola control stations (Consoles) at 2nd & Wyoming and 1234 Market St into the new dispatch system.

24. Development of subscriber templates for SEPTA's subscriber equipment.

25. Programming of all SEPTA subscriber equipment (mobiles, portables, and mini base control stations).

26. Installation of all mobile subscriber equipment in SEPTA Revenue vehicles (Bus, Paratransit, Trolley, and Subway/Surface) and Maintenance/Supervisory/Operations vehicles as identified in the contract drawings. As part of the Revenue vehicle radio installations, the contractor shall program the mobile radios to operate on both the existing UHF system and the replacement 700 MHz system. The 700 MHz Radio System cutover shall not require a physical touch of the revenue vehicle mobile radio for 700 MHz operation.

27. Provision Verint Logging Audio Recorders at 1234 Market St, 2nd & Wyoming (primary/redundant master sites) and Suburban Station as per the contract drawings.

28. Upgrade, refurbishment and interfacing of existing Verint Logging Recorders at all District sites including FTC/ACC as per contract drawings.

29. Maintain interfaces to existing Verint Logging Recorders at all locations.

30. Interface to City of Philadelphia owned Motorola Radio System including surrounding County and other Agency / Authority interfaces.

a. The Contractor shall maintain the existing interface of 12 control stations (over-the-air (OTA)) at both 1234 Market St & Wyoming Ave locations.

b. The Contractor shall maintain the existing SECOM interface

c. The Contractor shall maintain the existing interface to the Delaware River Port Authority (DRPA) and to the city of Philadelphia currently interfacing to the L3Harris ViDA system.

d. The Contractor shall provide a total of eight (8) ISSI interfaces. ISSI interfaces shall be made to each of the following counties; Bucks, Montgomery and City of Philadelphia. The Contractor shall include equipment and integration costs for full ISSI functionality between the SEPTA 700 MHz System and the County/City Systems identified above. In addition, the Contractor shall provide equipment and Integration to future connections to the Counties of Chester, Delaware, the Delaware River Port Authority (DRPA)/PATCO and two (2) spare to be identified neighboring systems.
31. Maintain software and data compatibility for incident recreation between all Verint Logging Recorders SEPTA Wide.

32. Provide all AC and/or DC power wiring from source electrical panels to the Radio System equipment. Existing conditions drawings describing the available power at each radio site is available for the Contractor upon request. The Contractor shall review the power availability during site surveys to verify the available power meets the Radio System site design requirements. Should sites require additional power needs (including UPS and/or Generator as per the requirements) the Contractor shall include those costs in their proposal.

G. Engineering, furnishing, installing, and testing all necessary radios, consoles, mini-base control stations, fixed-site equipment, devices, Antennas, interconnecting cabling, and software. This shall include furnishing and installing the necessary equipment shelters along with supporting electrical and mechanical facilities, electrical connection to AC receptacles/DC power plants, electrical circuits to source panels, electrical earthing, grounding, bonding, Ethernet cabling, coaxial cabling, waveguide physical installation, connection to new and existing termination blocks, connection to new/existing logging recorders, and connection to telephone lines, microwave, fiber or other interconnecting systems necessary to provide complete Radio System functionality.

H. Perform all fixed station, mini-base control station, mobile and portable radio programming and installations.

I. Design and develop the Radio System interface(s) in order to meet system functional requirements specified herein and to ensure a complete and fully integrated SEPTA Radio System.

J. Conduct site visits and provide close coordination and technical support as necessary to ensure that the design and functions of the Radio System meet the requirements specified herein.

K. Coordinate installation details and schedules with SEPTA to ensure adherence to the implementation schedule.

L. Coordinate activities with SEPTA for Radio System deployment and site upgrades/modifications.

M. Coordinate with CAD/AVL vendor for integration of Radio System with CAD/AVL system

N. Provide Radio System data, link budgets, antenna system parameters, coverage data and services, as required by SEPTA, regarding the necessary site preparations, facilities, field installation, and solutions to technical problems related to the Contract, throughout the design, implementation, installation, and testing phases through Final Acceptance.
O. Design, furnish and install all necessary transmitter combiners, multicouplers and RF antenna systems.

P. Install all necessary interconnecting cabling, connectors, earthing, grounding, bonding, power, and any software required for interfacing to SEPTA backhaul, antenna systems, transmitter combiners, and receive multicouplers. All work shall adhere to Motorola R56 “Standards and Guidelines for Communications Sites”

Q. Ensure that the equipment, materials and installation comply with all applicable FCC rules and regulations, with the provisions of the NEC, OSHA, and all local electrical, fire, and building codes, and with local seismic requirements for the zone in which the equipment shall be installed.

R. Provide electrical wiring from the existing breaker panels to Contractor supplied DC power plants for the new trunked simulcast equipment.

S. Design, furnish and install any prefabricated equipment shelters necessary at a remote site including electrical and mechanical support facilities as per the requirements of these specifications.

T. Ensure the Remote RF Simulcast Site equipment at every site (existing and new) is backed up with a minimum 48 hour rated Generator and 30 min UPS for critical RF and backhaul loads. Several existing SEPTA sites are provisioned with UPS and/or Generator backed power. The Contractor shall review the power availability during site surveys to verify the available power meets the Radio System site design requirements. Should sites require additional power needs (including additional UPS and/or Generator capacity as per the requirements) the Contractor shall include those costs in their design/proposal. At existing transceiver sites load calculations shall include the SEPTA 700 MHz RF loads and backhaul loads plus 20% of total loads for future growth. For any new transceiver sites, the Contractor shall provide an additional 50% of 700 MHz Radio System loads for future growth when sizing equipment.

U. Provide any jigs, fixtures, or software that is necessary for SEPTA technicians to test, align, troubleshoot and verify system operations. Motorola troubleshooting software shall be installed on laptops which shall be turned over to the SEPTA Radio Shop. In addition, the Contractor shall furnish the following; quantities are as identified in the drawing package.

1. Anritsu S412E LMR P25 Spectrum Analyzer with all options required to test, troubleshoot, analyze and calibrate the 700 MHz P25 System. Options shall include but not be limited to the following;

   • Option 25; Interference Analysis

   a. Option 27; Channel Scanner

   b. Option 31; GPS Receiver

d. Option 521; P25 & P25 Phase 2 Analyzer

2. Freedom R8100 Communications System Analyzer with all options required to test, troubleshoot, analyze and calibrate the 700 MHz P25 System. Options shall include but not be limited to the following:

a. R8-P25 Phase 1 Test

b. R8-P25TRNK; P25 Phase 1 Trunking Test

c. R8-P25; VOC P25 Phase 1 Vocoder

d. R8-P25_II; P25 Phase II Test

e. R8-AT_APX; Autotune for APX Mobiles & Portables

f. CHRG8100; Charger for R8100 Battery

3. Bird 7020 Series Power Sensor for measuring P25 output of a channel or combiner

4. Four (4) Tektronix Digital Storage Oscilloscope that allow for simulcast timing/prop delay verification in avoiding Time Domain interference (TDI).

V. Provide comprehensive site and Radio System acceptance testing and acceptance test procedures that demonstrate to SEPTA that the Radio System and all its components meet the acceptance criteria specified herein.

W. Provide detailed plan to be executed by the contractor for the transition of all existing users (User radios, dispatch consoles, logging recorders, radio control stations) from the existing Systems to the replacement systems required by this specification while maintaining the current service level all users with "No downtime".

X. Provide system administration and maintenance training of SEPTA personnel, and system and maintenance documentation, test jigs, and cables.

Y. Obtain Final Acceptance Certificate signed by SEPTA.

Z. Provide warranty as specified in Section 01400 “Quality Control and Warranty Requirements”.

AA. The contractor shall provide an implementation and phasing plan to SEPTA for approval transitioning SEPTA from the existing 500 MHz Trunked and conventional radio systems to the new 700/800 MHz trunked radio system. The plan shall take into account SEPTA operations are 24 x7 x 365 and no system wide down time is acceptable.
BB. Provide a subscription for software maintenance and updates for the duration of the warranty period.

CC. The Contractor shall provide spare parts for the 700 MHz Radio System Fixed Infrastructure. The spare parts shall include a total of 7% of the total cost of all furnished and installed active equipment including but not limited to; full base stations, routers, comparators, switches, site controllers, gateways, microwave radio modules and Prime/Core site equipment. In addition, a total of 7% of the total cost of all furnished and installed RF Transmissions systems including but not limited to; antennas, multicouplers, combiners, and passive RF devices. Coaxial Transmission line is excluded from this requirement. Spare mobile and portable radios shall be based on the quantities shown in the Contract drawings. The Contractor shall provide a spare parts list with a unit price for each item that shall be valid for the duration of the project.

1.3. RF System

A. The Contractor’s Scope of Work (SOW) shall include the replacement of all Motorola MTC3600 SMARTNET simulcast infrastructure equipment and software with equipment and software that is P25 Phase II compliant including IP linear simulcast at each of the RF sites. It shall also include the removal of all analog UHF conventional simulcast equipment.

B. Servers, computers, and network equipment shall be compatible with the latest stable Software Release including Network Routers, Switches, Astro 25 Core, GTR8000 Base Radio, GPW 8000 Receiver, GCP 8000/DSC 8000 Site Controller and GCM Comparators.

C. Physical floor space constraints exist at most sites and it shall be the responsibility of the Contractor to determine where the new Radio System equipment racks/cabinets are to be located and deal with any floor space issues required to accomplish the transition. Note that Bacton Hill, Y100, Oxford Valley, Roxborough and New Britain sites are managed by 3rd party’s respectively. All coordination of available space at these sites must be approved by the site manager. The Contractor shall field verify existing site conditions prior to submitting their proposal.

D. All the existing simulcast UHF SMARTNET Trunked equipment at each RF simulcast remote site and receiver site shall be replaced with new 700 MHz P25 Phase II simulcast radio system infrastructure equipment. All P25 transmit remote sites shall operate in the linear simulcast mode.

E. All P25 RF equipment proposed to meet the requirements of this Specification for SEPTA shall have been subjected to the Compliance Assessment Program (CAP) driven by National Institute of Standards and Technology, Office of Law Enforcement Standards (NIST OLES) and have a Supplier Declaration of Conformance (SDoC) Certificate.
F. The RF System requirements are as detailed in the following sections.

1. Astro 25 Architecture - The Motorola Astro 25 M Core Network Architecture and Main Master shall be located at SEPTA’s 1234 Market St.

2. Utilizing Dynamic System Resilience (DSR) a fully redundant back-up Astro 25 Core with automatic switchover shall be located at SEPTA’s 2nd & Wyoming Site in the existing “Voter Room”.

3. Drawings identifying existing conditions for these sites are part of the drawing package. Drawings are for reference only; the Contractor is responsible for verifying all field conditions.

4. The Contractor shall upgrade or replace all of the UHF SMARTNET/Conventional equipment and associated software at 1234 Market St with a new P25 Phase II Astro 25 M Core Network Architecture including IP control and monitoring of G-Series Base Stations in the IP linear simulcast mode at 1234 Market St.

5. The Contractor shall design furnish and install a Microwave Backhaul Network which provides for separate backhaul links from both the Primary and Redundant Master/Prime Site in order to maximize the system redundancy provided by the geo-redundant primary/redundant Master sites utilizing Dynamic System Resiliency. Under no circumstances shall the Contractor be permitted to utilize either Master site as an intermediary link back into the Microwave Network for its redundant Masters traffic.

6. The existing Fiber demarcation rack located at 1234 Market Street (Penthouse), the C&S Server Room and the 2nd & Wyoming “Voter Room” shall remain in place for connection of backhaul to the replacement Radio System.

7. The Radio System shall consist of the following as a minimum but not be limited to the following for a successful, reliable and stable operation:

   a. Radio WAN – Isolated

   b. COTS Servers – for radio call management and system management applications designed to the highest possible throughput, capacity and scalability that supports all call processing, data controllers, authentication, security management, administrative, backup and restore and network management

   c. DAS Array – For direct server attached storage.

   d. GCP8000 Site Controllers for control, management and monitoring of P25 Phase 2 simulcast equipment.

   e. DSC 8000 Site Controller

g. GPW8000 Receiver Sites.

h. GCM8000 Comparator.

i. Gateway Appliances to control communications between the Astro 25 Core and remote sites and perform the routing of audio, data and system management traffic in the system.

j. Service hardware to provide an access point for the administration of system devices for maintenance purposes.

k. VPN Router and Firewall to protect the system from unauthorized access and allow authorized technicians.

l. Interoperability Gateway(s).

m. ASTRO 25 Over the Air Rekeying (OTAR).

n. ASTRO 25 Over the air Programming (POP25).

o. Console Sub System Interface (CSSI)

p. P25 Inter-RF Sub System Interface (ISSI) Gateway and licensing for eight (8) foreign systems, City of Philadelphia, Bucks County PA, Montgomery County PA, Chester County PA, Delaware County PA, Delaware River Port Authority (DRPA) and two (2) yet TBD future systems.

q. P25 Phase II TDMA Architecture Software.

r. Firewall Application.

s. Motorola Standard Timing source.

t. Monitor, Keyboard, Mouse and KVM Switch with associated hardware for each dispatch console position.


v. MCC 7500e Dispatch Consoles.

G. Network Equipment

1. The Zone Controller shall be capable of operating in a redundant mode. A high availability software application shall be capable to run on both the main and redundant servers to qualify event failures and initiate switchovers eliminating call processing functionality.
2. The Network Switching Core Infrastructure shall be capable of running two different versions of software simultaneously in order to facilitate verification of upgrade functionality prior to programming both controllers.

3. Astro 25 Core Main Master

a. The new Astro 25 Master shall enable H-DQPSK and linear simulcast for all P25 simulcast Remote Site transmitters and be the central point for all system traffic. Call processing and system management shall occur at the Master. The simulcast control equipment shall be redundant to the extent possible, such that the failure of any module does not take down the system.

b. The Main and Redundant Master shall be an IP-Architecture, Astro 25 based Core for the H-DQPSK, Linear Simulcast infrastructure, The Main Master shall be located at the C&S Server Room with the Redundant Master at the 2nd & Wyoming Site.

c. An Astro 25 Master shall consist of the following:

- Redundant Zone Controllers.
- Redundant Network Management Servers including ATR, ZBS, UEM, ZSS and UCS.
- Redundant Core Routers.
- Redundant Gateway Routers.
- Redundant Backhaul LAN Switches.
- GPRS (General Packet Radio Service) Gateway Service Node Router.
- Peripheral Network Router.
- Network Firewall and Firewall Management Server.
- GPS Receiver with Rubidium Standard control as the backup timing source.
- MOSCAD Network Fault Management Server.
- Redundant Virtual Management Servers.
- Direct Attached Storage (DAS).
- OTAR Server.
- POP25 Server.
• Audio Logging Recorder.
• Network Management Workstation.
• ISSI Gateway System Including: Gateway Application Server, Firewall and Ethernet Switch, and Gateway Router.
• Packet Data Gateway.
• Wave 5000 Server.
• Cabinet/Rack.
• Cross Connect Panel.
• Service Monitor/Test Radio.

4. Radio System Network Architecture - The Radio System Network Architecture shall exhibit the following characteristics:

a. End-to-End IP – Every component shall have an IP address.

b. High Availability – Calculated reliability shall be greater than 99.99% including the software applications.

c. Dynamic Control Channel switching.

d. Fault Tolerant Design including:
   • Redundant power supplies.
   • Redundant Network Switching.
   • Automatic restoral for Control Channel failure using another channel.
   • Automatic selection of remote site alternate backhaul paths.

e. The 700 MHz Radio System Network Architecture shall be a standalone separate distinct network from the existing CARD and VHF Radio System networks. The systems may share the same backhaul as required by the Contractors design but each system shall utilize separate IP networks and subnets. These networks shall not overlap or interfere in any way.

5. **Network Management** - The P25 Radio System shall include a central Network Management System with remote access using a standard Web Browser. The Network Manager shall:

a. Consist of a High Availability Server loaded with the OEM Network Management Application.
b. Workstations & servers shall not exceed 50% CPU and memory utilization.

c. Only be comprised of hardware that is Enterprise Class.

d. Be accessible from anywhere on the network via a Web Browser.

e. Include two 24” LCD display monitors, keyboard and mouse at the desk in addition to a 42” Auxiliary LCD display.

f. Enable one to view the entire network from a single location displaying status information, forwarding alert information and performing diagnostic procedures.

g. Enable monitoring, reporting, controlling and optimization of system resources.

h. Enable maintenance of the operational parameters of the infrastructure components and end-user devices.


j. Exhibit a Hierarchical Design making it easy to drill down to details.

k. Exhibit audible and visual alarms.

l. Capable of sending alarms and notifications via email and text messages to select users (configurable by the system administrator).

m. Display real-time call activity, channel usage, radio traffic activity and historical radio usage statistics.

n. Be able to limit user access and set user privileges.

o. Be located at both 2nd & Wyoming “Voter Room” and 1234 Market St with respective workstations. Additional workstations shall be located at following locations; Wyoming Ave Help Desk, 1234 Market St 13th Floor, Market East Server Room and ten (10) laptops for remote use.

p. The Contractor shall provide a quantity of ten (10) Remote Portable Test Units (RPTU). These shall be Panasonic Toughbook CF-54 minimum configuration: i5-6300U2.4Ghz with 8 GB of ram, 1T SSD, backlit keyboard, serial port, Microsoft Office Professional. RPTU’s shall be preconfigured with all software and hardware required for maintenance and troubleshooting of the radio system. The devices shall be provided with Microsoft Office Professional suite for generating reports and analyzing and tracking events. All original disks to re-install software and required licensing keys shall be included.

q. The network management System shall be accessible at all remote simulcast sites via Contractor-provided Remote Portable Test Units.
6. System Administration Management - The Radio System shall include a central administration system with remote access using a standard Web Browser. The central administration system shall:

   H. Consist of a High Availability Server loaded with the OEM System Administration Application.

      a. Be a secure partitioned database that allows SEPTA to administer its users and talkgroups and automatically propagate changes throughout the network.

      b. Allow administrators to manage the configurations of networks and devices in the Astro 25 system.

      c. Allow for provisioning of subscriber radios, consoles and other devices requiring access to the system.

      d. Only be comprised of hardware that is Enterprise Class.

      e. Include a 24" LCD display keyboard and mouse.

      f. Be accessible from anywhere on the network via a Web Browser.

      g. The central administration servers shall be located with the Astro 25 Core servers at Wyoming Ave & 1234 Market St locations.

      h. Remote terminals shall be provided by the Contractor at: 1234 Market St. 13th floor, Wyoming Dispatcher Desk, Wyoming Radio Room and Market East Server Room.

      i. Be accessible via Contractor provided Remote Portable Test Units.

7. Alarm System - The Astro 25 Network Architecture shall incorporate an Alarm System which shall support all the Radio System equipment using SNMP traps and be capable of a minimum of 32 binary external alarms and/or analog points to monitor other SEPTA site equipment.

   a. The Alarm System at each site shall:

      • Collect internal alarms and activity from the site equipment including but not limited to base stations, switches, routers and gateways etc.

      • Collect external alarms (SEPTA equipment) and activity from the site.

      • Forward alarms to the Network Manager.

      • Forward activity to the System Manager.

      • Maintain a Database of the Site Configuration.
• Time, store, document all events, alarms and control actions for historical retrieval and printing in hard copy.

8. **External Alarms** - SEPTA requires the monitoring of external alarms (digital and analog) at each Prime/Remote Site and Main/Back-up Master. The Contractor shall connect all existing external alarms at each Remote Site and the Master to the local alarm system for transmission to the Main/Back-up Master Network Manager terminals. A typical example of existing Remote Site alarms and analog points to be connected to the new P25 alarm system shall include, but not be limited to the following:

a. Typical Simulcast Remote Site:

• UPS Mains Failure.
• UPS Overload.
• UPS Fan Failure.
• UPS Inverter Fuse Failure.
• UPS Low Battery Voltage.
• UPS High Temp.
• UPS Output Out of Limits.
• UPS On Static Bypass.
• UPS Ext Manual Bypass On.
• UPS Normal Operation.
• UPS Common Fault.
• UPS Bypass Volts Outside Limits.
• UPS Battery Charge Fail.
• UPS Battery Operation.
• UPS Battery DCD Off.
• Room Temp > 80 °F.
• Hydrogen Gas Danger.
• Smoke Detectors
b. The Contractor shall develop a list of recommended monitored alarms to SEPTA for review and final approval.

c. Alarms shall be grouped and categorized by severity- Major, Minor and Critical. Remote notifications Email, Text and Page shall be sent out by category to limit excessive notifications. No more than one notification or page per event or incident shall be sent out. Maintainer can then log into the system to determine the root cause of the notification or alarm.

9. **Interoperability Gateway** - The Astro 25 Network Core Architecture shall include an Interoperability Gateway which allows the IP based digital network to interface with conventional analog equipment. The Interoperability Gateway chassis shall convert analog voice and controls to VoIP. The Interoperability Gateway shall:

   a. Be equipped to accommodate up to twenty-four (24) channels (per Astro 25 core site location)

   b. Allow Dispatchers to access analog channels without any intervention by others.

   c. Allow the display and operation of conventional analog channels on the MCC7500e consoles.

   d. Support the creation of Interoperability Groups on the Network.

   e. Support voice logging recording.

10. **Inter-RF Sub System Interface (ISSI)** - The Astro 25 Core Network Architecture shall be equipped with an ISSI 8000 server, router and interface in accordance with the P25 standards developed and approved to date. The ISSI 8000 interface shall support the following functions as a minimum:

    a. Physically support up to twenty-four (24) system interfaces.

    b. Licensing for interfacing to eight (8) systems including City of Philadelphia, Montgomery County, Bucks County, Chester County, Delaware County, the Delaware River Port Authority (DRPA) and two future systems to be determined at a later date.

    c. PTT ID and Alias Sharing.

    d. TDMA/FDMA Talkgroups between zones/systems.
e. Automatic Roaming between zones/systems (auto w/latest software and GTR based systems)

f. Broadcast Call.

h. Confirmed Group Voice Service.
i. Unconfirmed Group Voice Service.
j. Emergency Group Call.
k. Encrypted Voice.
l. P25 Full-Rate Vocoder (FDMA).
m. P25 Half-Rate Vocoder (TDMA).
n. Subscriber Unit Registration.
o. Transport of Authentication Credential.
p. Secure SU authentication.
q. Group Affiliation.
r. Call Restriction.
s. Inter-WACN (auto w/latest release and GTR based sites).
t. Inter-System (auto w/latest release and GTR based sites).
u. Intra System (auto w/latest release and GTR based sites)
v. RFSS Service Capability Polling.
w. Transport of Talking Party Identity.
x. Priority Call.
y. Emergency Alarm.
z. Emergency Alarm Cancellation.

aa. Group Emergency Cancellation.
bb. Unit to unit calls.
cc. Group Affiliation.
dd. Unit Tracking.

ee. Home User Roaming.

ff. Roaming Management.

11. The Contractor shall identify any features which have been tested and verified as not functioning through the ISSI8000 (i.e. Radio Monitor, Inhibit, Call Alert etc.) as part of their response to this proposal.

12. **Console Sub System Interface (CSSI)** - The Astro 25 Core Network Architecture shall support a CSSI interface in accordance with the P25 standards developed and approved to date. The Radio System shall be equipped with a CSSI Server, Router and Firewall. The CSSI shall support at a minimum the functions as described in Section 13700 1.3 G #10 ISSI above.

13. **Digital Voice Logging Recorder**

   a. The existing Logging Recorder System is comprised of several KOVA Audiolog Digital Logging Recorders integrated into one system;
      
      - Radio /Telephone Logging recorders
      - Bus depot Logging recorders
   
   b. The existing Radio Logging Recorders are integrated into the SMARTNET/VHF system via 2-Wire audio tap for each talkgroup/conventional channel on the system. Four (4) recorders are located on the 11th Floor at 1234 Market St. and a fifth is located on the 19th floor.
   
   c. The Contractor shall furnish one (1) new Verint Media Recorder v15 on the 11th floor for 344 channels of analog recording to replace the existing v5 Bus, Police and Telephone Information Center loggers and the v4 CCT logger.
   
   d. On the 19th floor, the Contractor shall furnish and install one new Verint Media Recorder, v15 for 96 channels of analog recording to replace the existing v4 Rail Logger. The existing Analog Tap cards will be reutilized in this system upgrade. The Contractor shall also furnish and install a new Verint Media Recorder v15 datacenter server on the 11th floor.
   
   e. At the FTC/ACC location, the Contractor shall upgrade the FTC recorders to Verint Media Recorder v15 from v5. The Contractor shall include both the hardware and software to be capable of logging all audio traffic by talkgroup/channel and the capability to review recordings by talkgroup/channel in the same manner as exists today. The existing Analog Tap cards will be reutilized in this system upgrade.
   
   f. In addition to the recorders at the Market St and FTC/ACC locations, SEPTA operates ten (10) local District logging recorders for telephone conversations.
The Contractor shall upgrade the District recorders to Verint Media Recorder v15 from v5. The Contractor shall include both the hardware and software to be capable of logging all audio traffic and the capability to review recordings in the same manner as exists today. The existing Analog Tap cards will be reutilized in this system upgrade.

g. The Contractor shall coordinate with SEPTA exact talkgroups and channels to be recorded during final design/installation prior to going live.

h. Contractor shall ensure industry standard “Beep Tones” are required on all recorded POTS lines.

I. Remote Sites

1. Table 1 (below) is a summary of the existing UHF System sites. Due to tower loading issues, Lowes is NOT to be considered for future RF coverage design. The coordinates were extracted from FCC licenses and are not field verified. The Contractor shall utilize the existing sites to the maximum extent as possible in order to meet the requirements. Where required, the Contractor shall select new remote RF Transmit/Receive sites to achieve the required coverage requirements identified in Division 13.

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<tr>
<th>SITE NAME</th>
<th>LATITUDE</th>
<th>LONGITUDE</th>
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</table>

**J. General – All Remote Sites**

1. The Contractor is required to perform a site survey of each location prior to submitting a proposal. The site survey is required to review available rack space, electrical power and any other Contractor requirements needed to provide a successful, reliable and stable operating Radio System. Site drawings are included as part of the contract drawings, the drawings are for reference only, the Contractor is responsible to field verify all site conditions and include all system requirements in their design.

2. The Contractor shall replace all of the Motorola UHF Trunked SMARTNET and UHF Conventional RF simulcast site equipment and associated software at each Remote Site with new P25 TDMA Phase II compliant RF site equipment capable of IP linear mode simulcast connected via existing and newly furnished/installed backhaul.

3. Roxborough Tower
   a. The UHF SMARTNET/Conventional equipment is located in the east equipment shelter adjacent to the tower. The Contractor shall coordinate with SEPTA for all work to be performed at Roxborough.

4. Oxford Valley (Mall)
   a. The UHF SMARTNET/Conventional equipment is located in the Penthouse radio room at the Oxford Valley Mall. The Contractor shall coordinate with the Building Manager, for all work to be performed at Oxford Valley.

5. New Britain
   a. The UHF SMARTNET/Conventional equipment is located in the larger equipment shelter adjacent to the tower. The Contractor shall coordinate with the landlord, for all work to be performed at New Britain.

6. Bacton Hill
a. The UHF SMARTNET/Conventional equipment is located in the larger equipment shelter adjacent to the tower. The Contractor shall coordinate with the landlord, for all work to be performed at Bacton Hill.

7. Y100

a. The UHF SMARTNET/Conventional Equipment is located in the larger equipment shelter adjacent to the tower. The Contractor shall coordinate with the landlord, for all work to be performed at Y100.

1.4. DISPATCH LOCATIONS

A. SEPTA operates out of several dispatch locations, the Contractor shall reference the drawing package for a table identifying locations and quantities for all consoles requiring replacement under this specification.

B. 1234 Market Street

1. On the 19th floor, SEPTA operates a combination of Motorola Centracomm Gold Elite Consoles, Motorola Command Plus Consoles and L3Harris Symphony Consoles all requiring replacement under this contract.

C. Frankford Transportation Center (FTC) Ancillary Control Center (ACC)

2. The Frankford transportation Center (FTC) /Auxiliary Control Center (ACC) operates as the back-up Dispatch Center for SEPTA operations, dispatch consoles and support equipment shall be installed as part of this contract as indicated by these specifications.

D. 2nd & Wyoming

1. 2nd & Wyoming has typically been the head-end of SEPTA’s existing radio network, and will remain as one of the redundant sites for the new 700 MHz radio system. This location also serves as the Maintenance headquarters for dispatching of radio maintainers and as such requires support consoles and equipment for maintenance tasks.

1.5. SUBSCRIBER EQUIPMENT

A. The Contractor shall be responsible for furnishing ALL the subscriber equipment and their accessories identified in the drawing package except for the SEPTA police portable/mobile radios and existing 700/800 MHz City of Philadelphia Control stations. The Contractor shall reference the drawing package for a table identifying departments and quantities for all replacement subscriber equipment and associated accessories.

B. The contractor shall be responsible to re-program all existing 700/800 trunked portable and control stations. The Contractor shall reprogram these radios to add additional new talk groups or frequencies required by the new SEPTA trunked radio system. These radios are currently in use and critical to the life safety nature of Police
Operations, the Contractor shall include a plan to update the radios with minimal impact to the SEPTA Transit Police in the overall Transition Plan.

C. The contractor shall be responsible to reprogram and integrate the existing trunked control stations currently in use as the dispatch interface to the City of Philadelphia (COP) trunked radio system. These control stations shall be maintained as backup to the ISSI interface required by this specification as primary connection to the COP trunked radio system. The control stations shall be configured to support all Motorola feature sets for seamless integration the COP.

D. The Contractor shall be responsible for installing subscriber equipment in all Revenue and Non-Revenue (i.e. Maintenance, Supervisory etc.) vehicles. The Contractor shall reference the drawing package for a table identifying the number of vehicle installations required for all replacement subscriber equipment.

E. The Contractor shall be responsible to develop a fleet map based on the SEPTA’s existing radio fleet map, provide all required subscriber personality templates based on clones of existing SEPTA units, and program all mobile, mini-base control, radios and portables owned by the SEPTA Police Department and Transit Operations for operation on the replacement Radio System.

F. Prior to mass programming, the Contractor shall submit one radio for each personality to SEPTA for approval, in order to avoid programming errors.

G. The contractor shall submit to SEPTA for approval a detailed plan to transition SEPTA subscribers on to the new trunked radio system. The contractor shall supply personnel to facilitate and implement the reviewed transition plan.

H. The Contractor shall be responsible for providing programming software, appropriately equipped laptop computers, and all other support equipment and special cables necessary to program each type of subscriber equipment.

I. The Contractor shall program supplied subscriber units with a SEPTA reviewed personality for use on P25 trunked systems

PART 2 – PRODUCTS – NOT APPLICABLE

PART 3 – EXECUTION – NOT APPLICABLE

END OF SECTION
SECTION 13701
700 MHz RADIO SYSTEM DESIGN REQUIREMENTS

PART 1 - GENERAL

1.1. DESCRIPTION OF WORK

A. The Contractor shall review all available documents provided by SEPTA and perform extensive site surveys prior to submitting a cost proposal. Any work required based on the survey results or document reviews shall be included in the proposal and itemized on a site by site basis.

B. It shall be the responsibility of the Contractor to design, manufacture, install, and test the replacement Radio System, produce a transition plan to be submitted and reviewed by SEPTA, and implement the transition of users from UHF/SMARTNET/Conventional to P25 Trunked with minimal disruption. In conjunction with these processes, the Contractor shall submit designs and implementation plans for approval and SEPTA will perform design reviews and approvals contiguous with each step.

C. All equipment submittals by the Contractor shall be accompanied by a lifecycle roadmap. Upon review by SEPTA, any equipment and Software not deemed appropriately supported will require an alternate submittal.

D. The OEM/Manufacturer’s Engineer shall be required to attend and participate in all design meetings. This Engineer shall be employed by the OEM/Manufacturer directly and not be a partner, distributor or authorized retailer.

E. The Contractor shall meet the following schedule for submissions, design reviews, transition and approvals which are required at the following steps, as a minimum:

F. Design Stage - The Design Stage shall be complete and SEPTA approvals obtained prior to start of the Manufacture Stage.

1. Submission of Detailed Schedule – 1 month after Award.
2. Completion of traffic load/capacity analysis – 3 months after award
3. Completion of SEPTA Fleet Map – 4 months after Award.
4. Completion of Intermodulation Analysis for all sites – 4 months after Award.
5. Completion of radio personalities with templates – 4 months after Award.
6. Completion of Implementation, Test and Transition Plan – 4 months after Award.
7. Completion of Final Radio System design with drawings – 12 months after Award.

G. Manufacture Stage - The Manufacture Stage shall be complete, and all SEPTA approvals obtained prior to proceeding with installation.

1. Completion of Factory Acceptance Test Plan – 9 months after Award.

2. Factory Acceptance Testing – 18 months after Award.

3. Factory Acceptance Test results, data and analysis –19 months after Award.

H. Site and System Acceptance

1. Completion of RF Site Prep Work (i.e. Shelter, electrical, mechanical etc) – 24 months after award.

2. Completion of Site Acceptance Test Plan – 10 months after Award.

3. Site Acceptance Test results, data and analysis – 24 months after Award.

4. Completion of Radio System Test Plan – 12 months after Award.

5. Radio System Test results, data and analysis – 24 months after Award.


7. Completion of Coverage Acceptance Testing with data and analysis – 36 months after Award.

8. Completion of the Transition Plan after which all users are on 700 MHz P25 Trunked and the legacy UHF systems have been turned off – 42 months after Award.

9. Submission of Punch List for approval which SEPTA will update and maintain – 42 months after Award.


1.2. SPECIFIC REQUIREMENTS

A. It shall be the responsibility of the Contractor to derive a fleet map compliant with 700 MHz P25 Phase II equipment supplied that includes all the talkgroups/channels that presently exist for all operations within SEPTA (Police and Transit). SEPTA will supply the existing System fleetmaps to the Contractor as a basis for conversion to a 700 MHz P25 fleetmap. The Contractor shall coordinate with SEPTA representatives in assigning existing “Open Channel” PTT and passenger carrying vehicle user groups priority access on the replacement 700 MHz Radio System.
B. The list of existing SEPTA talkgroups are available to the Contractor upon request.

C. The Contractor shall also supply all personality templates for subscriber equipment that they program and for the SEPTA Radio Shop for future programming of new mobiles and portables.

1.3. DESIGN REVIEW PROCESS

A. The design review process shall proceed as follows:

1. The Contractor shall submit content for review and approval in accordance with the requirements herein and the Project Schedule.

2. The Contractor shall submit interrelated items concurrently.

3. The Contractor shall notify SEPTA one week prior to each submission.

4. SEPTA will review each submission and provide comments and/or corrections as appropriate.

5. The Contractor shall correct each submission based on the comments/corrections and re-submit for approval.

6. SEPTA will grant approval in writing upon successful completion of each submission resolving previous comments and concerns.

1.4. DESIGN SUBMISSION AND APPROVAL TIMEFRAMES

A. The Contractor shall follow the submittal and task schedule below which requires Final Acceptance 46 months after the contract award.

<table>
<thead>
<tr>
<th>Submission</th>
<th>Submission Due after Award (MONTHS)</th>
<th>Approval Time (WEEKS)</th>
<th>Resubmission Approval Time (WEEKS)</th>
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<tbody>
<tr>
<td>Detailed Schedule</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Traffic load/capacity analysis</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Intermodulation Analysis</td>
<td>4</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Fleet Map</td>
<td>4</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Event Description</td>
<td>Submission</td>
<td>Submission Due after Award (MONTHS)</td>
<td>Approval Time (WEEKS)</td>
</tr>
<tr>
<td>--------------------------------------------------------</td>
<td>------------</td>
<td>-------------------------------------</td>
<td>-----------------------</td>
</tr>
<tr>
<td>Radio Personalities</td>
<td>4</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Transition Plan</td>
<td>4</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Final System Design</td>
<td>12</td>
<td>3</td>
<td>1.5</td>
</tr>
<tr>
<td>Factory Acceptance Test Plan</td>
<td>9</td>
<td>3</td>
<td>1.5</td>
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<tr>
<td>Factory Testing</td>
<td>18</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Factory Test Results</td>
<td>19</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Completion of RF Site Prep Work</td>
<td>24</td>
<td>2</td>
<td>1</td>
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<tr>
<td>Site Acceptance Test Plan</td>
<td>10</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Site Acceptance Results</td>
<td>24</td>
<td>2</td>
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<tr>
<td>System Test Plan</td>
<td>12</td>
<td>3</td>
<td>1.5</td>
</tr>
<tr>
<td>System Test Results</td>
<td>24</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Coverage Acceptance Test Plan</td>
<td>13</td>
<td>3</td>
<td>1.5</td>
</tr>
<tr>
<td>Coverage Acceptance Test Data</td>
<td>36</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Completion of Transition Plan, All users on new Radio System</td>
<td>42</td>
<td>3</td>
<td>1.5</td>
</tr>
</tbody>
</table>
1.5. DESIGN APPROVAL PROCESS

a. The Contractor shall not proceed with any manufacturing, installation or testing without the Final System Design and Transition plan approval in writing. Failure to follow this procedure is solely at the risk of the Contractor.

PART 2 – PRODUCTS – NOT APPLICABLE

PART 3 – EXECUTION – NOT APPLICABLE

END OF SECTION
SECTION 13702

700 MHz RADIO SYSTEM ARCHITECTURE REQUIREMENTS

PART 1 - GENERAL

1.1. DESCRIPTION OF WORK

A. The SEPTA Radio System architecture shall be based on the Motorola Astro 25 Core Network IP Architecture.

1.2. RADIO SYSTEM ARCHITECTURE REQUIREMENTS

A. The SEPTA Radio System architecture, based on the Motorola Astro 25 Core Network IP Architecture, shall include the following:

2. Redundant Zone Controllers and Network Management Server.
3. Redundant LAN Switches.
4. Redundant Core Routers.
5. Redundant Gateway Routers.
7. GPRS Gateway Support Node Router.
8. Packet Data Gateway.
9. Network Router(s).
11. GPS Sourced NTP for time synchronization of all Ethernet based systems.
12. MOSCAD Network Fault Management Server.
15. Redundant Hot-Standby Microwave Radios.
17. Network Key Management Facility (KMF).
18. Console Sub System Interface (CSSI) Gateway (server, switch and router).
19. Inter-RF Sub System Interface (ISSI 8000) Gateway (server, switch and router).
20. PTT across broadband and radio networks (WAVE Server, switch and router)

B. The P25 Radio System shall have the following attributes:

1. A unique Wide Area Communications Network Code (WACN) programmed into terminals and Radio System and used to uniquely identify a particular P25 network of trunked systems.

C. The P25 Radio System architecture proposed shall be equipped with or be capable of all interfaces defined by the P25 standard, as follows:

1. Air Interface
   a. Common Air Interface.

2. IP Interfaces
   a. Subscriber Data Peripheral Interface.
   b. Network Management.
   c. Data Network Interface.
   d. Interoperability Interface.
   e. Logging recorder interface.
   f. Network Key Management Server Interface.
   g. Event Log Server Interface.
   h. Security Server Interface.
   i. Active Directory Server Interface.
   j. Inter RF Subsystem Interface (ISSI).
   k. Console Subsystem Interface (CSSI).
1.3. KEY RADIO SYSTEM ATTRIBUTES

A. The Radio System shall be equipped with the features and functions listed in Table 13702-1 hereunder. The Contractor shall provide information on these features in their proposal.

<table>
<thead>
<tr>
<th>Table 13702-1</th>
<th>Radio System Feature Set</th>
</tr>
</thead>
<tbody>
<tr>
<td>• 12000 Bits/Second Control Channel</td>
<td>• Radio Check</td>
</tr>
<tr>
<td>• Automatic Access Retry</td>
<td>• Radio Inhibit</td>
</tr>
<tr>
<td>• Busy Queuing With Callback</td>
<td>• Radio Uninhibit</td>
</tr>
<tr>
<td>• CAD Interface</td>
<td>• Recent User Priority</td>
</tr>
<tr>
<td>• Call Interrupt (System)</td>
<td>• Roaming (Other P25 Trunking Systems)</td>
</tr>
<tr>
<td>• Call Interrupt (User)</td>
<td>• Roaming De-Registration</td>
</tr>
<tr>
<td>• Call Validation By Group And Individual</td>
<td>• Transmission Trunking By Group Or User</td>
</tr>
<tr>
<td>• Console Priority Interface</td>
<td>• Trunk Disable</td>
</tr>
<tr>
<td>• Continuous Trunk Updating</td>
<td>• Mission Critical Enhanced Geo-Fence</td>
</tr>
<tr>
<td>• Emergency Alarm Channel Hold</td>
<td>• Personal Accountability</td>
</tr>
<tr>
<td>• Group Priority Levels</td>
<td>• Location on PTT</td>
</tr>
<tr>
<td>• Message Trunking By Group Or User</td>
<td>• Enhanced Data</td>
</tr>
<tr>
<td>• Remote enable “hot” microphone</td>
<td>• OTA Firmware to Subscriber (firmware &amp; codeplug)</td>
</tr>
</tbody>
</table>
B. The System shall have a main and geo-redundant Astro 25 Master core such that voice and data services would remain operational if the primary core was destroyed. The switch between cores shall be automatic and require no intervention from technicians or end users.

C. The System shall have a Prime and geo-redundant Prime site in that audio processing and channel resource management remains operational should the Prime Site experience a failure. The switch shall be automatic and require no intervention from technicians or end users.

D. Compliance with AES 256 Bit on Project 25 systems as described in ANSI/TIA/EIA-102.AAAD (2002), titled “Project 25 - Block Encryption Protocol.”

E. Provide hierarchical addressing and inter-subsystem organization for:
   1. Network IDs (NIDs)
   2. 64K Group IDs
   3. 16M Unit IDs

F. Provide the following:
   1. Group Calls (Normal and Emergency)
   2. Individual Call
   3. System All Call
   4. Call Queuing
   5. Queuing Priority
   6. System Busy
   7. Call Denied
   8. System All Call
   9. Call Queuing
10. Queuing Priority

11. System Busy

12. Announcements (Assigned as Group Call)

13. Radio Out of Range (No Control Channel)

14. Patch from IP Console (Temporary or Permanent)

15. Simuselect from IP Console

16. Telephone Interconnect

G. Wide Area Scan - The P25 Radio System shall supply a wide area scan feature with the following attributes:

1. Algorithm Based on Received Signal Strength Indicator (RSSI) and Control Channel verification

2. Scan starts after RSSI Drops below a User Defined Threshold

3. Searches for new Control Channel based on User Defined adjacent System Scan List (fixed programming in radio or dynamic from Central Controller via Control Channel messages).

4. Switches to new Site, if User Defined Criteria is met.

5. Radio will not switch if improvement in RSSI does not meet User Defined Criteria.

6. Radio will go into full time scan if no Control Channel is found

H. Core Capacity - The SEPTA Astro 25 Core shall be able to support the following as minimum quantities:

1. Number of Channels 300 Channels

2. Number of Sites 24 Sites

3. Number of Consoles 125

4. Number of concurrently Registered Users 16000

1.4. SIMULCAST EQUIPMENT

A. In order to reduce cost, achieve maximum spectrum efficiency, reduce time domain interference, and maximize the RF coverage with the existing number of remote sites, the 700 MHz Radio System shall employ IP linear mode simulcast technology.
B. The Main Master and Prime Site equipment shall be located at the 1234 Market St location.

C. The redundant Main Master and redundant Prime Site shall be located at the SEPTA 2nd & Wyoming “Voter Room” location.

D. P25 TDMA Simulcast technology based on Network timing as the primary synchronization source and a GPS as the backup timing source shall be used.

E. The simulcast sub-system shall be a fault tolerant design with auto re-synchronization and possess redundant key components.

F. Each simulcast channel shall be capable of the following:
   1. Control the amplitude of the transmitted radio signal from each base/repeater station.
   2. Control the phase of the transmitted radio signal from every base/repeater station.
   3. Control the timing of the transmitted audio signal from every base/repeater station.

G. The equipment shall allow for control from a central location without any manual intervention at other Remote Sites. The equipment shall provide for automatic, scheduled timing and optimization routines to simplify maintenance. However, equipment shall also permit manual adjustment for delay spread optimization, as required. The equipment shall be of a design that can be easily expanded in the field. The Contractor shall supply all equipment and training required to perform timing and optimization.

H. The following additional requirements and specifications shall also apply where applicable:
   1. The Contractor shall be responsible for the simulcast performance of the integrated Radio System, and shall provide equipment that will provide such performance.
   2. The Contractor shall provide a method for automatic alignment of simulcast parameters from a central point in the network. This equipment used to perform the automatic alignment shall incorporate remote control capability to disable and enable individual transmitters for troubleshooting.
   3. Simulcast frequency stability shall be maintained with the use of Network Timing or Rubidium GPS receivers, rubidium clocks, or similar sources or standards at each simulcast site.
   4. The frequency standard equipment shall have the following design features:
a. High-stability reference, capable of maintaining the transmitter frequency stability required for voice quality at the level of DAQ 3.4, and data transmission with BER $<10^{-6}$, with normal maintenance intervals of no more than 1 year.

I. Operational temperature range of -22 to +140 degrees F.

J. Appropriate alarm outputs to alert SEPTA of degradation or failure.

1. The Radio System shall provide for maintaining the audio phase, delay, and equalization parameters necessary for high-signal-quality simulcast operation from the Radio System central control equipment at the simulcast RF remote sites, via interconnecting backhaul facilities. The equalization equipment shall have the following design features:

a. Delay equalization equipment shall be capable of adjustment in steps of 1 microsecond or less.

K. Bulk audio propagation delay shall be controlled through an automatically adjustable delay line. The delay line shall be digital and shall automatically adjust for changes in baseband propagation delay as a result of changes in the interconnecting microwave network.

L. Audio phase and amplitude equalization shall be controlled automatically. Alignment test signals that are transmitted automatically during alignment shall not be heard by the users of the Radio System.

1.5. ASTRO 25 CORE NETWORK

A. Main/Redundant Master

1. The Motorola Astro 25 Main Master components loaded with mission critical P25 TDMA software shall be located at the Radio System’s Central Control Site located at 1234 Market St. This site is tightly secured and has floor space for additional racks.

2. The Motorola Astro 25 Redundant Master components loaded with mission critical P25 TDMA software shall be located at the Radio System’s redundant Central Control Site located in the “Voter Room” at SEPTA’s 2nd & Wyoming location. This site is tightly secured, well-grounded and has floor space for additional racks.

3. The Motorola Astro 25 Core Network, WAN/LAN components, Simulcast Prime Site, all Servers, and associated sub-systems shall be connected to Contractor supplied DC power plants at the Contractor’s proposed rack locations.

4. The Motorola Astro 25 Core Network Architecture and associated sub-systems shall provide the following functions:
a. Registration and de-registration of individual portable, mobile, mini-base, console and control station units with individual repeater sites to allow assignment of voice channels to allow communication over the Radio System to and from these units.

B. Processing of all call requests, including private calls, group calls and fleet calls to and from Dispatchers and to and from Radio System subscriber units, and directing calls to the required repeater sites, so that all individual users in the talkgroup or fleet receive the call, and that all users in the voice group or fleet and the Dispatcher receive all responding calls.

C. Processing of PTT requests from vehicle operators and requests for individual, group, and fleet calls to Dispatchers or other vehicles from Dispatchers. The Radio Network Controller and associated equipment shall perform all of the functions required to process the original PTT over the control channel, to request a voice channel from the trunked voice channel pool, to cause the radio in the vehicle(s) or portable to perform the appropriate functions to obtain a trunked voice channel for the voice call, and to cause the radio in the vehicle(s) to revert to operation on the control channel when the voice call is completed.

D. Control of all trunked and conventional channel functions related to call routing, receiver voting, and site selection required to allow both the conventional channel data and the trunked voice channel components of the Radio System to operate transparently and without significant intervention on the part of the Dispatchers and other users of the Radio System.

E. Control of IP linear mode simulcast process including timing, delay, and launch controls.

F. Prime/Redundant Prime Site

1. The Simulcast Prime Site equipment shall be located at 1234 Market Street. The Prime Site equipment shall be connected to IP links from the Simulcast and Auxiliary Receiver Radio Sites all of which terminate in the 1234 Market Street Penthouse. Dark Fiber from the Penthouse to the C&S Server Room shall be provided by SEPTA.

2. The redundant Simulcast Prime Site equipment shall be located at 2nd & Wyoming “Voter Room”. The redundant Prime Site equipment shall be connected to IP links from the Simulcast and Auxiliary Receiver Radio Sites all of which terminate in the “Voter Room”.

3. Existing T1 and IP Data links are provided by SEPTA via fiber and/or leased circuit links. The Contractor shall replace the existing Alcatel MDR8000 Microwave system and furnish/install any additional Microwave backhaul links required to deploy a functioning system.

G. Roaming and Hand-off
1. The Radio System shall permit the radio user to roam across the entire area of coverage without requiring manual switching or changing of site information.

2. As a user roams through the Radio System, the system shall automatically provide Uplink handoff from one site to the next, ensuring that it will always select a high quality signal. The Contractor shall indicate whether the handoff is based on the “best server” or some other algorithm, the parameters (RSSI, bit error rate) used to determine Uplink handoff, and to what degree speech is lost during handoff.

3. The Radio System shall track users as they roam through the network and direct his/her voice calls to the site at which the user is located.

4. When operating across a multiple zone simulcast network, the Radio System shall provide the user the same features as when operating within a single simulcast zone network.

H. Voice Group Priority

1. The Radio System shall queue calls based on voice group priority, with a minimum of eight priority levels. Calls shall be positioned in the queue based on priority, with calls of highest priority (such as emergency calls) being serviced first. Calls of equal priority shall be processed on a first in, first out basis.

2. Queuing Priority shall be programmed in the Network Administration System database.

3. Voice shall also be given the highest Class of Service available on any router or switches in the IP network associated with the Astro 25 Core Network Architecture.

I. Administration and Network Management

1. The Radio System shall be provided with Administration and Network Management applications and associated User Terminals that provide Network Administration and access to operational data and statistics for the Radio System. These applications shall provide user access based upon a defined authorization hierarchy to be configured by the Radio System Administrator. The Radio System shall provide the data and functions described in this section for the Radio System as a whole, including interoperability channels, and trunked voice channels.

2. The User Terminals shall have access to the following functions as a minimum:

   a. Individual radio enable/disable.

   b. Pre-canned or custom text messaging.

   c. Current unit voice group affiliation (unit search).
d. Activity (PTT-ID) Display.

e. User Terminal password/access levels.

f. Trunked and conventional channel conditions (activated/idle/failed).

g. Enable/disable selected trunks/channels.

h. Priority levels (unit and voice groups).

i. Unit, voice group and trunk usage reports.

3. User Terminals shall provide a graphical user interface and extensive on-line help database. Servers supporting the Administration and Network Management applications shall be interfaced to the trunked/conventional voice/data Radio System through a standard Ethernet interface protocol.

J. Channel Controller

1. The SEPTA’s replacement Radio System shall be a single IP simulcast zone consequently, the channel control equipment rack(s) (cabinet(s)) shall be located adjacent to the Astro 25 Core Network cabinets/racks at both the C&S Server Room and 2nd & Wyoming respectively.

2. The channel control equipment chassis and power shall be capable of a minimum of 18 Trunked channels.

K. GPS System

1. The Contractor shall provide Network Based Timing as the primary Radio system synchronization source. All equipment required to provide for Network timing including GPS antenna and servers shall be provided.

2. In addition, Two (2) GPS receivers, Two (2) GPS antenna, and transmission line shall be furnished and installed by the Contractor at each simulcast Remote Site and at the Network Controller location. The GPS receivers, antenna, and antenna mount shall be of modern high sensitivity, low noise, and ultra-stable frequency standard units. The GPS receiver system shall include Rubidium Standard backup. GPS shall be used as the backup timing system to synchronize the Radio System simulcast delays and provide a Network Clock.

L. Net Clock

1. The Contractor shall configure all provided sub-systems and devices to operate using a common, redundant network timeserver (GPS based), which shall provide a single source “fixed time” standard. This includes the following major sub-systems and components, as a minimum:

a. Trunked Radio System components.
b. Market St and Frankford Dispatch Workstation sub-system.

c. System Management Workstations.

d. Interconnection sub-system (multiplexers and/or routers, managed switches).

e. Verint Digital Logging recorder(s).

2. The NetClock software shall be addressable via a standard PC for management and configuration changes.

M. Software

1. The Contractor shall provide all the software required for a P25 TDMA Simulcast Radio System including the software required to meet any of the APCO P25 options specified herein. Software shall be the latest Release or the latest stable Version available from the Contractor.

2. Software and licenses shall be provided for the following as a minimum:

   a. Network Switch.

   b. All Routers and IP Switches.

   c. IP Simulcast Technology.

   d. Network Administration Application.

   e. Network Management Application.

   f. Directory Services Application.

   g. Firewall Application.

   h. Base Stations.

   i. IP Consoles.

   j. IP Console Workstations.

   k. Control Stations.

   l. Mini-Base Radios.

   m. Portable Radios.

   n. Mobile Radios.

   o. Net Clock.
q. Event logging servers.
r. Verint Logging Recorder.

N. Network Alarm System

1. The Contractor shall provide and install an Alarm System which shall support all the Radio System equipment using SNMP traps and be capable of a minimum of 32 binary external alarms and/or analog points to monitor other SEPTA site equipment.

2. Each site shall have a chassis that provides digital and analog inputs/outputs. Binary points shall be connected to SEPTA equipment as specified elsewhere herein.

3. The Alarm System at each site shall:
   a. Collect alarms and activity from the site.
   b. Forward alarms to the Network Manager.
   c. Forward activity to the System Manager.
   d. Forward alarms to Administrators via email and/or text message notifications
   e. Maintain a Database of the Site Configuration.
   f. Support remote alarm monitoring.

4. The Alarm Systems shall be addressable via a standard PC for management and configuration and changes.

1.6. INTEROPERABILITY GATEWAY

A. The Radio System shall provide automatic interoperability with existing trunked and conventional Radio Systems from the same or different manufacturers. Interoperability is defined as the capability to connect or patch trunked voice groups on the new Radio System through the wide area controller with trunked voice groups on an existing Radio System. Automatic is defined as taking place without operator (User or Dispatcher) intervention. It is acceptable for an operator to be required to set up the initial connection. However, all subsequent inter-system communications should occur without any human intervention.

B. The Radio System shall provide automatic interoperability with existing conventional radio channels, where a voice group on the new P25 Radio System is connected through the wide area controller to a conventional radio channel, or alternatively to a CTCSS defined voice group on a conventional radio channel.
C. SEPTA has voice interoperability with multiple agencies available on the existing L3Harris and Motorola Consoles and this functionality shall be maintained with the replacement Motorola MCC7500e consoles. The Contractor shall provision interfaces for up to 24 outside agencies via wireline or over-the-air (OTA) pickup. The audio for this interoperability shall appear as an Icon on the dispatch console via a communications module.

D. The existing trunked or conventional Radio Systems to be interfaced may operate in the VHF, UHF, 700/800 MHz, or 900 MHz frequency bands. The conventional station interface shall accommodate any one or all of these. Interoperability is not required at the air interface.

E. The Radio System shall support statically defined interfaces between CTCSS talkgroups on conventional channels and talkgroups on the new Radio System, where once the interface is configured it is not changed.

F. The Radio System shall support dynamically defined dispatch console patch style interfaces between conventional channels and talkgroups on the new Radio System, and talkgroups on the new Radio System with conventional channels, where the interface can be configured by the Dispatcher.

G. The Radio System shall support permanent patches configured such that there is no degradation in audio quality from a P25 talkgroup to a conventional channel.

H. The Contractor shall maintain all the existing interoperability and as a minimum supply the interoperability functionality on the replacement consoles for up to 24 outside channels/agencies.

1.7. BROADBAND PUSH-TO-TALK (WAVE) SERVER

A. The Radio System shall provide a communications interoperability and broadband push-to-talk (PTT) solution that delivers real-time voice and data securely over any network using a SEPTA approved device. An approved device shall include but not be limited to: SEPTA approved commercial smartphones, tablets and PC’s. Broadband PTT shall be through an appropriate application for each respective device type.

B. The Broadband solution shall leverage any type of IP Network including but not limited to, commercial cellular (3/4/5G), commercial Wi-Fi, Private LTE or Mesh Networks and Private Wi-Fi/LAN/WAN.

C. The Broadband PTT solution shall provide at a minimum the following features:

1. Group/Private Call
2. Group/Private Text
3. Voice/Data Encryption
4. Device Authorization
5. Presence Status

6. Location Sharing and mapping

7. Forward alarms to the Network Manager.

D. The Contractor shall furnish licenses for interfacing up to two hundred (200) SEPTA approved devices.

PART 2 – PRODUCTS – NOT APPLICABLE

PART 3 – EXECUTION – NOT APPLICABLE

END OF SECTION
SECTION 13703
700 MHz RADIO SYSTEM EQUIPMENT REQUIREMENTS

PART 1 - GENERAL

1.1. DESCRIPTION OF WORK

1.2. Fixed Site Equipment

A. The following sections describe the requirements and specifications for trunked repeater base stations and associated equipment for SEPTA’s Radio System.

B. Tower Top Pre-Amplifiers (TTA) shall not be utilized by the Contractor. All active electronics equipment shall be located in the Radio Equipment shelter/room/hut/house etc.

C. Repeater Base Station Specifications

1. Base station transmitters and receivers shall be Motorola GTR8000 stations that comply with the following:
   b. Base Stations supplied shall operate primarily in P25 Trunking Phase 2 (TDMA) with the ability to fall back to P25 Trunking Phase 1 (FDMA) should a P25 FDMA user join or affiliate with a call.
   c. Type accepted by the FCC.
   d. Base Stations shall be designed for continuous duty, 100% operation at full manufacturer’s specification.
   e. Base Stations shall meet the following Emission Designators: 8K70D1E, 8K70D1D, 8K70D1W, 8K10F1E, 8K10F1D, 8K10F1W, 10K0F1E, 10K0F1D, 10K0F1W, 9K80D7E, 9K80D7D, 9K80D7W, 17K7D7D, 16K0F1D, 16K0F3E, 11K0F3E, 14K0F1D, 14K0F3E, 21K7D7E, 21K7D7D, 21K7D7W
   f. Base Stations shall be certified compliant with the APCO Project 25 Phase II suite of standards.
   g. Base Stations shall have been subjected to the Compliance Assessment Program (CAP) driven by National Institute of Standards and Technology, Office of Law Enforcement Standards (NIST OLES) and have a Supplier Declaration of Conformance (SDoC) Certificate.
   h. Base Stations shall operate on two frequencies, one transmit, and one receive.
i. Base stations shall be configured for operation from either standard 120 VAC 60 Hertz with a voltage tolerance of ± 10% and a frequency tolerance of ±3.0 or a 48VDC Battery Plant with a voltage tolerance of -42.0 to -60 VDC. The Contractor shall determine the configuration based on the outcome of their pre-proposal site surveys of existing conditions.

j. 700 MHz Transmitters (Trunked) shall operate in the IP linear simulcast mode.

k. Transmitters shall be equipped to provide a minimum power output of 100 watts continuous at 140°F ambient temperature with input AC voltage anywhere within the base station input voltage range specified in i above. In-service power settings shall be determined by coverage requirements, FCC licensed ERP, and the Contractor’s overall Radio System design.

l. Each repeater base station at each site shall be equipped with an automatic station identifier to transmit the FCC call sign in Morse code at intervals of not more than 30 minutes, in accordance with FCC rules. Radio System users shall not hear the identifier signal. The identifier shall be "polite," such that it begins during an interruption in radio traffic and, if interrupted, resets and attempts to send again, until such time that the complete message has been sent.

m. One complete metering package and microphone common to all base stations at a single site shall be supplied. This includes a local speaker and volume control to monitor all on-channel signals.

n. Base stations shall be equipped with visual indicators and contact outputs indicating malfunctions in transmitter output power, synthesizer condition, and AC or battery power-supply status.

o. The indication of failure of transmitter power and/or receiver operation shall be transmitted by the local alarm system to the Network Manager terminal.

p. Shall include a “fail-soft” trunking configuration designed to maintain radio system performance in the event of critical site component failures. The network design shall be fault tolerant with redundant levels of hardware and software required to maintain trunking during equipment failures.

D. Base Station Test Modes

1. The static receiver sensitivity required to achieve a 5 % BER or less stated in the response shall be the guaranteed value for operation in a high noise environment (SEPTA service area) and not a nominal or typical value. The Faded Reference Sensitivity based on providing a DAQ 3.4 (2.4% BER) shall be based on testing in accordance with TIA-102.CAAA-C section 2.1.5 and shall be used for coverage predictions.

2. Each base station shall allow local control using a common test set or laptop computer.
3. As a minimum, the test set (or base station equipment) shall provide the following controls and functions for local operations:
   a. Transmitter keying and modulation.
   b. Local receiver audio volume.
   c. Coded squelch encode and decode disable switch (affecting local and console).
   d. Coded squelch decode disable switch (affecting local speaker only)
   e. Repeater disable.
   f. Intercom to Comm. Controller console (on voice channel only).
   g. Transmitter disable - effective in all modes of operation.
   h. Line input/output disable switch for testing purposes.
   i. Local control functions that could cause service interruptions shall be equipped with visual indicators.

1.3. CONTROL STATION EQUIPMENT
   A. Mini-Base/Control Station Radios
      1. 700 MHz P25 Mini Base/Control Station Radio’s shall be the latest iteration of the Motorola APX6500 that comply with the following:
         b. The Contractor shall provide proof of FCC "Type Acceptance" for the subject radio, over the required frequency range, by including the manufacturer’s "Type Acceptance Number" with the Technical Submittal, as part of the bid response.
         c. Meet APCO minimum recommendations and EIA/ TIA standards for P-25 Public Safety 700/800MHz trunked radio systems. Radios shall have been subjected to the Compliance Assessment Program (CAP) and have a Supplier Declaration of Conformance (SDoC) Certificate. Furnished equipment must be operable for Phase II TDMA operating modes.
         d. Control stations shall operate from 120 VAC 60 Hertz with a voltage tolerance of ± 10% and/or a frequency tolerance of ±3.0 Hertz.
e. Control stations shall be available as an integrated 120 VAC-powered desktop radio cabinet or a remotely located AC powered radio package with a local desktop control head.

f. Radios shall be housed in rugged cases, with all points of access gasketed and sealed against dust. No internal ventilation shall be required. Cable connectors shall be securely attached to unit.

g. Radio’s shall be fully operational and maintain all settings previously in effect following restoration of 120 VAC power. Control stations shall be able to withstand repeated short cycling of the AC input power and still restore to normal operation.

h. Radios shall operate on 700 MHz Trunked and Conventional frequencies.

i. Include heavy duty construction and weather-sealed cases to meet Military Standards 810 C, D, E, F and G for shock, vibration, dust, humidity, high/low temperature and water resistance.

j. Meet IP54 standards

k. Allow operations on P-25 Trunked Systems with priority scan of talk groups or conventional channels.

l. Include APX O5 control head.

m. Allow to be programmed over-the-air (OTA) via the Astro 25 700 MHz Network. OTA updates to include but not be limited to: Codeplug and configuration parameters available via traditional programming software. The OTAP system shall require a Hardware System Key as a security feature to prevent unauthorized programming of fielded radios.

n. Over The Air Programming (OTAP) shall not interfere with radio users by requiring them to switch to a non-busy channel or remain in an area with high signal strength during data download.

o. The user shall be able to transmit and receive as normal during the programming data download without causing the OTAP session to be aborted.

p. If an OTAP session is interrupted the radio must have the ability to pause data downloads during an incoming voice transmission and then resume once the call is finished to minimize restarts for OTAP sessions.

q. OTAP sessions shall be seamless to the user and users shall have no knowledge of OTAP sessions being performed until the codeplug downloads are complete.
r. Radios shall be capable of supporting batch simultaneous firmware updates over the P25 system and not require one firmware update to be conducted in a sequential manner.

s. Firmware updates whether conducted over the P25 network or over Wi-Fi shall be seamless to the user until the session is complete. Not requiring interruption of user transmit or receive calls until updates have been completed is mandatory.

t. The radio shall accept programming of the subscriber’s firmware, codeplug, and radio license data over the air.

u. The user shall be prompted to accept software updates before the subscriber applies the update and reboots.

v. Subscribers shall support continued download even while roaming between sites over the P25 network.

w. Radio shall support out of the box programming, where the radio can be received, taken out of the box, turned on, and programmed over Wi-Fi without the need for additional user intervention for initial programming on the subscribers.

x. Allow to be programmed in the field using a laptop computer. The connection shall be accessible without requiring the removal of equipment from its mounting bracket or from the equipment rack.

y. Be programmable via common piece of software for technicians to program all radios on the system via OTAP or traditional wired method in order to minimize training.

z. A software application shall be available to allow for the management of all radio codeplugs, templates, personalities or profiles which store system, channel, talkgroup and other radio configurations.

aa. A programming software application shall be capable of copying radio channel information and radio configuration between portable and mobiles or between tiers by simple "Drag and Drop" operation.

bb. The software application shall have the ability to store these files in a database and keep track of each individual configuration file on a per radio basis.

cc. The software application shall have the capability of scheduling at once 1000+ subscribers for updates to systems, talkgroups, channels and other codeplug configurations.

dd. The application shall also include a programming interface that can be loaded on a remote computer that allows the user to connect the subscriber via USB.
on the remote computer and receive programming updates over IP without requiring the end user interface to the application.

e. A codeplug template shall be shareable across multiple radios and changes to the template must be capable of being automatically applied to all affected radio codeplugs to reduce fleet programming time.

ff. Allow for secure over-the-air key distribution and management.

gg. Include P25 Authentication

hh. Shall be capable of a minimum 1000-channel capacity

ii. Include digital voice encryption, using federally approved AES coding, to provide enhanced security during transmission and reception of sensitive communications.

jj. Time-out Timer: A time-out timer shall turn off the transmitter after a time interval (adjustable up to three minutes) of continuous transmit, generate an alert tone on the radio speaker, and reset upon release of the PTT switch. It shall be possible to completely disable the timeout timer. Thermally controlled transmit power reduction is also acceptable.

kk. Mini-Base/Control station radios shall be capable of "cloning" a radio personality (without individual ID numbers) to minimize future reprogramming costs.

ll. PTT ID – Radios shall be capable of individual identification numbers that are transmitted with every PTT.

mm. The Contractor shall supply to SEPTA a Mini Base Station kit comprised of the following: 700 MHz programmable radio (based on Mobile Radio requirements herein these specifications, radio mounting bracket, Omni directional antenna including 50’ of coaxial cable with connectors and antenna mounting brackets. Contractor shall program each Mini Base as per project manager direction and turnover to the SEPTA Radio Shop.

nn. The Contractor shall maintain the connection to the Digital Logging Recorder at each Dispatch location (where existing).

1.4. COMPARATORS

A. Comparators shall meet the following requirements:

1. 700 MHz P25 Trunking Comparators shall be Motorola GCM8000 supporting P25 Trunking.

2. 700 MHz audio quality comparison shall be on the basis of lowest IP voice Packet Error Rate or BER.
3. To provide the highest audio quality, voice shall be re-assembled from the best IP voice packets available.

4. The comparator shall differentiate between a weak signal with a high signal-to-noise ratio (or low BER) and a strong signal with a low signal-to-noise ratio (or high BER) and choose the former.

5. A comparator for each radio channel shall be provided to accept and compare the received audio from the multiple base station receivers. Voted audio for that channel shall be sent to all dispatch consoles and shall be simulcast from the base station sites.

6. Each comparator shall be equipped with multiple receiver inputs as required for the Radio System design.

7. On any transmission, the comparators shall make an initial comparison and selection within 50 msec. and subsequent changes in selection within 1 msec.

8. The comparator shall dynamically change receiver selections so that received signals with higher signal-to-noise ratio (or lower BER) are always selected.

9. Controls shall be provided to allow manual override of receiver selection and the disabling of any receiver line at the comparator.

10. Indicators and controls shall be provided at the comparator to display the status and to allow loudspeaker monitoring of each receiver line.

11. The comparators shall operate on 120 VAC ± 10% at 60 Hertz or 43-60 VDC. The operating temperature range shall be -22° to 140° F.

1.5. RF TRANSMITTER DISTRIBUTION SYSTEM

A. The Contractor shall furnish and install a Transmitter Distribution System as per the Radio Design needed to meet the specifications and requirements of this RFP as described in Division 13700. The transmitter combiner system shall interface the base station radios and antennas and may include but not be limited to: combiners, diplexers, isolators, transmit filters and power monitors.

1.6. RF RECEIVER DISTRIBUTION SYSTEM

A. The Contractor shall furnish and install a Receiver Distribution System as per the Radio Design needed to meet the specifications and requirements of this RFP as described in Division 13700. The Receiver Distribution system shall interface the base station radios and antennas and may include but not be limited to: duplexers, preselectors and multicouplers.
1.7. ANTENNA SYSTEMS

A. The Contractor shall furnish and install required antennas and transmission line as per their Radio System design. In addition, the Contractor shall furnish and install replacement antennas and transmission lines at all existing sites being repurposed as part of the Radio System design. The antenna systems shall comply with the following specifications:

B. Antennas

1. Antennas shall meet or exceed the requirements of Part I of EIA-329-A. Separate transmit and receive antennas shall be provided.

2. The Contractor shall replace ALL existing antenna mounts and associated mounting hardware with new components that meet mechanical and wind load requirements. The Contractor shall be responsible for providing structural/civil load calculations for all Tower/Building Antenna work. These calculations and drawings shall require submission of drawings for approval by SEPTA and drawings must be stamped/sealed by a Professional Engineer registered in the state of Pennsylvania. All work required to the tower/building as a result of the Contractors Antenna/Mounts/Transmission line shall be the responsibility of the Contractor.

3. Replacement transmit antennas shall be selected based on the expected transmitter power available at the antenna input so as to not permit the transmit ERP to exceed that on the FCC license.

4. The Contractor shall be allowed to optimize the Radio System performance through the choice of antenna selection; however, replacement antennas shall meet the performance requirements of this section.

5. Antennas shall offer a passive intermodulation performance with a minimum PIM rating of -150 dBc or better.

6. Where feasible, all antennas shall be mounted so as to minimize the pattern distortion effects caused by tower members, transmission lines, other antennas, and other objects located near the antenna.

7. Antennas shall be high-quality, ruggedized models, and designed for long-term, high-reliability performance under high wind and ice conditions, ultraviolet light exposure and for minimal generation of passive intermodulation.

8. Antenna shall be of the highest quality and capable of surviving in and withstanding winds of up to 150 mph with no damage.

9. Antenna selection shall consider the following characteristics:

a. Characteristics to minimize Time Domain Interference (TDI) in coverage overlap areas within the SEPTA coverage area.
b. Suitability for survival at high elevations on tall buildings (150 mph wind velocity and ½-Inch radial ice loading).

c. Suitable for a high noise environment like the greater Philadelphia area with PIM ≤ -150dBc.

d. Electrical and/or mechanical down-tilt requirements.

e. Transmitter to Receiver isolation.

f. VSWR shall be 1.5:1 or better.

g. Vertical polarization.

C. Transmission Lines

1. The Contractor shall furnish and install required transmission line as per their Radio System design. In addition, the Contractor shall furnish and install replacement transmission lines at all existing sites being repurposed as part of the Radio System design. The antenna systems shall comply with the following specifications:

   a. The contractor shall furnish transmission cable as manufactured by Commscope, or approved equivalent.

   b. Sizing and transmission characteristics of transmission lines shall be specified based on the Contractors Radio System design needed to meet the coverage requirements of this RFP.

   c. The replacement RF jumper cables shall be Commscope FSJ4-50B, 1/2-inch Super-flex Heliax®.

   d. Antenna and transmission line connectors shall be weather-proofed, using Commscope type 221213 weather-proofing kit or approved equivalent. Butyl-rubber tape shall be applied liberally to the antenna connector and 3M Scotchcoat® shall be applied liberally over the butyl-rubber tape.

1.8. ANTENNA SUPPORT STRUCTURES

   A. No replacement towers are required as part of this Proposal.

   B. Details of antenna mounting shall be determined by the Contractor, as required by the availability of support structures at each site and the Contractor’s specific design, and in coordination with SEPTA and site specific landlords. Any structural changes or additions require the signed and sealed approval of a Professional Engineer registered in the state of Pennsylvania. Any additional tower loading will require a structural analysis approved by a Professional Engineer registered in the State of Pennsylvania.
1.9. OTHER ANTENNA SYSTEMS

A. Microwave Dish Antennas

1. The microwave antenna systems at each site shall be specified by the Contractor as required to meet the system performance requirements stated in this specification and the regulatory requirements of the FCC.

   a. The Contractor shall furnish all antennas, side arms, pipe mounts, stabilizing bars, radomes, feedlines and related accessories, and mounting hardware necessary for a complete and fully functional installation. Contractors are to assume that a structural analysis of the antenna support structure will be required at any of the sites.

   b. The choice of antennas at each site shall be left to the Contractor. It is SEPTA’s objective to use single antenna configurations with the smallest possible antenna diameter for each path.

   c. The antenna shall be of a solid, parabolic reflector construction. One-piece reflectors are preferred.

   d. At a minimum, the antenna shall have a wind survival rating of 125 MPH with 1-inch radial ice.

   e. All antenna mounts and associated mounting hardware shall be manufactured of steel and hot-dipped galvanized at the manufacturer’s facility.

2. The Contractor shall furnish and install replacement transmission line and Microwave Dish Antennas (waveguide) as part of this proposal. Transmission line work shall comply with the following specifications:

   a. Main antenna feedlines shall be pressurized air-dielectric coaxial or elliptical waveguide transmission cable as manufactured by Commscope, or approved equivalent.

   b. The size of the feedline shall be as required to meet the system performance requirements stated in this specification, however, the cross-section size at its widest point shall not exceed 2-1/4”.

   c. All main line connectors shall be as appropriate to the size of feedline cable being supplied.

   d. Each main feedline shall be furnished with a cable entry port boot.

   e. Transition jumper cables from the main antenna feedlines to the equipment terminals and antennas shall be furnished as required.

   f. All transition cable connectors shall be as required.
g. Feedline ground straps shall be furnished in accordance with SEPTA's installation standards and practices.

h. Straps shall be from the same manufacturer as the main antenna feedlines.

i. Feedline lightning suppression devices shall be furnished in accordance with SEPTA’s installation standards and practices.

j. All feedline mounts and associated mounting hardware shall hot-dipped galvanized or stainless steel.

k. An automatic, integrated air pressurization and dehydration (APD) unit shall be furnished for the main antenna feedline(s). It shall be powered from an external power source supplying a nominal 120 VAC @ 60 Hz, single phase power; and shall not be of the regenerative desiccant type.

l. At a minimum, the APD unit shall be sized to pressurize all the furnished feedlines at each site plus two (2) additional feedlines of the same size and length. The APD unit shall be equipped with a pressure relief valve.

m. At a minimum, the APD unit shall be equipped with an output manifold capable of supporting all the furnished feedlines at each site plus two (2) additional feedlines. The manifold shall be capable of being expanded; and each output port shall be equipped with a pressure gauge and shut-off valve.

n. The APD unit shall be equipped with dry-contact alarm output capability; and, at a minimum, shall alarm the following conditions. These conditions can be combined into a single alarm output or appear as separate outputs. A local visual indicator shall indicate an alarm condition.
   - Low Pressure
   - High Humidity
   - Power Fail
   - Excessive Run Time

o. The output(s) of the APD unit shall be integrated by the Contractor into the new alarm monitoring system. See Section 2.5 for additional information.

B. Mini-Base/Control Station Antennas

1. The Contractor shall furnish and install replacement transmission line and 700 MHz Antennas as part of this proposal.

2. The Contractor shall ensure adequate RSSI for all donor antenna’s in the SEPTA system.
C. GPS Receiver Antennas

1. The Contractor shall replace all existing GPS Receiver antennas including antenna mounts and associated transmission line.

1.10. MICROWAVE RADIO EQUIPMENT

A. The Contractor shall replace all components of the existing CARD 1.0 microwave system with new equipment and augment the microwave system with a redundant link to the 1234 Market St site to facilitate the implementation of the geo-redundant Master/Prime sites specified herein. The Contractor shall propose a Microwave/ Fiber Optic network backhaul system plan to provide connectivity to all RF and the geo-redundant Master/Prime sites required to meet the coverage requirements identified in this RFP. The Contractor shall provide a complete microwave system in accordance with the following requirements and specifications as part of the backhaul supporting SEPTA's replacement 700 MHz, VHF and non-radio legacy T1 systems. The Contractors design shall provide sufficient capacity and bandwidth to support the transition period which may include a combination of some or all of the SEPTA systems including the existing simulcast Transmit/Receive UHF, legacy VHF, replacement 700 MHz System and legacy T1’s supporting non-radio systems. For any given link, the Contractor shall supply the minimum number of T1 interfaces needed to support non-radio legacy T1 equipment AND a minimum 100 Mbps Ethernet connectivity. The Contractor may utilize SEPTA's Fiber Optic network as part of the backhaul design. The Fiber network may be incorporated into this design in order to facilitate a redundant design architecture and overcome limitations of microwave link issues. The overall microwave/fiber optic network backhaul design architecture shall be submitted to SEPTA for approval prior to implementation.

B. General Technical Requirements

1. The Microwave radio design shall be such that a common rack mounted multiplexer/modem unit can be used with an indoor rack mounted RF Unit for the 6, 7, 8 and 11 GHz bands. The radio shall be “software defined” to the extent that a radio terminal can be reconfigured for different applications, data rates, bandwidths and modulations via software alone, without the need to change or modify the hardware. The Contractor shall provide a licensed band, full duplex, digital microwave radio system with single channel full duplex data capacities capable of carrying DS1, DS3 and Gigabit Ethernet traffic independently or in combination.

2. In their response to the RFP, the Contractor shall identify their proposed link bandwidth capacity calculations ensuring that the bandwidth calculated supports traffic for the replacement 700 MHz P25 Radio System, existing VHF Conventional Analog System, SEPTA's existing legacy T1 non-radio systems and the existing SMARTNET UHF Trunked and UHF Conventional Systems during the transition. Furthermore, the Contractor shall provide for 20% additional capacity beyond the capacity required herein for each Microwave Link. The Contractor shall furnish and install all components necessary to produce a working system.
C. Standards

1. The following technical references or standards are applicable to the extent specified herein:

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<td>Microwave Digital Radio Systems Criteria (Telcordia)</td>
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D. Environmental

1. The microwave equipment components shall be designed to operate in a continuous duty cycle in the following environmental ranges:

   a. Rack Mounted Mux/modem Unit
      - Operating Temperature: -5° to +50°C
      - 95% Humidity (non-condensing)
      - Altitude: up to 15,000 ft. AMSL

E. Rack Mounted RF Unit

   - Operating Temperature: -5° to +50°C
   - 95% Humidity (non-condensing)
   - Altitude: up to 15,000 ft. AMSL

F. Primary Power

1. The microwave radio power supply shall be designed to operate from standard -20 to -60 VDC power systems. The supplier shall state the total power consumption for a non-protected and a protected terminal in watts. Power consumption figures will include both “as quoted” and maximum loaded terminals.

2. Voltage Transients - The equipment shall not be damaged and shall recover to normal performance following application of the following maximum transient voltages for the duration shown.
3. Power Connection - Rack mounted RF Unit shall have primary power input connectors separate from the mux/modem unit. In protected terminals, separate primary power connectors shall be provided for the main and standby mux/modem units and for the main and standby rack mounted RF Units.

G. Physical Requirements

1. Proposed equipment shall support an indoor rack-mount configuration. Rack mounted hardware shall mount in a standard 19-inch EIA rack. Split mount RF units mounted indoors shall not be considered an indoor configuration.

2. In the rack-mounted configuration it shall be possible to mount up to four 1+1 protected radios in a seven-foot (45 RU) equipment rack. It shall be possible to configure co-located radios with a separate antenna port for each radio terminal, or combine the signals from several radios into a single antenna port.

3. For efficient use of available rack space when retrofitting radios in existing sites it shall be possible to mount the mux/modem unit and the rack mounted RF Unit separately within a rack or in separate racks up to 10 feet apart.

H. Microwave Radio System RF and Traffic Requirements

1. The microwave equipment components shall adhere to the following:


   b. The radio shall be designed to provide the following transmitted RF bandwidths: 2.5 MHz, 3.75 MHz, 5 MHz, 10 MHz, 20 MHz, 30 MHz, 40 MHz, 50 MHz, and 60 MHz RF transmitted bandwidths as allowed by FCC Part 101 channel plans.

   c. The radio shall provide options for Ethernet and DS1 traffic. Each traffic type will be available in its native format as an input or output from the microwave radio system.

   d. Radios shall incorporate forward error correction as standard equipment. The supplier shall state the type of forward error correction algorithm used.

   e. The radio shall have a residual bit error rate (BER) performance in the absence of thermal, multipath or dispersive fading of 1x10-12 or better.
I. Capacity Upgrades/Bandwidth Upgrades

1. Microwave link capacity and RF transmitted bandwidth shall be set via software. Physical input/output connectors may be either directly provisioned on the mux/modem unit or provided via modules plugged into the mux/modem unit. If the latter, the plug-in modules must be “hot-pluggable”.

2. To reduce upgrade costs, conversion to higher capacities must not involve replacement of high cost units such as modems, power amplifiers, transmitters, control modules, or power supplies. The same mux/modem unit and RF unit shall be used throughout the entire capacity range.

J. Terminal Interconnection

1. At sites with two or more co-located radio terminals, it shall be possible to interconnect terminals such that DS1 and DS3 traffic can pass among the terminals via a single interconnecting cable, eliminating the need to cross connect individual DS1s or DS3s. It shall be possible to distribute individual DS1’s and DS3’s from any of the co-located terminals to any other of the terminals via the interconnecting cable.

K. Traffic Grooming

1. The radio shall feature built in M1-3 multiplexing, DS1 or DS3 routing capability, DS1 drop/insert capability, and DS3 and/or DS1 cross connect capability.

L. Loop Protection

1. To allow radio terminals to operate a loop protected network, an option for loop protection of individual DS1s shall be built into the radio so external 3rd party loop protection switching equipment (i.e., T1 Loop Switch) is not required. Each DS1 channel shall be switched independently of the other channels and DS1 loop switching shall be hitless.

2. Service channels and engineering orderwire shall be loop protected.

3. Ethernet channels shall be loop protected without the need for an external Ethernet switch. Ethernet loop protection switching time shall be less than 900 milliseconds. It shall be possible for an individual radio link to be a member of multiple overlapping Ethernet loops.

M. Modulation

1. The radio terminal shall be capable of operating with modulations from QPSK to 256 QAM. Modulation shall be selected by the terminal based on user software configured payload capacity (Mbps) and software configured RF channel bandwidth (MHz).

N. Adaptive Code and Modulation
2. The radio terminal shall incorporate an Adaptive Code and Modulation (ACM) scheme which allows the radio to dynamically change modulation to maintain a working path during challenging transmission conditions. ACM switching shall be hitless and the radio shall be able to switch through every modulation from 256 QAM to QPSK. It shall be possible through software to disable ACM.

3. It shall be possible to set a Do Not Exceed transmit power such that the set power level will not be exceeded even when ACM selects a lower modulation mode which is capable of higher transmitter power.

O. Encryption

1. The radio terminal shall be capable of encrypting Ethernet data using an AES encryption algorithm. Encryption key size shall be selectable among 128, 196 or 256 bit.

P. RF Interface

1. Rack mounted RF Units shall present the following waveguide interface:

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Waveguide</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 GHz</td>
<td>CMR-137 or CPR-137 as required</td>
</tr>
<tr>
<td>7/8 GHz</td>
<td>UG-51G</td>
</tr>
<tr>
<td>11 GHz</td>
<td>UG-39/U or CPR-90 as required</td>
</tr>
</tbody>
</table>

Q. Antennas

1. The Contractor shall utilize the existing SEPTA CARD 1.0 microwave antennas to the maximum extent possible. Where required, new microwave antennas shall be the minimum diameter required to achieve the required link parameters.

R. Traffic Interfaces

1. The DS1 low speed interface shall be DSX-1 (1.544 Mb/s) as per TR-TSY-000499 and ANSI T1.102.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Rate</td>
<td>1.544 Mb/s +/- 32 ppm</td>
</tr>
<tr>
<td>Data Rate Sink Tolerance</td>
<td>+/- 130 ppm</td>
</tr>
<tr>
<td>Line Code</td>
<td>Provisionable for B8ZS or AMI</td>
</tr>
<tr>
<td>Line Impedance</td>
<td>100 ohms +/- 5%, balanced</td>
</tr>
<tr>
<td>Jitter Accommodation</td>
<td>5.0 UI peak-peak low frequency, 0.1 UI high frequency per TR-TSY-000499 para 7.3.1</td>
</tr>
<tr>
<td>Jitter Transfer</td>
<td>0.1 dB low frequency per TR-TSY-000499 para 7.3</td>
</tr>
<tr>
<td>Jitter Generation</td>
<td>Less than 0.28 UI peak-peak</td>
</tr>
</tbody>
</table>
2. DS1 Interface will be presented on two CHAMP connectors with all DS1 TX signals on one connector and all DS1 RX signals on the second connector.

3. Each individual DS1 shall be independently provisioned for B8ZS or AMI line code.

4. Ethernet Interface - 10/100/1000BaseT Ethernet Interface shall be per IEEE 802.3ab

5. Ethernet interface shall be presented on RJ-45 connectors.

6. An option shall be available to provide an optical Ethernet interface via a Small Form Pluggable (SFP) interface.

7. Multiple 10/100/1000BaseT interfaces shall operate as a Layer 2 switch.

8. Ethernet shall support IEEE 802.1p and 802.1Q for QoS and tag-based VLAN

S. Protection Configurations

1. The radio system shall be available in the following protection configurations:
   a. Non-protected (1+0)
   b. Full Hot-standby (1+1)
   c. Full Hot-standby/space diversity (1+1 SD)
   d. Non-protected Repeater

2. 1+1 and 1+1 SD radios shall be fully redundant with no unprotected active components. Preference will be given to systems with complete duplication of the primary and standby terminals. It shall be possible to do maintenance, up to and including completely removing the terminal, on either the primary or standby terminal without disconnecting traffic cables or interrupting traffic on the other terminal.

3. The use of “Y” cables for the user interface to protected radios is not allowed.

4. Space diversity radios shall feature errorless receiver switching.

5. Repeater configuration shall provide an “East-West” 1+0 repeater in a single radio eliminating the need for two independent radios as repeaters sites.

T. Radio Transmitter Requirements

1. The microwave radio transmitters shall adhere to the following:
a. The radio shall meet the FCC’s emissions mask requirements specified in FCC Part 101 for applicable frequencies and bandwidths.

b. The frequency setting accuracy and stability shall be at least ±0.001% over all specified operating conditions.

c. The supplier shall state the guaranteed operating RF transmitter power output measured at the antenna port for both non-standby and hot-standby configurations. Transmitter power levels shall be guaranteed across the radio’s specified temperature range.

d. Hot-standby protection schemes using transmitter combining to achieve the indicated power levels are not desired but may be considered provided required path availability can be achieved for each transmitter individually with the protection power amplifier disabled or removed. Higher power outputs that cannot be sustained for indefinite periods shall not be included as part of this requirement.

e. The radio system shall have the capability of operation with automatic transmitter power control (ATPC). A minimum of 10 dB of transmitter power reduction from full normal operating power shall be provided. The Contractor shall describe the ATPC feature and its operation including the maximum power reduction, ATPC threshold, and the step increase in transmit power when activated from a low power state. Preference will be given to ATPC implementations that provide an incremental increase in transmit power over a single step method. The ATPC feature shall incorporate an alarm indication that shall be activated if the transmitter remains in the full power mode for greater than 5 minutes. ATPC shall be a standard feature on all radios; however, it should be possible to disable ATPC by software selection.

U. Radio Receiver Requirements

1. The Contractor shall state the typical dispersive fade margin (DFM) for BER of 10-6.

2. The Contractor shall state the guaranteed receiver 10-6 BER thresholds for non-standby, hot-standby and hot-standby with space diversity configurations. The threshold shall be measured at the terminal antenna port. Guaranteed threshold levels shall be guaranteed across the radio’s entire specified temperature range. In the event of Receiver IF combining for protected or diversity systems, the threshold of a single, non-combined receiver shall be used.

3. The Contractor shall state the maximum received signal level for BER 10-6 measured at the antenna interface. The maximum RSL for a 10-6 BER shall not be lower than –20 dBm.

4. The Contractor shall provide Threshold-to-Interference (T/I) parameters for the receiver for like modulation for co-channel and adjacent channel interference. The T/I ratio is defined as the ratio of the receiver threshold to the interfering
carrier level that results in a degradation of the receiver threshold from 10^-6 to 10^-5 BER.

5. The receivers shall employ errorless switching between the primary and protection traffic. Errorless switching is defined as any switching method that does not generate bit errors at the DS1 or Ethernet signal due to the switching action itself for manual or fade induced receiver switches.

6. The radio shall activate and output Alarm Indication Signal (AIS) on the DS1 line upon detection of an incoming DS1 line failure or in the event of a radio path failure. The AIS format shall be as described in TR-TSY-000191.

7. Ethernet ports shall include the ability to optionally set Link Loss Forwarding such that loss of the microwave path will disable all front panel Ethernet ports to signal down-stream equipment that the path is not available.

8. It shall also be possible to set Link Loss Forwarding such that loss of the microwave path will only disable the Ethernet switch port leading to the RF Path but allow other ports to remain active. The intent is to allow co-located devices which communicate locally through the radio modem/mux unit to maintain contact while preventing the buffers leading to the RF path from overflowing.

9. Link Loss Forwarding shall be enabled or disabled via software.

10. Ethernet ports shall be configurable such that Port 1 at the near end connects exclusively to Port 1 at the far end, and Port 2 to Port 2, etc. Under such a configuration it shall be possible to set Loss of Ethernet Input Forwarding such that a loss of Ethernet signal into a port of the near radio will disable corresponding port on the far end radio, while other ports will remain active.

V. Radio Ancillary Items

1. The radio system shall include integral voice orderwire that shall terminate the audio channel with a standard telephone set. The orderwire shall have its own dedicated bandwidth in the overall radio bit stream and shall not consume user payload. In the event the voice orderwire is not used the dedicated orderwire channel shall be available as an RS-422 asynchronous data channel.

2. The radio system shall provide two RS-232 digital service channels.

3. The radio shall incorporate at least six inputs for external alarms. External alarm input will be activated (put into the alarm state) by pulling the alarm input to ground. An active external alarm will show on the radio terminal’s alarm list and result in an SNMP trap being issued by the radio terminal.

4. The radio shall incorporate at least 4 form-C dry relay contacts for signaling alarm conditions in the radio terminal. The alarm outputs shall be mappable such that any alarm or combination of alarms generated within the radio terminal can be used to toggle one of the relays.
5. In protected radios the default mapping shall be to indicate Major and Minor alarms from the Primary and Major and Minor alarms from the Standby terminals.

W. Terminal Configuration, Control, Monitoring & Diagnostics

1. In this context, local is meant as being one or more of the terminal sites with direct physical access to the terminal. The radio shall have visual indicators for Power On, Major Alarm, Minor Alarm, and in the case of protected or diversity radios, on-line status.

2. Local radio setup, control and monitoring will be done with a laptop computer. The radio shall provide access via both a serial interface and an Ethernet (10/100 BaseT or 10/100/1000 BaseT) interface. The radio shall support both a text-based Craft Terminal Interface (CTI) which can be accessed using standard terminal emulation software such as Hyperlink, and software based Graphic User Interface (GUI) which must be provided by the vendor free of charge. The GUI must run on both Windows based and Apple laptop computers.

3. Access to terminals on the network shall require a logon name and password to be stored in the radio terminal. Authorization levels shall include “Guest”, a read only authorization, and “Administrator”, a full configuration and control authorization.

4. Remote Authentication Dial In User Service (RADIUS) remote password authentication shall be supported in which a network RADIUS server maintains a listing of passwords and authorizations for each radio and each individual who may access radios in the network. Attempts to logon to any radio in the network will be authorized by RADIUS before logon is permitted. The implementation must allow for at least two separate RADIUS servers on the network.

5. The configuration capability shall include at a minimum, the following:
   a. Set radio terminal Identification and IP addresses
   b. Set radio frequency
   c. Set transmitter output power in 1 dB increments
   d. Select Automatic Transmit Power Control (ATPC) on/off and select set point
   e. Select Adaptive Code and Modulation (ACM) on/off
   f. Set RF channel bandwidth
   g. Set radio aggregate data rate
   h. Provision individual inputs (DS1/DS3) and select line code (AMI/B8ZS) on a per DS1 basis.
i. Set Ethernet LAN and VLAN functions and ingress rate.

j. Set M1-3 functions and DS1/DS3 routing through the radio hop

k. Configure alarm output relays (configurable for which alarm or combination of alarms each relay represents)

l. Set terminal internal clock for time stamping

m. Ability to save an inventory of terminal components, including part and serial numbers.

n. Select on-line and off-line terminal in protected or diversity systems

o. Transmitter mute

p. Current alarm status

q. On-line/off-line status

r. Alarm History

s. Time Stamped alarm and event log

t. Transmitter output power

u. Received Signal Level

v. Aggregate BER

w. G.826 Statistics

6. The radio terminal shall contain a non-volatile memory section in the mux/modem unit in which all configuration parameters are stored. This memory section will be easily removable from the MUX/MODEM unit such that it can be installed into a replacement MUX/MODEM unit to replicate all MUX/MODEM functions.

7. It shall be possible, with local access to any terminal within contiguous network to log onto any other terminal in the network and perform all of the functions available for Local Display and Control.

8. The radio terminal shall incorporate an SNMP network management agent which can be used with any commercially available SNMP network management system. The terminal shall support SNMP v1, v2 and v3.

9. SNMP management traffic shall be carried in an out-of-band channel, separate from user payload. It shall be possible, however, to insert the SNMP traffic into the user payload channel.
10. The SNMP Management Information Base (MIB) shall be provided.

11. A history of radio performance (including Received Signal Level (RSLs), transmitter power output, alarm status, G.826 stats) shall be stored for a period of at least six months in the radio itself. Performance measurements shall take place at a user definable time period, with a minimum sample taken at one second increments. This feature shall support automatic uploads to a central server via Trivial File Transfer Protocol (TFTP).

12. The GUI shall provide a method of displaying analog values (such as RSL) and alarm status retrieved from the radio terminal’s performance history in a graphical format.

13. A facility allowing network monitoring from mobile devices (smart phone, tablet computers, etc.) shall be provided. Monitoring shall include overall network health, identifying specific radio hops within the network which are not operating properly, and basic operational characteristics such as RSL, Errored Seconds, etc. Mobile Network Monitoring shall be “read only”.

X. Electromagnetic Compatibility

1. The radio equipment shall be designed to operate in a communications equipment environment installed in or near the vicinity of other types of equipment which may include other digital radio equipment, fiber optic terminal equipment, FDM analog microwave, VHF/UHF base stations, transfer trip and power line carrier equipment and telephone signaling equipment.

Y. Maintenance

1. In 1+1 protected terminals, normal maintenance actions that include replacements of failed or faulty redundant traffic processing units on the off-line portion of the radio shall not impair operation of the on-line portion of the radio.

2. It shall be possible to remove defective components without unplugging or disconnecting user input cables.

3. The radio terminal will have built in features for the following diagnostic testing:
   a. Remote and local loopback functions for DS1, and aggregate data rates
   b. Aggregate Bit Error Rate monitoring
   c. Built-in DS1 PRBS Bit Error Rate Tester which can be activated on any individual DS1
   d. RF Mute
   e. Software selection of on-line/off-line status in 1+1 radio terminals.
f. QAM Constellation Viewer

g. RF signal SNR (Signal to Noise Ratio) display

h. FEC (Forward Error Correction) stress indication

Z. Factory Testing

1. The radio equipment shall be configured and tested by the Contractor on a per hop basis prior to delivery in accordance with the supplier’s standard, commercial test procedures and methods. The testing shall be adequate to ensure proper operation and performance of the radio equipment in accordance with these requirements.

2. The provider shall provide facilities for in factory acceptance testing.

AA. Service Life

1. The radio equipment shall be designed for a service life of at least 15 years.

BB. Warranty

1. The radio equipment warranty period shall be as specified in Section 01400 “Quality Control and Warranty Requirements”.

1.11. SUBSCRIBER EQUIPMENT

A. The following sections describe the requirements and specifications for subscriber equipment including Portable and Mobile Radios for SEPTA’s Radio System.

B. Portable Radio Equipment

1. 700 MHz P25 Portable Radio’s shall be the latest iteration of the Motorola APX900 Model 2 that comply with the following:


b. The Contractor shall provide proof of FCC "Type Acceptance" for the subject radio, over the required frequency range, by including the manufacturer's "Type Acceptance Number" with the Technical Submittal, as part of the bid response.

c. Meet APCO minimum recommendations and EIA/ TIA standards for P-25 Public Safety 700/800MHz trunked radio systems. Radios shall have been subjected to the Compliance Assessment Program (CAP) and have a Supplier Declaration of Conformance (SDoC) Certificate. Furnished equipment must be operable for Phase II TDMA operating modes.
d. Radios shall be operable on 700/800 MHz conventional and trunked frequencies.

e. Include heavy duty construction and weather-sealed cases to meet Military Standards 810 C, D, E, F and G for shock, vibration, dust, humidity, high/low temperature and water resistance.

f. Meet IP68 (2m/2hr) standards

g. Allow operations on P-25 Trunked and P25 Conventional Systems with priority scan of talk groups or conventional channels.

h. Include enhanced noise reduction feature.

i. Include an integrated GPS allowing for outdoor location tracking and telemetry

j. Allow to be programmed over-the-air (OTAP) via the Astro 25 700 MHz Network. OTA updates to include but not be limited to: Codeplug and configuration parameters available via traditional programming software. The OTAP system shall require a Hardware System Key as a security feature to prevent unauthorized programming of fielded radios.

k. Over the Air Programming (OTAP) shall not interfere with radio users by requiring them to switch to a non-busy channel or remain in an area with high signal strength during data download.

l. The user shall be able to transmit and receive as normal during the programming data download without causing the OTAP session to be aborted.

m. If an OTAP session is interrupted the radio must have the ability to pause data downloads during an incoming voice transmission and then resume once the call is finished to minimize restarts for OTAP sessions.

n. OTAP sessions shall be seamless to the user and users shall have no knowledge of OTAP sessions being performed until the codeplug downloads are complete.

o. Radios shall be capable of supporting batch simultaneous firmware updates over the P25 system and not require one firmware update to be conducted in a sequential manner.

p. Firmware updates conducted over the P25 network shall be seamless to the user until the session is complete. Not requiring interruption of user transmit or receive calls until updates have been completed is mandatory.

q. The radio shall accept programming of the subscriber's firmware, codeplug, and radio license data over the air.
r. The user shall be prompted to accept software updates before the subscriber applies the update and reboots.

s. Subscriber units shall support continued download even while roaming between sites over the P25 network.

t. Allow for secure over-the-air key distribution and management.

u. Include P25 Authentication

v. Shall be capable of a minimum 512 channel capacity

w. Include top-mounted rotary controls with positive stops for volume and channel selection and a backlit Keypad, Model 2.0

x. Incorporate electronic, alphanumeric white full bitmap color LCD backlit display to provide visual indication of system availability, channel/talk group selected, incoming user ID, call alerts and operational status such as scan, transmit or low battery.

y. Transmit a Time-Out Timer to warn the user that the radio may be transmitting longer than a predetermined time limit and then disable the transmitter. The portable radio shall permit flash programming of the transmitter Automatic Time-out (ATO) period from 30 to 90 Seconds, in at least three increments.

z. Incorporate an accessory receptacle for the connection of external devices such as remote microphones or combination remote speaker/microphone units (with or without antenna), vehicular adapters and mobile data computer equipment.

aa. Be programmable through the use of a flash upgradable CPU. Flashing of the CPU shall occur without disassembly of the radio housing. A readily accessible external connector shall function as a data communication port for this purpose. Specific quantities, as listed in other purchasing documents, of computer interface devices, software, and software instructions shall be provided with the radio equipment as part of this acquisition. The software shall be provided via USB read-only memory for compatibility with the Microsoft 7 or 8 (or later) Windows Operating System. The Contractor shall provide a minimum of 10 programming cables or interconnect devices for configuration and uploading of software to the radios.

bb. Permit flash programming of any other specified function requiring adjustment of transceiver circuit operation to make the transceiver compliant with this specification. It shall not be necessary to employ tools or to remove the cover of the transceiver to provide full and complete implementation of all functional and operational requirements of this specification.
cc. Be programmable via common piece of software for technicians to program all radios on the system via OTAP or traditional wired method in order to minimize training.

dd. A software application shall be available to allow for the management of all radio codeplugs, templates, personalities or profiles which store system, channel, talkgroup and other radio configurations.

ee. A programming software application shall be capable of copying radio channel information and radio configuration between portable and mobiles or between tiers by simple "Drag and Drop" operation.

ff. The software application shall have the ability to store these files in a database and keep track of each individual configuration file on a per radio basis.

gg. The software application shall have the capability of scheduling at once 1000+ subscribers for updates to systems, talkgroups, channels and other codeplug configurations.

hh. The application shall also include a programming interface that can be loaded on a remote computer that allows the user to connect the subscriber via USB on the remote computer and receive programming updates over IP without requiring the end user interface to the application.

ii. A codeplug template shall be shareable across multiple radios and changes to the template must be capable of being automatically applied to all affected radio codeplugs to reduce fleet programming time.

jj. Provide single-unit 120VAC rapid chargers capable of fully charging a discharged high capacity battery pack within a one-hour period.

kk. Battery shall operate the proposed radio equipment a minimum of twelve-hours using a duty cycle of 5% transmit, 5% receive and 90% standby.

ll. Fully integrated and compatible products shall be provided as indicated on the project drawings.

C. Non-Revenue Mobile Radio Equipment

1. 700 MHz P25 Mobile Radio’s shall be the latest iteration of the Motorola APX4500 that comply with the following:


b. The Contractor shall provide proof of FCC "Type Acceptance" for the subject radio, over the required frequency range, by including the manufacturer's "Type Acceptance Number" with the Technical Submittal, as part of the bid response.
c. Meet APCO minimum recommendations and EIA/ TIA standards for P-25 Public Safety 700/800MHz trunked and conventional radio systems. Radios shall have been subjected to the Compliance Assessment Program (CAP) and have a Supplier Declaration of Conformance (SDoC) Certificate. Furnished equipment must be operable for Phase II TDMA operating modes.

d. Radios shall be operable on 700/800 MHz conventional and trunked frequencies.

e. Include heavy duty construction and weather-sealed cases to meet Military Standards 810 C, D, E, F and G for shock, vibration, dust, humidity, high/low temperature and water resistance.

f. Meet IP56 standards

g. Allow operations on P-25 Trunked, P25 Conventional and Conventional FM Analog Systems with priority scan of talk groups or conventional channels.

h. Include APX O2 control head

i. Include Remote mount kits

j. Include speaker increased audio power to 15W @3.2 ohms.

k. Include Palm Microphone

l. Include an integrated GPS allowing for outdoor location tracking and telemetry

m. Allow to be programmed over-the-air (OTAP) via the Astro 25 700 MHz Network. OTA updates to include but not be limited to: Codeplug and configuration parameters available via traditional programming software. The OTAP system shall require a Hardware System Key as a security feature to prevent unauthorized programming of fielded radios.

n. Over The Air Programming (OTAP) shall not interfere with radio users by requiring them to switch to a non-busy channel or remain in an area with high signal strength during data download.

o. The user shall be able to transmit and receive as normal during the programming data download without causing the OTAP session to be aborted.

p. If an OTAP session is interrupted the radio must have the ability to pause data downloads during an incoming voice transmission and then resume once the call is finished to minimize restarts for OTAP sessions.

q. OTAP sessions shall be seamless to the user and users shall have no knowledge of OTAP sessions being performed until the codeplug downloads are complete.
r. Radios shall be capable of supporting batch simultaneous firmware updates over the P25 system and not require one firmware update to be conducted in a sequential manner.

s. Firmware updates whether conducted over the P25 network or over Wi-Fi shall be seamless to the user until the session is complete. Not requiring interruption of user transmit or receive calls until updates have been completed is mandatory.

t. The radio shall accept programming of the subscriber’s firmware, codeplug, and radio license data over the air.

u. The user shall be prompted to accept software updates before the subscriber applies the update and reboots.

v. Subscribers shall support continued download even while roaming between sites over the P25 network.

w. Radio shall support out of the box programming, where the radio can be received, taken out of the box, turned on, and programmed over Wi-Fi without the need for additional user intervention for initial programming on the subscribers.

x. Allow for secure over-the-air key distribution and management.

y. Include P25 Authentication

z. Shall be capable of a minimum 512-channel capacity

aa. Transmit a Time-Out Timer to warn the user that the radio may be transmitting longer than a predetermined time limit and then disable the transmitter. The mobile radio shall permit flash programming of the transmitter Automatic Time-out (ATO) period from 30 to 90 Seconds, in at least three increments.

bb. Be programmable through the use of a flash upgradable CPU. Flashing of the CPU shall occur without disassembly of the radio housing. A readily accessible external connector shall function as a data communication port for this purpose. Specific quantities, as listed in other purchasing documents, of computer interface devices, software, and software instructions shall be provided with the radio equipment as part of this acquisition. The software shall be provided via USB read-only memory for compatibility with the Microsoft 7 or 8 (or later) Disk Operating System. The Contractor shall provide a minimum of 10 programming cables or interconnect devices for configuration and uploading of software to the radios.

cc. Permit flash programming of any other specified function requiring adjustment of transceiver circuit operation to make the transceiver compliant with this specification. It shall not be necessary to employ tools or to remove the cover
of the transceiver to provide full and complete implementation of all functional and operational requirements of this specification.

dd. Be programmable via common piece of software for technicians to program all radios on the system via OTAP or traditional wired method in order to minimize training.

D. A software application shall be available to allow for the management of all radio codeplugs, templates, personalities or profiles which store system, channel, talkgroup and other radio configurations.

E. A programming software application shall be capable of copying radio channel information and radio configuration between portable and mobiles or between tiers by simple "Drag and Drop" operation.

F. The software application shall have the ability to store these files in a database and keep track of each individual configuration file on a per radio basis.

G. The software application shall have the capability of scheduling at once 1000+ subscribers for updates to systems, talkgroups, channels and other codeplug configurations.

H. The application shall also include a programming interface that can be loaded on a remote computer that allows the user to connect the subscriber via USB on the remote computer and receive programming updates over IP without requiring the end user interface to the application.

I. A codeplug template shall be shareable across multiple radios and changes to the template must be capable of being automatically applied to all affected radio codeplugs to reduce fleet programming time.

   1. Equipment groupings and quantities are contained in the project drawings.

J. Revenue Vehicle Mobile Radio Equipment

   1. Multi-Band 700/800 MHz and UHF Range 2 (450-512 MHz) P25 Mobile Radio's shall be the latest iteration of the Motorola APX8500 that comply with the following:


   b. The Contractor shall provide proof of FCC "Type Acceptance" for the subject radio, over the required frequency range, by including the manufacturer's "Type Acceptance Number" with the Technical Submittal, as part of the bid response.

   c. Meet APCO minimum recommendations and EIA/ TIA standards for P-25 Public Safety 700/800MHz and UHF Range 2 (450-512 MHz) trunked and
conventional radio systems. Radios shall have been subjected to the Compliance Assessment Program (CAP) and have a Supplier Declaration of Conformance (SDoC) Certificate. Furnished equipment must be operable for Phase II TDMA operating modes.

d. Radios shall be operable on 700/800 MHz and UHF Range 2 (450-512MHz) conventional and trunked frequencies.

e. Include heavy duty construction and weather-sealed cases to meet Military Standards 810 C, D, E, F and G for shock, vibration, dust, humidity, high/low temperature and water resistance.

f. Meet IP54 standards

g. Allow operations on P-25 Trunked, P25 Conventional and Conventional FM Analog Systems with priority scan of talk groups or conventional channels.

h. Include APX O5 control head

i. Include Remote mount kits

j. Include speaker increased audio power to 13W

k. Include Palm Microphone

l. Include an integrated GPS allowing for outdoor location tracking and telemetry

m. Include 802.11 b/g/n 2.5 GHz and 802.11 a/n/ac 5 GHz WLAN (Wi-Fi) Connectivity

n. Allow to be programmed over-the-air (OTAP) via the Astro 25 700 MHz Network. OTA updates to include but not be limited to: Codeplug and configuration parameters available via traditional programming software. The OTAP system shall require a Hardware System Key as a security feature to prevent unauthorized programming of fielded radios.

o. Over The Air Programming (OTAP) shall not interfere with radio users by requiring them to switch to a non-busy channel or remain in an area with high signal strength during data download.

p. The user shall be able to transmit and receive as normal during the programming data download without causing the OTAP session to be aborted.

q. If an OTAP session is interrupted the radio must have the ability to pause data downloads during an incoming voice transmission and then resume once the call is finished to minimize restarts for OTAP sessions.
r. OTAP sessions shall be seamless to the user and users shall have no knowledge of OTAP sessions being performed until the codeplug downloads are complete.

s. Radios shall be capable of supporting batch simultaneous firmware updates over the P25 system and not require one firmware update to be conducted in a sequential manner.

t. Firmware updates whether conducted over the P25 network or over Wi-Fi shall be seamless to the user until the session is complete. Not requiring interruption of user transmit or receive calls until updates have been completed is mandatory.

u. The radio shall accept programming of the subscriber's firmware, codeplug, and radio license data over the air.

v. The user shall be prompted to accept software updates before the subscriber applies the update and reboots.

w. Subscribers shall support continued download even while roaming between sites over the P25 network.

x. Radio shall support out of the box programming, where the radio can be received, taken out of the box, turned on, and programmed over Wi-Fi without the need for additional user intervention for initial programming on the subscribers.

y. Allow for secure over-the-air key distribution and management.

z. Include P25 Authentication

   aa. Shall be capable of a minimum 1000-channel capacity

   bb. Include digital voice encryption, using federally approved AES coding, to provide enhanced security during transmission and reception of sensitive communications.

   cc. Transmit a Time-Out Timer to warn the user that the radio may be transmitting longer than a predetermined time limit and then disable the transmitter. The mobile radio shall permit flash programming of the transmitter Automatic Time-out (ATO) period from 30 to 90 Seconds, in at least three increments.

   dd. Be programmable through the use of a flash upgradable CPU. Flashing of the CPU shall occur without disassembly of the radio housing. A readily accessible external connector shall function as a data communication port for this purpose. Specific quantities, as listed in other purchasing documents, of computer interface devices, software, and software instructions shall be provided with the radio equipment as part of this acquisition. The software shall be provided via USB read-only memory for compatibility with the Microsoft 7 or
8 (or later) Disk Operating System. The Contractor shall provide a minimum of 10 programming cables or interconnect devices for configuration and uploading of software to the radios.

ee. Permit flash programming of any other specified function requiring adjustment of transceiver circuit operation to make the transceiver compliant with this specification. It shall not be necessary to employ tools or to remove the cover of the transceiver to provide full and complete implementation of all functional and operational requirements of this specification.

ff. Be programmable via common piece of software for technicians to program all radios on the system via OTAP or traditional wired method in order to minimize training.

gg. A software application shall be available to allow for the management of all radio codeplugs, templates, personalities or profiles which store system, channel, talkgroup and other radio configurations.

hh. A programming software application shall be capable of copying radio channel information and radio configuration between portable and mobiles or between tiers by simple "Drag and Drop" operation.

ii. The software application shall have the ability to store these files in a database and keep track of each individual configuration file on a per radio basis.

jj. The software application shall have the capability of scheduling at once 1000+ subscribers for updates to systems, talkgroups, channels and other codeplug configurations.

kk. The application shall also include a programming interface that can be loaded on a remote computer that allows the user to connect the subscriber via USB on the remote computer and receive programming updates over IP without requiring the end user interface to the application.

ll. A codeplug template shall be shareable across multiple radios and changes to the template must be capable of being automatically applied to all affected radio codeplugs to reduce fleet programming time.

2. Equipment groupings and quantities are contained in the project drawings.

1.12. Multi-unit chargers

A. Multi-unit chargers shall comply with the following:

1. Multi-unit chargers shall be capable of simultaneously charging, at a minimum, six (6) batteries at a time.

2. Chargers shall accommodate fast charging as well as extended life cycle through battery conditioning.
3. Each charging pocket shall have LED indication with charge status.

4. The multi-unit charger shall have the capability of data upload to a battery management system.

5. The charger shall be capable of recharging the batteries while standalone or while on the portable unit.

PART 2 – PRODUCTS – NOT APPLICABLE

PART 3 – EXECUTION – NOT APPLICABLE

END OF SECTION
SECTION 13704

700 MHz RADIO SYSTEM PERFORMANCE REQUIREMENTS

PART 1 - GENERAL

1.1. DESCRIPTION OF WORK

A. The Contractor shall design, furnish, and install all necessary system switches, controllers, routers, base station repeaters, antennas, interconnecting RF and Ethernet cabling, software, and all other devices and equipment required to completely implement the Radio System described in this Specification, and to fully comply with the system performance requirements described herein.

1.2. General Operational and Functional Requirements

A. The following items define SEPTA’s general operational and functional Radio System requirements, which must be met by SEPTA’s replacement Radio System. The Contractor shall fully describe the manner in which their offering meets or exceeds each of these requirements. Accordingly, if the Contractor’s offering does not meet one or more of the requirements then, each requirement not being met shall be clearly indicated for SEPTA’s evaluation and consideration.

B. All references to coverage reliability in this Specification refer to a channel performance criteria (CPC) service area reliability of 95% where the CPC is a certain level of delivered audio quality (DAQ) or corresponding bit error rate (BER) percentage. For example, the phrase “95% coverage” indicates that the total area described shall exhibit at least 95% statistical probability that coverage areas, if tested, would be found to support RF performance which equals or exceeds that minimum received signal level necessary to deliver Contracted delivered audio quality, as specified by this Specification and the Contract.

C. SEPTA’s Radio System shall:

1. Operate on the existing eighteen (18) licensed 700 MHz channels (WQZG612) at each simulcast Remote Site.

2. Meet APCO Project 25 Phase II requirements.

3. Use 700 MHz IP Linear Simulcast Technology


5. Utilize all eighteen (18) 700 MHz channels for carrying voice and/or data for efficient usage of the available radio channels to meet SEPTA’s operational needs.
6. Provide RF mobile and portable P25 coverage that meets the coverage specifications and requirements as defined in Division 13 throughout SEPTA’s Service Area and meets the specifications and requirements of this RFP as described using IP linear simulcast.

7. Provide mobile and portable coverage reliability throughout the SEPTA bounded service area based on coverage acceptance testing criteria developed in accordance with the latest version of the TSB-88 standard with a CPC corresponding to Delivered Audio Quality (DAQ) = 3.4 or better, corresponding to a Bit Error Rate (BER) = 2.4% or less, whichever is the more stringent.

8. Provide RSSI equivalent to or better than that provided by the existing Radio System to donor antennas that support in-building systems identified in the drawing package. The Contractor shall test and record pre and post RSSI signal levels at each donor antenna and provide these results to SEPTA.

9. Provide RSSI equivalent to or better than that provided by the existing Radio System to donor antennas for all control station systems as identified in the drawing package. The Contractor shall test and record pre and post RSSI signal levels at each control station antenna and provide these results to SEPTA.

10. Interface to SEPTA’s existing Underground DCS System. It shall be the responsibility of the Contractor to account for DCS delay characteristics/parameters when optimizing the outdoor P25 simulcast system. The Contractor shall not be responsible for RF coverage of SEPTA’s Underground DCS at individual passenger stations. The Contractor shall be responsible to interface to the existing system and make any and all required design adjustments, or modifications to provide a working and integrated system. Delay line calculations of SEPTA’s Underground DCS as well as engineering drawings and reference documentation are available to the Contractor upon request.

11. Exhibit P25 RF coverage for both mobiles and portables throughout the Service Area. The Contractor shall submit P25 coverage maps for both mobile and portable coverage over the Service Area with their proposal. Individual large scale coverage maps shall also be submitted for each SEPTA Facility exhibiting both mobile and portable coverage. There shall be two sets of coverage maps for both mobile and portable coverage predictions; one set for talk-out and one set for talk-in. Coverage maps shall include SEPTA GIS routes and specific SEPTA facility locations identified.

12. Support all SEPTA operations requiring voice communications by using either “Open Channel” architecture requiring “Push-to-Talk” or “Request-to-Talk”, “Priority-Request-to-Talk” in conjunction with the CAD/AVL system respectively. The Contractor shall coordinate with SEPTA representatives in assigning existing “Open Channel” PTT users priority access on the 700 MHz Radio System.

13. Provide Radio System interface to all specified subsystems.
1.3. RADIO LINK BUDGET ANALYSIS

A. Over-the-Air Analysis

1. The Contractor shall include in their proposal document a detailed link budget analysis or table for the proposed Radio System, showing the assumptions used to establish minimum required talk-out and talk-in portable and mobile radio signal levels corresponding to a DAQ = 3.4 or BER = 2.4 % Channel Performance Criterion (CPC) requirement as follows:

a. Static sensitivity for mobile and portable radios (dBm), and corresponding BER (digital) performance. Static sensitivity values shall be those that the Contractor guarantees in a high noise environment (Greater Philadelphia Metro Area) and not nominal or typical values.

b. Faded sensitivity for mobile and portable radios (for DAQ 3.4) in dBm, and corresponding BER (digital) performance.

c. Statistical distribution assumed for multipath fading (Rayleigh, Okumura-Rice, etc.).

d. Fading factor (dB) and statistical assumptions (log-normal fading, etc.) used to account for location variability (i.e. adjustment from median required signal level in a given coverage sector or grid segment that were used to model reliable operation at 95% of the locations in that sector or grid segment).

e. Transmit antenna system gain (dBi).

f. Transmitter combiner Net Gain/Loss (dB).

g. Transmission antenna system loss (dB).

h. Base Station Receiver Multi-coupler Net Gain/Loss (dB).

i. Base Station Receiver Multi-coupler Noise Figure (dB).

j. Mobile radio antenna system net gain (dB).

k. Mobile radio transmitter output power (dBm).

l. Portable radio antenna system net gain (or loss), including body losses for waist level operation (dB) with lapel microphone. Body losses attributable shall be specified and shown separately from antenna gain.

m. Portable radio transmitter output power (dBm).

n. Assumptions used to account for IP linear mode simulcast advantage (dB).
o. Assumptions regarding talk-out and talk-in path reciprocity (e.g. any offset factor used to compensate for the difference between talk-out and talk-in coverage) and to allow talk-out signal level targets and acceptance test procedures to be used to confirm talk-in coverage reliability.

p. Assumptions regarding any difference between talk-out and talk-in transmission paths and Radio System performance that may affect the validity of the assumption of path reciprocity with an offset for the difference in base station and mobile and/or portable radio transmitter output power, as described in the current version of TSB-88.

q. RF propagation prediction model (including version number, if applicable) used to provide coverage predictions.

2. The Contractor shall submit both talk-out and talk-in coverage prediction maps for the proposed Radio System. All coverage maps shall be based on the assumptions submitted in the Link Budget Analysis described above.

3. Coverage maps shall be provided for the following types of coverage: throughout the entire Service Area:
   a. Mobile Radio Talk-out (700 MHz with 3 dBi gain antenna) throughout the entire Service Area.
   b. Mobile Radio Talk-in (700 MHz 3 dBi gain antenna) throughout the entire Service Area.
   c. Portable Talk-out Outdoor (with Portable On-Belt with lapel microphone) throughout the Service Area.
   d. Portable Talk-in Outdoor (with Portable On-Belt with lapel microphone) throughout the Service Area.

4. Coverage maps shall be provided using a SEPTA reviewed base map of the Service Area boundary and overlaying the coverage plots to produce the coverage maps.
   a. These maps shall be provided in a scale that lack of coverage is easy to spot during the review of such maps. The paper size shall be 24 inches by 36 inches.

1.4. COVERAGE

A. General

1. The SEPTA Phase II P25 Digital Trunked Simulcast Radio Network shall be designed to support mobile radio equipment on the street throughout the SEPTA service area which extends to an additional 2 mile perimeter boundary from the outermost Bus and/or Paratransit routes. The Contractor shall fully identify and
guarantee the coverage predicted for their proposed solution, per the functional and operational requirements of this Specification. SEPTA has also identified critical yards/depots and general areas which shall have mobile on-street mobile coverage and shall be included in the Contractor’s Functional Test Plan and Coverage Test Plan for both signal strength and DAQ testing.

2. The Contractor shall take into account the following criteria in the development of their coverage guarantee:

a. A 700 MHz mobile with 3 dBd gain antennas with a height of 6’ AGL shall be considered the normal configuration for the purpose of the mobile coverage design. The Contractor shall provide both talk-in/talk-out predicted coverage model maps for mobile coverage.

b. Half wavelength antennas shall be required for portable units. Shoulder microphone units without antennas shall be considered the normal configuration for the purpose of the portable coverage design thus requiring body loss and hip-level, antenna height adjustments to be considered in both talk-in/talk-out coverage analyses. The Contractor shall provide both talk-in/talk-out coverage model maps for portable outdoor coverage.

c. A listing of areas including yards (requiring portable) and depots requiring in building mobile and portable coverage includes; Fern Rock, Bridge St, 69th Street Transportation Center complex including: Platforms & Boarding areas, 69th St, MFSE, 69th NHSL, 69th st MSHL, Midvale Bus Depot, Comly Bus Depot, Frankford Bus Depot, Allegheny Bus Depot, Frontier Bus Depot, Southern Bus Depot, Callowhill Bus Depot, Victory Ave. Bus Depot, Germantown Bus Depot, Wyoming Bus Garage, Elmwood Trolley garage, Woodland Trolley Garage. These locations shall be coverage tested individually as separate service areas (in addition to the overall coverage verification test) to ensure the areas are covered to the same overall coverage standard.

3. For the locations listed above the Contractor shall be responsible for testing the indoor and outdoor coverage (portable and mobile). Should the indoor and/or outdoor coverage not be that of a minimum DAQ 3.4 or 2.4 % BER, the Contractor shall be responsible for furnishing an In-Building/Outdoor Coverage Solution for these areas where the tested coverage does not meet the requirements.

4. The digital test patterns for BER coverage testing shall be based on the latest version ITU-T pseudo-random sequence and the pass/fail criteria for each test tile shall be a Bit Error Rate (BER) that less than or equal to the specified Channel Performance Criteria (CPC).

5. Coverage calculations shall be based on guaranteed static receiver sensitivity for a 5.0 % BER for operation in an urban, high noise environment (SEPTA Service Area) and not a nominal or typical value. This guaranteed value for
receiver sensitivity shall be used for any coverage predictions submitted with your proposal and for equipment calibration in coverage testing.

B. Service Area

1. Mobile radio on-street coverage, for 700 MHz P25 Phase II, shall extend throughout no less than 95% of the SEPTA service area which extends to an additional 2-mile perimeter boundary from the outermost Bus and/or Paratransit routes. A drawing depicting this service area is included as part of drawing package in the contract drawings.

2. Coverage shall be defined as the minimum usable signal necessary to provide “Speech understandable with repetition only rarely needed. Some Noise/Distortion” within the defined service area. The delivered audio quality (DAQ) throughout the service area shall be no less than DAQ 3.4 for mobile operations.

3. All references to coverage reliability in this Specification refer to a channel performance criteria (CPC) service area reliability of 95% where the CPC is a DAQ 3.4 or better corresponding to a measured BER of 2.4% or less. For example, the phrase “95% coverage” indicates that the total area described shall exhibit at least 95% statistical probability that coverage areas, if tested, would be found to support RF performance which equals or exceeds that minimum received signal level necessary to deliver Contracted delivered audio quality, as specified by this Specification and the Contract. However, it will not be acceptable to provide a coverage guarantee which includes a relatively large number of failed points within any given vicinity (no more than four (4) adjacent failed tiles), while still meeting the overall goal of 95% coverage.

C. Propagation Analysis

1. The Contractor, as part of their proposal, shall provide a formal statement that the coverage objectives specified above are met by their proposed solution. ANY exception taken to the specified coverage requirements shall be clearly identified with a detailed description of the extent of the exception and the reason for which it was taken, in order for full consideration to be given to the Contractor during the evaluation process.

2. The Contractor shall provide a written description of the processes and propagation models used to calculate proposed area coverage objectives.

3. Additionally, the Contractor shall ensure that the proposed Radio System design developed must be in compliance with the Region 28 Regional Planning Committee 700 MHz plan for public-safety communications.

1.5. COVERAGE ACCEPTANCE TEST PLAN

A. The Contractor shall include in their proposal, a complete detailed description of the proposed Radio System Coverage Acceptance Test Plan (CATP) that provides a
verifiable and statistically valid means of confirming the Radio System coverage requirements over the entire Service Area.

B. The Radio System Coverage Acceptance Test Plan shall conform to Radio System Coverage Testing requirements as defined in TSB-88 unless more stringent requirements are detailed herein. The Radio System Coverage Test Plan shall conform to the Radio System coverage prediction maps in reference to the assumptions and modeling utilized to predict radio coverage. Requirements for the Coverage Acceptance Test Plan include:

1. No downtime for SEPTA Police & Transit Operations radio communications is acceptable for implementation of the Coverage Acceptance Test Plan.

2. The Coverage Acceptance Test Plan (CATP) shall be designed to verify that the replacement Radio System implemented by the Contractor meets or exceeds the coverage requirements specified herein. The CATP shall define the coverage testing method and procedure, the coverage acceptance criterion, the test documentation, and the responsibilities of both the Contractor and SEPTA. To verify that the radio coverage reliability is met, SEPTA’s Service Area shall be divided into equally sized test tiles as specified elsewhere herein and in accordance with the latest revision of the TSB-88 standards.

3. Coverage testing shall be based on statistical sampling of the predicted coverage area to verify that the CPC is met or exceeded at the required reliability for each of the defined equipment configurations. The Contractor shall sample a statistically significant number of randomly selected locations uniformly distributed throughout the coverage area.

4. These are the types and configurations of radio network and field unit equipment upon which coverage acceptance testing shall be based. Coverage acceptance for this Radio System shall verify the coverage area for the following equipment configurations:
   a. Simulcast P25 Phase II Trunking 700MHz coverage to Mobile radios (in-bound & out-bound)) measured using BER for the Service Area
   b. Simulcast P25 Phase II Trunking 700 MHz coverage to Portable radios (in-bound) & out-bound) measured using BER for the Service Area

5. With approval of SEPTA upon receipt of substantiation documents with necessary calculations, the Contractor may measure in-bound coverage out-bound such that a calibrated receiver with designated RF Pad can be used and BER utilized rather than subjective DAQ testing at the console.

6. RSSI data for the control channel shall be collected on a per tile basis, concurrent with the DAQ test. Multiple samples shall be collected in each tile with a minimum average sample rate that meets the requirements in the latest iteration of TSB-88.
7. For mobile and portable coverage testing the Contractor shall divide the Service Area into a tile pattern to produce the number of uniformly sized test locations (or tiles) required by SEPTA. With the approval of SEPTA, the Contractor may adjust the tile size slightly to correspond to street to street distances, if applicable.

8. The Test Vehicle shall pass through each test tile with the vehicle crossing into the tile at an arbitrary point, with an arbitrary speed and direction. Test vehicle speeds during testing shall not exceed 60 mph, nor be slower than 5 mph.

9. In accordance with TSB-88, a series of sequential measurements (sub-samples) shall be taken in each test tile using the latest ITU-T test pattern. This test location measurement, containing several sub-samples, constitutes the test sample for this location. The test sample will establish the local median BER within the test tile. The distance over which the sub-samples are measured shall be 40 wavelengths. The median of multiple BER sub-samples is used rather than a single measurement to ensure that the measurement is not biased by taking a single sample that might be at a peak or null point on the radio wave. The number of sub-samples shall be based on a 95% confidence interval.

10. Mobile coverage acceptance testing shall be performed in the talk-out direction to a test receiver in a vehicle. Portable coverage testing shall be performed with the appropriate attenuator value installed in the test receiver’s antenna line, to establish an equivalent signal level performance for each equipment configuration. In-bound portable coverage testing shall be performed out-bound, if reviewed by SEPTA with the correct attenuation of the test receiver for BER tests. In the out-bound case, the attenuation shall be the difference between the mobile test receiver’s antenna system and the additional loss used in the Contractor’s coverage prediction to account for portable antenna performance. This provides an objective method of verifying that the Radio System will provide the faded performance threshold (BER) for the specified CPC requirement for each of the defined equipment configurations.

11. After measurements have been recorded for all accessible tiles in each service area; the coverage area reliability percentage shall be determined by dividing the number of tiles that pass by the total number of tiles tested.

12. Inaccessible tiles shall not be included in the coverage calculations.

13. The coverage area reliability calculation result shall not be rounded up or down but remain as calculated to two decimal places.

14. No failed tiles shall be re-tested either subjectively or by BER measurement, to try and obtain a “pass”.

15. The Contractor shall provide the raw coverage test data, mobile and portable coverage maps (inbound & out-bound), and Service Area reliability calculations exhibiting the measured coverage results to SEPTA as part of the documentation requirement of this Specification.
16. SEPTA’s identified list of critical locations including; Fern Rock, Bridge St, 69th St, MFSE, 69th NHSL, 69th St, MSHL shall be coverage tested individually to the same standards (in addition to the overall coverage verification test) to ensure the areas are covered to the same overall coverage standard. None of the critical locations above shall be permitted to fail the individual location coverage test despite the Contractor passing the overall coverage area requirement. A failed coverage test for any identified critical location shall result in a failure of the comprehensive system coverage test.

1.6. **RELIABILITY**

A. The proposed Radio System shall be a robust design ensuring continued operation should any of the following failures (or combination thereof) occur:

1. Loss of transmitter(s) operation
2. Loss of receiver(s) operation
3. Failure of dispatch console terminal(s)
4. Failure of console/audio controller
5. Failure of one site controller
6. Loss of DC-DC power converter(s)
7. Failure of entire single site.
8. Loss of control channel(s)
9. Loss of prime site
10. Loss of single/multiple microwave path connectivity
11. Loss of single/fiber link connectivity

B. The Contractor shall furnish a description of the effect each of the above listed failure modes would have on their proposed network configuration. The Contractor shall also describe appropriate mitigation/restoration steps to return the network to full operational capability in response to each of the above listed failure conditions in their response to this RFP.

C. **Radio System Failure Modes**

1. The proposed infrastructure shall include a "fail-soft" trunking scheme designed to maintain network performance as critical site components fail. Proposed network solutions must be fault tolerant with redundant levels of computer hardware/software, as necessary, to maintain trunked operation during equipment failures.
2. In the event the control channel receiver becomes blocked (continuously or intermittently) for a predetermined period, the Radio System shall automatically reassign the control function to another available radio channel.

3. Failure of the signaling and control system that causes a complete loss of trunking capabilities shall cause an indication (Control Channel Scan) in all radio units, and at the Network Manager workstations.

1.7. RADIO SYSTEM AVAILABILITY

   A. This section identifies the equipment and functions required for SEPTA’s Radio System to be considered available.

   B. For the purposes of Radio System availability calculations, the Radio System availability will exclude failures in existing support utilities, facilities, and communications links provided by SEPTA. Sub-systems provided by SEPTA such as, fiber links, HVAC and AC power shall be presumed to be 100% available for calculations. The Contractor shall communicate with SEPTA any concerns or recommendations toward reliability prior to calculating system availability.

   C. SEPTA’s Radio System shall have a total calculated availability, including complete functional and hardware/software availability of 99.99%. That is, the ratio of time period of system availability over the total measurement period shall be equal to or greater than 0.9999. SEPTA’s Radio System shall include any and all equipment and sub-systems provided by the Contractor, regardless of manufacturer – including existing components recommended by the Contractor for reuse or replacement without exception.

1.8. NUISANCE MALFUNCTIONS AND FAILURES

   A. Nuisance problems are recurring operational or functional problems that cause systems or equipment not to provide the degree of availability necessary for SEPTA operations, or cause SEPTA to assign significant resources (SEPTA or outside Contractor staff) to resolve, on three or more occasions, on similar models of equipment. Such problems may not cause the Radio System to drop below the availability threshold described earlier and shall not be acceptable.

   B. Such problems can be caused by software, firmware, or hardware that is faulty or improperly engineered, or manufactured and shall not include communications links provided by SEPTA that meet the Contractor defined data bandwidth/throughput transmission criteria.

   C. The Contractor shall be responsible for resolving such problems promptly in a jointly agreeable manner. Resolution of any such problems shall be considered as part of the basis for Final Radio System Acceptance.
1.9. EXTERNAL INTERFERENCE

A. The Contractor shall be responsible for basic diagnosis of all interference that degrades the performance of its own or other’s equipment included in the 700 MHz Radio System. The Contractor shall be responsible for resolution if the equipment supplied under this contract is found to be the source of such interference. If the Contractor’s equipment is determined to be limited to contributing to such interference rather than the source, the Contractor shall assist with identifying the source of its contribution and make all necessary changes or modifications to reduce its equipment’s susceptibility and impact on the system.

B. Interference in this case is defined as a degradation of effective receiver performance by 1 dB or greater. Interference includes Passive Intermodulation (PIM) interference, which must be kept 10 dB below the noise floor of all co-located receivers.

1.10. SECURITY

A. The Network shall provide security via the use of firewalls to monitor and protect any traffic from outside the network and detect internal threats. Firewalls shall be in place even though the Radio Network is isolated.

B. Cybersecurity for Mission Critical LMR Communication Systems shall be addressed. In its broadest sense, Cybersecurity for the Public Safety industry addresses all of the security issues, and risks relative to mission critical communications that affect the day-to-day operations of law enforcement, fire departments, emergency medical, and the various federal agencies in support of our national security.

C. Due to the fact that the Motorola Astro 25 Network System Architecture is based on standard IP protocol, it shall employ a Firewall Application for detection of intrusions and malicious code from any external gateways and/or internal intrusions. In particular the Network shall be protected from any outside access to the Administration or Network Manager applications, such that an outside party could assume control of the Network.

D. In addition, the Radio System design, software, and components used, shall to the greatest extent possible; guard against deliberate and inadvertent threats.

E. The Contractor in their design and selection of components for this Radio System shall address the following capabilities as a minimum for system security:

1. Access Control
2. Centralized Logging and Auditing
3. Intrusion Detection Systems
4. Host Security
5. Antivirus software
6. Firewalls
7. Enterprise Backup (Disaster Recovery)
8. Automated Patch & Vulnerability Management

F. Although the Radio System LAN will not be connected to SEPTA’s wide area network, a Firewall is required to detect security breaches and/or technician errors and to prevent any malicious code being transported via insertion of USB sticks, disk drives or other means.

1.11. ENCRYPTION

A. The Astro 25 Core Network Architecture shall be equipped and enabled for AES 256 Bit encryption to prevent monitoring of communications, when necessary. Encryption shall be end-to-end, meaning from radio unit to radio unit or from console to radio unit and vice versa. Transmissions shall not be decrypted at any intermediate points other than the digital logging recorders located at the Market Street, 2nd & Wyoming and FTC locations.

PART 2 – PRODUCTS – NOT APPLICABLE
PART 3 – EXECUTION – NOT APPLICABLE

END OF SECTION
SECTION 13705
700 MHz RADIO SYSTEM POWER REQUIREMENTS

PART 1 - GENERAL

1.1. DESCRIPTION OF WORK

1.2. POWER REQUIREMENTS

A. General

1. The AC supply for all equipment at existing sites varies in configuration; with/without UPS, with/without generator backup. The Contractor shall be responsible for all required electrical service required at each site for the Radio System Cabinets. The Contractor shall be responsible for resolving any generator/UPS compatibility issues as part of this proposal. Drawings depicting existing conditions of each existing site are included as part of the drawing package.

2. The Contractor shall furnish and install a double conversion UPS with a 30 min runtime and separate wall mounted wraparound bypass switch at all 700 MHz Transceiver sites. The UPS shall power 700 MHz and VHF Radio System Racks. The Contractor shall provide an additional 20% for future/growth for all electrical loads when sizing equipment. Receive only sites along SEPTA ROW in existing SEPTA signal huts are excluded from this requirement. For any new transceiver sites, the Contractor shall provide an additional 50% of 700 MHz Radio System loads for future growth when sizing equipment.

3. The Contractor shall furnish and install a Generator and fuel storage/delivery system with a 48 hour runtime at all 700 MHz Transceiver sites. The Generator shall power 700 MHz and VHF Radio System racks as well as shelter supporting systems in the event of the loss of primary utility power. The Contractor shall provide an additional 20% for future/growth for all electrical loads when sizing equipment. Receive only sites along SEPTA ROW in existing SEPTA signal huts are excluded from this requirement. For any new transceiver sites, the Contractor shall provide an additional 50% of 700 MHz Radio System loads for future growth when sizing equipment.

4. The Contractor shall furnish and install an “Appleton” receptacle at all 700 MHz Transceiver sites to accommodate mobile generator connections.

5. The Contractor shall provide SEPTA two (2) full spare DC power plants for a full transceiver site load as spares.
6. SEPTA shall supply 24/48 VDC power for all Receive Only sites chosen by the Contractor which utilize existing SEPTA Communications House’s along the ROW.

7. The Contractor shall tie in all critical power, UPS and Generator alarms into the Radio System Network Management System.

1.3. DISPATCH AREAS

A. SEPTA shall supply AC power (nominal 120 VAC, 60 Hertz) in twist lock receptacles adjacent to each console.

B. The existing AC power feed to each console may be adequate to feed the new MCC7500e and if so, it shall be re-used. If the power requirements for the new MCC7500e consoles is more than presently provided, the Contractor shall include the additional work to provide the required AC power for their design in the cost proposal itemized on a site by site basis.

PART 2 – PRODUCTS – NOT APPLICABLE

PART 3 – EXECUTION – NOT APPLICABLE

END OF SECTION
SECTION 13706

700 MHz RADIO SYSTEM BACKHAUL REQUIREMENTS

PART 1 - GENERAL

1.1. DESCRIPTION OF WORK

1.2. GENERAL

A. The Contractor shall supply all the backhaul requirements for this project.

1. SEPTA shall supply a combination of Dark Fiber, Wave Division Multiplex (WDM) connections and fiber MUX connections for use by the contractor to support the contractors design for backhaul connections. The Contractor shall reference the contract drawings for more information. The Contractor shall furnish and install replacement transmission line (waveguide) and Microwave Dish Antennas (as further detailed in 13703 1.10) as part of this proposal.

2. WDM Connections shall be provided at the following locations:

   a. Between 2nd & Wyoming and 1234 Market Street
   b. 1234 Market Street and the FTC/ACC
   c. Between FTC/ACC and 2nd & Wyoming

3. Fiber MUX connections can be made available to the Contractor but shall require connection requirement to be provided and tested by the Contractor.

1.3. SEPTA EXISTING INFRASTRUCTURE

A. SEPTA presently operates an Alcatel MDR8000 digital microwave Network that provides T1 connections from remote UHF/VHF Simulcast Transmit Sites to their respective Head-Ends (VHF at 2nd & Wyoming, UHF at 1234 Market Street). Satellite receivers are over the SEPTA fiber SONET network along the rail right-of-way.

B. The Contractor shall supply enough bandwidth/capacity to support the existing SMARTNET UHF Trunked/Conventional and Analog VHF systems and their replacement radio systems, legacy T1’s supporting non radio systems AND an additional 20% bandwidth capacity buffer. The minimum provided Microwave link bandwidth shall be 100 Mb. Table 13706-1 below identifies the existing DS1 assignments on the Alcatel network.
### Table 13706-1

<table>
<thead>
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<th>DS#</th>
<th>Circuit</th>
<th>Equipment</th>
</tr>
</thead>
<tbody>
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<td>2(^{nd}) &amp; WYOMING to ROXBOROUGH</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>2(^{nd}) &amp; Wyo to Roxborough</td>
<td>Adtran Channel Bank</td>
</tr>
<tr>
<td>2</td>
<td>2(^{nd}) &amp; Wyo to Y100</td>
<td>Adtran Channel Bank</td>
</tr>
<tr>
<td>3</td>
<td>2(^{nd}) &amp; Wyo to Oxford Valley Mall</td>
<td>Adtran Channel Bank</td>
</tr>
<tr>
<td>4</td>
<td>2(^{nd}) &amp; Wyo to Bacton Hill</td>
<td>Adtran Channel Bank</td>
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<tr>
<td>5</td>
<td>2(^{nd}) &amp; Wyo to New Britain</td>
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<td>SECOM Eq</td>
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<td>13</td>
<td>1234 to ROX SECOM Secondary</td>
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### ROXBOROUGH to Y100

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<td>Adtran Channel Bank</td>
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**ROXBOROUGH to BACTON HILL**

1. CARD, CCT, UHF, VHF | TeNSr Channel Bank
2. Phone               | Adtran Channel Bank
3. Open                |                        
4. Open                |                        

**ROXBOROUGH to NEW BRITAIN**

1. CARD, CCT, UHF, VHF | TeNSr Channel Bank
2. Phone               | Adtran Channel Bank
3. Open                |                        
4. Open                |                        

**ROXBOROUGH to OXFORD VALLEY MALL**

1. CARD, CCT, UHF, VHF | TeNSr Channel Bank
2. Phone               | Adtran Channel Bank
3. Open                |                        
4. Open                |                        

**PART 2 – PRODUCTS – NOT APPLICABLE**

**PART 3 – EXECUTION – NOT APPLICABLE**

**END OF SECTION**
SECTION 13707

700 MHz RADIO SYSTEM VOICE LOGGING RECORDER REQUIREMENTS

PART 1 - GENERAL

1.1. DESCRIPTION OF WORK

A. SEPTA presently has seventeen (17) logging recorders, manufactured by Verint Corporation. In addition to recording servers, there is also an existing Network Attached Storage device (NAS) and a Web server. Regarding radio communications, the existing logging equipment currently records them from the existing radio systems via analog feeds. The Contractor shall maintain recording capability to the existing system in support of the subsystems included in this project. Reference the Contract drawings.

B. To ensure continued compatibility with the existing networked recording servers the additional voice logging recorders (required to record P25 Trunked, Conventional VHF traffic and any VoIP channels utilized as part of the CAD System) shall be capable of centralized playback, so that users can playback both radio recordings and phone recordings from the existing voice logging equipment from a single call catalog if desired.

C. The proposed system shall maintain equivalency to current functionality through the complete migration process. This functionality shall include connectivity with the existing Logging Recorder system, which shall be expanded/modified to V.15 as required to maintain current functionality with proposed 700 MHz trunked radio system and existing conventional and trunked systems. The existing logging recorder system is provided by KOVA, Corp. 102 East Bay Ave, Suite J, Manahawkin, NJ 08050 Vendor Phone: 609-597-1498.

D. All UHF / VHF voice channels and CAD VoIP channels and talk groups shall be recorded. The Contractor shall coordinate with SEPTA for grouping and setup of channels to be recorded during final design/installation prior to going live. All logging recorders shall be synchronized to the Network Clock.

E. The Contractor shall provide new (additional) logging recorders at the 1234 Market St and 2nd & Wyoming to record all UHF / VHF voice channels and CAD VoIP channels and talk groups. The logging recorders shall record for a minimum of seven (7) months with local storage at each site. These new logging recorders shall be interfaced and become part of the existing logging system.

1.2. 1234 MARKET STREET

A. Four (4) recorders are located on the 11th Floor 1234 Market St. and a fifth is located on the 19th floor. The Contractor shall furnish one (1) new Verint Media Recorder v15
on the 11th floor for 344 channels of P25 trunked recording to replace the existing v5 Bus, Police and Telephone Information Center loggers and the v4 CCT logger.

B. On the 19th floor, the Contractor shall furnish and install one new Verint Media Recorder, v15 for 96 channels of analog recording to replace the existing v4 Rail Logger. The existing Analog Tap cards will be reutilized in this system upgrade.

C. The Contractor shall also furnish and install a new Verint Media Recorder v15 datacenter server on the 11th floor.

1.3. FTC/ACC

A. At the FTC/ACC location, the Contractor shall upgrade the two (2) FTC recorders to Verint Media Recorder v15 from v5. The Contractor shall include both the hardware and software to be capable of logging all audio traffic by talkgroup/channel and the capability to review recordings by talkgroup/channel in the same manner as exists today. The existing Analog Tap cards will be reutilized in this system upgrade.

1.4. DISTRICT RECORDERS

A. In addition to the recorders at the Market St and FTC/ACC locations, SEPTA operates nine (9) local District logging recorders for telephone conversations. The Contractor shall upgrade the District recorders to Verint Media Recorder v15 from v5. The existing Analog Tap cards will be reutilized in this system upgrade. A tenth recorder shall be installed by the Contractor at the Suburban Station. The Contractor shall include both the hardware and software to be capable of logging all audio traffic and the capability to review recordings in the same manner as exists today.

1.5. VOICE LOGGING RECORDER SERVER

A. The minimum specifications for the P25 Trunked radio recording server to be provided by the Contractor are as follows:

1. The recording server proposed shall be at a minimum, a KOVA Titanium recorder.

2. The recording server shall support up to 8, hot swappable hard drives, within its chassis.

3. The recording server shall support up to 768 GB memory within its chassis.

4. The recording server shall have redundant, hot swappable power supplies.

5. The recording server shall be configured with a Microsoft Windows Server operating system.

6. The recording server proposed shall have software that can be configured to record P25 Trunked radio traffic on both a talk path and a talk group based recording methodology.
7. The recording server shall support 100,000,000 call recording segments at minimum.

8. The recording server shall support a separate Microsoft SQL database server.

9. The recording server shall support recordings being stored on a local drive array that is separate from the array the operating system is installed upon.

10. The recording server shall support a remote SQL server.

11. The recording server shall support additional non-p25 analog feeds from telephones, trunks and radios.

12. The recording server shall support other recording integrations in the same box such as ANI/ALI, Cisco PBX, Avaya PBX, etc.

13. The recording server shall provide email alerting.

14. The recording server shall support SEPTA VPN for remote servicing.

15. The recording server shall have access the radio system controller and the associated radio transmission IP packets.

16. The recording server shall reside within the radio network or have access to the network via a firewall. The radio vendor shall provide via that connectivity, metadata, start and stop, and audio to the recorder.

17. The existing Audiolog Recording Servers shall be upgraded to V.15 in order to support the addition of a Trunked Logging Recorder P25 Recording Solution.

1.6. EXISTING RECORDER V.15 UPGRADE

A. The minimum specifications for the V.5 to V.15 upgrade to the existing equipment by the Contractor are as follows:

1. Two recording servers proposed shall be at minimum, a KOVA Silver recorder.

2. One recording server proposed shall be at minimum, a KOVA Gold recorder.

3. One recording server proposed shall be a KOVA Expansion Chassis.

4. The above recording servers shall support up to 8, hot swappable hard drives, within its chassis.

5. The recording servers shall support up to 768 GB memory within its chassis.

6. The recording servers shall have redundant, hot swappable power supplies.
7. The recording servers shall be configured with a Microsoft Windows Server operating system.

8. A Database Server shall be configured with Microsoft SQL server.

9. The recording servers proposed shall have V.15 software with 440 channel licenses.

10. There shall be (2) two V.15 recording server licenses.

11. The recording servers shall support a separate database server.

12. The recording servers shall support recordings being stored on a local drive array that is separate from the array the operating system is installed upon.

13. The recording servers shall support a remote SQL server.

14. The recording servers shall support additional analog feeds from telephones.

15. The recording servers shall support other recording integrations in the same box such as ANI/ALI, Cisco PBX, Avaya PBX, etc.

16. The recording servers shall provide email alerting.

17. The recording servers shall support SEPTA VPN for remote servicing.

18. The recording servers shall reside within the network or have access to the network via a firewall.

1.7. VOICE LOGGING RECORDER

A. The minimum specifications for the Suburban Station Voice Logging Recorder are as follows:

1. The recording server proposed shall be at a minimum, a KOVA Silver recorder.

2. The recording server shall contain 2 analog 24 port telephony cards.

3. The recording server shall support up to 8, hot swappable hard drives, within its chassis.

4. The recording server shall support up to 768 GB memory within its chassis.

5. The recording server shall have redundant, hot swappable power supplies.

6. The recording server shall be configured with a Microsoft Windows Server operating system.
7. The recording servers proposed shall have V.15 software with 40 channel licenses.

8. The recording server shall include (1) one V.15 recording server license.

9. The recording server shall support a separate database server.

10. The recording server shall support recordings being stored on a local drive array that is separate from the array the operating system is installed upon.

11. The recording server shall support a remote SQL server.

12. The recording server shall support additional analog feeds from telephones.

13. The recording server shall support other recording integrations in the same box such as ANI/ALI, Cisco PBX, Avaya PBX, etc.

14. The recording server shall provide email alerting.

15. The recording server shall support SEPTA VPN for remote servicing.

16. The recording server shall reside within the network or have access to the network via a firewall.

PART 2 – PRODUCTS – NOT APPLICABLE

PART 3 – EXECUTION – NOT APPLICABLE

END OF SECTION
PART 1 - GENERAL

1.1. DESCRIPTION OF WORK

1.2. GENERAL

A. SEPTA Dispatch operations are as follows:
   1. The Contractor shall reference the drawing package for a table identifying locations and quantities for all replacement consoles.
   2. 1234 Market Street –
      a. New Motorola MCC7500e P25 Trunked compliant consoles equipped with the latest software directly connected via IP to the replacement Radio System Core Network Architecture.
   3. FTC/ACC –
      a. New Motorola MCC7500e P25 Trunked compliant consoles equipped with the latest software directly connected via IP to the replacement Radio System Core Network Architecture.
   4. 2nd & Wyoming –
      a. New Motorola MCC7500e P25 Trunked compliant consoles equipped with the latest software directly connected via IP to the replacement Radio System Core Network Architecture.
   5. Mobile Laptops –
      a. New Motorola MCC7500e P25 Trunked compliant consoles equipped with the latest software directly connected via IP to the replacement Radio System Core Network Architecture. These shall be configured in a laptop application allowing for a mobile/remote dispatch operation.

B. 1234 Market Street Dispatch Requirements
   1. The Dispatch Consoles on the 19th Floor are part of the existing UHF CARD.
   2. The Motorola Command Plus Consoles utilized as back-up console equipment shall be removed and not replaced.
3. The Contractor shall coordinate with SEPTA exact console locations, talkgroups and channels to be monitored and displayed on each dispatch groups console screen during final design/installation.

C. FTC ACC Dispatch Requirements

1. The Dispatch Consoles at 2nd & Wyoming are part of the existing UHF CARD and VHF Systems respectively (depending on operator function).

2. The Contractor shall reference the drawing package for a table identifying locations and quantities for all replacement consoles.

3. The Contractor shall coordinate with SEPTA exact console locations, talkgroups and channels to be monitored and displayed on each dispatch groups console screen during final design/installation.

D. 2nd & Wyoming Dispatch Requirements

1. The Dispatch Consoles at the FTC/ACC are part of the existing UHF CARD and VHF Systems respectively (depending on operator function).

2. The Contractor shall reference the drawing package for a table identifying locations and quantities for all replacement consoles.

3. The Contractor shall coordinate with SEPTA exact console locations, talkgroups and channels to be monitored and displayed on each dispatch groups console screen during final design/installation.

1.3. Equipment Requirements

A. New Dispatch Consoles

1. The Radio System shall support Dispatch Console operations that facilitate dispatching throughout the entire RF coverage area of the new Radio System.

2. New dispatch consoles shall be Motorola MCC7500e connected to the Astro 25 Core Network Architecture via IP. Software features for the dispatch console shall be field programmable through changes in firmware or software. Adding or deleting modules and changing module names shall be software programmable.

3. Dispatch consoles shall be field-reconfigurable through a common configuration management application that defines GUI/Screen layouts, overall sub-system functionality, console privileges, and subscriber databases. All configuration, administrative, and alias changes shall take effect in real-time without propagation delay and/or data buffering.

4. No hard-coding of functionality or features shall occur for an individual console so that each position remains flexible enough to serve any operational role in the event of crisis or console position failure. At a minimum, access to the centralized...
configuration management application(s) shall be provided with the proper administrative logon(s).

5. The dispatch console GUI shall provide adequate screen resolution and useable window “real-estate” to provision all SEPTA trunking and conventional resources across multiple active folders for organizational and layout purposes. Each console position layout shall be equipped to permit/deny a Dispatcher to reorganize (in real-time) console resources across organizational folders within a pre-defined screen layout template. Console layout templates shall be password-protectable (as required) to ensure that only authorized personnel have access to specific resources (i.e., encrypted resources).

6. Client dispatch consoles shall be equipped to function equivalently while networked to the redundant/fault-tolerant configuration management server(s) and/or while severed from the network using console layout templates and alias databases archived locally on the Dispatcher client workstation. Client switching between the redundant/fault-tolerant configuration management server(s) shall be seamless and require no user intervention in the event of an online server failure. All configuration and alias databases shall be mirrored on redundant and/or fault-tolerant configuration management server(s) for maximum console subsystem availability and failure preparedness. Each console position shall provide real-time audible and visual feedback as to the networked status of the console and overall mode of system communications. All fallback modes of system communication shall be communicated to each dispatch screen in real-time so that a Dispatcher’s operational behavior can be adjusted as necessary to stay in constant communications with all field users.

7. Per logon ID, client dispatch consoles shall be equipped to disable all computer applications deemed irrelevant to the real-time voice dispatching mission. SEPTA requires the ability to deactivate miscellaneous computer applications (e.g., embedded games, productivity applications, network explorer, etc.) as required upon field installation so as to increase dispatch position availability and prevent dispatchers from becoming distracted while performing the real-time voice dispatching mission.

8. All distinct console functionality shall be defined and accessible through intuitive icons and/or user menus for quick access to necessary functionality. Each console position shall be equipped to provide the Dispatcher with an embedded “Help” application that utilizes a search engine/topic index. The “Help” utility shall be configurable to turn on or off as the network administrator deems appropriate (i.e., training purposes).

9. Each dispatch console position shall be equipped to log the unique transaction data (i.e., time, date, resource ID, PTT-ID, alias, channel assigned, encryption status, start of call, end of call, length of call, call type, assigned infrastructure resources, console ID, etc.) associated with every talkgroup and conventional conversation made from that console position. This transaction data shall be archived in a database, *.csv (Comma Separated Value) or equivalent format to local and/or network repositories. The Contractor shall define the availability of
any dispatch console subsystem APIs that will facilitate the customization and retrieval of real-time console transaction information.

10. Although it is desirable that the consoles connect via a CSSI interface, the Contractor is permitted to use a proprietary protocol if this supports more functionality.

11. It shall be configured for a Dispatcher to log-on to any console and obtain a screen layout with his/her personality format.

B. Console Power

1. The equipment shall operate primarily from an external SEPTA provided UPS power source with generator backup. This source is a nominal 120 VAC (± 10%) at 60 Hz (± 3), single phase.

2. Power losses, restorations, surges, sags and/or brownouts shall not alter the system software and/or operating parameters. Other than total power loss or lethal surges, the workstation shall remain fully operational while experiencing any of these occurrences within the specifications of its design.

3. Transition from the primary UPS power to AC generator power (≤ 10 msec.) shall not cause the workstations to lose and/or reset any of their functional and/or operational capabilities.

4. All workstation operators shall be alerted of the transition to AC generator power and shall also be alerted to the initial failure of the UPS power supply.

C. Dispatch Console Equipment

1. Each new Motorola MCC7500e Console shall be based on the latest Motorola approved version of Microsoft Windows operating system.

2. The minimum acceptable workstation requirements shall be as follows:

   a. Compatible with ASTRO 25 System
   b. Designed for an operating ambient temperature of 41 → 104 °F
   c. AMBE, IMBE, G.728 and G.711 Vocoder support
   d. AES, DES-OFB and ADP Encryption Algorithm Support
   e. Support 60 Simultaneous Audio Sessions per Console
   f. Support 35 kbps Bandwidth requirement per channel
   g. Support Up to 16 multi-Select Groups per Console
h. Support Up to 20 member per multi-select group per console

i. Support Up to 16 patch groups per console

j. Support up to 20 members per patch group

k. Latest Motorola approved Version of Microsoft Windows operating system installed. The operating software for the workstations shall be supported by its manufacture at time of the Radio System delivery.

l. A state-of-the-art color, 22-inch (minimum) flat panel (solid-state) LCD Touch-screen monitor shall be provided. Each operator shall have the ability to change screen displays to suit operator preferences. No less than eight console preferences shall be configurable for each console.

m. Supports an Audio Interface Module with RJ45 and DB15 connector types

n. Supports six RJ-45 Connector Ports, Two DB-15 connector ports and two USB 3.0 ports

o. LCD must be fully compliant with ANSI standards

p. Radio control boot-up time shall not exceed 90 seconds – time shall be measured from the PC power turn-on until the radio control software is available for use by the operator.

q. BIOS and motherboard shall be capable of automatically restarting (powering-up) after an unplanned, or forced shutdown by a remote backup power system.

r. USB Mouse

s. USB Keyboard

t. Gooseneck microphone

u. Headset microphone

v. Dual foot switch

w. The console shall support one (1) select audio speaker and one (1) unselect audio speakers

D. New Workstation Features

1. Dispatch Workstations shall be state-of-the-art color-display-based radio communications workstations that are user friendly, that incorporate radio, signaling and other ancillary functions and controls in a manner that provides simple and efficient operation for the Dispatchers.
2. The new radio control equipment shall include identical workstations. All workstations shall be functionally identical.

3. Workstations shall be capable of withstanding immediate loss of power or power reset with no damage to the workstation functionality or operation. Upon power being reenergized the workstation shall reboot to its former operational state, while requiring users to log in.

4. Workstation functionality shall conform to the following:
   a. Utilize a 22-inch or larger, full color touch-screen LCD screen based on IPS panel technology.
   b. Operator functions shall be able to be controlled by touch, a mouse or by the QWERTY keyboard.
   c. The Contractor shall transfer all existing channels to the new console workstation.
   d. New workstations shall handle 200% of the number of channels transferred from the existing workstations and additional capacity to handle all the talk groups programmed on the system, in order to accommodate potential expansion. Actual talkgroup assignment shall be coordinated with SEPTA and the engineer.
   e. New Workstation shall be capable of 100 additional telephone lines per console.
   f. New workstation auxiliary controls shall be capable of the following:
      - Inputs must be configurable for momentary and latching.
      - Inputs must be configurable to sound an alarm and display a message on the LCD at specific position(s)
   g. The Contractor shall provide a site license for all positions, resources, and features.
   h. Radio workstations shall be equipped with separate and independent radio and telephone volume controls (total of 4 controls per position). Telephone talk-out mute shall be automatic when transmitting on the radio.
   i. A heavy-duty, non-skid dual foot switch with a non-skid base for monitor and PTT shall be provided.
   j. Workstations shall be capable of relocation anywhere on the Workstation LAN without the need for additional audio and signaling cables or other connectivity, for full operation. This will permit SEPTA to place workstations anywhere at a
future time if the Workstation LAN is extended elsewhere (SEPTA responsibility).

k. Voice and signaling interfaces to communications networks and auxiliary radio equipment shall be digital unless interfacing to existing or the Contractor provided analog equipment.

l. Audio output to the logging recorder shall not contain control tones. The sum of all noise shall be 40dB below the average audio level.

m. Voice truncation, between the dispatcher's operation of the PTT switch, and audio output from a field radio unit, and between a radio unit keying the microphone and audio output at the dispatcher position, shall not exceed 400 milliseconds.

n. Radio System dispatch workstations must be sufficiently redundant that there is no single point of failure.

o. Radio System logging shall be to a log file that automatically archives old logs based on file size and/or date. Log files shall be printable by a designated supervisor's workstation. Log write errors shall result in a visual and audible alarm to the workstations. The Contractor shall describe size constraints on log files and how they can be automatically archived.

p. Dispatcher configuration files shall be transportable based on log-on and password information, such that a Dispatcher can log-on to any console and be presented with their user-defined screen configuration.

q. Workstation channel icons shall be capable of displaying eight-character, user “aliases” derived from emergency button activation from field units and from PTT-ID. Up to 256 aliases shall be stored in history for immediate access.

r. Capability for full-duplex operation between Dispatcher and radio units shall be provided, with dispatcher priority.

s. An inter-position intercom shall be provided that allows selective calling between all positions within a Dispatch Center. The intercom shall include provision to interconnect other future remote locations on the Workstation LAN.

E. Supervisory Console

1. It shall be possible to create one Supervisory at any position just with log-on credentials.

2. Supervisory consoles shall have the same features as a normal dispatch console, with the following additions:

   a. The supervisory console shall be able to listen to any of a programmed individual entity radio calls. It shall be able to display an emergency declared
on an un-programmed talk group, and shall be able to disable a non-supervisory console.

b. The supervisory console shall be physically the same as other consoles except that it has been programmed to have supervisory capabilities by log-on credentials.

F. Dispatch Console Functionality

1. The console application shall run on the latest Motorola approved version of the Windows operating system approved for use on the ASTRO 25 network and shall be software driven to allow for access to future features and technologies.

2. The console shall be easy for a properly trained Dispatcher to use. It shall enable the Dispatcher to perform dispatch tasks efficiently and with minimal confusion due to screen clutter. The displays on the monitor shall have clearly distinguishable words so that there is no confusion over the operation function of a particular button. The process of maneuvering through functions on the screen shall be possible with only a mouse.

3. The console shall be able to support up to ten (10) user-defined screen setups/appearances to enable each dispatch shift to select its own screen appearance. These screen appearances shall be pre-configurable and selectable by the Dispatcher.

4. The console shall have a dedicated display for Radio System related messages. These messages shall include information regarding emergencies, console set-up, patch and simulselect.

5. The console shall display in a dedicated panel the individual unit alias with whom the Dispatcher is conversing.

6. The console shall display the console identification number.

7. The display and operation of the command buttons shall be independent of the display and operation of the page/modules. The console shall allow the flexibility of having operations commands display in combination with any screen. The screen and command button labels shall be displayed with distinguishable text. The console screen layouts shall be identical to the existing to the extent possible.

8. The console shall support up to 40 simultaneous talk paths.

9. The consoles shall support full 256 bit AES encryption.

10. Each radio control position shall provide the following functions or displays as a minimum requirement:

a. A 24-hour digital clock
b. A digital or analog Volume Unit (VU) meter

c. Separate select, unselect and monitor speakers and volume controls

d. An electronic transmit interlock so that no more than one Dispatcher can simultaneously transmit on a channel

e. Automatic muting between speakers having the same channel selected

f. Upon depressing any PTT, the transmitted telephone audio shall be muted not less than 60 dB

g. Display icons or screen depictions to indicate PTT, COS/Busy, Enable/Disable, and all other utility functions

h. An output to record dispatch audio (transit and receive) of each position

i. Selectable muting or reduction in volume levels of select, unselect and monitor speakers during a PTT

j. “Select”, “Unselect” and monitor controls for the selection or de-selection of audio channels

k. “Instant Transmit” control providing instant push-to-talk capability for the selected, unselected and monitor audio channel

l. “Volume Control” indicator for each audio channel

m. “Selected Site” indicator for each audio channel shall display the site selection of inbound audio traffic

n. “Mute” control to mute any channel

o. An internal adjustable "squelch" or muting control shall be provided to reduce background noise of idle channels and amplifier "white-noise" in each speaker. Muting shall reduce noise to a minimum of 60 dB below reference level

p. An adjustable compression point for transmit audio on each position shall be provided. Expansion of audio during pauses in speech shall not cause a perceptible increase in background noise

q. A single-action mute control for each unselected channel shall be provided. Muting a specific channel from one position shall not mute the same channel at other radio control positions

r. Each channel shall be equipped with an adjustable threshold control at which time the (carrier-operated-switch) COS/BUSY display that shall light, or unmute received audio
s. Provisions to control an existing SEPTA GUI-based digital instant-recall recorder shall be an integral part of each radio control. It shall have the following features:

- Capable of three separate audio channels
- Capable of simultaneous record and playback
- Controls shall be integrated into the radio control panel
- Recorder status shall be displayed on the LCD
- It shall be possible to route the playback audio to the selected, unselected, monitor or a dedicated recorder speaker
- Time stamped messages

G. Maintenance Features

1. New Dispatch workstations shall be equipped with the following maintenance features:

   a. An internal 1004 Hz test-tone generator and Project 25 test sequence for trouble-shooting and alignment.

   b. Test points for each audio and data line from the Radio System network control to the specific radio control position.

   c. Interrogation of system alarms or operations at one position shall not interrupt operations at any other position.

   d. Automatic diagnostics function, with problem reporting in plain text to the designated Supervisor's Workstation.

   e. Radio System shall provide in electronic file or a diagnostic output (for a terminal and/or printer) that reports all service interruptions and failures relevant to system/console/channel/talk group operation. All messages shall be in plain text for easy troubleshooting.

   f. Capability to automatically send an alphanumeric pager message to a service interruption to a technician.

H. Management Software for Consoles

1. The Contractor shall provide for an advanced management tool that provides:

   a. Airtime & call count statistics, by position and operator – maintain 18 months of archived records of airtime and call counts, by operator ID, summed in one-hour bins (for workload calculations).
b. Per Dispatcher log-on statistics – such as the time the Dispatcher logged “on” and “off” the Radio System.

c. Capability to archive and generate reports against archived data.

d. Raw text airtime data output (capable of being imported into Microsoft Access and/or Excel) for special analysis purposes.

e. The workstation shall be equipped to produce usage activity information and data to be used to generate reports.

f. Captured activity data shall be able to be queried or sorted by operator position, channel, time, type of event, etc.

g. The information and data shall include, at a minimum, the following:
   - Each event time and date stamped
   - Number of transmissions per position
   - Number of transmissions per channel or talkgroup, per hour
   - Total transmission time per position
   - Total transmission time per channel or talkgroup
   - Total receive time per position
   - Total receive time per channel or talkgroup, in one-hour increments

I. Modules

1. The console shall support and display audio communications modules, where a module is a Dispatcher defined space in a view screen that permits voice or data communications.

2. A module shall be programmable to support communication with one or more entities, which could include:

   a. A trunking talkgroup

   b. An individual call

   c. A conventional channel

   d. A CTCSS talkgroup on a conventional channel

   e. Another console
f. A PSTN telephone number

g. Status (inbound data messaging)

h. Paging (outbound data messaging)

i. Auxiliary I/O (bi-directional data messaging)

3. The console shall support module names of at least eight characters and preferably sixteen.

4. The console shall support a minimum of 100 different modules. If a module is in use at one console, a busy indicator shall be displayed at the other consoles in the Radio System.

5. For received calls, an alias (alpha-numeric representation of the radio terminal) shall be displayed in the appropriate module.

6. The console shall permit the operator to monitor call activity using up to four separate speakers, one with select audio and the others with unselect audio. The console shall permit the Dispatcher to route any module to the speakers.

7. Each module shall have its own volume adjustment. The console shall be capable of muting individual modules or all unselected modules.

8. The console shall be able to display the call history of a particular module. The call history display shall place the most recent call at the top of a scrollable list of up to five entries. The console shall also be able to display a comprehensive call history for each module including up to 64 of the most recent calls.

9. The console shall retain “user profiles” such that a Dispatcher can log on to any console and be presented with the customized screen that he/she has developed.

J. Patches

1. The console shall support patches, which involves temporarily combining two or more modules. A patch merges the entities into a super group, such that each member hears every other member.

2. Each console shall be able to support up to five patches with up to 15 entities (groups and/or channels) each. All entities patched together shall be able to communicate with one another. The console shall support pre-configured patches.

3. Consoles shall have the ability to patch trunked talkgroups to analog conventional channels or other trunked system types without audio degradation.

K. Interoperability
1. SEPTA has voice interoperability with multiple agencies available on the existing L3Harris, Zetron and Mindshare consoles, and this functionality shall be maintained with the replacement Motorola MCC7500e or later release consoles. The audio for this interoperability shall be supplied via the existing solution.

2. The Contractor shall provide interoperability with the COP, DRPA and surrounding counties. Interoperability shall be through the ISSI router link described within these specifications.

3. Contractor shall maintain the COP control stations along with icons and connectivity as a backup path for talk groups assigned on the COP trunked radio system.

L. Simulselect

1. The console shall support simulselect, which involves temporarily linking together multiple talkgroups dynamically for one-way outbound communications from a dispatch console. Simulselect merges the entities for the benefit of the Dispatcher, however does not create a super group. Only the Dispatcher can hear all simulselect members.

2. Each console shall be able to support up to two Simulselects with up to 15 entities each. The console shall support pre-configured Simulselects in conjunction with the simulselect feature support within the trunked/conventional system.

M. Cross Muting

1. The console shall be capable of muting the audio from other consoles (cross-muting).

2. For consoles connected to the same switch, two console operators shall be able to communicate with one another through an intercom feature. No RF channel shall be utilized during the inter-console communication.

N. Emergencies

1. During emergencies, the console shall give both visual and audible alert. The module and page with the emergency shall be displayed in red. The module and the call history shall display the alias of the unit declaring the emergency. Further, the emergency shall be displayed in the Radio System information panel, which shall be red.

2. If an emergency is declared when another emergency already exists:

3. Same group – If the original emergency has not been acknowledged; the console shall display a counter with the emergency message to indicate the number of emergencies for the same group. The declaring alias shall be displayed in the appropriate call history display.
4. Different group – The new emergency shall also be declared and shall exist with the original emergency. Both modules shall be red. The declaring alias shall be displayed in the appropriate call history display. The emergency message shall correspond to the most recently declared emergency.

5. The Dispatcher shall be able to declare an emergency and clear an emergency at the console.

O. Conventional Channels

1. The console shall be able to control (via IP/two/four wire) conventional channels and (in conjunction with a conventional base station that supports these functions) provide the following functions:

   a. Select the station’s transmit/receive frequency pair from a pre-defined list
   b. Enable the base station to repeat radio-originated audio
   c. Enable the base station to be controlled by remote controller
   d. Enable scan of selected channels of a multi-channel base station
   e. Enable all receiver audio to be passed to the console switch regardless of the originating conventional radio unit’s transmitted tone code
   f. Enable toggling between main conventional base stations and standby conventional base stations

P. Alert Tones

1. The console shall be capable of initiating the following three alert tones:

   a. Steady – nominal 1000 Hz steady tone
   b. Warbling – warbling tone (1600/2000 Hz at a 4 Hz rate)
   c. Pulsed – (repeating 1000 Hz for 260 ms, then no tone for 240 ms)

Q. Link Failures

1. The console shall visually notify the Dispatcher of a link failure to the Radio System Astro 25 Core Network Switch.

1.4. ADDITIONAL OPERATIONAL FEATURES

A. Multiple Screen Configurations

1. The console shall support a flexible graphical user interface environment via multiple screen configurations. The number and types of modules, module
location, number of pages (up to eight), and color schemes for the screen shall be user definable off-line.

2. The screen configurations shall be customizable via an off-line program. The operational editing of the screen configuration files shall be the “drag-and-drop” method.

3. The screen configuration shall be part of the Dispatcher’s profile, such that a Dispatcher can log-on to any console and be instantly presented with his/her user-defined customized screen.

4. Each console shall be able to have its own unique screen configuration. The screen configuration shall be password protected.

B. Status Messaging

1. The console shall provide the capability for radio users to send up to 127 pre-defined text messages to the console for the functionality described below.

2. The text messages can be used to indicate status reports of units. The identification of the user sending these pre-defined text messages shall be in a dedicated display module on the graphical user interface of the console. This dedicated display module shall clearly identify the text that is being sent.

3. The status message module shall display the alias and a time stamp. The modules shall be able to display multiple Aliases at one time.

4. The text messages shall include requests of a user to talk with the Dispatcher at the console. The identification of the user sending these pre-defined text messages shall be in a dedicated display module on the graphical user interface of the console (separate from the status message display).

5. The request to talk module shall display the alias. The modules shall be able to display multiple aliases at one time. The Dispatcher shall be able to respond with a group call for a group alias display and an individual call for an individual alias display. When the console receives a repeat request from an individual to whom no reply from a Dispatcher has been made, the module shall be configurable to display either a “count” (up to number 8) or display the repeated aliases.

6. The console shall be configurable such that an audible announcement indicates when a request to talk is received at the console.

C. Auxiliary Input/Output

1. Each console shall be able to support up to 64 unique auxiliary input/output modules. The console system shall be able to support up to 255 unique auxiliary input/output modules. Each module shall contain a button and a text line to identify the function and the status, respectively. The text and colors shall be configurable offline. Auxiliary I/O shall support each of the following four types:
a. Input
b. Output Momentary
c. Alarm Input
d. Output Toggle

2. The input/outputs shall be either optically isolated inputs or control relay switches that activate relays, open doors, and perform special tasks by depressing the module associated with it.

D. Last Caller Display

1. The console shall be able to display the last pre-defined number of unique callers on a programmed trunked group directly under the respective special communication module. Each module shall display the list of individual aliases that is applicable to its own module.

2. The list shall display up to eight entries (with 64 stored and viewable by scrolling). The most recent call is placed at the top of the list.

3. The Radio System Administrator shall be able to define an “exclude” list or an “include” list for particular individuals in talk groups. If an “exclude” is defined, the console shall track all individuals except for the ones in the exclude list. If an “include” list is defined, the console shall track only the individuals in the list.

E. Tone Generation

1. The console shall support a tone that is able to transmit for a user definable length of time (up to 9999 msec) upon a press of a button on the GUI. The tone shall be configurable as a DTMF digit (digits 0 to 9) or a frequency value (0 to 5000 Hz in 0.1 Hz steps). The parameters shall be configurable off-line.

F. Background Color

1. The console shall be able to support a visual background color change in a communication module depending upon two special statuses, such as Yes/No or On/Off. The background color shall change when a status other than the existing status has been sent from the radio to the console.

PART 2 – PRODUCTS – NOT APPLICABLE

PART 3 – EXECUTION – NOT APPLICABLE

END OF SECTION
SECTION 13709

700 MHz RADIO SYSTEM INSTALLATION REQUIREMENTS

PART 1 - GENERAL

1.1. DESCRIPTION OF WORK

1.2. General Installation Requirements

A. The Contractor shall perform installation of all fixed site equipment and vehicle subscriber equipment required under this Contract.

B. Manufacturer Support

1. The Contractor shall provide a letter from all sub-system manufacturer(s) which guarantees manufacturer’s support in the event of any conditions or issues which cannot be remedied by the Contractor or in case the Contractor defaults on its warranty and/or maintenance agreements.

C. Installation

1. The scope of installation work for the Contractor includes, but is not necessarily limited to, the following:

a. The Contractor shall design, furnish, and install all racks, necessary system computers, controllers, switches, routers, base stations, auxiliary receivers, GPS receivers, consoles, WANs, transmitting and receiving antennas, interconnecting RF cabling, coaxial transmission line, antennas, microwave radios, waveguide, microwave dish antennas, power wiring, external alarm cabling, Ethernet cabling, firmware, software, and all other devices and equipment required to completely implement SEPTA’s new Radio System.

b. Engineering, furnishing, installing and testing of equipment shelter(s) (where necessary) and their supporting services including but not limited to, electrical service, back-up generator, UPS and HVAC of the equipment shelter(s).

c. Engineering, furnishing, installing, and testing all necessary fixed-site equipment, ancillary devices, interconnecting cabling, and software. This shall include electrical connection to electrical panels, physical installation, earthing, grounding, bonding, connection to new and existing termination blocks, connection to any new or existing logging recorders, and connection to telephone lines or other interconnecting systems necessary to provide complete functionality. The Contractor shall provide all grounding, bonding earthing and lightning protection per the latest version of Motorola’s R56 Standards and Guidelines for Communication Sites, IEEE, TIA, NFPA or ANSI
standards and shall utilize the most stringent standard at the time of construction.

d. Electrical connection/interface to the CAD/AVL Head-End equipment at the C&S Server Room and Wyoming locations.

e. Engineering, furnishing, installing and testing all necessary subscriber equipment on vehicles.

f. Electrical connection/interface to the CAD/AVL equipment onboard revenue vehicles.

g. Electrical connection/interface to the demarcation points for the SEPTA fiber networks.

h. Providing all labor, materials, appliances, tools, equipment, software, facilities, documentation, training, transportation, and services necessary for or incidental to performing all operations of the work of this Specification, completely, as specified herein. It is the intent of this Specification to provide for a complete, integrated, working system. Inadvertent omission of any necessary items of work, material, or equipment shall not negate the Contractor's responsibility to provide those items.

i. Providing post project award engineering data and services, as required by SEPTA, regarding the necessary site preparations, facilities, field installation, and solutions to technical problems related to the contract, throughout the design, implementation, installation, and testing phases through final acceptance.

j. Provide all labor, materials, appliances, tools, equipment, software, facilities, documentation, training, transportation, and services necessary for or incidental to performing all operations of the work of this Specification, as specified herein.

k. Conducting site visits and providing close coordination and technical support as necessary to ensure that the design and functions of the Radio System meet the specified requirements.

l. Coordinating installation details and schedules with SEPTA to ensure adherence to the implementation schedule.

m. Ensuring that the equipment, materials and installation comply with all applicable FCC rules and regulations, with the provisions of the NEC, OSHA, and all local electrical, fire, and building codes, and with local seismic requirements for the zone in which the equipment will be installed.

n. Disconnection, removal and disposal of old equipment and hardware from fixed sites. All cables disconnected shall be removed and not just cut-off at each end.
o. The Contractor shall be responsible for all material and components that are delivered to the proposed sites including any off-load equipment that is required for local handling of any material.

p. Personnel designated by SEPTA will provide inspection and approval of all installations. Such approval shall be limited in scope to the specific subsystem physical installation and shall not be construed to imply full acceptance of the Radio System, or subsystem.

q. Notwithstanding the details presented in these specifications, it is the responsibility of the Contractor to verify the correctness of the material lists and suitability of devices proposed to meet the requirements of the specifications.

r. The Contractor shall be responsible for providing or arranging for all parts necessary for the equipment and its installation up to and including Final Radio System Acceptance.

s. Any equipment or parts required to provide a complete and operational Radio System, and not specifically mentioned herein, shall be provided by the Contractor without any claim for additional payment. It shall be understood that the contract and agreement contemplates and requires the "turnkey" construction and installation of a completely operational compliant Radio System that meets the requirements of SEPTA.

t. All rubbish and debris associated with site preparation, unpacking of shipping materials, and/or installation of new equipment related to this project shall be removed from the premises by the Contractor. At the end of each working day, the Contractor shall sweep and clean any debris and trash at the location where work is being performed.

u. Removal of rubbish and debris shall be performed daily.

v. For purposes of continuity and quality control, to the greatest extent possible, the Contractor shall maintain the same installation crew(s) through completion of all installs. SEPTA requires consistent installation practices. In particular, the Contractor shall maintain the same Installation Crew Foreman from the beginning to approved completion of installation.

D. Parts Availability

1. The Contractor shall provide written guarantee that all proprietary components and repair parts shall be available for at least fifteen (15) years from the date of network acceptance. End user equipment (i.e. portables, mobile, etc.) repair parts shall be available for at least five (5) years from the end-of-life (EOL).

2. The Contractor shall disclose the end-of-life status of each major equipment grouping proposed in response to this Specification and will include at a minimum for base stations, microwave radios, network controllers, power supplies, dispatch consoles, audio switches, simulcast optimization subsystems...
and all models of user equipment. It is the intent for SEPTA to avoid the purchase of any network equipment that is nearing (within 24 months) the end of its production cycle.

E. Equipment Removal

1. The Contractor shall be responsible for the removal and proper disposal of all fixed/subscriber equipment that is part of the existing UHF Smartnet Trunked, UHF Conventional Analog System and not scheduled for upgrade or re-use subject to approval of SEPTA.

2. All hard drives from equipment that is to be removed shall be delivered to SEPTA.

3. Equipment removal shall be completed for all equipment owned and operated by SEPTA, such as:

   a. UHF Smartnet Trunked Infrastructure at 1234 Market and 2nd & Wyoming
   b. UHF Conventional Infrastructure at 1234 Market and 2nd & Wyoming
   c. UHF Smartnet Trunked equipment and associated components at each remote site
   d. UHF Conventional equipment and associated components at each remote site
   e. SEPTA owned antennas and transmission lines being replaced by the Contractor
   f. All consoles, equipment and associated components at 1234 Market, FTC/ACC and 2nd & Wyoming that are being replaced
   g. Radio Subscriber equipment on-board vehicles.

4. Note: The SEPTA Radio Shop shall be given the option to retain any equipment that they desire to keep and shall instruct the Contractor accordingly.

1.3. REFERENCES AND STANDARDS

A. Without limiting the generality of other requirements of this Specification, all work specified herein, and the performance of all products and systems specified herein, shall conform to or exceed the applicable requirements of the referenced Standards; provided, that wherever the provisions of said publications are in conflict with the requirements specified herein, the more stringent requirements shall apply unless in conflict with the equipment manufacturer’s written recommendations:

1. NEC 70 (National Electrical Code) Sections 100-300 and Section 800

2. NFPA 170 (National Fire Protection Association)

4. 47 CFR 1.1310 – Radio Frequency Radiation Exposure Limits

5. Uniform Building Code, including the seismic requirements of Section 2312, for Earthquake Zone 2

6. EIA Standards RS 232-C, RS 485

7. TIA TSB-102 Suite of Standards adopted for APCO 25 Land Mobile Communications


9. Codes and Standards of good practice issued by the following organizations:

10. National Electric Manufacturers Association (NEMA)

11. Underwriters Laboratories (UL)

12. National Fire Protection Association (NFPA)

13. Publication No. 70, National Electrical Code

14. Occupational Safety Health Administration (OSHA) Standard

15. OSHA Standards, 29 CFR, Part 1910

16. Motorola R56 Standards and Guidelines for Communication Sites

1.4. SUB-CONTRACTORS

A. It is intended that a single Contractor have total turnkey responsibility for the project so as to assure a fully operational network. Therefore, any Contractor desiring to use Subcontractor(s) must include within their Proposal Response a list and description of the qualified Subcontractor(s). SEPTA will require documentation and references, including a thorough background investigation, to ensure the qualification of a Subcontractor. Any Subcontractor or person that is determined by SEPTA to be unqualified or unacceptable to perform their duties, at SEPTA’s sole discretion, may be barred from working on the project. The Sub-Contractor(s) cannot be changed after submission of the Proposal Response except with the written permission of SEPTA. Changes in Subcontractors shall not provide an extension of time to the Contractor.

B. Any work performed by Sub-Contractors shall be to the same standard as that of the Contractor. The Contractor shall be responsible for all Work.
1.5. SEPTA RESPONSIBILITY

A. SEPTA will be responsible for the following:

1. Supply of existing floor space at existing sites for temporary and permanent installations. Should the replacement Radio System require more floor space than currently exists, costs for an equipment shelter and supporting Architectural/Engineering costs shall be the responsibility of the Contractor and included in their design. All architectural and engineering calculations and drawings shall be signed and sealed by a registered Professional Engineer in the state of Pennsylvania and submitted to SEPTA for approval.

2. Supply and operation of a UPS system at the following sites listed below.
   a. Oxford Valley Mall
   b. Roxborough
   c. New Britain
   d. Montgomery (potential candidate site)
   e. C&S Server Room
   f. 1234 Market St Penthouse
   g. 2nd & Wyoming “Voter Room”
   h. FTC/ACC Dispatch
   i. Should the existing UPS require additional capacity to support the new Radio System, costs for additional capacity and supporting costs shall be the responsibility of the Contractor and included in their design.

3. Supply and operation of AC generators for backup power at the following sites:
   a. Roxborough
   b. New Britain
   c. Bacton Hill
   d. Montgomery (potential candidate site)
   e. Bensalem (potential candidate site)
   f. Should the existing Generator require additional capacity to support the new Radio System, costs for a new generator and supporting costs shall be the responsibility of the Contractor and included in their design.
4. The existing overhead cable trays at each site can be used by the Contractor. In cases where additional overhead racking is required, the Contractor shall be responsible for the installation.

5. Installation of Mini-Base subscriber equipment. The Contractor shall program all of the Mini-Base radios and turn them over to the SEPTA radio Shop.

1.6. FIXED EQUIPMENT INSTALLATION

A. The following standards shall apply to all fixed equipment:

1. Installation shall fully comply with the Uniform Building Code and State seismic requirements for the local Earthquake Zone and any provisions of the State of Pennsylvania Health and Safety Code pertaining to Essential Services Buildings, and associated regulations.

2. Installation shall fully comply with Motorola R56 Standards and Guidelines for Communications Sites at all sites. The Contractor shall be responsible for bringing all equipment shelters chosen as part of this Radio System up to Motorola R56 Standards as part of their design.

3. All fixed equipment shall be securely attached to the floor and/or wall. If applicable, the first rack in each row shall be securely anchored to the wall, and additional racks shall be bolted to the adjacent rack at the top of the rack. Stand-alone racks, and every third rack, shall be securely cross-braced to the ceiling to prevent tipping.

4. Racks and cabinets shall be shimmed to plumb alignment.

5. Equipment rack spacing shall allow not less than 3-foot clear working space per code when possible. All equipment shall have full access front and rear, except equipment mounted on swing-out type racks.

6. All equipment and equipment racks shall be separately and securely grounded to a single point ground bar.

7. Audio lines and control function lines shall be terminated on industry-standard "66-type" punch blocks, with pre-wired 25-pair telephone-type connectors. Color-coding shall follow telephone industry standards. Without exception, all sites shall be wired identically. SEPTA must review exceptions to this.

8. Equipment cabinet power supplies shall be connected to Contractor supplied DC power systems.

9. All cable wraps, ties, etc. shall not be left with sharp edges.

10. Significant inter-cabling, whether RF, AC, AUDIO or CONTROL cables and/or wiring, shall be labeled with pre-printed adhesive wire markers. Markers shall be
placed at each end, adjacent to the connector, plug or terminus. This data shall be recorded and match that in the installation documentation.

11. All equipment cables or cable bundles, to the greatest extent feasible, shall be neatly tied by means of plastic tie wraps and secured by clamps to flat surfaces.

12. All cable/wiring bundles exiting the equipment must do so through the top of the cabinets. Rubber grommets or other suitable protection shall be used at cabinet knockouts to protect the cable/wiring. Splicing of AC, AUDIO or CONTROL cable/wiring will not be permitted.

13. With the doors closed, all equipment cabinets shall present a sealed enclosure to minimize the entry of insects and to prevent entry of birds and rodents.

14. All equipment operating from AC power, including radio controls, central electronics, repeaters, remote receivers, control stations, controllers, switches, routers, and computer terminals, shall be equipped with surge protection devices. All outlet strips and surge protection shall be rack mounted.

15. Lightning suppression devices shall be provided for power input circuits, control circuits, telephone lines, antenna transmission cables, and all other circuits, equipment, and cabling that could be exposed to lightning-generated transients. Surge protection devices shall be rated for maximum surge suppression and noise suppression as appropriate to the protected device, and the Contractor's equipment and design.

16. Lightning suppression devices shall be rated for maximum surge current, turn-on voltage, turn-on time, power capacity, and other characteristics as appropriate to the protected circuit, and the Contractor's equipment and design. Lightning suppression devices shall be connected to earth ground with insulated wire appropriate to the application. The following are general requirements:

a. Maximum surge current shall be 20,000 Amps, based on the IEEE 8-microsecond rise-time/20-microsecond decay-time waveform.

b. The turn-on voltage shall be no less than 600 VDC.

c. The turn-on time shall be no more than seven nanoseconds after voltage attains the 600 VDC turn-on level.

d. The device shall be capable of passing up to 600 Joules of energy.

e. High-current spike suppression shall be capable of 15,000 Amp, based on the IEEE 8-microsecond rise-time/20-microsecond decay-time waveform.

f. High frequency noise suppression shall be:
   - Greater than 20 dB at 1 MHz
1.7. MINI-BASE CONTROL STATION RADIOS

A. Equipment

1. All Control Stations shall be Motorola Model APX6500 based on the Motorola radio.

2. The Contractor shall replace the existing antennas and coaxial cables linking the control stations and their antenna systems.

B. Antennas and Transmission Lines

1. When replacing transmission lines the following shall apply:

a. Transmission lines shall be as necessary to support the system design.

b. Antenna transmission lines shall be labeled with cable identification tags indoors at each connector. Labels shall denote the antenna model, frequency, height, azimuth and VSWR at installation. Labels shall be permanent and not hand written.

c. The manufacturers’ minimum bending radius shall not be exceeded during installation.

d. Transmission lines shall be secured through standard cable hangers attached to channel supports or "Unistrut" as appropriate. All cables shall be dressed appropriately, and run parallel to each other.

e. Wall feed-through boots shall be sized for the correct cable OD. Feed-through panels and boots shall be sealed to prevent moisture and dust intrusion.

f. At sites with more than one antenna, antenna transmission lines shall be labeled with cable identification tags indoors at each connector. Labels shall denote the antenna model, center frequency, height, azimuth and VSWR at installation. Labels shall be permanent and not hand written.

g. For each cable installation, the coaxial antenna transmission line shall be cut to length. The radio equipment end of this line shall terminate at a point where the lengths of any jumper cables are kept as short as possible. Each coaxial transmission line terminus shall be secured to a wall or ceiling surface.

h. All coaxial antenna transmission line connectors shall be type 'N' or DIN as required to meet PIM specifications. The ends of the main transmission line shall not connect directly to the antenna, or to any RF equipment, interference protection, or multiplexing devices.
i. The transmission line shall be fastened to the external antenna support structure in accordance to the manufacturers’ specifications or every four (4) feet for vertical runs. Fasteners shall be of stainless steel; nylon cable ties are not acceptable.

j. Transmission line runs inside equipment shelters or buildings shall be supported, every three (3) feet, with stainless steel cable hangers. Multiple cable runs shall not be bundled together but rather, shall be strung and supported adjacent to each other.

k. All coaxial jumper cables for receivers shall be 1/2” diameter, such as Commscope Outdoor (where applicable) Superflex.

l. The jumper cables shall be used to interconnect all interference protection or multiplexing devices with the coaxial antenna transmission line and radio frequency equipment.

m. A jumper cable shall be used to interconnect the antenna(s) to the top end of the coaxial antenna transmission line. Jumper cables used to reach a side arm mounted antenna shall be shaped to form a drip loop.

n. All jumper cables shall be cut to length and shall use type 'N male' or 7/16” DIN connectors as required to meet PIM specifications except as dictated by the connector supplied with the antenna.

o. To meet cable bend-radius specifications, receiver equipment cabinet intra-cabling shall be permitted by the use of 1/4” diameter, such as Commscope Superflex, or RG-142 double shielded coaxial cable. These cables shall be limited to 6 feet in length.

p. All coaxial cables exiting the equipment cabinets shall do so through cabinet feed-throughs.

q. Transmit antennas, connectors, and surge suppressors shall be selected to prevent radio signal degradation caused by Passive Inter-Modulation (PIM) interference. In some cases, 7/16 DIN connectors, and/or silver-plated connectors with gold center pins shall be required to meet the PIM specification. No additional components shall be used after the combiner except the RF surge protector, RF power sensors, coaxial cable, connectors, grounding kits, and antenna unless specifically required herein.

C. Grounding and Lightning Protection

1. For new antenna and/or transmission line installation, the following shall apply:

a. The Contractor shall be responsible for providing all transmission line grounding devices at the cable entry point and for connection to the building ground system.
b. Remote Site antenna protection – The Contractor shall use a Polyphaser ISUT50HN lightning protection device (or equivalent) installed indoors in combined transmitter antenna lines. A Polyphaser ISGF50LN (or equivalent) shall be installed in the multicoupled receiver line.

c. Receiver site antenna protection – The Contractor shall use a Polyphaser ISGF50LN or equivalent for the multi-coupled receiver line only. Includes all mounting hardware and cables to connect to existing site ground buss bars.

d. An IS50NX-C2 or equivalent shall be supplied and installed on the transmission line of non-multicoupled receivers or control stations. Includes all mounting hardware and cables to connect to existing site ground buss bars.

e. All external radio control circuits, such as telephone lines, to the new fixed equipment provided under this contract shall be protected by a punch-down bridge clip suppressor, Northern Technologies Model TLP-M66 or equivalent.

f. All impulse suppressors shall be placed at the point where the coaxial antenna transmission line connects to the jumper cable from the radio frequency equipment, and shall be grounded at this point.

g. All radio frequency and ancillary equipment supplied by the Contractor under this contract shall be grounded to a central ground buss. All grounding interconnections shall be made by using #2 AWG solid copper wire or flat copper strapping having a width of not less than 2 inches and comply with NEC Code 70 where applicable.

h. All coaxial antenna transmission line outer conductors shall be grounded to the tower. These grounding points shall be:
   - Below the top connector of the line
   - Above the point at which bends are made to exit the tower or antenna support structure.
   - At the cable entry port (outdoors)

i. The ground points shall be made by using copper ground straps from the same manufacturer as that supplying the coaxial antenna transmission line and in accordance with the manufacturer's installation practices. No grounding to tower cross braces is allowed, only direct conductor to ground. Braided ground straps are not acceptable.

j. Cuts made in the outer jacket of the transmission line to install the ground straps shall be thoroughly sealed with a water resistant tape or compound as required by the manufacturer and in accordance with the manufacturer's installation practices. Ground connections to galvanized tower legs shall be made with transition clamps thereby reducing the oxidation effect of dissimilar metals.
D. Terminating Cross Connect

1. To conserve space in the wall mounted cross connect backboard small "110" or 3 M "BICS" type blocks should be utilized.

2. The preferred terminating/cross connect type equipment is the KRONE, INC. LSA-PLUS series of blocks.

3. All terminations must be clearly marked and labeled to allow rapid identification of every circuit and its termination point to facilitate repair or relocation of equipment.

4. To the greatest extent possible, all equipment inter-cabling and/or cable/wiring bundles shall be neatly secured by means of plastic tie wraps, secured by surface mounted clamps and hidden from view.

1.8. FLOOR SPACE

A. At each existing site all replacement Radio System hardware shall be located in the same room as the present hardware to the maximum extent possible. Should the Contractor require additional space in order to support permanent and temporary installations, the Contractor shall include the cost to furnish and install those facilities in their response to this proposal.

B. Drawings depicting the existing (and potential candidate site) Radio System facilities are available in the drawing package.

C. The Contractor’s installation, testing, and transition plan must take these floor space limitations and temporary installations into account.

1.9. CABLE ROUTING

A. In general, cable routing shall be in overhead trays above the cabinets/racks. Vertical cabling shall be in cable chases or tied to rack stand-offs.

1.10. POWER CABELING

A. Power cabling at all Simulcast and Receiver locations shall be provided by the Contractor. The conductors shall be of sufficient gauge that the voltage drop from the electrical panel to the cabinet/rack is less than 2.0% at the rated load.

PART 2 – PRODUCTS – NOT APPLICABLE

PART 3 – EXECUTION – NOT APPLICABLE

END OF SECTION
SECTION 13710
700 MHz RADIO SYSTEM TRANSITION PLAN

PART 1 - GENERAL

1.1. DESCRIPTION OF WORK

1.2. Transition Plan Submittal Requirements

A. The Contractor shall include with their response to this Specification a detailed outline of their proposed Transition Plan to transition users from the existing UHF Trunked and Conventional Radio System to the replacement P25 Trunked Radio System. The Transition Plan shall describe testing stages, installation and transition/cutover from the SMARTNET/Conventional to P25 system. The transition plan shall also include the relocating of any temporarily installed equipment and the tie into the office and vehicle CAD/AVL equipment. Included in the transition plans shall be details on transitioning the following subsystems:

1. Remote site equipment shelters (where needed)
2. Simulcast radio site equipment
3. Auxiliary Receiver site equipment (where needed)
4. Microwave radio site equipment
5. Microwave Antenna equipment
6. Antennas and transmission lines
7. Primary/Redundant Radio Astro 25 Core Network Site equipment
8. Primary/Redundant Radio Prime Site equipment
9. MCC7500e Consoles
10. Conventional Channels
11. Mini-Base Control Station Radios
12. 1234 Market and 2nd Wyoming Digital Audio Logging Recorders
13. Station Logging Recorders
14. Mobile Radio vehicle installations
15. Mobile radio programming
16. Mini-Base Control Station radio programming
17. Portable radio programming and distribution to Users

B. This Transition Plan outline shall include as a minimum but not be limited to:

1. Requirements specified hereunder as “SEPTA Guidelines”
2. Consideration of “SEPTA Transition Requirements” specified hereunder
3. Breakdown by project steps and schedule as it relates to transition including work to be done by others
4. Details sufficient to show how the transition will proceed without creating downtime for any SEPTA Police and Transit Operations/Maintenance
5. Details sufficient to exhibit how Coverage Acceptance will be accomplished without creating downtime for SEPTA Police and Transit Operations/Maintenance
6. Details sufficient to exhibit how System Acceptance will be accomplished without creating downtime for any SEPTA Police and Transit Operations/Maintenance
7. Details sufficient to exhibit how the Operational System test will be accomplished without creating downtime for any SEPTA Police and Transit Operations/Maintenance
8. Details sufficient to exhibit that SEPTA's Radio System will always have one level of redundancy at all times
9. Details of the Contractor’s manpower and schedule requirements for the Transition Plan
10. Details of any requirements of SEPTA for transition

1.3. SEPTA GUIDELINES

A. The Contractor shall develop and submit to SEPTA a detailed transition plan to transfer users from the existing UHF Trunked/Conventional Radio System to the new Motorola Astro 25 P25 Radio System. The level of detail to be provided by the Contractor shall include the following as a minimum:
1. A step by step procedure from start to completion of the transition including all testing. The plan shall include a description of the impact to the users at each step. The impact to the users must be kept to a minimum due to the Public Safety and Transit requirements of the system.

2. Daily work hours required and timeframes from start to finish for each step and total transition

3. Steps to abort and restore in the event of any unforeseen event at any stage of the transition

4. Procedure for replacement of existing L3Harris Symphony, Motorola Centracomm and Motorola Command Plus consoles at 1234 Market Street with new Motorola MCC7500e P25 consoles

5. Procedure for integration of system testing into the overall Transition Plan

6. Procedure for integration of Coverage Testing into the overall Transition Plan

7. Procedure for integration of CAD/AVL equipment into the overall Transition Plan

8. Details and timing of channel allocations for each of the 18 channels during each step of the Transition Plan

9. Details on the channel allocations to each Police Command and Transit fleet (i.e. end user group) during each step of the Transition Plan

1.4. SEPTA TRANSITION REQUIREMENTS

A. Communications is critical for SEPTA Police and Transit Operations, consequently the Contractor’s Transition Plan shall adhere to the following:

1. There shall be zero downtime for any Police or Transit Fleet group. Zero downtime is defined as: no reduction in coverage areas, every officer/Transit end user and revenue vehicle shall have access to pre-planned radio channels without coverage degradation

2. Users on the UHF Trunked and Conventional Radio System shall experience no downtime at any time during the transition. This requirement applies to all subsystems.

3. The Transition Plan schedule shall be as short as possible consequently the Contractor shall deploy multiple installation and test crews

4. The Contractor shall notify SEPTA at least three weeks prior to the commencement of the Transition Plan

5. If the Transition Plan process is halted for any reason, the Contractor shall notify SEPTA and re-start the process with two weeks notification
6. SEPTA will only assign its UHF Trunked radio users to operate in reduced modes of operation, including operating on less than a seven-channel trunked radio system or operating on separate conventional channels during the hours of 1am – 4 am Saturday and Sunday. Other reduced mode windows may be made available upon request with SEPTA’s approval. SEPTA requires that all channels on the Trunked system be fully functional for all other time periods until transition is complete.

7. Any part of the Transition Plan that requires transferring radio channels from the SMARTNET Trunked/Conventional system to the P25 system at all transmit site locations shall be accomplished by the Contractor utilizing as many crews as necessary to accomplish the effort at all transmit sites simultaneously during the hours of 10 pm to 6 am Sunday through Friday.

PART 2 – PRODUCTS – NOT APPLICABLE

PART 3 – EXECUTION – NOT APPLICABLE

END OF SECTION
SECTION 13711

700 MHz RADIO SYSTEM TESTING AND ACCEPTANCE REQUIREMENTS

PART 1 - GENERAL

1.1. DESCRIPTION OF WORK

1.2. General

A. This section shall apply to all equipment provided to SEPTA as part of the 700 MHz Radio System upgrade from UHF SMARTNET Trunked/Conventional to Trunked P25.

B. All materials furnished and all work performed under this Contract shall be tested as specified hereunder.

C. Testing results that indicate specific hardware, software, or documentation does not meet the requirements of this Specification, shall require that the identified items shall be replaced, upgraded, or added by the Contractor at their expense, as necessary to correct the noted deficiencies. After correction of a deficiency, all necessary re-tests shall be performed to verify the effectiveness of the corrective action.

D. The System Acceptance Test Plan shall be considered complete, only when:

1. All tests have been performed and successfully passed test objectives
2. All discrepancies have been resolved to the satisfaction of SEPTA
3. All test records and reports have been submitted to SEPTA and have been reviewed
4. SEPTA acknowledges, in writing, successful completion of all testing

E. System Acceptance shall only occur after successful completion of the System Operational Test and other requirements and criteria as specified in this section.

F. At all times during the execution of the UHF to P25 replacement testing, there shall be a minimum of one level of communications redundancy for the SEPTA’s Radio System.

1.3. Test Plans and Procedures

A. Test plans and test procedures for all tests shall be provided by the Contractor to ensure that each test is comprehensive and verifies all the features of the functions to be tested. During the development of test plans and test procedures for software, firmware, and hardware, special emphasis shall be placed on comprehensively testing of each function and feature. The test procedures shall be modular to allow individual test segments to be repeated as needed (i.e. many MCC7500e consoles to be tested)
B. For each factory and field test, test plans and test procedures shall provide a high level functional summary. Test procedures shall provide the step-by-step activities associated with each test.

C. All test plans and test procedures shall be submitted to SEPTA for review and approval.

1.4. System Acceptance Test Plan (SATP)

A. There shall be one System Acceptance Test Plan (SATP), made up of individual subsystem test plans as required. The following information shall be included in the SATP:

1. Test schedule
2. Vehicle and facility access requirements, and resource constraints
3. Record-keeping procedures and forms
4. A list of all individual tests to be performed and the purpose of each
5. Procedures for monitoring, correcting, and re-testing discrepancies
6. Block diagram and general descriptions of the hardware test configurations, including the Contractor and SEPTA supplied equipment, radio equipment, vehicle equipment and any test equipment
7. Procedures for controlling and documenting any and all changes made to any system or subsystem after the start of testing
8. Provisions for testing of operational scenarios defined by SEPTA
9. Provisions for independent testing by SEPTA to exercise the features of the installed system
10. Identification of any special hardware, software, test equipment, and tools to be used during testing
11. Copies of certified environmental date to be used in lieu of testing (There will not be any temperature, humidity or vibration G-force testing on the actual system components supplied to SEPTA )
12. Example forms for test reports and test failure reports

1.5. Test Procedures

A. Test procedures shall be submitted to SEPTA for approval only after the SATP has been reviewed by SEPTA. Fully reviewed test procedures are required prior to the commencement of the respective testing. SEPTA will only review test procedures if
they are inclusive and thoroughly test each purchased system component and subsystem, both independently and collectively. All test procedures shall include the following items as a minimum:

1. Purpose of each test
2. Function or feature to be tested
3. Testing set-up and configuration
4. Procedures to be followed
5. Anticipated responsibilities of SEPTA during each test
6. All input and test equipment settings
7. Pass/Fail acceptance criteria for each test

B. The Contractor shall provide all items, instrumentation, materials, equipment and personnel to conduct the tests in the presence of SEPTA.

1.6. Test Records

A. The Contractor shall maintain complete and accurate records of all test results. All test records maintained by the Contractor shall be made available for inspection by SEPTA or its representative(s) at any time. The following items shall be included in the test records, as a minimum:

1. Test procedure name
2. Date and time of the test
3. Test results for each test, including a passed/failed indication
4. Any modifications made to the procedures or test setup during the test
5. Identification of the Contractor's test engineer and SEPTA's representative(s) witnessing the test
6. Comments by SEPTA's representative(s), if any
7. Discrepancy reports generated, with class of discrepancy highlighted
8. System documentation including log files, alarm printouts, configuration description, measurement records, photos, or other output saved as part of the test
1.7. Test Discrepancy Reports

A. A Test Discrepancy Report shall be prepared by the Contractor and witnessed by SEPTA’s representative(s) each time there is a deviation from the requirements of the Specification, test procedures, or the system design that is detected during any factory or field testing, beginning with Factory Testing and through to Final System Acceptance. Each Test Discrepancy Report shall include a complete description of the discrepancy, including the following items as a minimum:

1. A sequential identifying number assigned to the discrepancy
2. The date and time of the discrepancy
3. Discrepancy classification (Class 1, 2, or 3)
4. Discrepancy status (open, closed, etc.)
5. Appropriate references to the test procedures, technical Specification clause, or design documentation
6. A description of the test conditions at the time the discrepancy was detected
7. Identification of the Contractor personnel and SEPTA’s witnesses
8. A sign-off by both the Contractor and SEPTA when the correction of the discrepancy has been completed and verified.

B. Each discrepancy shall be assigned to one of the following three classes, depending on its severity and impact on the testing and the system. Discrepancies will be classified by the Contractor with SEPTA having approval rights:

1. Class 1: Severe discrepancy (Prevents, invalidates, or significantly impairs further testing). Testing will stop for immediate evaluation and correction by the Contractor
2. Class 2: Significant discrepancy (Testing will continue and the discrepancy will be corrected by the end of the current session or day)
3. Class 3: Minor discrepancy (Does not impact or invalidate other testing). Testing will continue and the discrepancy will be corrected and tested at a mutually agreed upon time (e.g. at the end of the test, or later in the test period)

1.8. Disposition of Test Discrepancies

A. All actions taken by the Contractor to correct discrepancies shall be documented. Sufficient information shall be provided in the discrepancy documentation to enable SEPTA’s representative to determine the need for re-testing the function, and for updating appropriate documentation as a result of the corrective action. Discrepancy
corrections that would result in a change to a reviewed document or configuration changes must be reviewed by SEPTA prior to implementation by the Contractor.

B. Discrepancy reports shall be closed when authorized Contractor personnel and SEPTA’s representative(s) acknowledge, by signatures, correction of the discrepancy.

C. In addition to discrepancy reports, the Contractor shall maintain a discrepancy summary that lists the following for each discrepancy:
   1. Discrepancy number
   2. A brief description of the discrepancy
   3. Date generated
   4. Test procedure reference
   5. Discrepancy class
   6. Current status (open, closed, other issues)
   7. Date the discrepancy was closed
   8. A brief description of the resolution

D. The current discrepancy summary shall be published by the Contractor at the completion of each phase of testing or whenever requested by SEPTA.

E. Discrepancies not resolved at the completion of testing shall be assigned to the master Punch List for immediate action and correction.

1.9. System Acceptance Test Plan Program

A. The System Acceptance Test Plan (SATP) Program shall consist of the phases listed hereunder and performed in the following order:
   1. Factory Testing
   2. Field Inspections
   5. P25 Subsystem Integration Testing
   6. P25 Site Acceptance Testing
   7. P25 System Testing (3-4 channel Trunk group)
9. Donor Antenna Signal Level Testing
10. P25 System Testing (all channels group)
11. Operational Radio System Test
12. Final Radio System Acceptance

B. A Final Acceptance Certificate shall be granted to the Contractor upon completion of all testing and delivery of all “as-built” documentation to the satisfaction and approval of SEPTA.

1.10. Factory Testing

A. Prior to packing and shipment, the Contractor shall assemble and interconnect all equipment being supplied to SEPTA under this Contract at their manufacturing facility in preparation for Factory Testing.

B. The following conditions must be satisfied prior to the start of the factory tests:

1. All applicable hardware and software engineering design changes shall be incorporated into the P25 Radio System

2. No system, subsystem or module shall be running on “beta” version software

3. Missing subsystems such as microwave shall be simulated in the test setup. Equipment shall not be substituted by the Contractor during factory tests without prior authorization by SEPTA

4. All action items related to system design, system performance, and test simulation techniques shall be resolved

5. All documentation, including drawings, list of deliverables, software functional documents, factory test plans and test procedures, and user manuals shall have been reviewed and reviewed by SEPTA

C. The following types of tests, as discussed below, shall occur as part of Factory Testing at the Contractor Facility:

1. Component/device/module testing

2. Individual sub-system testing

3. Sub-system integration testing

4. System testing (functionality and traffic loading)
D. Factory testing shall consist of a Contractor dry run of the factory tests, formal Factory Testing, and unstructured testing by SEPTA, its representative(s), or the Contractor.

E. Written certification that the dry run testing has been successfully completed shall be provided to SEPTA prior to the start of formal Factory Testing. All discrepancies that would preclude testing all, or portions of, the formal factory testing shall be corrected by the Contractor prior to the start of formal testing. SEPTA or its representative(s) shall have the right to review the discrepancies with the Contractor and to determine which discrepancies must be fixed prior to the start of the formal factory testing. The Contractor shall provide SEPTA with copies of all discrepancies found during the dry run testing.

F. All radio communications systems tests shall be performed using a dummy load attached to the combiner output.

G. As part of the Factory Testing an abbreviated suite of equipment shall be provided but must still include, at a minimum, two trunked voice radio communications channels, and one trunking control channel. Testing shall include demonstration of trunked voice channel operations.

H. Testing shall include system loading with traffic similar to SEPTA’s load profile.

I. The factory tests shall be considered successfully complete only when all tests have been performed, all discrepancies have been resolved to the satisfaction of SEPTA, all test records have been issued to SEPTA, all test reports are reviewed by SEPTA, and SEPTA acknowledges, in writing, successful completion of the Factory Testing and grants authorization to ship the P25 Radio System to SEPTA.

1.11. Factory Acceptance Test Procedures

A. The Contractor shall demonstrate with Factory Testing that the P25 Radio System being supplied to SEPTA shall meet all the requirements of this Specification.

B. Acceptance Test procedures which shall demonstrate all the features and complete functionality of the Motorola Astro 25 Core Network Architecture shall include the following as a minimum:

1. Zone Controller
2. Network Management Servers including ATR, ZBS, UEM, ZSS and UCS
3. Network Firewall and Firewall Management Server
4. MOSCAD Network Fault Management Server
5. GPRS Gateway Service Node Router
6. Virtual Management Servers
7. OTAR
8. POP25
9. Core and Gateway Routers
10. Packet Data Gateway
11. P25 Site Features
12. P25 Trunked Voice Features
13. P25 Data features
14. P25 Subscriber Radio Features
15. MCC7500e Dispatch Feature Set
16. Motorola internal equipment Alarm System
17. ISSI
18. CSSI
19. Broadband PTT (WAVE)
20. System traffic loading

C. Although specific tests are not included relating to electrical measurements or timing parameters of equipment, these tests and levels shall have been conducted and recorded as part of the Contractor’s standard Factory Test procedures. These parameters include but are not limited to:

1. Repeater Transmit Frequency and Deviation
2. Transmitter Output and Reflected Power
3. Simulcast Timing Parameters
4. Receiver Sensitivity
5. Receiver Intermodulation Rejection
6. Transmitter spurious emissions
7. Adjacent Channel Rejection (12.5 KHz)
8. Receiver Image Rejection
9. Combiner Loss (if applicable)
1.12. Field Inspections

A. After installation of the fixed infrastructure, the Contractor shall perform field inspections to verify that equipment installations have been completed in accordance with SEPTA’s specifications, the Contractor’s installation practices and standards, and SEPTA’s expectations that the workmanship is neat and professional.

B. Thirty (30) calendar days prior to the commencement of this activity, the Contractor shall deliver a final field inspection plan to SEPTA for review; modification, if necessary; and approval.

C. At the conclusion of this activity, the Contractor shall submit to SEPTA for approval written certification that the field inspections performed were in accordance with the reviewed plan, and that the results of the inspections were satisfactory.

D. SEPTA staff and designated personnel shall attend these inspections.

1.13. P25 On-Site Device and Module Testing

A. Device and module testing shall include all hardware, software and firmware components. The Contractor shall test all of the following as a minimum:

1. Core Network Servers (and all associated servers)
2. Workstations (Dispatch, Administration and Management)
3. Dispatch consoles (MCC7500e)
4. Radio transmitters and receivers and associated hardware modules
5. Simulcast equipment
6. Networking equipment (Routers and switches)
7. Network Timing and GPS equipment including antennas and transmission lines. GPS over fiber transceivers if required by Contractor design.
8. Antennas and Transmission Lines (VSWR, Cable Loss, Distance To Fault, Return Loss, System Return Loss, etc.)
9. Combiners and multicouplers (Losses, Tuning, Filtering, etc.)
10. Microphones and footswitches
11. Network Management and Administration systems
12. All software applications

13. Alarm systems


A. Subsystem acceptance testing shall be performed at each SEPTA Radio Site including the primary and redundant Astro 25 Core/Prime site locations.

B. Individual subsystem testing shall include all Contractor-defined groups of equipment classified as subsystems. Testing shall include hardware functional tests and tests to verify that all software functional requirements have been met.

C. At the conclusion of this activity, the Contractor shall submit for approval to SEPTA written certification that the tests performed were in accordance with the reviewed test plan that the results of the test were successful and the actual results of the test, as recorded.

D. SEPTA staff and designated personnel shall attend this test.

1.15. Site Acceptance Testing

A. Upon completion of the subsystem testing at each SEPTA Radio Site, the Contractor shall perform a series of tests to verify that each site performs in accordance with the requirements of this Specification when connected to the Astro 25 Core Network Architecture.

B. The following items at a minimum shall be tested:

1. Electrical parameters for all P25 equipment (TX power, TX frequency, deviation, receiver noise floor, etc.)

2. Timing parameters for all P25 equipment (simulcast settings)

3. Antennas and Transmission Lines (VSWR, Cable Loss, Distance To Fault, Return Loss, System Return Loss, etc.)

4. Receiver Subsystem Parameters including but not limited to Total Receiver System Gain and Noise Figure, Effective Receiver Sensitivity, Site Environmental Noise Level, etc.

5. Testing of all voice and data channel features, network control, network management systems, and fault/diagnostic monitoring

6. All trunking features between the Astro 25 Core Network Architecture and each Remote Site

7. All alarm functionality
8  Simulation of equipment failures and other abnormal operating conditions
9  Simulation of power failures
10 Simulation of failures of the Astro 25 Prime Site and switchover
11 Simulation of loss of Microwave links
12 Simulation of loss of Network Timing and GPS signal
13 Testing of all applications, user interfaces and user dialog screens

C. At the conclusion of this activity, the Contractor shall submit for approval to SEPTA written certification that the tests performed were in accordance with the reviewed test plan that the results of the test were successful and the actual results of the test, as recorded.

D. SEPTA staff and designated personnel shall attend this test.

1.16. Radio System Testing

A. The 700 MHz P25 system shall be first tested in an abbreviated mode with only 2 or 3 trunked channels active. The remaining trunked channels shall be rotated through the trunk group until all channels are tested.

B. System testing shall be comprehensive and completely test the functionality of all the major subsystems connected together that make up SEPTA’s P25 simulcast trunked radio system.

C. P25 System Testing shall include all the major subsystems connected together as follows:

1. Astro 25 Core Network Architecture
2. All Optional Servers and Gateways
3. Network Management and Administration systems
4. P25 Radio Simulcast Infrastructure
5. 1234 Market and FTC/ACC Dispatch Facilities
6. Control/console radios
7. Security systems
8. Maintenance systems
9. Digital Audio Logging recorder
10. Microwave backhaul network
11. Fiber backhaul network
12. Alarm systems
13. Antenna systems
14. Combiner/multicoupler systems
15. GPS systems including GPS signal over fiber optic transceivers (if needed)
16. Donor antennas

D. System Testing shall include the following as a minimum:

1. Electrical and timing parameters for all P25 equipment
2. Testing of all voice/data channel features, network control, network management systems, and fault/diagnostic monitoring
3. All trunking features between the Astro 25 Core Network Architecture and each Remote Site
4. All alarm functionality
5. Simulation of equipment failures and other abnormal operating conditions
6. Simulation of power failures
7. Simulation of failures of the Astro 25 Core/Prime Site
8. Simulation of loss of Microwave backhaul links
9. Simulation of loss of Fiber backhaul links
10. Simulation of loss of Network Timing and GPS signal
11. Testing of all applications, user interfaces and user dialog screens
12. Dispatch equipment functionality testing as specified hereunder
13. Digital Audio logging recorder functionality
14. Antenna systems VSWR
15. Combiner/multicoupler systems losses/gains
16. Receive signal levels at all donor antennas
1.17. Coverage Acceptance Testing

A. Implementation of the Coverage Acceptance Test Plan shall not create any communications down time for SEPTA.

B. This Coverage Acceptance Test Plan (CATP) shall be designed to verify that the 700 MHz P25 Radio System implemented by the Contractor meets or exceeds the coverage reliability as specified herein. The CATP shall define the coverage testing method and procedure, the coverage acceptance criterion, the test documentation, and the responsibilities of both the Contractor and SEPTA. To verify that the radio coverage reliability is met, SEPTA's Service Area shall be divided into equally sized test tiles as specified elsewhere herein and in accordance with the latest revision of the TSB-88 standard.

C. All coverage testing shall be in conformance with TSB-88(latest rev) unless the criteria specified herein is more stringent, in which case it shall be used.

D. Coverage testing shall be executed for both mobile and portable coverage reliability.

E. The Service Area for wide area mobile and portable coverage shall be defined as an additional 2 mile perimeter boundary from the outermost SEPTA Bus and/or Paratransit routes in which communications shall be provided that meets or exceeds the specified Channel Performance Criterion (CPC) at the specified reliability for the specified equipment configuration(s).

F. SEPTA’s identified list of critical locations including yards and depots requiring both outdoor and in building mobile and portable coverage includes; Fern Rock, Bridge St, 69th Street Transportation Center complex including: Platforms & Boarding areas, 69th St, MFSE, 69th NHSL, 69th St MSHL, Midvale Bus Depot, Comly Bus Depot, Frankford Bus Depot, Allegheny Bus Depot, Frontier Bus Depot, Southern Bus Depot, Callowhill Bus Depot, Victory Ave. Bus Depot, Germantown Bus Depot, Wyoming Bus Garage, Elmwood Trolley garage, Woodland Trolley Garage. These locations shall be coverage tested individually as separate service area’s (in addition to the overall coverage verification test) to ensure the areas are covered to the same overall coverage standard. None of the critical locations above shall be permitted to fail the individual location coverage test despite the Contractor passing the overall coverage area requirement. The test shall result in a fail and the Contractor shall mitigate coverage deficiencies at their cost.

G. The coverage reliability exhibited by the P25 Radio System shall meet or exceed the coverage reliability as specified herein over the entire coverage area.

H. Prior to testing the Contractor and SEPTA shall determine whether any test tiles are inaccessible for the coverage test (due to lack of roads, restricted land, water, etc.) Inaccessible tiles shall be extracted from the total number of test tiles in the service area.

I. The CPC is the specified minimum design performance level in a faded channel. For this Radio System, the CPC is a Delivered Audio Quality of DAQ-3.4 corresponding to
a 2.4 % BER whichever is more stringent. Given the static reference sensitivity of a
receiver, the faded performance threshold for the specified CPC is nominally the faded
sensitivity for the required CPC of 3.4 DAQ in SEPTA’s operating environment plus a
margin.

J. A DAQ criterion of 3.4 is described in TSB-88 as "Speech understandable with
repetition only rarely required. Some Noise/Distortion." It is usually equal to a BER of
2.4 % or an RSSI that is equivalent to a BER = 2.4%.

K. The Validated Service Area is the percentage of locations (tiles) within the coverage
area that meet or exceed the specified CPC.

L. No failed tiles shall be re-tested either subjectively or by BER measurement, to try and
obtain a “pass”.

M. The Confidence Level used to determine the minimum number of Test Tiles shall be
99%.

N. The Sampling Error Allowance shall be ±1.0%.

O. The number of sub-samples used to determine the tile value shall be based on a 95%
confidence interval.

P. The Contractor shall conduct a wide area mobile and portable coverage test for the
entire SEPTA service area with all Remote Sites active.

Q. Test routes or grid to be traversed in conducting the Radio System coverage tests
shall be submitted by the Contractor within four (4) months after Contract award.
SEPTA must be included in the process of selecting routes and associated test grids
prior to mutually agreeing to the test routes.

R. The Contractor shall divide the Service Area into a tile pattern to produce the number
of uniformly sized test locations (or tiles) required by this Specification. With the
approval of SEPTA, the Contractor may adjust the tile size slightly to correspond to
street to street distances in Philadelphia, if applicable.

S. The minimum number of test grids for wide area mobile coverage testing shall be 4
per square mile.

T. The Contractor shall measure the noise floor of the P25 receiver. Both the Faded
Reference Sensitivity and the Noise Floor shall be subject to approval by SEPTA prior
to any Coverage Acceptance Testing.

U. Routes shall be described and shown on an appropriate map, suitable for use during
the test. Test routes and the test evaluation shall emphasize roadways utilized by
SEPTA.

V. The coverage area reliability calculation result shall not be rounded or truncated, but
remain as calculated to two decimal places.
W. Calibration of the coverage test equipment that is mounted in the test vehicle shall be done in the presence of SEPTA personnel or their designate.

X. The final coverage Acceptance Test Plan (CATP) is subject to approval of SEPTA. Any testing conducted prior to final approval will not be considered valid and shall be re-done.

Y. BER tests shall be performed for P25 coverage testing to ensure signal quality and uniformity of test results.

Z. At the conclusion of all coverage testing, the Contractor shall submit to SEPTA all raw test data, mobile wide area coverage map and portable coverage maps plus reliability calculations.

1.18. Radio System Coverage Test Failure

A. The Contractor shall determine and record from the coverage testing the coverage reliability (in % to two decimals) defined as the percentage of test tiles within the defined Service Areas that meet or exceed the specified CPC which is a Delivered Audio Quality of DAQ = 3.4 or 2.4 % BER whichever is more stringent, tested to a 95% confidence interval for the replacement 700 MHz P25 Radio System for both mobiles and portables inbound.

1. It is acceptable to do portable coverage testing using a mobile and padding the radio receiver input for the level difference in dB. Such adjustment is subject to prior review of calculations and approval.

2. Failure for Coverage Acceptance Testing is defined as the point where the replacement P25 Radio System coverage reliability is less than that is specified herein.

3. If the P25 Radio System fails the coverage test, then the Contractor shall take corrective action. This action shall be at no cost to SEPTA, either for the corrections or for re-tests to verify adequacy of the corrections.

4. For the purposes of both mobile and portable coverage testing, the Contractor shall be responsible to provide properly equipped test vehicles of a similar nature to those used by SEPTA and drivers.

5. Test vehicles provided shall have the identical antenna and mounting location as generally used by SEPTA in their vehicles. The test vehicle height above ground to the antenna shall also be the same.

6. At the conclusion of this activity, the Contractor shall present to SEPTA written certification that the tests performed were in accordance with the reviewed plan, and that the results in reference to corrective action, have resulted in the passing of the prior failed test area.
7. SEPTA staff or designated personnel shall participate in these tests if portable inbound testing is used to determine the DAQ in each tile.

1.19. Dispatch Equipment Testing

A. General

1. The Contractor shall prepare and submit to SEPTA for approval a detailed and comprehensive Dispatch Equipment Test Plan sixty (60) days prior to testing that includes the following equipment:

   a. MCC7500e Consoles
   b. Digital Logging Recorder
   c. Alarm Systems
   d. Network Manager
   e. Netclock

B. MCC7500 Consoles

1. Each new MCC7500e console and associated equipment shall be subject to acceptance testing for the suite of features and functionality contained within this Specification with testing for the hardware/software functionality and performance parameters listed hereunder as a minimum:

   a. Damage, installation and wiring deficiencies or errors
   b. Hardware installed and tested
   c. Software installed and up to date
   d. IP addresses
   e. Dispatcher Log-on
   f. Supervisor Log-on
   g. Synchronization with the Netclock
   h. Access to common configuration management application that defines GUI/Screen layouts, overall sub-system functionality, console privileges and subscriber database
   i. Digital audio processing with adjustable AGC level settings on an individual console basis
j. Select and Unselect speakers with adjustable volume controls for individual resources

k. User-friendly, field-reconfigurable independent GUI interface(s) for each console position

l. Password-protectable console positions with comprehensive event log to note specific Dispatcher time/date usage

m. Full interoperability between IP-based and conventional subsystems

n. Interface to all proposed single and multiple site trunked and conventional systems (as required based on design)

o. Selection, control and audio functionality with every control station displayed on the console workstation

p. Fully-equipped individual conventional channel and talkgroup controls

q. Access to any combination of clear/encrypted digital system talk-paths/resources

r. Access to any combination of clear/encrypted conventional analog and digital system talk-paths/resources

s. Interface to digital audio logging recorder as defined in this specification (e.g trunked & conventional)

t. Instant recall recorder functionality

u. Access and control of single and multi-frequency base stations

v. Console-enabled cross-patch function between trunked digital talkgroups and digital/analog conventional stations (permanent and dynamic patch equipped)

w. Patch and Multi-Select with and without group re-grouping

x. Console-enabled announcement group functionality

y. Console-enabled emergency activation/acknowledgement/reset functionality definable by talkgroup resource

z. Console-enabled multiple alert tone generation (at least three unique tones – warble, solid and high/low)

aa. Alphanumeric aliasing of all individual radio subscriber unit and console ID’s

bb. Console-to-console intercom and console-to-base station transceiver site intercom
cc. Complete message activity system statistics with a selectable on-screen real-time activity display of variable call transaction length (at least 50 previous time-stamped call transactions/events)

dd. Full-duplex audio (console outbound transmit capability while receiving inbound audio from subscriber unit)

ee. Parallel operator usage status visual indication on each resource (i.e., busy indicate)

ff. Acoustic and RF cross-mute capability

gg. Call activity indication

hh. Configurable supervisory position takeover and individual position enable/disable functionality

ii. Independent inbound audio receive visual indication on each console resource

jj. Configurable time duration all-mute capability of all unselected resources

kk. Support for main/standby conventional resource interfaces with on-screen console switching mechanism

ll. General and instant transmit functionality

C. Digital Logging Recorder

1. The new and upgraded Digital Logging Audio Recorder’s at 1234 Market, FTC/ACC and the Local Districts shall be subject to acceptance testing for the suite of features and functionality contained within this Specification with testing for the hardware/software functionality and performance parameters listed hereunder as a minimum:

a. Hardware furnished and installed

b. Hardware upgrade completed

c. Software upgrade installed

d. Storage capacity

e. De-trunked audio recording of all talkgroups

f. Audio recording of conventional channels

g. Audio recording of all Control Station traffic

h. Audio recording of phones
i. Audio record levels
j. Audio recall functionality

1.20. Operational Radio System Test

A. This test shall be performed to demonstrate that the 700 MHz Radio System and related sub-systems have been properly configured and optimized; and that they will operate fully and properly without a major Radio System failure.

B. This test shall be performed after all the tests and inspections defined herein have been accepted, and before transition.

C. During the test, all Radio System features and functions shall be fully operational and accessible to the test users. SEPTA shall review the selection of test users.

D. The duration of this test shall not be for less than a continuous ten (10) calendar day period.

E. SEPTA requires the following, not to exceed, response and repair times during this period for all fixed infrastructure equipment

1. 24-hour x 7-day coverage
2. 2-hour on-site response (OSR)
3. 4-hour repair from time of OSR

F. If a major failure occurs within the ten (10) calendar day period, the continuation or re-start of the test will be at the discretion of SEPTA. SEPTA defines major failure as follows: “Any failure that causes full featured or full function trunked or Conventional operation to be lost on any one radio channel or at any one fixed equipment site”.

1.21. Radio System Acceptance

A. Final System Acceptance of the Motorola 700 MHz P25 linear simulcast Radio System for SEPTA shall only occur after the following:

1. Completion of all contractual requirements to the satisfaction of SEPTA
2. Completion of all facility work, system, component, hardware and software delivery, installation, testing, optimization, phased integration, documentation, and training.
3. Successful completion of all tests as determined by acceptance and approval of all test reports by SEPTA
4. Acceptance by SEPTA of all delivered equipment as listed in the hardware inventory provided by the Contractor
5. SEPTA approval of all drawings, manuals, and all other documentation

6. SEPTA approval of all equipment installations at all sites

7. SEPTA approval of all training provided by the Contractor

8. Correction of any operational, performance, or workmanship defects at the sole expense of the Contractor.


10. Successful completion of the System Operational Test and all pre-requisite testing

11. Final clean-up at all sites

1.22. Final Acceptance Certificate

A. A Final Acceptance Certificate shall be granted to the Contractor upon satisfactory completion and approval by SEPTA of all conditions for Final Radio System Acceptance.

PART 2 – PRODUCTS – NOT APPLICABLE

PART 3 – EXECUTION – NOT APPLICABLE

END OF SECTION
SECTION 13714

700 MHz RADIO SYSTEM FCC LICENSING REQUIREMENTS

PART 1 - GENERAL

1.1. DESCRIPTION OF WORK

1.2. MAINTENANCE REQUIREMENTS

A. The Contractor shall provide technical support/engineering as required to modify existing FCC licenses and/or to acquire additional licenses required to facilitate operation of the proposed digital radio network (including Microwave system licensing). This activity shall include all FCC licensing application development, frequency coordination and engineering fees.

B. The Contractor shall be responsible for providing all information required to complete modifications or new applications for all frequencies within 30 days of the Final Design.

C. The Contractor shall be responsible for all costs associated with license modification or re-licensing as a result of errors, omissions or unplanned design changes following the Final Design Review. Such costs include coordination and FCC fees, as well as required efforts by SEPTA or its agents.

PART 2 – PRODUCTS – NOT APPLICABLE

PART 3 – EXECUTION – NOT APPLICABLE

END OF SECTION
SECTION 13715
TRAINING, SUPPORT SERVICES AND MAINTENANCE

PART 1 - GENERAL

1.1. DESCRIPTION OF WORK

A. Requirements for Contractor-supplied training of SEPTA personnel, for Contractor-supplied support services, and for maintenance of the 700 MHz System are described in this section.

1.2. TRAINING

A. The Contractor shall provide a comprehensive training program that prepares SEPTA personnel for operation, administration, and troubleshooting of the 700 MHz Radio System. Training may be conducted by, and all training requirements shall apply to, the Contractor, the Contractor's subcontractors, third-party software suppliers, and original equipment manufacturers (OEMs). The Contractor shall provide to SEPTA all training credits supplied to the Contractor by the subcontractors, third parties, and OEMs and shall provide a list of subcontractor, third-party, and OEM training courses for which these credits can be used.

B. The Contractor shall provide technical service and administrative use training based on classroom style instruction at a SEPTA location to be determined.

C. The maximum classroom size shall be 10 students.

D. Actual training material for each course shall be delivered to SEPTA 30 days in advance of the session date.

E. All student instructional and hand-out material shall be supplied by the Contractor as part of the training. There shall be one handout per student plus 15 extra copies. Electronic copies of training documents shall be supplied to SEPTA.

F. Any equipment required in the classroom for training shall be provided, installed, and removed by the Contractor.

G. All training materials specifically produced for SEPTA by the Contractor shall become the property of SEPTA.

H. The proposal shall define the syllabus for each training course offered to satisfy the requirements of SEPTA for training on all equipment supplied under this Contract. Each course listing shall outline, as necessary, course syllabus, session schedules and timeframes, classroom materials, audiovisual aids, hands-on fixtures, course locations, timeframes, etc.
I. The Contractor shall be permitted to combine courses for Administration and Maintenance where the same material is required by both parties, if reviewed in writing in advance by SEPTA.

J. Costs associated with training shall be clearly and individually identified in the pricing section of the response.

K. The Contractor shall submit a schedule for all the training sessions to be reviewed by SEPTA.

L. **Hardware Basic Maintenance Training** – 700 MHZ Radio System hardware basic maintenance training courses shall be provided for all Contractor-provided 700 MHz Radio System equipment. The hardware basic maintenance training shall provide SEPTA personnel with a working knowledge of the 700 MHz Radio System hardware including its control, operation, interfaces with other SEPTA computer systems and devices, interfaces with data communications hardware, and the operation of diagnostic tools. The courses shall provide SEPTA support personnel with an overall knowledge of the installation, preventive maintenance, troubleshooting, repair, and expansion procedures. The courses shall provide sufficient understanding in the above topics so that trained SEPTA personnel may perform basic maintenance tasks and assist maintenance contractors with more detailed troubleshooting, as well as oversee the work performed by maintenance contractors.
a. Topics to be covered shall include but not be limited to;
   i. Astro 25 Systems Overview
   ii. Astro 25 Features Overview
   iii. Astro 25 M Core including Dynamic System Resilience
   iv. Astro 25 Systems Fleetmapping
   v. Astro 25 Security Management
   vi. Astro 25 Radio Authentication
   vii. Astro 25 GTR8000 Repeaters
   viii. MCC7500e Dispatch Consoles
   ix. WAVE System
   x. MOSCAD System
   xi. Microwave Radio System Overview
   xii. Microwave Radio Features Overview
   xiii. Fiber Multiplexer Systems Overview
   xiv. APX Subscriber Feature Overview
   xv. APX Subscriber Programming and Template Building including POP25 operation.

M. Vehicle Equipment Maintenance Training - Vehicle equipment maintenance courses shall be provided that enable qualified SEPTA maintenance personnel to troubleshoot, replace, and configure 700 MHZ Radio System vehicle equipment. Equipment covered by the courses shall include the vehicle 700 MHz Radio equipment, vehicle wiring, and other associated equipment and sub-systems that are installed by the Contractor on the vehicles. The vehicle training course shall include
theory of operation, vehicle configuration, vehicle wiring and interfaces, diagnostics, and any special procedures that must be observed.

a. Topics to be covered shall include but not be limited to;
   i. APX Subscriber Equipment
   ii. Integration/Interface with CAD/AVL Equipment
   iii. Wiring, Antenna and Alarm Systems

N. System Administration Training - The system administration training course shall provide training on the procedures necessary to configure, operate, and maintain the 700 MHz Radio System in an efficient, controlled, well-documented manner. This training course shall include, but not be limited to, the following:

1. The structure, interfaces, and functions of the 700 MHz System software and databases
2. The configuration settings and maintenance of operating systems, third party software, and network devices using the operating system(s) and network administration facilities
3. Familiarity and operation of the Fault Manager Software
4. Familiarity and operation of Configuration Management Software
5. Familiarity and operation of System Performance Management Software
6. System backup and restoration procedures, including disaster recovery procedures
7. Configuration and maintenance of all fixed-end hardware (e.g., servers, workstations, mass storage devices, etc.)
8. Managing system security and user access
9. Installing software updates provided by the Contractor and third-party software suppliers
10. Using the software configuration management and administration tools
11. Failing over to backup servers and devices, and restoration procedures
12. Interpreting and responding to error and warning messages generated by system and device monitoring software
13. Maintaining and tuning the databases using database management tools
14. System troubleshooting procedures

O. The System Administration course also shall include overview level training on the structure, organization, and functionality of the system software, application software, and database to allow SEPTA administrative and system administrator personnel to effectively support maintenance contracts for this software.

P. Console Training - The Contractor shall train Dispatchers in the functional capabilities and operation of the MCC7500 Console System. The course shall provide a thorough understanding of the UI and operation of all Console System functions, and shall familiarize the Dispatchers with general Radio System design concepts and features. It shall include hands-on training using the actual hardware and software being delivered to SEPTA. Training aids for this course shall include the Console System Manual.

a. Topics shall include but not be limited to;
   i. Overview of Console Configuration
   ii. Console Dispatcher and Supervisor Operation
   iii. Alias Management and
   iv. Messaging

Q. Revenue Vehicle Operator Instructor Training - The Contractor shall train selected SEPTA personnel to be qualified instructors in the operation of the 700 MHz Radio System fixed-route and CCT revenue vehicle equipment supplied by the Contractor. This course shall provide a thorough and clear presentation of the UI of the vehicle equipment and shall include hands-on training using the actual vehicle hardware and software being delivered to SEPTA. This course shall also instruct SEPTA instructor personnel on the setup, operation, and configuring of the vehicle Operator training hardware and any simulation hardware and software provided for vehicle Operator training. Training aids for the course shall also include the Operator Manual.

R. Non-Revenue Vehicle Operator Training - The Contractor shall train SEPTA non-revenue vehicle Operators in the operation of the non-revenue 700 MHz Radio vehicle equipment supplied by the Contractor. This course shall provide a thorough and clear presentation of the UI of the vehicle equipment and shall include hands-on training using the actual vehicle hardware and software being delivered to SEPTA. Training aids for the course shall also include the non-revenue vehicle Operator Manual.

S. Subscriber Radio Training - The Contractor shall train selected SEPTA personnel to be qualified instructors in the operation of the 700 MHz Radio Subscriber equipment. This course shall provide radio users an introduction to their radio’s, a review of their radio’s basic functionality by means of job aides tailored to exactly how they use their
radios. End-users shall learn to perform common tasks associated with their radio configuration.

a. Topics to be covered shall include but not be limited to;
   i. Overview of radio configuration
   ii. General radio operations

T. Training Course Requirements - The following sections describe general requirements that apply to all training courses.

1. **Class Size** – Training quantities are provided in the contract drawing package.

2. **Training Schedule** - The Contractor shall conduct training in a timely manner that is appropriate to SEPTA operations. The Contractor shall finalize the training schedule in consultation with SEPTA after Contract Award.

3. **Training Location and Classrooms** - All training shall be conducted at SEPTA supplied facilities. SEPTA will provide classroom facilities for all training conducted at their facilities.

4. **Instructors** - The principal instructors provided by the Contractor, subcontractors, third-party software suppliers, and OEMs shall have had previous formal classroom instructor training and relevant experience with the 700 MHz System hardware and software. The instructors shall also demonstrate a thorough knowledge of the material covered in the courses and familiarity with the training documentation, tools, and training aids used in the courses.
   
a. When prerecorded lectures are part of a training course, the lecturer or a qualified substitute shall supplement the recorded material. All SEPTA-specific material shall be presented in person by a qualified instructor.

5. **Training Documentation and Equipment** - The Contractor shall provide editable training documentation in a digital format and detailed agendas, including the training instructor for each training course, to SEPTA for review prior to the start of classroom instruction. SEPTA requires that training materials specifically prepared for use as training aids be used as the primary training document; but system documentation such as reference manuals, maintenance manuals, and user manuals may also be used. Materials used for training shall be tailored to reflect all SEPTA hardware, software, terminology, and user requirements. If system documentation is used for training, the quantities of documentation provided for training shall be in addition to the quantities otherwise required in Section 13350.
   
a. Upon completion of each course, instructor’s manuals, training documentation, and training aids shall become the property of SEPTA. As part of the delivered system documentation and the final documentation, the Contractor shall supply SEPTA with all changes and revisions to the training documentation. SEPTA
reserves the right to copy all training documentation and aids for use in SEPTA-conducted training courses.

b. The Contractor shall furnish for use during training courses all special tools, equipment, training aids, and any other materials required to train course participants. The number of special tools and other training equipment shall be adequate for the number of participants attending the course.

6. **Video-Based and Computer-Based Training** - The Contractor may use standard prerecorded lectures and workbooks and/or computer-based interactive courses as training material, subject to prior approval by SEPTA. All such courses shall be supported by the availability of qualified personnel to answer questions and provide in-depth discussion of difficult topics. The Contractor shall provide SEPTA with copies of all such training course material for retention and playback by SEPTA as reference documentation and training aids. SEPTA reserves the right to record all training courses using its own recording equipment.

PART 2 – PRODUCTS – NOT APPLICABLE

PART 3 – EXECUTION – NOT APPLICABLE

END OF SECTION
SECTION 13900

CAD DRAFTING STANDARDS

PART 1 - GENERAL

I.1. General

A. The criteria herein has been compiled for the purpose of establishing, defining and clarifying procedures and CADD standards to be used in in-house C & S department and by consultants in preparing CADD based contract documents for SEPTA. The intent of this document is to provide guidelines to assure that all project drawings have a uniform appearance and reflect high quality drafting workmanship. Each engineer, project manager, designer and CADD operator shall be responsible for ensuring that these criteria are implemented by both in-house forces and by third-parties tasked with the development of design content for SEPTA and that all drawings show the information completely and clearly without unnecessary embellishments.

B. References

1. The original “Transit Design Manual” developed by the City of Philadelphia and SEPTA “Drafting Standard” developed in June 1989 has been used as the foundation to specifically tailor CADD standards for SEPTA C & S department engineering efforts.

C. Interpretation

1. The listed criteria, rules and procedures set forth in this document shall be read together and interpreted as a whole in order that all provisions may be considered inclusive. In cases of conflict between any of the criteria, rules or procedures listed, the most stringent requirements shall govern. When an issue arise that is not addressed within this document or adequate interpretation cannot be achieved, contact the SEPTA C & S Engineering Department.

D. Standards Compliance

1. CADD requirements discussed in this document shall be incorporated into the drafting presentation. The engineer may be required to provide CADD examples as described in this document representing product output for review by SEPTA for adherence to these criteria at a time prior to any submittal of contract documents.

E. Definitions

1. As-Built Drawings – Drawings marked up in the field to reflect changes to the design.
2. Bid Drawings – The drawings issued to the prospective contractors for the purpose of bidding the project work.

3. CADD – Computer-Assisted Design Drafting. As applied to SEPTA it refers to all AutoCAD versions.

4. Conformed Drawings – Post bid project drawings which have been combined with drawings and changes stemming from addenda or requests for clarification during the estimating and bidding process.

5. Contract Drawings – The drawings incorporating all the addenda issued during the bid process.

6. EM&C – Engineering, Maintenance and Construction (a division within SEPTA).

7. Project Drawings – Preliminary, bid, contract, conformed, as-built or record-set drawings.

8. Record Drawings – A complete set of drawings that incorporate the as-built revisions into the design documents, including addenda and design revisions.

9. SEPTA – Southeastern Pennsylvania Transportation Authority.

10. The Consultant – The design firm under contract with SEPTA.

1.2. Drawing and Electronic Submission Media

A. Printed Media

1. Four hard copies of the drawing set on 11” x 17” 60# bond (If required at time of submission).

2. Four hard copies of the specifications on 8.5” x 11” bound (If required at time of submission).

B. Electronic Media

1. SEPTA C & S department requires all drawings be saved to AutoCAD 2010.

2. All drawing files shall be submitted in AutoCAD format and in PDF format at each required submission. AutoCAD drawing files only are due at the schematic phase to ensure proper use of SEPTA drawing standards.

3. AutoCAD drawings must have all utilized fonts, symbols, standard drawing template and indexing.

4. All specification files shall be provided in Microsoft Word and in PDF format at each required submission.
5. Submissions in electronic format shall be provided on ISO9660 formatted CD-R or DVD disks. Media shall be labeled with indelible ink indicating Project Name, SEPTA project number and submission date.

C. Electronic Transmittal

1. A transmittal sheet shall accompany all printed and electronic media and contain a description of the drawing set.

1.3. Drawing Organization, Content and Identification

A. UCS Global Origin

1. The standard AutoCAD User Coordinate System origin of 0,0 shall be used in all instances and shall be oriented so that X point to the direct right and Y points to the direct top of the sheet.

B. Units of Measurement

1. Decimal units of measurement with 0.0000 precision shall be used in all instances.

2. Snap X and Y spacing shall be set at .05 and Grid X and Y spacing shall be set at 0.1

C. 3Model Space

1. A drawing file may contain both “Model” and “Layout” (Paper) space environments; however, SEPTA C & S department only uses “Model” space on all of its drawings.

D. C & S Border and Index Sheets

1. The border template will be provided by the C & S engineering department.

2. In some cases, a template for the index will accompany the title block. The lower left portion of the border is the designated area for contractors address and logo.
3. In the revision section of the Title, Index, Revisions and Notes sheet, the revision designation, the date of the revision and the initials of the designer, checker and approver shall be shown along with a description of the revision being made. Any
changes made after the award of construction contracts will be considered revisions unless specifically approved by the Project Designer. The revision block is an attribute editable block and should not be exploded for any reason.

E. Drawing Element Organization

1. Project drawings shall be carefully organized so that the designer’s intent can be easily read. The drawings shall be laid out with ample space between drawing items to ensure sufficient space for unanticipated details which may be required.

F. Drawing File Title Blocks

1. This section deals with the proper procedure for entering information onto the signal drawing cover sheet and subsequent sheets. The following list shall be the only procedure for accomplishing this task. All information entered onto the title blocks shall be capital letters.

   a. Location - This space is reserved for the name of the specific location of the drawing. See section 3.3 for a detailed description.

   b. Project Title - This area describes the function of a certain location.

   c. Drawing Title - This is to be used for a basic description of an individual sheet. Sheet Line 2 shall be used for overflow descriptions and track designations.

   d. Rail Line - Rail Line names are to be used in accordance with the RRD branch / City / Suburban Transit required.

   e. Division - This space is reserved for the three letter designate representing various rail divisions, only the following shall be used:

      RRD - Regional Rail

      STD - Suburban Transit

      CTD - Subway/Elevated

   f. Municipality - This section is reserved for the city, town, township etc., where the particular location resides.

   g. Sheet Number - The Sheet number of an individual sheet.

   h. Drawn By - The initials of the Cadd operator shall be put in this section. Only three initials shall be used. NO FULL NAMES. If more than one person is involved in the creation of a drawing, the second set of initials shall be separated by a forward slash (/). Periods between initials shall not be used under any circumstance.
i. Date Drawn - This date refers to when the Cadd operator begins drawing an individual sheet. Only numbers shall be used and separated by dashes (-) with two digits per month, day and year. The order of sequence shall be month, day and year.

j. Designed By - The initials of the designer shall be put in this section. Only three initials shall be used. NO FULL NAMES. If more than one person is involved in the creation of a drawing, the second set of initials shall be separated by a forward slash (/). Periods between initials shall not be used under any circumstance.

k. Checked By - The initials of the checker shall be put in this section. Only three initials shall be used. NO FULL NAMES. If more than one person is involved in the creation of a drawing, the second set of initials shall be separated by a forward slash (/). Periods between initials shall not be used under any circumstance.

l. Date Checked - This date refers to when the checker completes checking the entire set of drawings. Only numbers shall be used and separated by dashes (-) with two digits per month, day and year. The order of sequence shall be month, day and year.

m. AIS Rev. - The revision number according to the marked field plans.

n. AIS Date - This date refers to the date that a revision has been completed in the field. Only numbers shall be used and separated by dashes (-) with two digits per month, day and year. The order of sequence shall be month, day and year.

G. Location Descriptions

1. All proper names shall be complete with no abbreviations. Periods shall not be used unless using a milepost number. Below are examples of different types of locations to be used when entering information into the title blocks.

   - Byberry Road
   - 16th Street Junction
   - Fairmount Interlocking
   - West Overbrook Station
   - CP Cynwyd
   - Signal 52 & 53
2. When there is more than one location description on a plan, the descriptions shall be separated by a dash with no spacing between the names. For example: ELM INTERLOCKING-MARSHALL STREET

H. Project Title Descriptions

1. Below are examples of different types of project descriptions to be used when entering information into the title blocks.

   Highway Crossing Warning Devices
   Pedestrian Crossing Warning Devices

   NB Start for ________________
   SB Start for ________________

I. Plotting Drawings

1. All sheets that are not for issue shall be printed on the [HP Color Laserjet CP 6015dn/Plotter at Signals Location] plotter queue and set to the following settings.
Click **OK** to begin the plotting process.

J. Signatures for Issuing Drawing Files

1. When the final check has been completed on a revision, various signatures must be placed on the drawing before the final plot. It is the responsibility of the Cadd operator to insure all appropriate signatures and dates are on each drawing before issue.

2. Use the `Ddedit` command to properly place the date of the final check in the “Date Checked” category on the drawing border.

3. The allotted space for the Project Engineer, Director, C&S Engineering and Assistant Chief Engineer – Communications & Signals must also be filled out on the drawing border. Use the `Ddedit` command to properly place revision information on the Revision Block on the Index sheet.
a. Revision Number - The designer shall be put in this section. Only three initials shall be used. NO FULL NAMES. If more than one person is involved in the creation of a drawing, the second set of initials shall be separated by a forward slash (/). Periods between initials shall not be used under any circumstance.

b. Issue Date - This date refers to the date that the set of plans are to be issued to the field. Only numbers shall be used and separated by dashes (-) with two digits per month, day and year. The order of sequence shall be month, day and year.

c. Designed By* - The designer's initials, responsible for designing that particular revision, shall be put in this section. If a draftsman is responsible for redrawing a set of plans, then the Cadd operators initials shall appear in this space. Only three initials shall be used. NO FULL NAMES. Periods between initials shall not be used under any circumstance.

d. Checked By* - The checker's initials, responsible for checking that particular revision, shall be put in this section. Only three initials shall be used. NO FULL NAMES. Periods between initials shall not be used under any circumstance.

e. Approved By* - The Approver's initials, responsible for approving that particular revision, shall be put in this section. Only three initials shall be used. NO FULL NAMES. Periods between initials shall not be used under any circumstance.

f. Description - This area shall contain the description of that particular revision.
g. AIS Drawn By - The Cadd operators initials, responsible for revising that particular as in service, shall be put in this section. Only three initials shall be used. NO FULL NAMES. Periods between initials shall not be used under any circumstance.

h. AIS Checked By - The checker’s initials, responsible for revising that particular as in service, shall be put in this section. Only three initials shall be used. NO FULL NAMES. Periods between initials shall not be used under any circumstance.

i. AIS Date - This date refers to the date that a revision has been completed in the field. Only numbers shall be used and separated by dashes (-) with two digits per month, day and year. The order of sequence shall be month, day and year.

j. Per - The field personnel’s initials, responsible for revising that particular as in service in the field, shall be put in this section. Only three initials shall be used. NO FULL NAMES. Periods between initials shall not be used under any circumstance.

* This block shall be initialed by the appropriate individual manually. The initials shall be entered electronically once the revision returned in service.

K. Sheet Assignments

I. When drawing a new location or redrawing an existing location, the following list shall be a guide to assigning sheet numbers in order of precedence.

**Highway Crossing Warning Devices**

1. Cover Sheet
2. Location Plan
3. Power Distribution
4. Track Circuits
5. Control Circuits
6. Line Circuits
7. Gate Control and Flasher Circuits
8. Gate Mechanism
9. Case Detail
10. Relay Functions and Energy Loops
Pedestrian Crossing Warning Devices

1. Cover Sheet
2. Location Plan
3. Power Distribution
4. Track Circuits
5. Control Circuits
6. Line Circuits
7. Gate Control and Flasher Circuits
8. Gate Mechanism
9. Case Detail
10. Relay Functions and Energy Loops

Switch and Crossover Locations
1. Cover Sheet
2. Location Plan
3. Power Distribution
4. Track Circuits
5. Control Circuits
6. Line Circuits
7. Gate Control and Flasher Circuits
8. Case Detail
9. Relay Functions and Energy Loops

Interlockings
1. Cover Sheet
2. Location Plan
3. Power Distribution
4. Track Circuits
5. Line Circuits
6. Route Check Circuits
7. Signal Control Circuits
8. Distant Circuits
9. Signal Lighting Circuits
10. Cab Signals
11. Signal Repeater Circuits
12. Time Locking Circuits
13. Route Locking Circuits
14. Switch Locking Circuits
15. Miscellaneous Circuits
16. Switch Control and Correspondence Circuits
17. CTC Code Chart and Code Line Circuits
18. CTC Indication Circuits
19. Manual Control Panel Circuits
20. Highway Crossing Circuits
21. Case Detail
22. Relay Connections

Communications Designs
1. Cover Sheet
2. Symbol Sheet
3. Location Plan
4. Single Line Diagrams
5. Interconnect Drawings
6. Typical Drawings
7. Circuit Assignment Tables
8. Rack Layout
9. Parts List

L. Placement of Parallel Wire leads

1. When Drawing parallel line circuits that contain positive and negative wire tagging, the positive wire shall be above the negative wire when the circuit is drawn horizontally. This policy is not to be used when the continuity of the case detail is affected.

2. When drawing power sources horizontally, the positive power shall be above the negative power.
3. When drawing power sources vertically, the positive power shall be to the left of
the negative power.

M. Multiple Repeater Relay Tagging

1. On all new work, the tagging of two or more repeater relays shall be as follows:

   First repeater - example: TPR
   Second repeater - example: T2PR not TPPR
   Third repeaters - example: T3PR not TPPPR

   and so on...

2. When revising existing work, use the tagging method that is in place for that
   particular location except when adding repeater relays.

N. Checked By and Date Checked

1. When creating a new set of plans for a location, the Checked By and Date
   Checked attributes shall be left blank until instructed by the checker to fill in the
   appropriate information.

2. To properly fill in the attributes, access the Notes & Lisp Applications section of
   the signal pulldown menu and click onto either the Checked By or Date Checked
   command. At the New String prompt, type the information desired.

   3. This command will not function if the attributes contain previously entered data.

1.4. Graphical Elements

A. General Text

1. All lettering shall be of sufficient size (no less than .1"), weight and clarity so that
   it can be easily read from an 11" x 17" print. On any one sheet, uniformity shall
   be maintained.

B. Text Formats and Lettering Type

1. Capitalize proper nouns, specific titles and trade names.

2. Unless otherwise specified, all lettering within any drawing shall be RomanS font.
   Where fractions occur in dimensions, a space shall be placed between the whole
   number and the fraction (example: 6 ½”).

3. All lettering shall be horizontal, unless related to dimensioning where it shall be
   parallel to the dimension line.
1.5. Server File Structure

A. Project Folder

1. This is the highest level folder, will contain the assigned project name. i.e. 810-Smart Stations 1.

Sub-Folders

01) Drawings- all Drawings including revisions
02) Equipment Data Sheets- all cut sheets for the project
03) Quotes Pricing- All project vendor quotes and SEPTA cost estimates
04) SEPTA Documentation – All internal documentation or correspondence deemed pertinent other than cost estimates
05) Vendor Documentation- All vendor documentation or correspondence deemed pertinent other than cost estimates
06) Pictures- all project related pictures
07) Additional folders as needed by Project Designer

B. As-In-Service

1. Once drawings are issued as-in service the drawings are moved to the Record Drawing Folder. The file structure is by division City Transit Division (CTD), Suburban Transit Division (STD) and Rail Road Division (RRD). With subfolder by Line.

PART 2 – PRODUCTS – NOT APPLICABLE

PART 3 – EXECUTION – NOT APPLICABLE

END OF SECTION
SECTION 16050
BASIC ELECTRICAL MATERIALS AND METHODS PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. This Section includes specifications for basic materials and methods of installation applicable to electrical work to be performed under this Contract.

B. Provisions of the Contract Documents including requirements of Division 1 of the Specifications apply to all work of this Section.

1.02 QUALITY ASSURANCE

A. The Contractor shall refer to Section 01400, "Quality Control Requirements".

B. Equipment shall be designed and installed in accordance with the pertinent provisions of the codes and standards as described in Section 01091, "Reference Standards".

C. Any law or regulation of the State of Pennsylvania or other local regulating body having jurisdiction over this equipment shall apply, including but not limited to local building codes.

D. Furnish all items of the materials, design, sizes and ratings shown on the Contract Drawings and herein specified.

E. Furnish materials and equipment bearing evidence of UL approval where UL standards exist and such product listing is available.

F. Method of fabrication, assembly and installation is optional unless otherwise specifically stated.

G. Provide products that are free from defects impairing performance, durability, or appearance, and of the commercial quality best suited for the purpose shown on the Contract Drawings or specified herein.

H. All steel items specified to be zinc coated: Hot dipped galvanized after fabrication in accordance with ASTM A286.

I. Method used to determine the thickness of zinc coating: The Referee Test included in the appendix to ANSI C80.1.

J. All other applicable laws, ordinance and requirements of the local agencies and utility companies having jurisdiction, shall apply.

K. In the event of any conflicts in the provisions stipulated in the referenced codes, regulations or standards and the specifications, the most stringent provision, as determined by the Project Manager, shall govern.

L. When any piece of equipment or any part thereof has a guarantee or warranty for a period of one year or more, deliver such guarantee or warranty to the Project Manager.
1.03 JOB CONDITIONS
   A. The materials specified in this Section shall be for general use in an Electrical Installation for indoor/outdoor application as shown on the drawings.

1.04 DELIVERY
   A. All equipment shall be protected from damage throughout delivery, storage and handling.
   B. The Contractor shall inspect each item of equipment for shipping damage prior to installation.
   C. Any equipment showing signs of damage shall be repaired or replaced, at SEPTA’s option, without cost to SEPTA.

PART 2 - PRODUCTS

2.01 RIGID GALVANIZED STEEL CONDUIT AND ACCESSORIES
   A. Rigid galvanized steel conduits shall be used where conduits are exposed.
   B. Conduit, couplings, elbows, bends and nipples shall be in accordance with ANSI C80.1 and UL approved.

2.02 FITTINGS AND ACCESSORIES
   A. Galvanized steel or malleable iron shall be in accordance with ANSI C80.4.
   B. Provide separable watertight hub fittings with a gasket, separate nylon insulated throat and a case hardened locknut.
   C. Nylon insulated metallic type bushings.
   D. Furnish conduit straps, clamp backs made of galvanized malleable iron.
   E. Furnish conduit with standard pipe thread, furnish with coupling, shipped with thread protector.

2.03 PVC ELECTRICAL CONDUIT AND FITTINGS
   A. PVC conduits encased in concrete shall be used underground. PVC conduits shall not be used in the Center City Commuter Tunnel.
   B. Heavy wall, high impact strength, rigid PVC conforming to the requirements of Schedule 40 PVC conduit and fittings of NEMA TC8 shall be used.
   C. PVC conduit shall be UL listed in accordance with Article 347 of the NEC for underground and exposed use.

PART 3 - EXECUTION
3.01 GENERAL

A. Install all items in their proper locations as shown on the Contract Drawings, rigid and secure, plumb and level, and in true alignment with related and adjoining work. Do not weld electrical materials for attachment or support.

B. Furnish anchor bolts and anchorage items as required, and field check to ensure proper alignment and location. Provide templates, layout drawings, and supervision at the job site to ensure correct placing of anchorage items in concrete. Check embedded items for correctness of location and detail before concrete is placed.

C. Install supporting members, fastening, framing, angers, bracing, brackets, straps, bolts and angles as required to set and connect rigidly the work.

D. Control erection tolerance requirements; do not impair the strength, safety, serviceability, or appearance of the installations. Determine exact location of conduit. Route all conduit parallel to building lines.

E. The trade size, type and general routing and location of conduits, raceways, and boxes are shown on the Contract Drawings.

F. Install exposed conduit so as to avoid conflicts with other work.

G. Install individual conductors in conduits and raceways as shown on the Contract Drawings to complete the wiring systems.

H. Install switches, receptacles, special purpose outlets, and cover plates complete in a neat manner in accordance with the NEC and local electrical codes.

3.02 CONDUIT, FITTINGS AND ACCESSORIES

A. Exposed Conduit

1. Rigid galvanized steel conduit shall be run exposed in both wet and dry locations. All conduits shall be run in straight lines parallel to column lines, walls or beams. Where conduits are grouped, the bends and fittings shall be installed so as to present an orderly appearance. Unnecessary bending and offsets shall be avoided. Conduits shall be kept at least 12 inches away from heating devices or similar equipment.

2. Supports for conduit shall be in accordance with NEC, Article 346. In general, single runs of conduit shall be supported with galvanized conduit straps or clamps on suitable channels, “Unistrut” or “Powerstrut” systems or approved equal. Conduit supports shall be installed using approved anchors and mounting accessories such as embedded concrete inserts, bolts, nuts, washers, and screws. All surface conduits shall be spaced from building structures a minimum of 1/2 inch.

3. Conduit shall be tightened securely and shall be supported rigidly in place. All connections to outdoor boxes shall be watertight. The Contractor shall drill all holes in concrete for installation of expansion anchors for conduit runs.

B. Embedded and Buried Conduit
1. Either rigid galvanized steel or PVC, non-metallic conduit shall be used for both embedded and buried applications. Buried conduit shall be run as directly as practicable, at least 36 inches below grade, and shall be located to avoid interference with other piping, foundations, and similar underground work. All conduits entering or leaving the ground shall be sealed to prevent condensation of moisture inside the conduit. Conduit shall be buried in accordance with Section 32 of ANSI C2 (NESC). Conduit entrances in the bottom of switchgear, power distribution panels, switchboards, etc., shall project into the enclosure a minimum of 3 inches to prevent water from entering conduits.

2. Buried non-metallic conduit shall have a minimum of 3 inches of protective concrete, on all sides, where they cross roadways, parking area, under the foundations or other areas subject to heavy loads.

3. Conduit required for the embedded conduit system shall be installed as shown on the Drawings. Runs of conduit to be embedded in concrete shall be rigidly supported in their proper positions while concrete is being placed. Ends of conduits shall be suitably plugged or capped during construction to prevent the entrance of concrete or other foreign matter. Connections shall be checked for tightness before being embedded.

4. Expansion couplings used in conduit runs crossing expansion or contraction joints in concrete shall be zinc coated and watertight.

C. Identification

1. Conduits terminating at floors or in cabinets or cubicles shall be identified by metal tags bearing the conduit number. The tags shall be securely attached to the conduit directly under the terminating bushing.

2. Conduit terminating in walls shall be identified by stenciling the conduit number on the wall directly under the conduit.

D. General Workmanship and Installation Requirements

1. Where field changes are required, every precaution shall be taken to ensure that the change is coordinated with other raceway work, structural work and plumbing work and piping. A complete record of such changes shall be made on the Record Drawings.

2. Metal conduit shall be cut square, threaded and reamed to remove sharp or rough edges and burrs. Running threads will not be allowed. Conduit joints and connections shall be made watertight and rust resistant by proper threading, application of a non-insulating thread compound, such as white lead or graphite, and zinc sealing material. Each threaded joint shall be thoroughly cleaned to remove cutting oil before the compound is applied.

3. In general, elbows and bends for conduit four inches in diameter and smaller shall be formed in the field and shall be reasonably free from flattened surfaces, indentations, or kinks. Conduit shall be bent cold to prevent damage to the protective coating. All
Raceway bends shall be gradual and smooth to permit the pulling of insulated electrical wires and cable without damage to the insulation or sheath. Radius of curvature shall be not less than that permitted by NEC. The number of bends shall not exceed three 90-degree bends between pull points. The distance between pull points shall not exceed 250 feet for straight runs. For each 90-degree bend, deduct 60 feet from the straight run length or approximately 0.66 feet per degree.

4. Conduit shall be rigidly secured to panels and other electrical equipment and terminal boxes with locknuts and bushings in such a manner that each system shall be electrically continuous throughout.

5. To reduce damage to the zinc coating, only strap type wrenches shall be used on galvanized conduit. All wrench marks, field cut threads, and all other places where zinc coating is damaged shall be repaired with zinc rich galvanizing repair compound.

6. Conduit pull boxes, sized in accordance with the NEC, shall be installed wherever necessary to avoid excessively long pulls or an excessive number of bends.

7. Boxes, fittings and accessories shall be installed to conform to the NEC. The Contractor shall also comply with any additional more stringent requirements specified elsewhere or shown on the Contract Drawings.

E. Pull Wires

1. Use wires of tensile strength no less than 200 pounds in each conduit and duct.

2. Free of splices, and having ample exposed length at each end.

3. Furnish a pull wire in all empty raceways and identified with labels or tag reading “pull wire” and giving the termination point.

F. Filling of Openings

1. Wherever slots, sleeves, or other openings are provided in floors or walls for the passage of raceways, including bus ducts, fill such openings as follows:

2. Use fire resistive filling material for openings similar to the material of the floor, wall or ceiling being penetrated, and finish preventing passage of water, smoke and fumes.

3. Where conduits pass through openings are exposed in finished rooms, use filling material that matches, and is flush with, the adjoining finished floor, ceiling or wall.

G. Junction and Pull Boxes

1. Provide junction and pull boxes where required to facilitate installation of wiring, whether or not shown on Contract Drawings.

2. Install so that covers are readily accessible after completion of the installation.
SECTION 16060
GROUNDING AND BONDING

PART 1 – GENERAL

1.1 DESCRIPTION OF WORK
A. This Section includes methods and materials for grounding systems and equipment.
   1. Wire.
   2. Mechanical Connectors.

1.2 SUBMITTALS
A. Product Data: For each type of product indicated.

1.3 QUALITY ASSURANCE
A. Provide grounding materials conforming to requirements of NEC, IEEE 142, and UL labeled.
B. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 – PRODUCTS

2.1 CONDUCTORS
A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
B. Bare Copper Conductors:
   4. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
   5. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

2.2 MECHANICAL CONNECTORS
A. Manufacturers:
   1. Erico, Inc
   2. O-Z Gedney Co.
3. Thomas & Betts Inc.
4. GTI Inc.

B. Description: Bronze connectors, suitable for grounding and bonding applications, in configurations required for particular installation.

C. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.

D. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.

1. Pipe Connectors: Clamp type, sized for pipe.

PART 3 – EXECUTION

3.1 PREPARATION

A. Remove paint, rust mill oils, surface contaminants at connection points.

3.2 INSTALLATION

A. Install in accordance with IEEE 142.

B. Install grounding and bonding conductors concealed from view.

C. Equipment Grounding Conductor: Install separate, insulated conductor within each feeder and branch circuit raceway. Terminate each end on suitable lug, bus, or bushing.

D. Permanently ground entire light and power system in accordance with NEC, including lighting panelboards, switch and starter enclosures, motor frames, grounding type receptacles, and other exposed non-current carrying metal parts of electrical equipment.

E. Accomplish grounding of electrical system by using insulated grounding conductor installed with feeders and branch circuit conductors in conduits. Size grounding conductors in accordance with NEC. Install from grounding bus of serving panel to grounding bus of served panel, grounding screw of receptacles, lighting fixture housing, light switch outlet boxes or metal enclosures of service equipment. Ground conduits by means of grounding bushings on terminations at panelboards with installed number 12 conductor to grounding bus.

F. Permanently attach equipment and grounding conductors prior to energizing equipment.

3.3 APPLICATIONS

A. Conductor Terminations and Connections:
1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.

3.4 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

3.5 FIELD QUALITY CONTROL

A. Perform continuity testing in accordance with IEEE 142.

B. When improper grounding is found on receptacles, check receptacles in entire project and correct. Perform retest.

END OF SECTION
SECTION 16070
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS PART 1 – GENERAL

1.1 DESCRIPTION OF WORK
A. This Section includes the following:
   1. Hangers and supports for electrical equipment and systems.
   2. Formed steel channel.

1.2 PERFORMANCE REQUIREMENTS
A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
B. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this project, with a minimum structural safety factor of five times the applied force.

1.3 SUBMITTALS
A. Product Data: For the following:
   1. Hangers and Steel slotted support systems: Submit manufacturers catalog data including load capacity.

1.4 QUALITY ASSURANCE
A. Manufacturer: Company specializing in manufacturing Products specified in this Section with minimum three years documented experience. B. Comply with NFPA 70.

PART 2 – PRODUCTS

2.1 CONDUIT SUPPORTS
A. Manufacturers:
   1. Thomas & Betts.
   2. O-Z Gedney Co.
   3. Allied Tube & Conduit Corp.
   4. ERICO International Corporation.
   5. Unistrut, Tyco International, Ltd.
B. Hanger Rods: Threaded high tensile strength galvanized carbon steel with free running threads.

C. Beam Clamps: Malleable Iron, with tapered hole in base and back to accept either bolt or hanger rod. Set screw: hardened steel.

D. Wall Clamps: One-sided steel hook type clamps.

E. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.

F. Toggle Bolts: All-steel springhead type.

G. Cable Ties: High strength nylon temperature rated to 185 degrees F. Self locking.

2.2 FORMED STEEL CHANNEL

A. Manufacturers:
   1. Unistrut Corp.
   4. Or equal.

2.3 SPRING STEEL CLIPS

A. Manufacturers:
   1. Acorn Fasteners.
   3. Unistrut Corp.
   4. Or equal.

B. Product Description: Mounting hole and screw closure.

PART 3 – EXECUTION

3.1 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT and RMC minimum of 10 feet O.C. Minimum rod size shall be 1/4 inch in diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
1. Secure raceways and cables to these supports with single bolt conduit clamps.

D. Wall clamps: All vertical drops shall be surface mounted to wall with one-sided “hook type” clamps and installed in accordance with the NEC.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT may be supported by openings through structure members, as permitted in NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.

2. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.

3. To Existing Concrete: Expansion anchor fasteners.

   Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.

4. To Steel: Beam clamps complying with MSS SP-69.

5. To Light Steel: Sheet metal screws.

6. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS
A. Comply with installation requirements in Division 5, Metal Fabrications for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Touchup: Comply with requirements in Division 9 for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION
SECTION 16075
ELECTRICAL IDENTIFICATION

PART 1 – GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Identification for raceways.
   2. Identification of power and control cables.
   3. Identification for conductors.
   4. Equipment identification labels.
   5. Nameplates.

1.2 SUBMITTALS

A. Product Data:
   1. Submit Manufacturer’s catalog literature for each product required.
   2. Submit electrical identification schedule including list of wording, symbols, letter size, color coding, tag number, and function.

1.3 QUALITY ASSURANCE

A. Comply with NFPA 70.

B. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years documented experience.

C. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.4 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Contract Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

C. Coordinate installation of identifying devices with location of access panels and doors.
D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 – PRODUCTS

2.1 NAMEPLATES

A. Manufacturers:
   1. Seton Identification Products.
   2. Thomas & Betts.
   3. Panduit Corp.
   4. Or equal.

2.2 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

A. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

B. Write-On Tags: Polyester tag, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
   1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
   2. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

C. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

2.3 CONDUCTOR IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.

B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

C. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

2.4 EQUIPMENT IDENTIFICATION LABELS
A. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch.

B. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 3/8 inch.


PART 3 – EXECUTION

3.1 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Outlet Cover Plates: Contractor shall permanently mark all electrical outlets with corresponding number and associated panelboard. Branch circuit breakers shall be marked at the panelboard and a directory shall be installed.

C. Junction Boxes: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels or paint with the designation. Letters if painted shall be red 2” high

D. Apply identification devices to surfaces that require finish after completing finish work.

E. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

F. Painted Identification: Use red paint with 2” high letters.

3.2 IDENTIFICATION SCHEDULE

A. Power-Circuit Conductor Identification, 600 V or Less: For conductors in pull and junction boxes use color-coding conductor tape to identify the phase.

1. Color-Coding for Phase Identification, 600 V or Less: Use colors listed below for branch circuit and feeder conductors.

   a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG.

   b. Colors for 208/120-V Circuits:

      1) Phase A: Black.

      2) Phase B: Red.

      3) Phase C: Blue.
c. Colors for 480/277-V Circuits:
   1) Phase A: Brown.
   2) Phase B: Orange.
   3) Phase C: Yellow.

2. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

B. Conductors to Be Extended in the Future: Attach tags to conductors and list source. All fibers shall be numbered at both ends for quick identification.

C. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
   1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
   2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.

D. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
   1. Labeling Instructions:
      a. Indoor Equipment: Adhesive film label. Unless otherwise indicated, provide a single line of text with 1/2-inch high letters on 1-1/2-inch high label; where two lines of text are required, use labels 2 inches high.
   2. Equipment to Be Labeled:
      a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be laminated acrylic or melamine label.
      b. Transformers.
      c. Enclosures and electrical cabinets.
d. Access doors and panels for concealed electrical items. e. Monitoring and control equipment.

END OF SECTION
SECTION 16095
MINOR ELECTRICAL DEMOLITION

PART 1 – GENERAL

1.1 DESCRIPTION OF WORK
A. Section Includes:
   1. Removal of existing electrical equipment, wiring, and conduit in areas to be
      remodeled; removal of designated construction; dismantling, cutting and
      alterations for completion of the work.
   2. Disposal of materials.
   4. Identification of utilities.
   5. Salvaged items.
   6. Protection of items to remain as indicated on Drawing.
   7. Relocate and rewire existing equipment and circuits to accommodate
      construction.

1.2 CLOSEOUT SUBMITTALS
A. Project Record Documents: Record actual locations of capped utilities.

1.3 PRE-INSTALLATION MEETINGS
A. Division 1 – Project Coordination: Pre-installation meeting.
B. Convene minimum one week prior to commencing work of this section.

1.4 SCHEDULING
A. Division 1 – Project Coordination: Requirements for scheduling.
B. Schedule work to coincide with new construction.
C. Cease operations immediately when structure appears to be in danger and notify
   the Owner. Do not resume operations until directed.

1.5 COORDINATION
A. Division 1 – Project Coordination: Requirements for coordination.
B. Conduct demolition to minimize interference with occupied building areas.

Shut-down Periods:
1. Arrange timing of shut-down periods of in service panels with the Owner. Do not shut down any utility without prior written approval.

2. Keep shut-down period to minimum or use intermittent period as directed by the Owner.

3. Maintain life-safety systems in full operation in occupied facilities, or provide notice minimum 3 days in advance.

PART 2 – PRODUCTS

Not Used

PART 3 – EXECUTION

3.1 EXAMINATION

A. Division 1 – Project Coordination: Verification of existing conditions before starting work.

B. Verify wiring and equipment indicated to be demolished serve only abandoned facilities.

C. Verify termination points for demolished services.

3.2 PREPARATION

A. Erect, and maintain temporary safeguards, including warning signs and lights, barricades, and similar measures, for protection of the public, Contractor’s employees, and existing improvements to remain.

3.3 DEMOLITION

A. Demolition Drawings are based on casual field observation and existing record documents. Report discrepancies to the Owner before disturbing existing installation.

B. Remove exposed abandoned conduit and cable, including abandoned conduit and cable above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.

C. Remove conduit, wire, boxes, and fastening devices to avoid any interference with new installation.

D. Disconnect electrical systems in walls, floors, and ceilings scheduled for removal.

E. Disconnect or shut off service to areas where electrical work is to be removed. Remove electrical fixtures, equipment, and related switches, outlets, conduit and wiring which are not part of final project.
F. Lighting, receptacles or equipment adjacent to the demolition area that are affected by the electrical demolition shall be permanently rewired to allow continued operation.

G. Install temporary wiring and connections to maintain existing systems in service during construction.

H. Perform work on energized equipment or circuits with experienced and trained personnel.

I. Remove, relocate, and extend existing installations to accommodate new construction.

J. Repair adjacent construction and finishes damaged during demolition and extension work.

K. Remove exposed abandoned grounding and bonding components, fasteners and supports, and electrical identification components, including abandoned components above accessible ceiling finishes. Cut embedded support elements flush with walls and floors.

L. Clean and repair existing equipment to remain or to be reinstalled. M. Protect and retain power to existing active equipment remaining. N. Cap abandoned empty conduit at both ends.

3.4 SALVAGE ITEMS

A. Remove and protect items indicated on Contract Drawings to be salvaged and turn over to the Owner.

B. Items of salvageable value may be removed as work progresses. Transport salvaged items from site as they are removed.

3.5 DISPOSAL OF MATERIALS

A. Remove demolished materials as work progresses. Legally dispose.

B. Keep workplace neat.

END OF SECTION
SECTION 16123
BUILDING WIRE AND CABLE

PART 1 – GENERAL

1.1 DESCRIPTION OF WORK
A. This Section includes the following:
   1. Building wires and cables rated 600 V and less.
   2. Connectors, splices, and terminations rated 600 V and less.

1.2 SUBMITTALS
A. Product Data: For each type of product indicated.
B. Project Record Documents: Record actual locations of components and circuits.

1.3 QUALITY ASSURANCE
A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
B. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
C. Comply with NFPA 70.

1.4 COORDINATION
A. Where wire and cable destination is indicated and routing is not shown, determine routing and lengths required.

PART 2 – PRODUCTS

2.1 CONDUCTORS AND CABLES
A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:
   2. Diamond Wire & Cable Co.
   3. General Cable Corporation.
4. Senator Wire & Cable Company.
5. Southwire Company.
6. Or equal.

B. Conductors: Copper, comply with NEMA WC 70. Minimum size #12 AWG.

C. Conductor Insulation: Comply with NEMA WC 70 for Types THHN/THWN OR TYPE XHHW for feeders and branch circuits. 90 degrees C, 600 volts.

2.2 CONNECTORS AND SPLICES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. AFC Cable Systems, Inc.
3. O-Z/Gedney; EGS Electrical Group LLC.
4. 3M; Electrical Products Division.
5. Tyco Electronics Corp.

B. Description: Factory-fabricated compression connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

2.3 MC CABLE

A. Manufacturers:

1. Diamond Wire & Cable Co.
2. AFC.
3. General Cable Co.

4. Substitutions: As approved by Engineer.

B. Product Description: Manufactured cable system with lightweight interlocking steel armor metal clad outer jacket and internal ground wire.

C. Conductor: Copper.

D. Insulation: 600 volt rating; thermoplastic material Type THHN/THWN rated 90 degrees C.
3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger. MC cable concealed in existing walls and ceilings. C. Class 1 Control Circuits: Type THHN-THWN, in raceway.

D. Class 2 Control Circuits: Type THHN/THWN.

3.2 INSTALLATION OF CONDUCTORS AND CABLES

A. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

B. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

C. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

D. Identify and color-code conductors and cables according to Section 16075, Electrical Identification.

3.3 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

3.4 FIELD QUALITY CONTROL

A. Inspect and test in accordance with NETA ATS, except Section 4.

B. Perform inspections and tests listed in NETA ATS, Section 7.3.1.

END OF SECTION
SECTION 16128
RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.1 DESCRIPTION OF WORK
A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

1.2 SUBMITTALS
A. Product Data: For raceways boxes and enclosures.

1.3 QUALITY ASSURANCE
A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
B. Comply with NFPA 70.

PART 2 – PRODUCTS

2.1 METAL CONDUIT AND TUBING
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. AFC Cable Systems, Inc.
   3. Anamet Electrical, Inc.; Anaconda Metal Hose.
   4. Electri-Flex Co.
   5. Manhattan/CDT/Cole-Flex.
   7. O-Z Gedney; a unit of General Signal.
   8. Wheatland Tube Company.
   9. Or approved equal.
B. Rigid Steel Conduit: ANSI C80.1.
C. EMT: ANSI C80.3. All fittings shall be compression type, made of ferrous material, no set screw couplings or connectors allowed.

D. FMC: Zinc-coated steel.

E. LFMC: Flexible steel conduit with PVC jacket.

F. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.
   1. Fittings for EMT: Compression type.

2.2 BOXES, ENCLOSURES, AND CABINETS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
   2. EGS/Appleton Electric.
   7. RACO; a Hubbell Company.
  10. Spring City Electrical Manufacturing Company.

B. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

PART 3 – EXECUTION
3.1 RACEWAY INSTALLATION

A. Minimum Raceway Size: 3/4 inch trade size.

B. Conduit in exposed areas up to 10’ shall be in Galvanized rigid steel conduit (GRS). EMT shall be installed elsewhere. Liquidtight flexible metal conduit (sealtight) shall be used for equipment connections.

C. Raceway Fittings: Compatible with raceways and suitable for use and location.

D. All turns in conduit shall be swept-conduit or manufactured elbows. No condulets are allowed.

E. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.

F. Ground and bond raceway and boxes in accordance with Section 16060, Grounding and Bonding.

G. Raceway routing is shown in approximate locations unless dimensioned. Route to complete wiring system

H. Do not support raceway with wire or perforated pipe straps. Remove wire used for temporary supports

I. Do not attach raceway to ceiling support wires or other piping systems. J. Route exposed raceway parallel and perpendicular to walls.

K. Maintain 12 inch clearance between raceway and surfaces with temperatures exceeding 104 degrees F. All conduit and junction boxes shall be installed a minimum of 6 inches clear from telephone lines, electrical, alarm, or other wiring, whether or not it is enclosed in conduit. Maintain 1 inch clearances at all perpendicular cross points.

L. Install suitable pull string or cord in each empty raceway except sleeves and nipples.

M. Support boxes independently of conduit. Metal to metal connections with junction boxes and panels are required to ensure ground connectivity to all points in conduit system.

N. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

O. Complete raceway installation before starting conductor installation. All conduits that start or terminate in a pull box or lower outlet box shall have the appropriate size insulating bushing on the end of the conduit.

P. Support raceways as specified in Section 16070, Hangers and Supports for Electrical Systems.
Q. Install no more than the equivalent of three (3) 90-degree bends in any conduit run.

R. Conceal conduit and EMT within ceilings, and surface mount vertical drops unless otherwise indicated. All exposed conduit shall be painted to match supporting wall color and disturbed areas shall be patched and painted to match surrounding wall areas.

S. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire.

T. Raceways for Optical Fiber and Communications Cable: Install raceways, metallic and nonmetallic, rigid and flexible, as follows:
   1. 1-Inch Trade Size and Larger: Install raceways in maximum lengths of 75 feet.
   2. Install with a maximum of two 90-degree bends or equivalent for each length of raceway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.

U. Flexible Conduit Connections: Use maximum of 72 inches of flexible conduit for recessed and semirecessed lighting fixtures.

V. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
   1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
   2. Repair damage to paint finishes with matching touchup coating recommended by manufacturer.

W. Install knockout closures in unused openings in boxes.

X. Clean interior of boxes to remove dust, debris, and other material. Y. Clean exposed surfaces and restore finish.

Z. If any part of this system is not as specified, the contractor shall at his expense, remove said part and replace with the type specified. No interim reviews or oral approvals to the contrary, from anyone, shall override these specifications. Only written approval from the construction manager shall be construed as an acceptable change method.

END OF SECTION
SECTION 16134

CABLE TRAYS FOR COMMUNICATIONS SYSTEMS

PART 1 – GENERAL

1.1 DESCRIPTION OF WORK

A. Section includes cable tray. B. Related Sections:
   1. Section 16060 - Grounding and Bonding.
   2. Section 16070 - Hangers and Supports for Electrical Systems.

1.2 REFERENCES

A. ASTM International:
   2. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

B. National Electrical Manufacturers Association:
   1. NEMA VE 1 - Metal Cable Tray Systems.
   2. NEMA VE 2 - Metal Cable Tray Installation Guidelines.

1.3 SUBMITTALS

A. Division 1 – Submittal Procedures: Submittal procedures.

B. Shop Drawings: Indicate tray type, dimensions, support points, and finishes. C. Product Data: Submit fittings and accessories.

D. Manufacturer's Installation Instructions: Submit application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

1.4 CLOSEOUT SUBMITTALS

A. Division 1 – Execution Requirements: Closeout procedures.

B. Project Record Documents: Record actual routing of cable tray and locations of supports.

1.5 QUALIFICATIONS
A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years experience.

1.6 PRE-INSTALLATION MEETINGS

A. Division 1 – Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

PART 2 – PRODUCTS

2.1 METAL LADDER-TYPE CABLE TRAY

A. Manufacturers:

1. Legrand Model PW.

2. Substitutions: Division 1 – Product Requirements.

B. Product Description: NEMA VE 1, ladder type tray.

C. Material: Steel.

D. Finish: Painted with gray epoxy.

E. Inside Width: 18 inches.

F. Inside Depth: 4 inches.

G. Straight Section Rung Spacing: 6 inches on center.

H. Inside Radius of Fittings: 12 inches.

I. Furnish manufacturer's standard clamps, hangers, brackets, splice plates, reducer plates, blind ends, barrier strips, connectors, and grounding straps.

2.2 WARNING SIGNS

A. Engraved Nameplates: 1/2 inch black letters on yellow laminated plastic nameplate, engraved with: WARNING! DO NOT USE CABLE TRAY AS WALKWAY, LADDER, OR SUPPORT. USE ONLY AS MECHANICAL SUPPORT FOR CABLES AND TUBING!

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install metal cable tray in accordance with NEMA VE 2.

B. Install fiberglass cable tray in accordance with NEMA FG 1.

C. Support trays and fasten to structure and finishes in accordance with Section 16070, Hangers and Supports for Electrical Systems. Install supports at each connection point, at end of each run, and at other points to maintain spacing between supports of 10 ft maximum.
D. Install expansion connectors where recommended by manufacturer.

E. Ground and bond metal cable tray in accordance with Section 16060, Grounding and Bonding.
   
   1. Provide continuity between tray components.
   
   2. Install #2 AWG bare copper equipment grounding conductor through entire length of tray; bond to each component.
   
   3. Make connections to tray using mechanical, compression or exothermic connectors.

F. Install warning signs at 50 feet centers along cable tray, located to be visible.

END OF SECTION
SECTION 16140
WIRING DEVICES

PART 1 – GENERAL

1.1 SUMMARY
A. This Section includes the following:
   1. Snap switches.
   2. Ceiling mounted occupancy sensors.
   3. Receptacles.

1.2 SUBMITTALS
A. Product Data: For each type of product indicated, showing manufacturer’s catalog information showing dimensions, colors, and configurations.
B. Operation and Maintenance Data: For wiring devices to include in all manufacturers’ packing label warnings and instruction manuals that include labeling conditions.

1.3 QUALITY ASSURANCE
A. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.
B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
C. Comply with NFPA 70.
D. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years documented experience.

PART 2 – PRODUCTS

2.1 MANUFACTURERS
A. Manufacturers:
   1. Wattstopper.
   2. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).
   3. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

2.2 SNAP SWITCHES

A. Product Description: NEMA WD 1 and UL 20, Heavy-Duty Specification grade, AC switch, back and side wired, with steel mounting bridge and automatic stainless steel grounding clip.

B. Switches, 120/277 V, 20 A

C. Body and Handle: Ivory plastic with toggle handle.

2.3 OCCUPANCY SENSORS

A. Ceiling Mounted Wall-Switch Sensors:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

   a. Watt Stopper (The); CI-200 or approved equal.

2. Description: Ceiling mounted passive-infrared type, 120/277 V, automatic adjustable time delay up to 30 minutes, zero crossing technology for long relay life, 360-degree field of view, white, with a minimum coverage area of 500 sq. ft. UL listed, NEMA WD7.

2.4 RECEPTACLES

A. Product Description: Heavy Duty Specification Grade general use receptacle, back and side wired with green ground screw terminal, automatic ground clip, nylon face, wrap around bridge for installation strength, and high heat base, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498. Hubbell HBL5352I or equal.


B. Product Description: Special purpose receptacle for computer rack. Back and side wired with green ground screw terminal, automatic ground clip, nylon face, wrap around bridge for installation strength, and high heat base, 125/250 V, 30 A: Comply with NEMA WD 1, NEMA WD 6 configuration 14-30R, and UL 498. Hubbell HBL2710 or equal.

1. Device Body: Black.

2.5 WALL PLATES

A. Single and combination types to match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install devices plumb and level.

B. Mount switches 4’ 0” above finished floor. C. Install switches with the off position down.

D. Set DIP switches for occupancy sensors as required for sensitivity and time delay.

E. Adjust motion sensor sensitivity to avoid nuisance tripping.

F. Install receptacles with grounding pole on top.

G. Connect wiring device grounding terminal to outlet box with bonding jumper and branch circuit equipment grounding conductor.

H. Connect wiring devices by wrapping solid conductor around screw terminal.

Coordination with Other Trades:

1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.

2. Install wiring devices after all wall preparation, including painting, is complete.

END OF SECTION
SECTION 16261
STATIC UNINTERRUPTIBLE POWER SUPPLIES

PART 1 – GENERAL

1.1 SUMMARY

A. Section includes static 480 volt uninterruptible power supply with integral 120/208 volt power distribution unit (PDU), shielded isolation transformer and maintenance bypass switch. Provide all equipment necessary to connect the UPS to the existing Site Scan system for remote monitoring.

1.2 REFERENCES

A. Institute of Electrical and Electronics Engineers:

B. National Electrical Manufacturers Association:
   1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
   2. NEMA PE 1 - Uninterruptible Power Systems.

C. International Electrical Testing Association:

1.3 SUBMITTALS

A. Division 1 - Submittal Procedures: Submittal requirements.

B. Shop Drawings: Indicate electrical characteristics and connection requirements. Indicate battery rack dimensions; battery type, size, dimensions, and weight; detailed equipment outlines, weight, and dimensions; location of conduit entry and exit; single-line diagram indicating metering, control, and external wiring requirements; heat rejection and air flow requirements.

C. Product Data: Submit catalog sheets and technical data sheets to indicate physical data and electrical performance, electrical characteristics, and connection requirements.

D. Manufacturer's Field Reports: Indicate inspections, findings, and recommendations.

1.4 CLOSEOUT SUBMITTALS

A. Division 1 – Execution Requirements: Closeout procedures.
B. Operation and Maintenance Data: Submit description of operating procedures; servicing procedures; list of major components; recommended remedial and preventive maintenance procedures; and spare parts list.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Division 1 – Product Requirements: Product storage and handling requirements.

B. Protect equipment from extreme temperature and humidity by storing in conditioned space.

C. Protect equipment from dust and debris by wrapping unit in dust tight cover and storing away from construction activity.

1.7 MAINTENANCE SERVICE

A. Division 1 – Execution Requirements: Maintenance service.

B. Furnish service and maintenance of uninterruptible power supply for one year from Date of Substantial Completion.

PART 2 – PRODUCTS

2.1 STATIC UNINTERRUPTIBLE POWER SUPPLY

A. Manufacturers:

1. Eaton Powerware Model 9390-40 with ESS energy saving system.

2. Liebert Corp.

3. Or approved equal.

B. Product Description: 480 volt input Uninterruptible Power Supply (UPS) with attached cabinet for 120/208 volt power distribution unit and K-13 shielded isolation transformer. Power distribution unit shall consist of two 42 pole 225 amp panels. Panel one shall be equipped with circuit breakers as shown on the contract drawings. Panel two shall be equipped with 42 spare 20 amp circuit breakers. Provide maintenance bypass switch. UPS shall be a double conversion unit with provisions to operate in economy mode to achieve 99% efficiency. Provide communications interface for alarms to connect to existing Site Scan system for remote monitoring.

C. System Ratings and Operating Characteristics:

1. System Continuous Rating: 40 kVA (36 kW at .9 pf lagging) over entire battery voltage range at specified power factor. Maintain output voltage within specified limits at load from full load to no-load.
2. Battery Capacity: Seven (7) minutes.
4. Input Voltage Operating Range: Plus or minus 10 percent.
5. Input Frequency Operating Range: 60 Hz. plus or minus 3 Hz.
6. Current Walk-in: 25 to 100 percent in fifteen seconds.
7. Harmonic Distortion of Input Current Wave Form: 5 percent maximum at full load.

D. Controls:
   1. AC input circuit breaker.
   2. "Inverter Operate" switch to initiate inverter operation.
   3. "Inverter standby" switch to cause inverter to cease operation
   4. "Static Switch Transfer" switch to permit manual actuation of static transfer switch.
   5. "Static Switch Lock-out" switch to inhibit automatic retransfer of load to inverter.
   8. Static switch preferred input circuit breaker
   9. Static switch output circuit breaker
   10. Static switch bypass circuit breaker.
   11. Controls for maintenance bypass switch.

E. Indicators:
   1. "Inverter synchronized to utility."
   2. "Load connected to utility."
   3. "Static transfer switch inhibited."
   4. "High/low DC voltage."
   5. "Overtemperature."
   6. "Inverter output overload."

F. Meters: Use 1 percent accuracy meters to indicate the following:
1. Rectifier/charger DC voltage and current.
2. Utility, inverter output, and load AC voltage.
3. Load AC current.
4. Inverter output and utility frequency.
5. UPS output watts.

Fabrication:
1. Electroplate brackets and securing hardware with corrosion resistant material. Secure bolts, studs and nuts with lock washers.
2. Identify internal wiring at each end of conductor. Furnish cabinet grounding lug.
3. Conversion Equipment Enclosure: NEMA 250, Type 1 enclosure allowing access from front for servicing adjustments and connections. Access through hinged door equipped with tumbler lock and latch handle. Equip cabinet for fork truck lifting.
4. Equip air inlet with permanent type filters and pressurize cabinet, or use gaskets around door and panel openings to prevent entry of dirt.
5. Cabinet finish: Primed and painted inside and outside with suitable semi-gloss enamel.

2.2 BATTERY
A. Storage Battery: Sealed maintenance free type.
B. Ampere-Hour Rating: Minimum 7 minutes at full load.

2.3 ALARMS
A. Provide alarm monitoring capability for dry contacts and communications through MODBUS output with gateway compatible with existing Liebert Site Scan system.

PART 3 – EXECUTION

3.1 EXAMINATION
A. Division 1 – Administrative Requirements: Coordination and project conditions. B. Verify HVAC Systems are operational to maintain specified environmental conditions.

3.2 FIELD QUALITY CONTROL
A. Inspect and test in accordance with NETA ATS, except Section 4. B. Perform inspections and tests listed in NETA ATS, Section 7.22. C. Verify specification performance criteria.
D. Measure battery discharge and recharge times.
E. Simulate fault in each system component and utility power. F. Operate unit at 77 degrees F (25 degrees C) for eight hours. G. Perform other tests as recommended by manufacturer.

3.3 MANUFACTURER’S FIELD SERVICES
A. Division 1 – Quality Requirements: Manufacturer's field services. B. Prepare and start up UPS.

3.4 ADJUSTING
A. Division 1 – Execution Requirements: Testing, adjusting, and balancing. B. Adjust output voltage to within 1 percent of nominal.
C. Adjust output frequency to within 0.6 percent of nominal.

3.5 DEMONSTRATION AND TRAINING
A. Furnish 2 hours of instruction each for two persons, to be conducted at project site with manufacturer's representative.

3.6 PROTECTION OF INSTALLED CONSTRUCTION
A. Division 1 – Execution Requirements: Protecting installed construction.

END OF SECTION
SECTION 16442
PANELBOARDS

PART 1 – GENERAL

1.1 DESCRIPTION OF WORK A. Section Includes:

1. Lighting and appliance branch-circuit panelboards.

1.2 SUBMITTALS

A. Product Data: For each type of panelboard, switching and overcurrent protective device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

1.3 QUALITY ASSURANCE

A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NEMA PB 1. D. Comply with NFPA 70.

PART 2 – PRODUCTS

2.1 BRANCH CIRCUIT PANELBOARDS A. Manufacturers:

1. Square D Co.

2. Siemens.


5. Or approved equal.

B. Product Description: NEMA PB 1, circuit breaker type panelboard.

C. Panelboard Bus: Copper current carrying components, ratings as indicated on the Contract Drawings. Furnish copper ground bus in each panel.

D. Molded Case Circuit Breakers: NEMA PB 1 circuit breakers with integral thermal and instantaneous magnetic trip in each pole. Provide circuit breakers with interrupting capacity of 10,000 amperes symmetrical minimum for 120/208 volt
system and 14,000 amperes symmetrical minimum for 277/480 volt system. Furnish circuit breakers UL listed as type HACR for air conditioning equipment branch circuits.

E. Enclosure: NEMA PB 1, Type 1.

F. Cabinet Front: Surface type, fastened with concealed trim clamps, hinged door with flush lock, metal directory frame, finished in manufacturer’s standard grey enamel.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.

3.2 INSTALLATION

A. Install panelboards and accessories according to NECA 407 and NEMA PB 1.1.

B. Mount top of trim six foot six inches above finished floor unless otherwise indicated.

C. Mount panelboard cabinet plumb and rigid without distortion of box.

D. Install filler plates in unused spaces.

E. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

3.3 IDENTIFICATION

A. Create a directory to indicate installed circuit loads after load balancing; incorporate final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

B. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 16, Electrical Identification.

C.

3.4 ADJUSTING

A. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.

1. Measure as directed during period of normal system loading.

2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.

3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

END OF SECTION
SECTION 16510
INTERIOR LUMINAIRES

PART 1 – GENERAL

1.1 DESCRIPTION OF WORK A. Section Includes:
   1. Interior lighting fixtures, lamps, and ballasts.
   2. Exit signs.
   3. Lighting fixture supports.

1.2 SUBMITTALS
A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:
   1. Physical description of lighting fixture including dimensions.
   2. Emergency lighting units including battery and charger.
   3. Ballast, including BF.

1.3 QUALITY ASSURANCE
A. Manufacturer: Company specializing in manufacturing products with minimum three years documented experience.

1.4 COORDINATION
A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 – PRODUCTS

2.1 LIGHTING FIXTURES A. Manufacturers:
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, products scheduled on Contract Drawings.

2.2 FLUORESCENT BALLASTS A. Manufacturers:
   1. Motorola.
2. General Electric Co.
3. Magnetek Inc.
4. Lutron
5. Substitutions: Division 1 – Product Requirements.

B. Product Description: Electronic ballast, instant start, less than 10 percent THD high power factor type.

2.3 FLUORESCENT LAMPS

A. Product Description: T-8, 32 watt, 4100 degrees K.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Locate recessed ceiling luminaires as indicated on reflected ceiling plan.

B. Install surface mounted luminaires plumb and adjust to align with building lines and with each other. Secure to prevent movement.

C. Install recessed luminaires to permit removal from below.

D. Install clips to secure recessed grid-supported luminaires in place.

E. Connect luminaires to branch circuit outlets provided under Section 16128, Raceway and Boxes for Electrical Systems.

F. Install specified lamps in each luminaire.

G. Ground and Bond interior luminaires in accordance with Section 16060, Grounding and Bonding.

3.2 FIELD QUALITY CONTROL

A. Operate each luminaire after installation and connection. Inspect for proper connection and operation.

B. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.

END OF SECTION
SECTION 16750

NETWORK MANAGEMENT SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. The work of this Section includes, but is not limited to, providing all engineering, labor, materials, tools, equipment, and incidentals necessary for the final design, supply, test and commissioning of four Network Management Systems (NMSs), in accordance with the Contract Documents.

B. The Contractor shall be responsible for any permits, licenses and associated costs pertaining to this Work.

C. The Contractor shall provide all engineering, labor, tools and materials required to furnish a completely tested and fully operational NMSs in accordance with these Contract Documents, including documentation of as-built conditions, acceptance, operational tests and training.

D. Each NMS shall be Commercial Off-The-Shelf (COTS) software.

1.02 REQUIREMENTS

A. This Section describes the functional requirements for each NMS that shall be furnished, integrated and implemented in support of all Project equipment and systems supplied. The NMSs shall monitor the entire CARD System and related subsystems as described in this and other Sections of this Specification.

B. The NMS shall report the status of all CAD devices.

1. Four Network Management Systems shall be provided.

   a. A CARD CAD/AVL NMS, supplied, provisioned and configured by the manufacturer of the CARD system to be installed, that shall report and manage all in-band CARD CAD/AVL NMS monitored messages and points.

   b. A CARD Radio 700MHz Network Fault Management System (NMS), supplied, provisioned and configured by the manufacturer of the CARD system to be installed, that shall report and manage all in-band CARD Radio 700MHz Network Fault Management System (NMS) monitored messages and points.

   c. A CARD Microwave Network Fault Management System (NMS), supplied, provisioned and configured by the manufacturer of the CARD system to be installed, that shall report and manage all in-band CARD Microwave Network Fault Management System (NMS) monitored messages and points.

   d. A Central NMS, supplied, provisioned and configured by the manufacturer of the CARD system to be installed, that shall report and manage all in-band CARD monitored messages and points. The Central NMS shall receive all alarms and events from the three subsystem NMSs and be protected by a dedicated hardware firewall as shown on the Contract Drawings.
C. The Contractor shall assume full responsibility for the interoperability and integration of the NMSs into a functioning system.

D. A failure of a NMS or any of its subsystems shall not interfere with the operation of the CARD or related subsystems as described in this and other Sections of this Specification.

E. The Contractor shall minimize the number of servers/workstations utilized for stand-alone NMS. The Contractor shall combine multiple NMS systems onto a single server/workstation, only as approved by the SEPTA Project manager.

F. Each NMS shall be a standalone device equipped with a workstation and shall function independently of the normal operation of any other NMS.

H. The Contractor shall provide all engineering, labor, tools and materials required to furnish completely tested and a fully operational NMS in accordance with these Contract Documents, including documentation of as-built conditions and acceptance and operational tests.

PART 2 - PRODUCTS

2.01 GENERAL APPLICATION REQUIREMENTS

A. The functional requirements of the CARD NMSs shall be realized in software and hardware. The hardware units upon which the CARD NMSs reside and run are referred to herein as NMS Hosts.

2.02 DEVICE MANAGEMENT APPLICATION

A. Each NMS shall display all alarms and events within two (2) seconds of receipt of said alarm or event.

B. Standard Interface - Each NMS shall support multiple protocols or formats including but not limited to:
   1. TL1
   2. ASCII
   3. SNMP v1, v2c and v3

C. SNMP Management - Each NMS shall be equipped with Simple Network Management Protocol version 1, version 2c and version 3 (SNMP v1, v2c and v3).
   1. The SNMP Manager shall provide access to information contained in a device’s Management Information Base (MIB).
   2. The SNMP Manager shall provide SNMP “GET” and “SET” (read and write) access to a device’s MIB.
3. The SNMP Manager shall provide an auto-discovery mechanism to facilitate NMS administration.

D. Non-Standard Protocol - Each NMS shall be equipped to create customized interfaces for devices, which may not support a standard protocol. In general, this should be applied to devices that are transmitted over a TCP/IP socket interface.

E. Expandability - The need for additional communication interfaces necessitates 20% allocated additional capacity beyond the final installed count of NEs and interfaces that shall be incorporated into the termination equipment beyond that required for the interfaces required in this and other Sections of this Specification.

2.03 ALARM MONITORING APPLICATION

A. Alarm Monitoring is defined herein as monitoring of unplanned or uninitiated events. The Contractor shall provide the NMS with Alarm Monitoring Application as specified herein.

B. Processing - Each NMS shall process a minimum of 500 alarms per second continuous.

C. Display - Each NMS shall display an alarm on the graphics display within two seconds.

1. Each NMS shall be equipped and configured with a Graphical User Display (GUI) that shall present a regional geographic map. The map shall emulate the SEPTA system as an overlay superimposed on a regional geographic overview as approved by the SEPTA Project Manager.

2. The GUI map shall present high level alarm status on the map at specific monitored alarm sites depicted on the map. The granularity of the highest level of alarms displayed shall be no less than a single control center and server site. Alarms shall be classified and displayed, at a minimum, as No Alarm (Green), Minor Alarm (Yellow), Major Alarm (Red) and Maintenance Mode (White). The definition of no Alarm, Minor and Major alarms shall be approved by the SEPTA Project Manager.

3. The GUI shall permit the user to “drill down” or “zoom in” to lower tiered, more specific, focused and detailed screens that shall depict the precise nature, type and severity of alarm.

4. In all circumstances, when a user has “drilled down” or “zoomed in” to a lower level screen representative of a specific site, all higher level alarms at other sites shall indicate on the screen and in audible format so that multiple alarms or alarms at other sites are not overlooked or not indicated during a diagnostic examination of a lower tiered screen.

5. The GUI shall be available from the NMS to be projected on a large screen LCD or wall projector using integral HDMI technology, and shall be made available for viewing on a web-based browser by an authorized user (with appropriate credentials) anywhere on the SEPTA network domain, as directed by the SEPTA Project Manager.
6. Graphic presentation of alarms shall distinguish between acknowledged and unacknowledged alarms. For example, a blinking red icon of the managed device shall visually indicate a “received critical alarm”. When the same alarm is acknowledged, the same icon stops blinking and remains red.

7. The GUI shall provide a dynamic list of both unacknowledged and acknowledged alarms organized by priority then by most recent. The bottom area of this list shall summarize number of acknowledged and unacknowledged alarms by priority.

8. All alarms received by a NMS shall be immediately date and time stamped by the corresponding internal clock. The date/time stamp shall be utilized for all consequential processing of associated alarms. The NMS shall include the date/time stamp reported to it by a managed device in the description section of the alarm message. The NMSs shall be synchronized to the same GPS based timing clock. Use of other synchronized timing sources shall be as approved by the SEPTA Project manager.

9. The information associated with each alarm shall include as a minimum: time and date of occurrence, location, device type, device identifier, descriptive section of alarm, logon identifier of user who acknowledged alarm, and priority (at minimum, Minor or Major).

D. Acknowledgement - Each NMS shall acknowledge and record that an authorized user has accepted responsibility for a particular alarm and the acknowledgement shall be reflected system wide to all authorized users.

1. Each NMS shall allow acknowledgement of an alarm only after the operator has “zoomed in” or actually seen and acknowledged the specific alarm from the NMS. Alarm acknowledgement shall not be permitted at a high level screen. This prohibition is to prevent an operator from inadvertently acknowledging an alarm without actually having seen the specific and detailed attributes of the alarm.

2.04 EVENT MONITORING APPLICATION

A. Event Monitoring is defined herein as monitoring of planned or operator initiated events. The Contractor shall provide the NMS with Event Monitoring Application as specified herein.

B. Display - Each NMS shall display event initiation time and date, initiator logon identification and event details on the graphics display within two seconds after initiation of a request.

C. Communications Network Parameters - Each NMS shall monitor and provide statistics for Communications Network parameters.

D. Through directly monitored as well as the interfaces to the various NMSs, the NMS shall monitor all CARD System events,

E. The Contractor shall configure each NMS to initiate a “health check” query, for verification of the health and viability of each non-passive device in the communication network.
2.05 ANCILLARY MONITORING

A. Each NMS shall provide for a minimum of 25% additional site alarms for future use.

B. The communication of an alarm to each NMS shall complete within one second or less from the receipt of the input at the monitored site.

2.06 CONFIGURATION MANAGER

A. An object-oriented graphical modeling system shall be used to create and update graphical elements that represent the network regions and elements. The NMS shall provide the ability to display and manipulate this information. This information shall be in a form usable by the operator when diagnosing a network problem. The configuration manager will separate elements, as submitted and approved by the SEPTA Project Manager, by:

1. CARD SUBSYSTEM
2. Site
3. Device

2.07 PRINTING

A. Each NMS shall support industry-standard laser printing hardware for both graphical and textual hard copy output.

B. Each NMS shall provide for printing of individual files and print screens of both graphical color and text color upon request of the network operator from any terminal/monitor attached to the associated LAN.

C. The printing of alarms shall be configurable by SEPTA as either “near real time” and ad-hoc or strictly on an ad-hoc basis. Ad-hoc alarms printing functionality shall be controllable by the operator.

2.08 REPORTING

A. Each NMS shall allow for historical extraction of all saved information by criteria, such as date, time, device type, location, alarm category, area of responsibility. Through the Graphical User Interface (GUI), the user shall be enabled to select one or more criteria stored in the historical database for inclusion in ad-hoc or on-going reports.

B. Each NMS shall provide the ability to retain report setups, formats and execution schedules for future use.

C. Users shall have the option to route reports to a file, screen or printer.

D. Each NMS shall output to a defined file, on an on-going basis daily, weekly and monthly reports that shall summarize the activity of the systems at the NMS workstations. The Contractor shall coordinate with the SEPTA
Project Manager in developing templates for reports. The Contractor shall develop and submit the report templates for review and approval by the SEPTA Project Manager.

2.09 HISTORICAL DATA

A. All data received or generated by the NMS shall be archived into historical database files. The data shall be cross-referenced by any of the contained fields, if required.

2.10 AREA OF RESPONSIBILITY

A. Access to the various sets of scenes shall be controlled by the operator category level, which is determined by the operator’s privilege level as tied to his login identification.

B. The Contractor shall submit descriptions of the NMS access privilege levels. SEPTA will assign access privilege levels by User ID.

2.11 TROUBLE TRACKING

A. Each NMS shall be provided with an Integrated Trouble Ticket Package (ITTP). The ITTP shall allow users the ability to associate alarms generated by the NMS or by the user with a particular ticket. The ITTP shall incorporate as a minimum:

1. SQL based ticketing.

2. The following fields: Priority, Status, Service Type (Radio Equipment, CAD/AVL Equipment), Type (Service Affecting, Non-Service Affecting, Degraded), Resource or Device Name, Group and Individual Assignee, Outage and Restoral date/time and computed elapsed time.

3. The ability to segment tickets by field.

4. Minimum of four levels of alarm escalation.

5. An escalation feature, which automatically escalates the priority of a ticket if not resolved within a period as designated by the SEPTA Project Manager.

6. Ticket notification to assignee by electronic mail, pager and mobile phone Text Messaging.

2.12 PAGING

A. The Contractor shall configure and provide the NMS to send designated alarms to Hip Link, the alarm notification system currently in use by SEPTA.

2.13 OPERATOR INTERFACE

A. Graphical User Interface - The Contractor shall provide a fully developed software graphics interface, utilizing point and click methodology, which can be modified to meet the customer’s needs.

1. The GUI shall give users access to all applications their logon privilege allows.
2. Each NMS shall offer a cut-through feature allowing authorized users to access network elements, or other operational support systems.

3. Each NMS shall give users the ability to traverse multiple views hierarchically.

4. The top-level scene shall represent a summarized view of the entire network with accurate graphical orientation and scaling.

5. The lowest-level scene shall be the lowest level of alarm that is available from the equipment being monitored at a particular site. In some cases, this will be a radio power amplifier, C/I+N (carrier to interface ratio plus noise) or timeslot utilization.

6. Using the window manager, all network scenes shall be able to be re-sized (stretch or shrink, horizontally, vertically, or diagonally) or moved by positioning the mouse pointer on the specified part of the window frame and performing the appropriate mouse button action.

7. The operator shall have an audible alert that will serve to notify of the receipt of an alarm or event. The volume level of this alert shall be adjustable at the NMS workstations and shall be audible up to a maximum distance of thirty feet. The audible alert adjustment shall not be capable of being silenced.

C. Remote Access - Each NMS shall allow remote users to access all functionality through the utilization of a web based browser via the SEPTA internal network or a SEPTA VPN that their logon privileges allow. Access shall only be granted once the appropriate login has been accomplished and as directed by the SEPTA Project Manager.

D. Internet Access - Each NMS shall, at a minimum, be compatible with a standards-compliant web-browser for viewing and accessing the application, and be upgradeable for future view and control access via any web browser on the SEPTA intra-NET, as approved by the SEPTA Project Manager. No Internet access shall be connected to, or provided for, this closed SEPTA network under any circumstances, except as approved by the SEPTA Project Manager.

2.14 NMS WORKSTATIONS

A. The Contractor shall provide NMS Workstations at the locations listed in the contract drawing package. The NMS Workstation hardware platform shall be latest Dell workstation and include a keyboard, monitor and mouse.

B. Workstations shall include as a minimum:

1. Web-browser access.

2. Client/Server software as required to meet all NMS requirements.


2.15 NMS MASTER UNITS
A. Each NMS shall be configured and licensed for a minimum of ten (10) concurrent users without a degradation of performance. The users shall be the NMS Workstations at the locations listed in the contract drawing package.

B. Each NMS Internal, Random Access Memory (RAM) shall be delivered at a minimum of 100% above the NMS RAM for complete system operation. The spare memory shall be completely free for future use and contiguous. The NM software shall be able to support and utilize all memory delivered.

C. Each NMS shall be sized to retain, at a minimum, (90) days of each individual alarm and event message, on-line, for analysis and reporting purposes.

D. Each NMS shall be configured to record automatically, off-line, for longer-term message retention and analysis, all records of alarms and events.
   1. The off-line media for storage of this data shall be RAID disk.
   2. The system shall be sized to contain a minimum dual 80 Gb hard drives in a RAID 1 configuration. The NMS shall alarm both audibly and visually before overwriting any history of events.
   3. Each NMS shall download new data recorded no more than every night at 3AM.

E. Each NMS shall be provisioned with 100/1000 mbps, Ethernet, LAN connectivity.

F. Each NMS shall allow access from desktop workstations.

G. Contractor shall supply and integrate the NMS with a laser printer, brand and model to be determined by the SEPTA Project Manager. Each printer shall be integrated as described in Printing Requirements in this Section.

H. NMS shall be as approved by the SEPTA Project Manager.

2.16 DIAGNOSTICS

A. The System shall monitor the internal system and the host processors operating within each NMS. This shall produce graphical indicators of the overall health status of the operating system programs. These measures shall be written to a defined file for report generation/analysis.

2.17 PROGRAMMING AND SCRIPTING

A. Message Processing - Each NMS shall be equipped to process each “individual” message from each managed NE.
   1. Each message shall be assigned at least six (6) priority levels (e.g., critical, major, minor and at least 3 others).

B. Alarm Filtering - Each NMS shall process and react to the first instance of a set of alarms so as to not “flood” the operator with redundant alarms sent by the network elements.
1. Each NMS shall support the filtering out (throwing away) of those events received by the Network Elements. This functionality shall only be configurable as approved by the SEPTA Project Manager.

2. Each NMS shall allow the operator to place a device into “Maintenance Mode”. This will allow the operator to suppress alarms associated with that NE and consequently remove any “Expert Mode” functionality associated with the alarming. The activation of any “Maintenance Mode” shall be indicated on the GUI and in the system log in a unique and distinct manner from any other alarms or system status, and shall be set to automatically release from Maintenance Mode after a set period of time, as approved by the SEPTA Project Manager.

C. Data Identification - Each NMS shall uniquely identify all data collected and displayed to the operator. Each data item shall be identified by at least the following:
   1. Site name.
   2. Equipment type and identifier.
   3. Time and date of occurrence.

2.18 POWER REQUIREMENTS

A. Unless indicated otherwise, all equipment associated with this Section shall operate on 120 VAC, 60 Hz.

B. Each NMS shall utilize a minimum of two, integrated, hot swappable power supplies. Each power supply shall be sized to carry the load of the entire associated NM. The redundant power supply shall operate in a “hot-standby” mode of operation.

2.19 REDUNDANCY

A. Each NMS system shall be comprised of two, totally independent systems configured on two separate Local Area Networks (LANs). The separate LANs shall be connected as a WAN to support communications between the two systems that shall function in a dual-master (hot standby) configuration.

B. One NMS shall be installed at the Primary Control Center, the second shall be installed at the Backup Control center.

C. Each NMS shall be configured so as to automatically initiate synchronization within one second for any change of status or for a resynchronization due to break and subsequent reconnection of link. This synchronization is to be maintained so that the two systems accurately reflect each other. Synchronization time shall be minimized to prevent interference with other functionality.

D. Each NMS shall be configured to initiate a “health check” query, for verification of the health and viability of each system. This query shall occur no longer then every 15 minutes.

2.20 SPARES, TOOLS AND TRAINING
A. A minimum of 20% additional units of each major device or component shall be supplied.

B. Training shall be supplied by the manufacturer of each NMS and sub-elements as described in the training section of this specification.

PART 3 - EXECUTION

3.01 INSTALLATION

A. The Contractor shall furnish and install all NMS devices, hardware and software as required herein, and as otherwise required for a fully functioning CARD System.

3.02 TESTING

A. Through testing and inspection the Contractor shall verify that each NMS meets Contract specifications and all technical and performance requirements. The Contractor shall test and inspect all items of hardware and software specified herein, and furnish test results to the SEPTA Project Manager.

B. Tests and inspections shall be conducted according to procedures submitted by the Contractor and approved by the SEPTA Project Manager.

C. Upon approval of the inspection and testing plan, and at least 60 days prior to the start of each test, the Contractor shall develop and submit for approval all necessary test procedures for placing into service all components, integrated sub-systems and completed communications systems.

D. If any system or component does not pass a required test the Contractor shall inspect the installation and take required action to bring the system or component to specified compliance and repeat the test procedure. If no problems are found the Contractor shall immediately notify the SEPTA Project Manager.

END OF SECTION
SECTION 16770

NETWORK SECURITY SYSTEM

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. The work of this Section includes, but is not limited to, providing all engineering, labor, materials, tools, equipment, and incidentals necessary for the final design, supply, test and commissioning of four Network Security Systems (NSSs), in accordance with the Contract Documents.

B. The Contractor shall be responsible for any permits, licenses and associated costs pertaining to this Work.

C. The Contractor shall provide all engineering, labor, tools and materials required to furnish a completely tested and fully operational NSS in accordance with these Contract Documents, including documentation of as-built conditions, acceptance, operational tests and training.

1.02 QUALITY ASSURANCE

A. Equipment shall be designed and installed in accordance with the pertinent provisions of the codes and standards as described in Section 01091, “Reference Standards.”

B. Any law or regulation of the USA Federal Government, the State of Pennsylvania or other local regulating body having jurisdiction over this equipment shall apply.

1.03 REQUIREMENTS

A. This Section describes the functional requirements for the NSS.

B. The NSS shall consist of four systems:

1. A CARD CAD/AVL NSS, supplied, provisioned and configured by the manufacturer of the CARD system.
2. A CARD Radio 700MHz NSS, supplied, provisioned and configured by the manufacturer of the CARD system.
3. A CARD Microwave NSS, supplied, provisioned and configured by the manufacturer of the CARD system.
4. Central NSS, supplied, provisioned and configured by the manufacturer of the CARD system to be installed.

B. Each NSS shall consist of a combination of dedicated hardware devices and associated software that shall provide multiple layers of security to the CARD System as described. The NSS shall be dedicated to the CARD System only, and shall not be associated with, or linked to any other network or system at SEPTA. The CARD System is mission critical and must be available on a 24/7 basis. The CARD System is independent of all other SEPTA networks and systems, and is closed, with little or no direct access by unauthorized internal SEPTA staff or external parties. Access to the CARD System by
SEPTA internal or external parties shall be only as specifically called for in this design, and as approved by the SEPTA Project Manager.

C. The purpose of the NSS is to protect the CARD Systems from both internal and external threats, whether intentional or accidental. The NSS is intended for the Control Systems only and shall have no interconnection with any other SEPTA network or system, except as specifically authorized by the SEPTA Project Manager or defined in these specifications.

D. The contractor shall be responsible for the configuration of all hardware, firmware and software elements with the NSS and fully configure all devices on the CARD System as part of the NSS.

E. The NSS shall be comprised of technology that is commercially available and shall not include any proprietary security countermeasures that have not been vetted by a public community of interest.

1.04 THREATS

A. Threats are defined as any man made or natural element that can act in either an accidental or intentional manner to adversely impact the function, performance and operation of the CARD Systems. Threats can manifest by connection of any hardware devices, software code, viruses, malware or any other function that can result in undesirable consequences pertaining to the operation of the CARD systems. Threats may be introduced, by either internal SEPTA or external parties, at any point in the networks.

B. The NSS shall secure all network elements, hardware, systems, software and data transport in the CARD Systems, to include, but not be limited to:

1. Office systems and all interconnecting networks and devices, in both the primary and backup facilities. This includes but is not limited to interfaces and existing alarm monitoring.

2. Interfaces to any external SEPTA systems or entities including but not limited to: Vendor Access including all associated firewalls.

3. Internet access and associated firewalls (Internet access shall only be as approved by the SEPTA Project Manager).

4. Interfaces to wired carrier supplied networks.

5. Interfaces to dedicated fiber.

6. Interfaces to wireless carrier supplied networks.


8. All radio systems.

1.05 STANDARDS
A. The NSS shall be designed by the Contractor consistent with the latest standards and recommended practices as presented in IETF, IEEE and ITU/T, ITU/R, TIA/EIA, NIST SP800-82 Rev2, NIST SP800-53 Rev5, ANSI/ISA-99.00.00-2007, ANSI/ISA-99.02.01-2009, DHS CSSP, APTA, FRA and NERC CIP recommended practices for telecommunications network security.

B. The following are reference documents from which the Contractor shall obtain and apply “Best Practices” in their final NSS design. The Contractor shall demonstrate the manner in which their NSS design is compliant with these practices:

2. Cyber Security Policy Planning and Preparation.


3. DMZs and Network Segmentation.


4. IDS & IPS Usage and Placement.


5. Authentication, Authorization, and Access Control For Direct and Remote Connectivity.
   r. NIST SP: 800-73-4, Interfaces for Personal Identity Verification (4 parts), September 2008.

s. NIST SP 800-76-1, Biometric Data Specification for Personal Identity Verification, 2007.


1.06 NETWORK ELEMENT COMPATIBILITY

A. The NSS shall be designed to ensure compatibility with all hardware and software (including operating systems) supplied by the Contractor. The NSS shall be equipped to communicate directly with each and every network element to be protected by the NSS without the need for any intermediate protocol conversion or separate interface devices, except as approved by the SEPTA Project Manager.

1.07 NSS ARCHITECTURE

A. General.

1. The NSS architecture shall be based on the principle of “Defense in Depth” and shall be a hierarchical implementation that shall work in conjunction with the various network elements of the systems to achieve the desired levels of protection of the networks and systems. The NSS shall consist of a platform of hardware and software dedicated to the NSS exclusively. A failure of the NSS shall not cause a failure of the CARD operational systems.

B. Integrated Security Event Management / Threat Management

1. The Contractor’s NSS design shall utilize devices that shall combine NSS functionality of security event management, and threat management into a comprehensive system that shall include, but not be limited to, the functionality described herein. This shall include the use of devices to provide firewall, Intrusion Detection System (IDS), Intrusion Protection System (IPS) and alarm reporting functionality as described herein. The use of firewalls, IDS and IPS shall not relieve the Contractor from the requirements for minimizing latency, preventing single-point-failure or other functionality described herein.

C. Centralized Management

1. The Contractor’s design for the NSS shall be managed from a single central management terminal that shall consolidate all NSS management, control, configuration and reporting functions. In the event that NSS devices are used with dissimilar reporting and management standards and/or formats, separate management systems may be proposed, however all similar sub-elements (i.e. Ethernet switches or Firewalls) shall be managed and configured from a single central management system supplied by the manufacturer of that element.

2. The central management system and all NSS workstations proposed shall be installed at the same locations as the Network Management Systems (NMS),
presented in Section 16750. In all cases, the Contractor’s design for NSS central management shall be submitted to the SEPTA Project Manager for approval.

D. Message Latency and Integrity

1. The NSS shall function without adding any data message latency, except as approved by the SEPTA Project Manager. In addition, the NSS shall function in a manner that any security countermeasure shall not introduce any modifications to control system traffic, except as approved by the SEPTA Project Manager. Any requests for an exception to the prohibition of added message latency or data modification shall be accompanied by an analysis and written presentation of the precise effect that any such requested latency or data modification will have on the overall ability of SEPTA’s Control Systems to deliver data messages within the minimum acceptable periods or within expected data structures, consistent with the overall system design.

E. Single Point of Failure and Failure Modes

1. The Contractor’s NSS design shall not present a single point of failure at any point in the system. If a device, such as a firewall protecting the network from external port “A” fails, it shall not impede traffic from external port “B”. The device shall include redundant, hot-switched power supplies and redundant components that shall not impede data message exchange upon an NSS element failure. Under no circumstances shall the device responsible for securing a network perimeter “fail open” when becoming nonoperational, thereby exposing the network to unprotected access from exterior sources.

F. Redundancy

1. The NSS shall be a fully redundant system installed in the primary and backup server rooms. The backup server room shall be equipped with duplicate hot-standby NSS equipment, and in the event of a failure of the primary NSS, shall failover to the redundant equipment in the same failover sequencing as the CARD System. The backup standby NSS shall be in “listening” mode and shall be synchronized with the primary NSS to maintain the identical database records and system configurations so that in the event of a failure of the primary NSS the standby NSS shall assume NSS functionality immediately without the need for re-entering network, user and device database information and configuration.

1.08 LAYERS OF SECURITY AND FUNCTIONALITY

A. The NSS shall minimally supply security that shall include, but not be limited to:

1. Port Access and Lock Down and Disable.

2. Firewalls

3. RADIUS Server

4. Intrusion Detection System (IDS)
5. Intrusion Prevention System (IPS)

6. Antivirus and anti-malware

7. Remote Access

8. Virtual Private Network (VPN)

9. Security Incident and Event Monitoring (SIEM)

10. Compliance Management and Reporting

11. Software Configuration Management and Reporting

B. Port and Access, Lock Down and Disable

1. All switches, routers, firewalls, servers and other device with I/O ports or external connections of any kind including but not limited to: Ethernet, serial, USB, Firewire, CD/DVD, Wi-Fi, Bluetooth, floppy disk or other that may serve as an entry point for a threat, shall have any open, unused I/O port or connection locked down and disabled to any device attached thereto. Enabling and use of any disabled port shall be under the direct control of AAA functionality of the RADIUS server. The NSS shall employ IEEE 802.1x.

C. Intrusion Detection System (IDS) and Intrusion Prevention System (IPS)

1. An integrated (defined as working together synchronously in an automated mode) system of an Intrusion Detection System (IDS) and an Intrusion Prevention System (IPS) shall be supplied that provides intrusion detection and takes preventive measures without direct human intervention. The IDS & IPS shall have a capability to learn “normal” baseline of control system traffic and be able to update this baseline on a scheduled basis. The IDS shall identify patterns of traffic or application data presumed to be malicious (misuse detection systems), and shall compare network and data traffic activities against the “normal” baseline. The integrated IDS & IPS shall work seamlessly in conjunction with the firewalls and other Contractor supplied NSS devices to automatically prevent such malicious packets or data from propagating into the SEPTA network and systems, and shall alert, log and report all such instances. The integrated IDS & IPS shall function in a manner that any active security countermeasure shall not introduce any modifications to control system traffic, except as approved by the SEPTA Project Manager. IDS & IPS shall use machine learning technology to improve its anomaly detection capability.

2. The IDS and IPS shall include a subscription for harmful traffic patterns and a database of viruses, worms, Trojans, malware and any other harmful code or attacks. A database shall be updated automatically over the internet by the manufacturer during a period not to exceed monthly. The IDS and IPS in the NSS shall have a capability for being updated automatically without human interaction and in a manner that does not expose the NSS IDS and IPS directly to the Internet.

D. Firewalls
1. Separate, independent device-level firewalls shall be supplied at each and every point of entry to the systems from connection points to the SEPTA systems, to include, but not be limited to, all wired, wireless, dedicated fiber connectivity or any other form of connection that constitutes a route into, or from, a system external to the SEPTA systems.

2. Firewalls shall also be installed between the primary and backup offices and the SEPTA systems field devices, for prevention of harmful accidental or malicious access to the offices from a field site. If a single chassis firewall device with multiple fire walls is proposed, it shall be acceptable only upon demonstration, to the sole and complete satisfaction of the SEPTA Project Manager, that no single point of failure in any component of the device, to include power supplies, shall permit the failure of more than one protected external connection or that any device shall “fail open”.

E. RADIUS Servers
1. The RADIUS servers shall be a Microsoft Windows based server application. The RADIUS servers shall be provided at the primary and backup control centers to manage network access and message exchange in the two-step AAA (Authentication, Authorization and Accounting) transaction process with the supplicant (user or network element).

2. Authentication and Authorization characteristics in RADIUS shall follow IETF RFC 2865 while Accounting is described by RFC 2866 and alignment with EAP is described by RFC 3579. The Authenticator and Authentication (RADIUS) Server shall have a trusted (client/server) relationship over the systems in the network. The Authentication (RADIUS) Server shall authenticate the supplicant based upon a user profile that shall be maintained at the central RADIUS and remotely in manageable devices, such as Ethernet switches and routers.

3. RADIUS authentication shall be X.509 certificate based and shall include certificate managements. Traffic between the RADIUS server and supplicant shall be encrypted.

3. RADIUS Accounting shall be utilized for management and forensic purposes for audit purposes and to provide a permanent record for the investigation of a security related event. No billing functionality is required.

4. RADIUS server AAA management of the edge devices (switches, routers, etc.) shall be in full compliance with IEEE 802.1x.

5. Access Requests

   a. Access Requests from a supplicant on the network shall include access credentials, in the form of username and password or security certificate provided by the user, as approved by the SEPTA Project Manager. Additionally, the supplicant’s request shall include the network address, and information regarding the user's physical point of attachment to the system.

6. Authentication
a. Authentication performed by the RADIUS server shall validate that the supplicant's information is valid using Extensible Authentication Protocol (EAP), except as approved by the SEPTA Project Manager.

b. The user's proof of identification shall be verified, along with the user's network address, account status and specific network service access privileges, as determined by the SEPTA Project Manager. The RADIUS server shall check the user's information to verify that the user's credentials are valid.

7. Authorization:

a. Authorization attributes shall be conveyed to the network element requesting access stipulating terms of access to be granted. Upon receipt and analysis of the Access request, the RADIUS server shall then return one of three responses to the requesting network element: 1) Access Reject, 2) Access Challenge or 3) Access Accept.

b. Access Reject - The user is unconditionally denied access to all requested network resources.

c. Access Challenge - Requests additional information from the user such as a secondary password, PIN, token or card. Access Challenge shall be implemented only as directed by the SEPTA Project Manager.

d. Access Accept - The user is granted access. Once the user is authenticated, the RADIUS server shall also check that the user is authorized to use the network service requested.

8. During an Access/Authorization transaction, attributes shall be exchanged to include, but not be limited to:

a. The specific IP address to be assigned to the user device.
b. The address pool from which the user's IP should be chosen.
c. The maximum length that the user may remain connected (permanent or temporary).
d. An access list, priority queue or other restrictions on a user's access. e. L2TP (Layer 2 Tunneling Protocol) parameters.
f. VLAN parameters.
g. Quality of Service (QoS) parameters.
h. Other parameters as required in accordance with the Contractor's design.

9. Accounting:

a. Accounting, as defined in RFC 2866, shall maintain statistical data of Access/Authentication transactions for forensic analysis and for general network monitoring. The data shall be maintained in an SQL database. The reports shall be presented in standard Windows Office compatible format, for investigation and analysis by SEPTA staff. No billing functionality is required. Use of other report formats shall be only as approved by the SEPTA Project Manager.
F. The Contractor shall provide all engineering, labor, tools and materials required to furnish completely tested and a fully operational NSS in accordance with these Contract Documents, including documentation of as-built conditions and acceptance and operational tests.

PART 2 - PRODUCTS

2.01 HARDWARE

A. The hardware platform for all NSS devices shall utilize COTS servers, workstations and network devices, as approved by the SEPTA Project Manager. Use of purpose built custom hardware devices shall be only as approved by the SEPTA Project Manager.

2.02 SOFTWARE

A. All software supplied by the Contractor for the NSS shall be COTS based and supplied by a commercial company that has demonstrable history of a minimum of five (5) years in business supplying NSS software with at least two (2) years supplying NSS software for control systems environments. No custom code shall be permitted, except as approved by the SEPTA Project Manager.

B. “Freeware”, or any other non-commercial code, shall not be permitted. All databases shall be SQL, except as approved by the SEPTA Project manager.

C. The Contractor shall supply all necessary licenses and seats to accommodate a full system implementation with 10% spare capacity to accommodate system growth, where applicable, to workstation and end user devices. The Contractor shall maintain, supply, and install all software and firmware updates for the duration of the installation until the CARD system is accepted by SEPTA, and for a period of seven (7) years thereafter, including all subscriptions and installations as may be required for any software, firmware, or hardware required for the firewall, SIEM, RADIUS, IDS, IPS, anti-virus/malware intrusion protection or any other element supplied as part of the NSS.

2.03 DEFENSE IN DEPTH

A. The Contractor shall utilize the “Defense In Depth” to defend the system against any particular attack using several independent methods.

2.04 FIREWALLS

A. Separate, independent device-level firewalls shall be supplied at each and every point of entry to the systems from connection points to the SEPTA systems, to include, but not be limited to, all wired, wireless, dedicated fiber connectivity or any other form of connection that constitutes a route into, or from, a system external to the SEPTA systems.

B. A seven (7) year subscription for all software, firmware, and updates shall be included.

2.05 INTRUSION DETECTION SYSTEM (IDS)
A. The Contractor shall utilize IDS in their design. IDS shall be installed at all locations that are supplied with a firewall.

B. A seven (7) year subscription for all software, firmware, and IDS updates shall be included.

2.06 INTRUSION PREVENTION SYSTEM (IPS)

A. An Intrusion Prevention System shall be deployed by the Contractor that shall be an active device that shall provide policies and rules for network traffic along with the IDS for alerting system or network administrators to suspicious traffic, and shall automatically take action to stop the intrusion and alert the administrator to the threat and action taken.

B. IPS shall be installed at all locations that are supplied with a firewall.

C. A seven (7) year subscription for all software, firmware, and IPS updates shall be included.

2.07 RADIUS SERVER

A. RADIUS server functionality described herein, to include AAA functionality, shall be supplied by a standalone system. The contractor shall demonstrate, to the complete satisfaction of the SEPTA Project Manager that the proposed system has been in successful, continuous service in a network comparable in size, function and scope to that of the SEPTA network for a minimum of ten (10) years.

2.08 NSS WORKSTATIONS

A. The Contractor shall provide NSS Workstations at the locations listed in the contract drawing package. The NSS Workstation hardware platform shall be latest Dell workstation and include a keyboard, monitor and mouse.

B. Workstations shall include as a minimum:
   1. Web-browser access.
   2. Client/Server software as required to meet all NSS requirements.
   4. Compatibility with, and oversight by, the NMS system.

2.09 POWER REQUIREMENTS

A. Unless indicated otherwise, all equipment associated with this Section shall operate on 120 VAC, 60 Hz.
B. Each NSS server shall utilize a minimum of two, integrated, hot swappable power supplies. Each power supply shall be sized to carry the load of the entire system. The redundant power supply shall operate in a “hot-standby” mode of operation.

2.10 REDUNDANCY

A. The NSS system shall be comprised of two, totally independent systems configured on two separate Local Area Networks (LANs). The separate LANs shall be connected as a WAN to support communications between the two systems that shall function in a dual-master (hot standby) configuration.

B. One NSS shall be installed at the primary server room, and a second shall be installed at the backup server room.

C. The NSS shall be configured so as to automatically initiate synchronization within one second for any change of status or for a resynchronization due to break and subsequent reconnection of link. This synchronization is to be maintained so that the two systems constantly and accurately reflect each other. Synchronization time shall be minimized to prevent interference with other functionality.

2.11 SPARES, TOOLS AND TRAINING

A. A minimum of 20% additional units of each major device or component (LRU) shall be supplied.

B. Training on the NSS systems shall be supplied to SEPTA staff in accordance with the Training Section of this specification. Training shall include the core NSS as well as interfacing, configuration, management and maintenance of all security related functions of the devices under the domain of the NSS. Training shall encompass all necessary material to provide allow for SEPTA maintained NSS.

PART 3 - EXECUTION

3.01 INSTALLATION

A. The Contractor shall furnish and install NSS devices, hardware and software as required herein and as otherwise required for a fully functioning NSS.

3.02 TESTING

A. Through testing and inspection, the Contractor shall verify the NSS meets Contract specifications and all technical and performance requirements. The Contractor shall test and inspect all items of hardware and software specified herein and furnish test results to the SEPTA Project Manager. Test cases shall be reviewed by the SEPTA Project Manager.

B. Tests and inspections shall be conducted according to procedures submitted by the Contractor and approved by the SEPTA Project Manager. The Contractor shall submit a Test Plan and a Test Procedure to SEPTA.

1. Test Plan. The Test Plan shall consist of a broad but complete overview of the intended tests to be performed, test methodology for demonstrating compliance to
the specification requirements, single line schematics of the test set up, a listing of
test equipment to be used to demonstrate compliance to the specification
requirements and the results to be generated for the entire NSS and all elements
that shall be under the surveillance and control of the NSS, to include a
comprehensive description of the protection provided against specific threats as
defined by the Contractor in their use cases.

2. Test Procedure. Upon SEPTA approval of the Test Plan, and at least 60 days prior
to the start of each test, the Contractor shall submit a detailed Test Procedure that
shall provide a step-by-step procedure for each component and subcomponent of
the NSS. The Contractor shall develop and submit for approval all necessary test
procedures for placing into service all components, integrated sub-systems and
related communications systems and elements that shall be under the surveillance
and control of the NSS. These shall include, but not be limited to:

   a. Firewalls   b.  IDS
   c.  IDP
   d.  RADIUS
   e.  Edge devices
   f.  Wireless devices g.  Servers

3. The Testing shall be witnessed by SEPTA and may include SEPTA requested
unstructured tests not called for in the Contractor’s Test procedure.

C. If any system or component does not pass a required test the Contractor shall inspect
the installation and take required action to bring the system or component to specified
compliance and repeat the test procedure. If no problems are found the Contractor shall
immediately notify the SEPTA Project Manager.

END OF SECTION