10.2.3 If a proposed lighting system is equipped with a lighting control circuit that will automatically dims main lighting to compensate for adequate ambient lighting in the car, the diming functionality shall be able to be cut out by Metra personal at any time to ensure nominal lighting levels. If such a system is proposed, the contractor shall ensure charging of HPPL material is maintained to meet APTA requirements. If proposed, the contractor shall list as an option. **[COPL CO-10-01]**

10.2.4 The passenger compartment lighting system proposed shall be tested to meet or exceed main light levels specified in the latest revision of APTA specification APTA PR-E-RP-012-99, Recommended Practice for Normal Lighting System Design for Passenger Cars. All material must comply with applicable flammability and smoke emission requirements of FRA Regulation 49 CFR Part 238 Appendix B and NFPA 130 as well as Section 18.16 of this specification. **[CDRL C-10-03]**

10.2.5 The material of all lenses shall be described and proposed to Metra, including any compliance certification received previously. Metra will require material test reports and certification letters for all lens materials prior to FAI.

10.2.6 The fixtures shall be mounted with non-exposed hardware and shall resist undesired opening to the maximum extent possible. Replacement of LEDs shall be accomplished readily from the exposed fixture face, with tamper resistant closing devices used. Lighting elements shall be supported by mechanical restraints to relieve mechanical loading on the power pins.

10.2.7 An "Occupied" LED light fixture, viewable from the aisle in either direction shall be provided above the toilet room door. A switch or sensor shall be provided in the door jamb to energize the light when the door is fully closed and the passage set is "locked."

10.2.8 Electrical lockers shall be provided with LED light fixtures. The light shall be operated by a door switch located so as to turn the locker light off when the door is closed.

10.2.9 Ceiling mounted LED light fixtures shall be provided in the cab of cab control cars. Control switches shall be provided.

10.2.10 LED reading lights shall be provided in cab of cab control cars. Control switches shall be provided.

10.3 EMERGENCY LIGHTING

10.3.1 Emergency lighting shall conform to the requirements of FRA Regulation 49 CFR Part 238 as well as APTA PR-E-S-013-99, latest revision. The emergency lighting system shall be tested to meet or exceed emergency light levels specified in the latest revision (at the time of notice to proceed) of APTA PR-E-S-013-99 Standard for Emergency Lighting System Design for Passenger Cars. The emergency light system shall be designed to maintain acceptable illumination for a minimum 120 minutes. For The emergency lighting solution that is proposed, details of the design, installation, and arrangement of the emergency lighting solution shall be submitted to Metra for review and approval. Test reports shall be submitted to Metra. **[CDRL C-10-04]**

10.3.2 Emergency lights shall be located in the main seating area, in stairways (if applicable), in the toilet room, in the cab, in each end passageway, above all escape sash locations with additional fixtures provided in the passenger compartments as required to comply with the lighting levels specified in FRA Regulation 49 CFR Part 238 and latest revision of APTA PR-E-S-013-99 Standard for Emergency Lighting System Design for Passenger Cars.

10.4 EXTERIOR LIGHTING

10.4.1 Exterior lighting fixtures installed on the vehicle exterior, and in the interior within 2 ft. of a doorway, shall be watertight, except for interior ceiling lights. All lighting lamps and fixtures shall be suitable for rough duty service found in the railroad environment throughout North America. All exterior lighting plans and design is subject to Metra and approval. **[CDRL C-10-05]**

10.4.2 End passageways outside body end doors shall be illuminated with LED fixtures. The fixtures shall be activated with the general interior lighting along with emergency light.

10.4.3 Exterior platform lighting shall be provided at side exits that meet or exceed latest revision of APTA Standard PR-E-RP-012-99, Recommended Practice for Normal Lighting System Design for Passenger Cars. The lights used to satisfy the above requirements shall be separate spotlights, LED lighting is preferred, on the exterior of the car (as stated in 49 CFR Part 38.101(b) and 49 CFR Part 38.157(b)) and mounted in the vicinity of the vestibule side loading doors. The exact location of the light used to illuminate the exterior platform shall be subject to Metra design review and approval, included in **[CDRL C-10-05].**

10.4.4 One (1) door open and one (1) lift activated light of differing colors shall be installed on the exterior adjacent to each set of side entrance doors.

10.4.5 The fixtures shall have redundant LED lamps in each fixture, each showing to the front and to the rear. The lamps shall have sufficient brightness that a person of normal visual acuity may tell, from a distance of six hundred (600) feet on a sunny day, whether the light is on or off, even if one of the lamps in the fixture is inoperative. The fixtures shall fall within clearance limitations. The lights shall be circuit breaker protected.

10.4.6 On the control end of cab cars only, two headlights (2) either sealed beam incandescent lamps or halogen low voltage D.C. sealed PAR 56, compliant with 49 CFR Part 229.125, shall be mounted in an enclosure. If lights are proposed with LED technology, they shall not be prone to ice or snow buildup and shall be reviewed by Metra.

10.4.7 The headlamp shall be accessible for maintenance purposes, for re-lamping of the headlight. The light beams may be adjusted both vertically and horizontally. The headlight shall be protected against lamp burnout due to high battery charging voltage. A headlight dimming resistor, or dimming mechanism like half-beam, subject to Metra review and approval, shall also be provided. The wiring within the enclosure shall be of the heat-resistant type and the enclosure shall be provided with adequate ventilation holes. **[CDRL C-10-06]**

10.4.8 On the control end of cab cars only, two ditch lights (low voltage D.C. sealed beam incandescent lamps or halogen lamps compliant with 49 CFR Part 229.125) shall be installed one each side of the cab control end. If lights are proposed with LED technology, they shall not be prone to ice or snow buildup and shall be reviewed by Metra. The lights shall be aligned to cross at approximately 300 feet down the track and illuminate the roadbed approximately 800 feet down the track.

10.4.9 Lights shall operate in one of the following modes: steady, flashing, or flashing after horn or bell only. The control unit shall be incorporated into the vehicle control unit (VCU). Installation location shall be subject to approval of Metra. Methods to protect the lamp from overvoltage (such as a resistor) and methods to dim the lamp (such as with a dimming resistor) shall be included in the design.

10.4.10 The contractor shall propose an additional mode of operation. A momentary push button or Metra approved alternative device located adjacent to the headlight/ditch light switches that when depressed will momentarily turn off the ditch lights, dim the headlights, and turn off Mars light (if Mars light proposed). When the momentary push button is let go the headlights, ditch lights, and Mars light (if Mars light proposed) revert back to whatever mode of operation the headlight/ditch light switches were set to.

10.4.11 (deleted)

10.4.12 The lights shall be controllable via the display or buttons.

10.4.13 On each end of the train, two (2) red lights shall be provided which indicate the end of the train, or indicate when the train is in parking position.. The entire arrangement shall comply with FRA regulations, as stated in 49 CFR Part 221.

10.4.14 In the control section on cab cars, the cab shall be equipped with a light burnout detection panel that notifies operating crew and/or Mechanical personnel that an exterior lamp has failed. Alternatively, an indication on the display can be made. The burnout detector panel or display indication shall have provisions to monitor both headlights and both ditchlights. The Contractor shall submit the design of this system for Metra review and approval. **[CDRL C-10-07]**

10.5 LOW LOCATION EXIT PATH MARKING (LLEPM)

10.5.1 Each car shall be equipped with a passive low location and exit path marking system that complies with the requirements of APTA SS-PS-004-99 and APTA PR-PS-S-002-98, latest revision. The system shall use HPPL marking material as specified in Section 19.2.21 of this specification. The system shall be detailed in the proposal. **[PDRL P-10-02]**

10.5.2 The system chosen by the Contractor shall be arranged to provide visual guidance for evacuation of the car when overhead lighting and the emergency lighting system has failed or has been obscured. The low location exit path marking system shall clearly identify the primary path to be followed for exiting the car under emergencies. The primary exit path shall be designed to evacuate the passengers to the next car and not onto the right-of-way.

10.5.3 The Contractor shall propose the techniques and options for integration of passive HPPL elements into floor coverings, seat frames, door, exit path, stairways and bulkhead elements to achieve the APTA standard requirements. Emergency Exit Route Evacuation Maps (Signs) and shall be constructed of HPPL material per APTA requirements. The system design shall be reviewed and approved by Metra and demonstrated on the Pilot Car. **[CDRL C-10-08]**

10.5.4 If additional LLEPM options are proposed, they shall be listed as options. **[COPL CO-10-02]**

10.6 PROPOSAL DELIVERABLES REQUIREMENT LIST

PDRL	Title
	(deleted)
P-10-02	LLEPM

10.7 CONTRACT DELIVERABLES REQUIREMENT LIST

CDRL	Title

C-10-01	Interior and Exterior Lighting Plan
C-10-02	Lighting Electronics Environmental Testing
C-10-03	Normal Mode Light Level Testing and Environmental standards
C-10-04	Emergency Lighting Details and Testing
C-10-05	Exterior Lighting Design and Functionality
C-10-06	Headlight Dimming/Protection
C-10-07	Light Burnout Detection
C-10-08	Low Location Exit Path Marking (LLEPM)

10.8 CONTRACT OPTIONAL PROPOSAL LIST

COPL	**Title**
CO-10-01	Automatic Dimming
CO-10-02	Additional LLEPM Options

11 ELECTRICAL

11.1 GENERAL REQUIREMENTS

The onboard power source shall be capable of supplying power to all loads on the trainset. The power sources may be distributed amongst the cars.

11.1.1 Complete circuit diagrams shall be submitted to Metra for approval prior to construction. Complete circuit diagrams are schematic level circuits **[CDRL C-11-01]** All wiring not explicitly referenced in other parts of this specification shall meet at a minimum the latest revision of APTA standard PR-E-RP-009-98, "Recommended Practice for Wire Used on Passenger Equipment", or EN 50264 and EN 50306, latest revision of APTA standard PR-E-RP-002-98 "Recommend Practice for Wiring of Passenger Equipment", or EN 50343, and latest revision of APTA standard PR-E-S-001-98 "Standard for Insulation Integrity", or EN 50124-1. The contractor shall submit to Metra for review and approval a "Regulation of Car Wiring Works" document that will at minimum include: scope, general car wiring methods, treatment of termination, wiring number marking, treatment for wiring and connection, wire label methods, and other items as agreed upon by Metra and the contractor.

11.1.2 An electrical load study detailing the electrical loads shall be provided to Metra for reference and approval. **[CDRL C-11-02]** A basic load study and overview of the electrical systems proposed in this section shall be included in the proposal. **[PDRL P-11-01]**

11.1.3 Where applicable, software or firmware shall be developed in accordance with and meet the latest revision of IEEE standard 1558 "IEEE Standard for Software Documentation for Rail Equipment and System" or EN 50657 "Railways Applications - Rolling stock applications - Software on Board Rolling Stock". **[CDRL C-11-03]**

11.2 VOLTAGES

11.2.1 Where applicable, equipment should follow guidelines in accordance with the latest revision of IEEE standard 519 "Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems" or equivalent rules and proven designs.

11.2.2 The contractor shall propose an onboard D.C. system voltage, and in the proposal shall justify the recommendation based on documented proven reliable design and prevailing industry standards in the United States commuter rail market. The DC voltage power system design shall be subject to Metra review and approval. **[CDRL C-11-04]**

11.2.3 The power system shall be trainlined in order to distribute power for redundancy, and efficiency of design. If such a design is included in the proposal, the trainlined battery voltage shall be protected by a circuit breaker or alternative approved protection scheme. The voltage power system design shall be subject to Metra review and approval.

11.3 LOW VOLTAGE DC POWER SUPPLY

11.3.1 Backup Power Requirements

11.3.1.1 The backup power system shall be sized to carry the full DC load under emergency conditions (defined as after loss of normal power condition) for no less than two hours before the activation of load shed. At a minimum but not limited to, these loads include items such as: pilot lights, TIMS, door closing lights, TIMS destination signs, PA System, Passenger emergency intercom (s), all cab operational equipment (cabs only), PTC (cabs only), event recorder system (cabs only), cab signal system (cabs only), train radio (cabs only),

forward facing camera system (cabs only), car level monitoring system, passenger seating camera system, lighting if applicable, and additional loads as agreed upon between the contractor and Metra.

11.3.1.2 (deleted)

11.3.1.3 (deleted)

11.3.1.4 The contractor shall submit a service proven reliable design that provides the latest available technology in passenger rail and provides the longest life-cycle cost effective system. The backup power system design shall be subject to Metra review and approval.

11.3.1.5 The load shedding concept for the first 120 minutes for worst case summer and winter operating conditions in the Chicago area shall be proposed and submitted to Metra for review and approval. **[CDRL C-11-03]**

11.4 SWITCHBOARD AND CONTROL FEATURES

11.4.1 Switchboards and equipment for the control of the various electrical circuits, such as circuit breakers, etc., shall be provided in electrical cabinets.

11.4.2 All switches, circuit breakers, relays, resistors, etc., shall be identified by nameplates. All circuit breakers shall be indicated ON with toggle up and OFF with toggle down.

11.4.3 All electric lockers shall be designed with provisions to prevent, to the greatest extent possible, the ingress of snow, moisture and heavy debris. Electric lockers shall be large enough to allow ergonomical access for railroad maintenance personnel. Each circuit breaker panel shall carry apparatus arranged to be easily accessible to connections and designed to prevent an operator form coming in contact with live voltage when operating switches or circuit breakers. In addition, a reasonable amount of locker footprint shall be open for future installation of new equipment by Metra. Inside each electrical locker a reasonable amount of spare terminal points and DIN rail shall be allocated for future expansion.

11.4.4 The circuit breaker panels shall be dead front type, with removable front covers. Circuit breakers shall be arranged so that the handles move vertically or horizontally. Breaker covers are to be provided on operational sensitive controls to prevent inadvertent use of breaker. If utilized, bus bars shall be arranged to have tapped holes along their entire length and be of a design such that all phase combinations are available at each breaker site.

11.4.5 All panels shall be conveniently located, in the electrical cabinets, for ease of access by service personnel. Reduced wiring and ease of maintenance shall be of prime consideration.

11.4.6 For electrical panels, a wiring gutter shall be provided along the top, sides, and bottom, for the routing of high voltage leads to their designated circuit breakers.

11.4.7 Circuit breakers shall each be grouped with their respective voltage and be labeled according to the appropriate voltage. A master circuit breaker shall be provided for each voltage level. The circuit breaker panel shall be configured for easy removal so that maintenance and repair action are not impeded. Design of the electric lockers shall be subject to Metra review and approval. **[CDRL C-11-06]**

11.5 480 VOLT AND CONTROL TRAINLINES

11.5.1 All trainline systems described below in Sections 11.5.1-11.5.7 shall be subject to Metra design review and approval. **[CDRL C-11-07]** It may be proposed to integrate the 27-wire locomotive control trainline, door control trainline, and communications trainline systems into the digital IP based trainline system. **[COPL CO-11-01]**

11.5.2 Door Control Trainline

11.5.2.1 The cars relevant door circuits shall be trainlined for door control to accomplish proper door operation.

11.5.3 Communications Trainlines

11.5.3.1 The cars PA system shall be trainlined for all cars in a train consist.

11.5.4 (deleted)

11.5.5 Digital Trainlines

11.5.5.1 The cars shall have an IP based digital trainline. This trainline may be used for such 3rd party systems as Train Information Management Systems (TIMS), passenger Wifi, PA announcements, digital monitoring systems, and other systems as agreed to by Metra and the Contractor.

11.5.5.2 (deleted)

11.5.5.2.1 (deleted)

11.5.5.3 Ethernet cable (Digital trainline)

11.5.5.3.1 Each train shall be equipped with two GigaBit Ethernet networks in a ring topology, one for Comunications and Information system and one for Train Control and Management System. The network cables shall be compliant with IEEE Standard 802.3-1999. Between the cars the networks shall be connected with jumper cables. The jumper and receptacle shall be at a minimum an IP67 grade connector when mated. The jumper shall be provided with a retention mechanism that will prevent the jumper from falling outside the acceptable gauge envelope of the vehicle and fouling any trackside equipment. The conductor size shall be selected to ensure that this will be capable of withstanding the daily operation of the harness including the flexing that can be expected in normal vehicle operation. Each jumper cable shall be protected along the length of the cables external jacket against abrasion that may occur during installation or normal vehicle operation. The jumper cables shall be screened over the length of the cables and the screen shall be connected to the connector. The screen connection will not be continuous over the full length of the assembly to prevent providing a common earth connection between adjacent vehicles. The screen of each cable shall be capable of being connected to the vehicle body at one point only. All other connector and parts of the assembly shall be constructed to prevent multiple point earth points on the cable screen.

11.5.5.3.2 In each car, there shall be a minimum of one PoE (Power over Ethernet) equipped network switch located in a minimum of one electrical locker. The network switch shall contain a minimum number of ports to provide connectivity to the digital (Ethernet) trainline as well as on-board compatible digital systems and spare ports for provisioned digital systems. The switches chosen shall also include a bypass feature, or other Metra approved methodology, to ensure the physical connection between the 2 end-point connections on the car remains continuous even when the car is not powered. Network equipment used must comply with current industry protocol standards. The proposer shall indicate which network standard(s) are met with their proposed solution. The proposer shall commit to design to a communication network standard with proven application in passenger rail in North America. The contractor shall provide justification for choosing such standard(s). Each car shall feature network redundancy such as ring network technology in order that failure of onboard communication systems will not affect the digital trainline. The digital trainline design, network equipment and equipment placement within the electrical locker shall be subject to Metra approval. **[CDRL C-11-07]**

11.5.5.4 (deleted)

11.5.5.4.1 (deleted)

11.5.6 USB and/or 120VAC outlet charging port shall be provided for each seating position, except flip seats where not possible. The ports shall be located on the side wall just below the window, or should fixed seating be provided, the USB ports may as an option be provided on the seat back of each multiple passenger seat (except for bulkhead and back to back seats). USB ports shall also be provided adjacent to the ADA position area on the locker wall. Final position of the USB ports and design of the USB system is subject to Metra design review and approval. **[CDRL C-11-09]** USB ports shall have the following current rating:
USB-A: 0.5 amp
USB-C: 3.0 amp
They shall be a compatible with all Apple and Android mobile devices.

11.6 CONDUIT

11.6.1 Conduits shall be in accordance with the latest revision of APTA PR-E-RP-002-98 “Recommended Practice for Wiring of Passenger Equipment" or EN 50343 "Railway applications - Rolling stock - Rules for installation of cabling". An exception may apply for trainline cables which may be cleated to the underfloor structure, in such manner as to prevent wire chafing.

11.6.2 The car shall be provided with thin wall conduit within the car body. Conduit shall be securely clamped with all runs electrically grounded to make a continuous ground. Suitable approved insulation to prevent electrolysis shall be provided where dissimilar metals are in contact. All conduits shall be arranged to prevent moisture traps and shall drain toward control boxes, except that all open-ended conduits shall be installed in such a manner as to ensure gravity drainage out the end. The conduit arrangement shall be subject to Metra review and approval.

11.7 ELECTRICAL GROUNDS

All electrical equipment, with a voltage of greater than 24 volts nominal shall be grounded to the car body. Grounding and bonding shall be done in accordance with the latest revision of APTA Standard SS-E-005-98 or EN 50153 "Railway applications - Rolling stock - Protective provisions relating to electrical hazards".

11.8 CAR LEVEL MONITORING SYSTEM

11.8.1 A monitoring system shall be included as part of the Train Control Management System. The monitoring system shall be Internet Protocol (IP) based, and a device with an Ethernet port or ad-hoc Wi-Fi capability shall be able to view real-time information when connected to the monitoring system. The monitoring system shall acquire and aggregate data from the following car subsystems (at a minimum): Door system, HVAC (including interior temperature), LVPS/Battery Charger, water and waste system, brake/wheel slide system, PA/IC/Communications (including interior audio levels), TIMS (Train Information Management System), lighting, CDVRS, passenger seating area camera systems, ADA systems, event recorder, data link, and other sub systems on the car as agreed upon between Metra and the contractor. The diagnostic system shall have spare interfaces for future systems, such as I/O and Ethernet ports. The parameters and subsets of data from each system to be stored onto the monitoring system shall be agreed upon between Metra and the contractor. The monitoring system shall store fault logs. In addition, a visual indication and status of the designated systems shall be displayed. The graphical user interface shall be clean, easy to use, and intuitive. The monitoring system shall be capable of holding seven (7) days' worth of data within the systems Rail Communications Units solid state drive (SSD).The data shall be capable of being securely transmitted to Metra storage servers through Wi-Fi when in range of wireless access points in depots and maintenance yards. The data shall be accessible via non-proprietary formats, such as .csv files. The design and infrastructure of the monitoring system shall be subject to Metra design review and approval. **[CDRL C-11-10]**

11.8.2 The contractor shall propose, as an option, a remote monitoring and diagnostic system. This system shall capture and analyze data from components and subsystems aboard the trainset.. The system accessibility shall be provided by a web based access or similar. The data that is monitored shall apply to the systems described in 11.9.1 and shall include: process data such as temperature, and pressure; counter data, such as start/stop, door opening cycles, loads cycles, and number of brake releases; Incident-based data such as emergency brake application, power unavailable, door failure to open; time and location stamps for event-based and process-based data from various sources. The monitoring system shall issue automatic alerts based on a specific event trigger and/or based on calculations of data. Archiving criteria shall be adjustable according to Metra's needs. There shall be a set of pre-defined reports, analysis and graphical tools. In addition, Metra shall be able to set up its own analysis, and reports and shall be able to edit the analytics provided without the involvement of a third party. There shall be a system of authorization profiles on the control center software. The data shall be accessible via non-proprietary formats, such as .csv files. All asset data shall be the property of Metra. **[COPL CO-11-02]**

11.9 PROPOSAL DELIVERABLES REQUIREMENT LIST

PDRL	Title
P-11-01	Electrical System and Load Study
P-11-02	(deleted)

11.10 CONTRACT DELIVERABLES REQUIREMENT LIST

CDRL	Title
C-11-01	Electrical Circuit Diagram
C-11-02	Electrical Load Study
C-11-03	Load Shedding
C-11-04	Battery Box and Battery Protection
C-11-05	Battery Charger/LVPS

C-11-06	Electric Lockers Design
C-11-07	Trainline Circuits
C-11-08	Surge Protective Device
C-11-09	USB Port Position and Design
C-11-10	Car Level Monitoring System

11.11 CONTRACT OPTIONAL PROPOSAL LIST

COPL	Title
CO-11-01	Integrated Digital Trainline
CO-11-02	Remote Monitoring System

12 COMMUNICATION SYSTEMS

12.1 GENERAL REQUIREMENTS

12.1.1 The system shall communicate between trainsets using trainline connections described in Section 11.5. Single points of failure along the trainline(s) shall be analyzed and mitigated.

12.1.2 The system shall feature redundancy to the greatest extent possible.

12.1.3 All critical subsystems, including Public Address, Emergency Intercom, Train Radio, and portions of the Train Information Management Systems shall utilize backup power and function in emergency situations.

12.1.4 A complete train communications system shall be installed. The system shall comply with FRA Regulations 49 CFR Parts 229 and 238. The details of the design, equipment, arrangement, and installation of the complete communication package shall be submitted to Metra for review and approval during the design review process. **[CDRL C-12-01]** It shall provide passenger cars with the following functions:

12.1.4.1 One-way communication from the train crew or operator's cab to the passengers (Public Address System)

12.1.4.2 Two-way private communication between the operator's cab and the train crew (Intercommunication System Function)

12.1.4.3 Two-way communication between passengers and the train crew/operator's cab (Emergency Passenger Intercommunication System Function)

12.1.4.4 Two-way communication between the Train Information Management system servers and the Train information Management system on the train.

12.1.5 The proposer shall include the detail the functionality and the onboard equipment of the above systems in their proposal to the greatest extent practicable **[PDRL P-12-01]**

12.1.6 All Communication System electronics shall be tested and conform to all applicable sections of Standard EN 50155 (including EN 50121-3-2), IEC 61373, 49 CFR 238 Appendix B, and NFPA 130. Certification to FRA and/or AAR S-9401 criteria shall be provided by the contractor upon the request of Metra.

12.1.7 The Public Address and Train Information Management systems shall be compatible with each other. The Train Information Management System shall be 100% compatible with Metra's ACORN (Automated Communications and Onboard Reporting Network) in terms of interfaces, transmission, and receiving of messages, signals, software, databases, and data. The user interface used by Metra GPS operators to track trains, prepare messages, and transmit messages shall utilize the same interface as ACORN and be integrated within the ACORN system Metra is adopting. The system shall meet all the technical and functional Requirements of Metra's ACORN system, which will be provided by Clever Devices. The system shall demonstrate compatibility with Metra's Clever Devices ACORN communication system and shall be subject to Metra review and approval. **[CDRL C-12- 02]** To be 100% compatible with the Clever Devices ACORN system, the following components and any necessary ancillary equipment for compatibility need to be utilized in the system:

12.1.7.1 Clever Devices IVN-R, 32G GPS Part #404-2185-0001
12.1.7.2 Clever Devices Bracket, IVN4 Part #101-120-0130
12.1.7.3 Clever Devices Transit Control Head, Rail Part #103-300-0009
12.1.7.4 Clever Devices Connector Kit, Acorn Part #KIT-CONN-ACORN

12.2 PUBLIC ADDRESS / INTERCOMMUNICATION SYSTEM

12.2.1 The public address and intercommunication equipment shall meet all applicable environmental tests specified in section 21.24 as well as other applicable standards for Sound and PA Equipment including those for Temperature Range, High Humidity, Vibration Stability, and Shock Stability.

12.2.2 All circuits shall be physically isolated and protected against any circuit that can cause or induce electromagnetic interference. Circuit breakers shall be provided for circuit protection. The PA system shall comply with all applicable aspects of 49 CFR 238.121, including emergency back-up power requirements.

12.2.3 The complete system shall utilize the following components installed on each car with alternative designs, subject to Metra approval:

12.2.3.1 Conductor Control Unit (CCU), designed to provide audio input, amplification, audio output, intercom and public address (PA) functions.

12.2.3.2 An indicator light or LED shall notify a conductor that a handset has gone off-hook (or conductor's microphone has been activated) and an intercommunication link has been made. When intercom is selected, loudspeakers in cars shall be muted.

12.2.3.3 Switch arrangement shall be provided to allow selection of PA and Intercom mode. Any mode selected (PA or IC) shall remain selected until the mode is changed.

12.2.3.4 Conductor voice input (microphone) capable of at least 1,000,000 operations. Handset microphone (or alternate microphone design) design will be subject to Metra review and approval

12.2.3.5 The CCU shall be mounted in a "Coach Key" locked compartment.

12.2.3.6 The public address system in each car shall include an ambient noise controlled amplifier monitored throughout the car. The unit will allow for automatic volume control, enabling announcements to be heard over the ambient noise level within the car.

12.2.3.7 One power amplifier shall be required for each car and designed to provide audio input, amplification, audio output and regulated voltage for control units.

12.2.3.8 The power amplifier shall be capable of: Transient suppression, Power supply line isolation (DC/DC Converter), Regulated voltage supply, Compressor pre-amplifier, and Power amplifier.

12.2.3.9 The output level adjustment and shall remain consistent throughout the specified temperature range.

12.2.3.10 The power amplifier must provide protection against transient voltage. Short and open circuits shall not impose damage to the power amplifier.

12.2.3.11 With speech and sound input, the amplifier shall operate continuously with full output at rated voltages and without damage or degradation to the PA components.

12.2.3.12 There shall be a minimum of six (6) speakers in each passenger seating compartment, with a detailed coverage analysis carried out to show best placement and quantity for each car. The power pack walkway shall contain minimum of two (2) speakers, one at each end. The contractor shall conduct a detailed audio sampling and study of all passenger areas of the car, ensuring volume consistency between areas, as well as optimal sound levels. **[CDRL C-12-03]**

12.2.3.13 There shall be a minimum of four (4) speakers on the exterior on each side of the car. They shall be high performance loudspeakers.

12.2.3.14 Exterior speakers must be outdoor rated and weatherproof. The external speakers shall be installed to prevent ingress of water and dust. The loudspeakers and their assembly shall be immune to the chemicals and detergents used normally during washing, as well as any normal abrasive cleaning that may occur during washing.

12.2.3.15 The external speakers shall feature a wide dispersion angle and be able to be heard and understood by passengers on the platform area.

12.2.3.16 The volume levels of each passenger area, including the exterior speakers, shall be adjustable independently by a maintenance person.

12.2.3.17 The PA system shall feature minimal Total Harmonic Distortion over their entire operating frequency range. Total Harmonic Distortion shall not exceed 2% at the output of the Power Amplifier into rated load at full rated power over the range from 300 Hz to 3 kHz.

12.2.3.18 The audio communication systems and PA systems shall exhibit a Speech Transmission Index (STI) rating of 0.6 or above according to the latest revision of IEC-602682-16 when measured in a quiet, empty car.

12.2.3.19 (deleted)

12.2.3.20 An Emergency Passenger Intercom Unit (EPIU) shall be provided per Federal regulation, 49 CFR Part 238.121 The units shall be flush mounted with the locations subject to Metra approval. **[CDRL C-12-04]** The units shall feature the following:

12.2.3.20.1 One-touch shall activate the intercom. The emergency intercom shall be recessed and otherwise protected against accidental activation.

12.2.3.20.2 Once activated, an alert will play to notify the crew that a passenger has activated an EPIU and state the car number and location within the car from which the EPIU was activated.

12.2.3.20.3 Upon Intercom initiation, the EPIU will become hands free. The passenger will not need to hold the push button down.

12.2.3.20.4 The EPIU shall allow crew members to respond via any CCU or OCU located on any car of a train consist including the locomotive.

12.2.3.20.5 Each EPIU shall be equipped with indicators: one to indicate the EPIU is successfully connected to the train intercom, one instructing a passenger to "wait/listen" and one indicating when the passenger can talk.

12.2.3.20.6 The conversation will be ended by the train crew hanging up on the OCU or CCU panel.

12.2.3.20.7 The EPIU shall have provisions to filter out ambient noise to ensure clear communication and also to prevent ambient noise from preventing the EPIU to disconnect after the call has ceased.

12.2.3.20.8 The face of the EPIU shall be labeled "Emergency Intercom" in luminescent material per APTA Standard PR-PS-S-001-98, latest revision and shall have instructions for operation. The car number shall be permanently and legibly applied to the car immediately above each EPIU.

12.2.3.21 In addition to the above, the following equipment shall be provided in the cab of cab control cars:

12.2.3.21.1 An Operator's Control Unit (OCU) located in an approved location on the cab lower console. The OCU shall be designed to provide: audio input amplification; audio output; control of the radio, intercom and public address functions. The OCU shall have the following:

12.2.3.21.2 An indicator light or LED shall indicate that the handset has gone off-hook (or engineer's microphone has been activated) and an intercommunication link has been made. When the intercom is selected, loudspeakers in cars shall be muted.

12.2.3.21.3 A three (3) push button switch arrangement shall be provided to allow selection of PA, Radio PA and Intercom mode. Logic shall be such that the radio receiver is always on regardless of function selected. When selected the PA or IC mode shall remain selected until the mode is changed. The Radio PA switch must be depressed to enable the radio to be transmitted on the PA.

12.2.3.21.4 A handset microphone with coiled cord shall feature a push-to-talk switch capable of 1,000,000 operations. Handset microphone design (or alternate modern microphone design), will be subject to Metra review and approval.

12.2.3.21.5 A loud speaker assembly shall be provided in the cab ceiling. The assembly shall have a control to adjust the output volume of the speaker.

12.2.4 The contractor may propose a fully digital Public Address system. If proposed, the system shall utilize the digital trainline(s) described in 11.5.5 or a standalone digital PA trainline.

12.2.5 The Public Address/Intercom system shall feature radio to PA capability, with the design and details subject to Metra review and approval.

12.2.6 (deleted)

12.3 TRAIN RADIO

12.3.1 Alternatively, and at Metra's sole discretion, Metra may elect to supply the train radio to the Contractor. If such an option is chosen by Metra, the Contractor shall be responsible for all ancillary equipment and materials needed to complete the installation and successfully conduct a full functional qualification test of the train radio. The qualification test procedure shall be subject to Metra review and approval. **[CDRL C-12-05]**

12.3.2 Cab Control cars shall be equipped with a narrow band train radio. The radio shall comply with AAR Standards and with any Federal Communications Commission or other regulations.

12.3.3 The radio shall be capable of adjustment to clarify reception and alter volume.

12.3.4 The radio shall be a >100 channel radio, with an internal microphone, remote audio connector and remote control head. The radio shall take power from the locomotive battery power source or (other approved independent power source) and the circuit shall be suitably protected. Power must be filtered if appropriate.

12.3.4.1 Clean cab mounting plate to be provided.

12.3.4.2 One handset (or alternate Metra-approved microphone) with push-to-talk switch, coiled cord, and AAR connector shall be provided at the operator's station.

12.3.4.3 The handset hang-up cup (or alternate Metra-approved design) shall include a radio control reverting switch.

12.3.4.4 The minimum functions of the transit control head shall be: PTT, Channel Display, Display brightness control, Number pad, Volume up/down, Home group, AAR group, and squelch tight/normal setting

12.3.5 A standard railroad style antenna shall be supplied. The location shall be subject to Metra approval.

12.3.6 The cab radio shall feature a ruggedized housing, ruggedized display, and ruggedized keypads.

12.3.7 The cab radio shall meet AAR S-9401 Vehicle Interior Cab standards (or Metra approved equivalent) for Humidity, Vibration, Mechanical Shock, and Abrasive Environment.

12.3.8 The cab radio shall conform to all applicable AAR standards for cab radio and radio transmission, including the capability of transceiving on all AAR channels. The radio must support all current AAR designated analog FM two-way radio channels, at “narrowband” 12.5 kHz deviation. This includes the standard designated channels 007-098 and 107-198 interstitial channels. These channels should be accessible in a specific group that allows entry by keypad of independent Tx and Rx frequencies. (ex. 077 077 for simplex operation).

12.3.9 The cab radio shall be set up to transmit and receive on all channels used by Metra. These channels shall be easily selectable. The radio must also support a "Home channel" group. Group must be customer programmable by Metra Radio Shop staff. Home channels may include any frequency in the VHF 155-174 MHz range, 25 kHz and 12.5 kHz. Home channels must also support standard CTCSS/PL and DCS/DPL tone coded squelch options. Must also support Rx only channels.

12.3.10 A full functional qualification test of the train radio shall be completed. The qualification test procedure shall be subject to Metra review and approval.

12.3.11 The details of the cab radio shall be proposed to Metra for review and approval. **[CDRL C-12-05]**

12.4 BUZZER SYSTEM

12.4.1 A trainlined electric signal system shall be provided in all cars. Pushbuttons and buzzers shall be located approximately as follows:

12.4.2 One (1) low tone buzzer located in the control station of cab-control cars

12.4.3 Two (2) pushbuttons located in the passenger boarding/alighting area of all cars, one adjacent to each door control panel

12.4.4 One (1) pushbutton in a Metra approved location near the body end door opening at one end of all cars

12.5 TRAIN INFORMATION MANAGEMENT SYSTEM/ACORN

12.5.1 The Contractor shall furnish and install a Train Information Management System (on train equipment only) in accordance with 49 CFR 38.103, Public Information System. The Train information Management System shall be 100% compatible with Metra's existing ACORN system as per section 12.1.6. The compatibility requirement shall not constrain the proposer to require wireless trainline connections. In the proposer's proposal, a description of how the system is networked and trainlined, including if wired or wireless connections are proposed shall be included. The details of the design, equipment, arrangement, and installation of the complete train information management system shall be submitted to Metra for review and approval during the design review process. **[CDRL C-12-06].** Proposal functionality and hardware details of this system shall be provided as part of **[PDRL P-12-01].**

12.5.2 The train information system shall be fully compliant with all applicable ADA regulations and recommendations.

12.5.3 The system shall monitor train location via the Global Positioning System and use this information to provide on-train text and audio messages regarding train arrivals and delays. The system shall transmit location information (within ten (10) meters) to Metra's existing base station servers. The system shall demonstrate compatibility with Metra's communication system back office and GPS operation.

12.5.4 The onboard train system will be linked via cellular communication to a Metra base station server. The system shall also be Wireless Fidelity (WiFi) equipped to allow for base station communication via Wi-Fi if in range. The system shall be independent from PTC Wi-Fi.

12.5.5 Metra personnel onboard shall be able to connect for troubleshooting and maintenance purposes.

12.5.6 The onboard train system shall be capable of sending customized messages from the user application to be displayed/announced aboard individual trains in real-time.

12.5.7 There shall be a user interface to allow the programmable control on its car and the interior signs on its car. The interface shall allow for control, testing, and adjustment of the text (signs) and audio announcements. The programmable interface shall feature a numeric keypad and a ruggedized screen display or proposed alternative, subject to Metra approval. The interface shall allow a trainman to specify the following:

12.5.7.1 Specify train number
12.5.7.2 Specify operating characteristics
12.5.7.3 Specify reason for delay and
12.5.7.4 Specify manual announcements.

12.5.8 The Train Information System Network controller will be stored in a secure area accessible only by using a train maintenance key or Metra's standard coach key.

12.5.9 The terminal shall store train schedules and train numbers in a database (approximately 245 stations, 482 trains inbound to and 482 trains outbound from Chicago traveling on 12 rail lines). Actual train performance is compared to scheduled performance and is used to alert passengers when a train is behind schedule. The system allows a trainman to select a reason for the delay. The updates to the database shall be made via a portable computer. The system shall be capable of updating the database from the base station computer. In addition to this information the database would also contain the voice files for the prerecorded commuter information and the safety messages.

12.5.10 The system shall allow for live announcements sent directly from the base station server.

12.5.11 The contractor shall include infotainment subject to Metra approval. This shall include features such as: dedicated digital display areas for advertisements that can be triggered based on location, time of day, Metra line, and date range. These signs/screens shall allow for animated graphic displays, including entertainment and advertising. These areas shall not interfere with displaying important passenger information including “next station stop," delay messages, conductor announcements, and messages sent from GPS operators. Importing and removing of advertisements shall be easily controlled by Metra. Infotainment details shall be included in the Proposal. **[PDRL P-12-02]**

12.5.12 The contractor shall propose additional infotainment options to Metra if they are available. **[COPL CO-12-01]**

12.5.13 The communication system shall be seamlessly interfaced with the PA system, and all necessary equipment to interface with the public address system shall be provided. The system shall be configurable to select whether generated audio and text messages yield precedence to conductor PA announcements. The system shall allow all cars on a train to play and display announcements simultaneously.

12.5.14 The system shall be fully compliant to all ADA codes and standards. Advanced features will be investigated and implemented where possible, with the designs and functionality being submitted as part of the Proposal Deliverable [PDRL P-12-01] for Metra review and approval.

12.5.15 Optional ADA passenger enhancements, including speech-to-text and assistive listening technology, which go beyond local, state, and federal requirements shall be proposed as options. **[COPL CO-12-02]**

12.5.16 The system will provide the following announcements automatically over the train's public address system and signage system for the selected train number:

12.5.16.1 Train destination and scheduled station stops prior to departure from the initial terminal

12.5.16.2 Train destination and scheduled station stops repeated along with emergency exit announcement after exiting the initial terminal

12.5.16.3 Emergency exit announcement prior to the arrival at the final destination

12.5.16.4 Announce an upcoming station prior to arrival

12.5.16.5 Announce the next station stop upon departure from a station (The signs shall continuously display this until the next arrival message is prompted)

12.5.16.6 Announce delay when a train is behind schedule and announce the reason for the delay if available

12.5.16.7 Announce any modifications to the normal schedule and any special announcements programmed.

12.5.17 The contractor may be responsible for the creation of the digitized audio files for the above, and the system shall allow loading of existing audio and text data and have the ability to schedule playback.

12.5.18 The system shall be designed to automatically display messages on specific cars in the train consist at specific times of the day. Example: "Quiet Car" logo is displayed on the screens of the second car and second to last car on weekday consists from 6am-9am and 4pm-6pm automatically regardless of train consist size. Provisions shall be in place to allow train crews to push a list of pre-defined messages/logos and custom messages to the Passenger Infotainment display screens of all or selected train cars of consist. Pre-defined messages/logos shall be editable to maintenance personnel. Examples of messages could be messages such as "No alcohol allowed on train – with predefined logo", "Toilet out of service – with predefined logo", or "a typed message – "Train will now operate express to '___'."

12.5.19 Interior/Exterior Signs

12.5.19.1 The contractor shall provide LED, LCD, TFT-LCD, OLED, or AMOLED (or any combination thereof) interior signage technology which has proven service in passenger transit applications. The signage shall be multipurpose, for simultaneous display of route/destination information and infotainment.

12.5.19.2 The interior signs shall display the text messages/animations that are coordinated with the on-train audio announcements. Text displays include time and date, train number, final destination, on-time / delay information, and emergency procedures. In addition to GPS location triggering of station stops, messages shall be initiated via back office of the train information management system and the programmable interface onboard.

12.5.19.3 The interior signs shall refresh at rate indiscernible to the human eye. The interior signs shall be capable of producing smooth animations. The interior signs shall be capable of producing multicolored text and animations.

12.5.19.4 The signs shall feature a wide viewing angle, and the signs shall be readable by a maximum number of passengers in each passenger area. The sign shall be clearly readable in all ambient light conditions from total darkness to direct sunlight. The signs shall adhere to all current and applicable ADA and APTA required and recommended standards at the time of the contract award.

12.5.19.5 For messages able to be entirely displayed on the screen at once, the text shall statically display, and not scroll or disappear. The interior signs shall continuously display next station stop announcements upon departure from the previous station until the arrival at the following station.

12.5.19.6 The signs shall function nominally during input voltage fluctuation ranges seen in passenger rail operation. The signs shall feature input protection for electrical inputs outside of the normal operating range. The signs shall function nominally in the vibrations seen in a normal railroad operating environment.

12.5.19.7 The interior signs shall be capable of featuring emergency messages and would be part of the trains essential load/emergency power supply.

12.5.19.8 The signs shall be applied in locations subject to Metra approval in anti-theft enclosures. The signs shall be housed in durable enclosures. The sign shall be accessible for maintenance crews to replace the sign or adjust settings.

12.5.19.9 The signs shall be tested in accordance with other tests required for onboard equipment in this specification, such as: vibration; flame, toxicity, and low smoke; electromagnetic compatibility; temperature and humidity.

12.5.19.10 The contractor shall supply two (2) exterior information signs on each car. These signs shall provide information to the passengers on the platform, this will include end destination, car passenger load, restroom locations. ADA areas and any key journey points of interest, such as Airport or Train station.
Each end car, shall provide an additional two (2) information signs. One providing the train number, while the other providing the trains end destination.
Destination signs shall have illuminated characters on a non-illuminated background and shall use electronic segment or LED type displays. Other technology will be considered. All signs shall be discernible in bright daylight.
Access to the signs shall be from inside the car, and shall provide for easy replacement and maintenance of all components.
The side signs shall also be programmable to display public-relations messages. They shall be capable of displaying in a static mode a minimum of 14 characters 2" height to be well perceived and well-read at least from 15 feet as well as from a very short distance by the passenger waiting on the platform or approaching the train and is subject to Metra approval.
The front destination sign shall be capable of displaying a minimum of nine (9) characters maximizing the available space to spell the destination. In compliant with IEEE1477 the display shall also be capable of displaying characters 4" height and to manage spelling of the message in scrolling mode.

12.5.19.11 The design, placement, and testing requirements for the passenger information signs shall be subject to Metra approval. **[CDRL C-12-07]**

12.5.20 The system shall utilize an open architecture to provide for future expansions and upgrades. The system shall be designed to easily add new functions and upgrades from different manufacturers. All input/output modules, control and data transfer protocols shall be non-proprietary to the greatest extent possible. The system shall also be designed for

adaptation to wireless local area networks (WLAN) for the purpose of automatic file update downloads.

12.6 PASSENGER COMPARTMENT DIGITAL VIDEO RECORDING SYSTEM

12.6.1 A secure, railroad-grade Passenger Compartment DVR system shall be proposed. It shall reliably capture and securely archive video for retrieval. The system shall be composed of one central dedicated recorder; a suitable number of cameras for each passenger compartment and the passenger boarding/alighting areas and all applicable interconnections. The DVR system shall be powered from a separate circuit breaker (on the breaker panel). If a cable break point is necessary, then the break should pass through a shielded ethernet bulkhead coupler, not a terminal board. The design and arrangement of the DVR system, including camera locations shall be proposed and subject to design review and approved by Metra. **[CDRL C-12-08]**

12.6.2 Each component must be modular, interchangeable, and replaceable without affecting the rest of the DVR system. The DVR system shall have capability of automatic detection when a camera is plugged into the DVR system and automatic configuration of the camera for plug and play functionality. To the greatest extent possible, the passenger camera system hardware and software shall be non-proprietary in nature, such that Metra will not be hindered from expansion, upgrading, or replacing certain components.

12.6.3 It is required that the DVR recorder be a digital IP (Internet Protocol) based system and support digital IP cameras. The DVR recorder shall, at a minimum, be designed to meet all applicable FRA, AAR and APTA regulations in place at the time of Contract Award. The DVR recorder video channels shall be used to capture and record video from multiple connected cameras simultaneously. The DVR recorder audio channels shall be used to capture audio from multiple connected microphones simultaneously. Microphones internal to the camera are acceptable for passenger compartment video monitoring system, provided that they can be enabled or disabled through the DVR software. It is preferable that the DVR recorder shall feature video motion detection to trigger recording. If proposed, the video motion detection sensitivity shall be adjustable, customizable, and shall be capable of being enabled or disabled by Metra. The DVR shall have the capability of remote live viewing of video and remote downloading. Video data transmission through digital trainlines may be proposed.

12.6.4 The cameras shall be capable of clearly recording in all types of temperature and humidity experienced on the car, day, or nighttime conditions, with normal nighttime illumination from the main LED lights of the rail car. The cameras are required to be a high definition digital IP type camera. The cameras are required to be powered by PoE. The cameras shall be capable of recording in color with a minimum resolution of 1080p and 20 FPS. The DVR shall have user adjustable resolution and FPS settings. The settings shall be made accessible to Metra. The settings shall be adjustable for each individual camera connected to the DVR. Each camera shall have 1 adjustable lens. The camera lens focal length shall be selected during the design. Each camera shall be housed in a compact vandal resistant enclosure. The cameras shall be suitable for interior trainset installations. The camera shall be adjustable to allow for camera positioning.

12.6.5 At least one camera shall capture clear, unobstructed, and consistent views of passenger's faces to enable Metra police forces to utilize facial recognition software using a still image from the camera feed.

12.6.6 All cameras and camera system components shall be electrically isolated to not cause a ground fault on the carbody.

12.6.7 The DVR shall have a visual indicator system that indicates the system is properly functioning and recording. The visual indicator system shall alert personnel upon failure of any camera, hard drive, or other type of fault.

12.6.8 The Passenger camera system components shall be moisture, dirt, and vandal resistant. The components shall comply with all applicable environmental standards for onboard electronic equipment mentioned elsewhere in this specification.

12.6.9 The lifecycle of the DVR system shall be a minimum of 8 years. Any components with an estimated lifespan of less than 8 years shall be field-replaceable. The contractor shall provide a parts list for the field-replaceable components in the maintenance manual and/or illustrated parts catalog.

12.6.10 The DVR shall feature an interface to enable for a direct computer connection. An Ethernet interface is preferred.

12.6.11 The DVR shall contain built-in Wi-Fi hardware (if possible, the contractor shall utilize Metra's ACORN Mesh Networks) to enable access and perform downloads from the system via ad hoc or peer-to-peer Wi-Fi such that will facilitate Metra in performing DVR data dumps via Wi-Fi/Mesh at maintenance facilities and outlying points. Metra shall retain the ability to enable or disable the Wi-Fi capability features on the DVR system.

12.6.12 The video archive is required to be a minimum 10 calendar days.

12.6.13 Passenger Camera DVR Software

12.6.13.1 The contractor shall enable security measures to prohibit unauthorized DVR downloads, including, at a minimum, password protection configurable by Metra.

12.6.13.2 The DVR system shall include computer software that allows for downloading and onboard viewing of video directly from the DVR recorder without removing the hard drive.

12.6.13.3 The software shall allow the user to specify specific dates and times in order to control the length of the video clips downloaded.

12.6.13.4 When downloading a video/audio clip, the user shall have the ability to select or deselect which video and audio channels are to be downloaded.

12.6.13.5 The software shall have the capability to export all video and audio channels on the trainset into 1 file with all video and audio channels synchronized.

12.6.13.6 Each audio/video clip shall contain at minimum a time stamp with date, time, name of DVR system (car number), and associated video channel names that are overlaid onto the image and synchronized with video and audio.

12.6.13.7 The computer software used to view the CCTV images, both live and downloaded, will be user friendly and self-intuitive, requiring a minimum amount of selections by the end user. Camera selection can be made for single cameras, cars or whole units when viewing live, if there are more images than can fit on the screen, the images shall scroll in an systematic fashion. When viewing downloaded images, a selection of at least 4 separate camera images will be able to be displayed simultaneously. The software interface design shall be subject to Metra approval.

12.6.13.8 The DVR system shall include computer software allowing for video downloads for a hard drive removed from the DVR recorder that is connected to a laptop or desktop computer, by means of a docking station or special adaptor cables. The software interface design shall be subject to Metra approval.

12.6.13.9 The ability for Metra personnel to install and configure all supplied software without contractor assistance or interaction shall be required.

12.6.13.10 Future DVR software and DVR firmware updates to any computer software shall be provided free of charge to Metra for the duration of the contract.

12.6.13.11 The Contractor shall supply Metra with all computer software archived on electronic media. The software shall be archived along with the DVR documentation.

12.6.13.12 The operating system requirements for all computer software supplied to Metra by the Contractor shall be compatible with currently supported Windows 10 Operating Systems.

12.6.13.13 Any software supplied shall have the ability to be configurable to meet the requirements outlined in this section. Metra shall have the ability to reconfigure the software as needs change and shall not be locked into the requirements as defined in this section.

12.6.13.14 If 360° or fisheye cameras are included, the software shall have a pre-configured set of four views automatically de-warped (or four raw feed views) when downloading footage. The software shall feature automatic (when configured) de-warping of the video footage. These views shall each appear as normal single camera footage and shall not exhibit any distortion or cropping. The capability, ease, and desirability of the aforementioned will be evaluated during the technical evaluation. The de-warping and/or view customization of any 360° camera and camera software shall be subject to Metra review and approval as part of **[CDRL C-12-08]**.

12.6.13.15 Video footage shall be able to be exported with the contractor's software into commonly used or non-proprietary video formals, such as .avi.

12.7 PASSENGER WI-FI PROVISIONS

12.7.1 The proposer may proposer passenger Wi-Fi as an option. **[COPL CO-12-04]** If the proposal does not include passenger Wi-Fi, provisions for passenger Wi-Fi shall be built into the car.

12.7.2 Provisions for a future Wi-Fi installation shall be made to include: spare power wires to where the future router may be provisioned, create a designated area where a hole can be drilled/used for the Wi-Fi exterior antenna. This area would ease the installation process when/if Metra decides to install the Wi-Fi system and in some way have existing safeguards to prevent water intrusion if a hole in the roof is utilized. The design and arrangement of this provision shall be subject to design review and approved by Metra. **[CDRL C-12-09]**

12.8 AUTOMATED PASSENGER COUNTING

12.8.1 The Contractor shall provide an Automated Passenger Counting (APC) system. The design, placement, and functionality shall be submitted to Metra for approval during the design review process. **[CDRL C-12-10]**

12.8.2 The APC shall have the ability to integrate with Metra's Computer Aided Dispatch and Automatic Vehicle Location (CAD/AVL) system.

12.8.3 The APC system shall have the ability to count every passenger of size and shape, boarding and alighting a train at each station.

12.8.4 The APC system shall have the ability to record passenger count data in a manner that allows for reporting as required by the National Transit Database (NTD) Certification Checklist.

12.8.5 The APC system shall accurately count passenger loads during high volume peak times for boarding and alighting.

12.8.6 The APC system shall be able to count passenger loads across the entrances and exits in each car, including end-doors.

12.8.7 The APC system shall have the ability to accurately count regardless of the size of the passenger from small child to large adult without requiring a passenger to carry an identifying ticket or other object to board or alight the train.

12.8.8 The APC system shall be able to reasonably distinguish an individual human passenger from non-human objects such as luggage, briefcases, service animals, strollers, walkers and bicycles.

12.8.9 The APC system shall have the ability to account for passengers boarding and alighting only, and not count after the doors have closed.

12.8.10 The APC system shall have the ability to associate APC datum with its date and time, accurate to at least the minute.

12.8.11 The APC system shall have the ability to associate APC datum with its geolocation.

12.8.12 The APC system shall have the ability to associate APC datum with entities such as train, station, and route.

12.8.13 The APC system shall have the ability to report total ridership count for entities such as train, station, and route.

12.8.14 The APC system shall provide APC data in a non-proprietary (open data) format. This data shall automatically be offloaded to the trainset's data storage unit or be automatically offloaded to Metra's database when in Wi-Fi range at Metra's facilities/yards.

12.8.15 The APC system shall have the ability to identify when an APC system aboard a train is not functioning normally.

12.8.16 The APC system accuracy shall be greater than 95%, based on a minimum of 1000 boarding and 1000 alighting events, accounting for different ridership and lighting conditions, and to be representative of Metra's operating conditions. The 95% accuracy level shall be reached on raw data without any post processing of the data and without use of any adjustments factor.

12.8.17 The APC system shall retain its normal accuracy in all lighting conditions and regardless of the speed of passengers.

12.8.18 The APC shall require no manual correction after installation and initial activation, regardless of its application and the season it is operating in.

12.8.19 The APC units shall have certification of counting accuracy.

12.8.20 The APC system shall require little to no calibration after it is installed. If calibration is required after a certain amount of years, this calibration procedure shall be as effortless as possible.

12.8.21 The APC system shall be modular with simple architecture and minimal wiring required.

12.8.22 The APC system shall feature clear and easy diagnostic indicators, such as LEDs or via quick and simple PTE or diagnostic interfaces.

12.8.23 The APC system shall integrate seamlessly into Metra's existing ACORN reporting tool and user interface. The software shall require no additional license fee and shall be used by an unlimited number of Metra users.

12.8.24 The APC shall be protected against and function in conditions seen in its operating environment, including: rain, snow, humidity, high and low temperature, condensation, dust, and vibration.

12.9 PROPOSAL DELIVERABLES REQUIREMENT LIST

PDRL	Title
P-12-01	Functionality and the Onboard Equipment of Complete Communication System
P-12-02	Infotainment Proposal

12.10 CONTRACT DELIVERABLES REQUIREMENT LIST

CDRL	Title
C-12-01	Design, Arrangement, Installation of Communication Package
C-12-02	Compatibility with Metra's existing ACORN communication system
C-12-03	Audio Sampling and Study of all Passenger Areas
C-12-04	Emergency Passenger Intercom Unit
C-12-05	Cab Radio
C-12-06	Train Information Management System
C-12-07	Passenger Information Signs
C-12-08	Passenger Compartment DVR System
C-12-09	Passenger Wi-Fi Provisions
C-12-10	Automated Passenger Counting

12.11 CONTRACT OPTIONAL PROPOSAL LIST

COPL	Title
CO-12-01	(deleted)
CO-12-02	(deleted)
CO-12-03	(deleted)
CO-12-04	(deleted)

13 BRAKE SYSTEM

13.1 GENERAL REQUIREMENTS

13.1.1 The blended brake system shall be capable of providing the total service braking effort and maintaining normal revenue operation without degradation of service. The brake system shall integrate and blend the braking efforts of the dynamic brake and the friction brake system to produce the required or demanded braking effort. The emergency brake shall be of fail-safe design and allow direct venting of the brake pipe. Brake pipe pressure is to be 90 psi. The brake equipment shall be provided on a per truck basis. The brake system shall include interface capability for Electronically Controlled Pneumatic (ECP) brake system with appropriate functionality with cab signals, overspeed protection, vigilance/alerter control and the event recorder. The ECP system and its interface with these ancillary devices shall have no single point failures. The ECP control logic and hardware platform shall be compatible with AAR standards. Trainsets shall be equipped with hard conduit ready to accept ECP wire trainline as defined by AAR Standards. Conduit shall be terminated with protective caps adjacent to the brake pipe train line hose connection. The brake system shall follow common AAR standards, EN standards (EN 16185 and EN 15595) are also applicable. The blended brake system is subject to Metra design review and approval. [CDRL C-13-01]

13.1.2 (deleted)

13.1.3 The Contractor shall submit to the Customer a detailed brake system, brake distribution, control, and blending description, including all interfaces, for review and approval.
The air brake equipment shall be arranged in the car so that there is sufficient clearance to remove the valve portions of the equipment. It shall be rack mounted. Details on the reliability and maintenance of the system shall be included. [CDRL C-13-01].

13.1.4 A Failure Mode Effects and Criticality Analysis (FMECA) shall be conducted by the Contractor. The specific systems, including software and interfaces for the FMECA shall be approved by the Metra during design review.

13.1.5 The contractor shall submit as part of the proposal, a general description of the air system, including specifics of the air brake system and air supply unit. **[PDRL P-13-01]**

13.1.6 Service brake applications shall be initiated from the master controller and shall be regulated by the control handle position. An Alerter system shall be provided. The Alerter system shall monitor the Operator's action. The Alerter shall comply with CFR 49 part 229.140 Alerters. If the Alerter is not reset as required, a penalty brake application shall be triggered. The Contractor shall submit, for the Authority's approval, complete data on the Alerter design, operation, and functionality. **[CDRL C-13-02]**

13.1.7 Service brake applications shall be initiated from the master controller and shall be regulated by the control handle position. An Alerter system shall be provided. The Alerter system shall monitor the Operator's action. The Alerter shall require periodic reset by the Operator as defined below. If the Alerter is not reset, flashing lights and increasing levels of audible alarm on the system alarm panel shall be initiated. The Alerter shall comply with CFR 49 part 229.140 Alerters. If the Alerter is not reset as required, a penalty brake application shall be triggered. The Contractor shall submit, for the Authority's approval, complete data on the Alerter design, operation, and functionality [CDRL C-13-02].

13.1.8 An Emergency Mushroom Push Button is to be provided per Cab. This Push Button shall vent the Brake Pipe and apply an Emergency Brake. The Push Button should be colored red.

13.1.9 (deleted)

13.2 AIR END CONNECTIONS

13.2.1 On trainset lead ends, brake pipe hose shall be of sufficient length to be compatible with all Metra equipment, AAR approved and dated. These hoses when coupled to a Metra coach or locomotive must negotiate the applicable curves described in Section 3 without hoses parting or distorting.

13.2.2 MU hoses shall be provided at both ends on both sides of the coupler and marked accordingly. The MU lines shall consist of:

13.2.2.1 Independent brake application and release line.
13.2.2.2 Main reservoir equalizing line
13.2.2.3 Actuating line.

13.2.3 Brake pipe angle cocks shall be ball-type.

13.2.4 The builder's standard dummy couplings shall be provided for the front and rear brake pipe hoses. All dummy couplings shall be vented.

13.3 AIR COMPRESSOR

13.3.1 A minimum of two (2) air compressor shall be provided. The air compressor system shall have enough reserves so that one air compressor can supply the required air delivery rate for the whole pneumatic system. The air consumption estimation and the duty cycle of the compressor shall be subject to Metra for review and approval. **[CDRL C-13-03]**

13.3.2 Air quality must comply with APTA standard PR-M-S-011-99, latest revision.

13.3.3 Main reservoir pressure shall be maintained at 125-150 psi operating range.

13.3.4 Alarm for air compressor low oil shall be provided (unless an oil-less compressor is provided).

13.3.5 The after cooler shall be equipped with a separate automatic drain dump valve and shall be designed to avoid condensate traps and dump valve shall be heated as required to avoid freezing.

13.3.6 If electric motor-driven, the compressor shall be able to operate when the locomotive is on wayside power.

13.4 GAUGES AND FITTINGS

13.4.1 At a minimum the following gauges should be available:
- Brake cylinder and park brake cylinder pressure (white hand), black dial
- Brake pipe (red hand) and main reservoir pressure (white hand), black dial

13.4.1.1 (deleted)
13.4.1.2 (deleted)
13.4.1.3 (deleted)