Mechanical Department

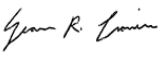
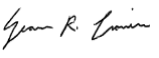
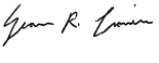
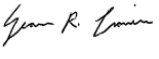
Technical Specification for New Push-Pull Commuter Car BAFO Edition - Alstom

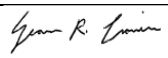
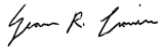
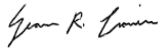
SPECIFICATION No. M-18-011

REVISION: E

DATE: 00/00/2023

RECORD OF REVISIONS

REVISION	PREPARED BY	DATE	DESCRIPTION	APPROVED BY	DATE
Draft	F. Mascarenhas	11/1/2018	Draft Spec for New Push-Pull Commuter Car		
First Issue	F. Mascarenhas	12/18/2018	New Push-Pull Commuter Car Specification		12/18/2018
A	S. Cronin	03/19/2019	Revised Sections 1.1.10.3.1; 3.1.6; 8.3.2; 8.3.3; 11.6.4		03/19/2019
B	S. Cronin	05/21/2019	Revised Sections 1.1.2; 2; Added Sections 1.1.3.2; 1.1.3.3; 1.1.5 Revised Sections 1.1.10.3.2; 3.1.2; 3.1.3; 3.1.9; 3.2.2; Added Sections 3.2.2.7; 3.2.2.8 Revised Sections 4.1.10; 7.2.1; 8.1.1.1; 8.3.1.5; 8.3.5.5; 8.5.1; 8.5.5; 8.6.2.2; 8.6.2.4; 8.6.2.6; Added Section 8.6.2.13 Revised Sections 8.6.3.1; 8.7.4; 8.7.6; 8.7.7; 8.7.8; 8.7.10; 8.8.8.9; 9.2.4; 9.3.2; 10.4.7; 11.5; 11.6.4 Added/Edited Section 11.9.1 and 11.9.2; Added CO-11-03 Revised Sections 12.5; 12.6.11; 12.6.13.5; 12.6.13.6 Added Section 12.6.13.15 Revised Sections 12.8.23; 13.1.1; 13.3.1; 14.12.3; 15.5.2; 15.7; 15.8; 16.1.2; 16.1.4; 16.1.14; 16.2.9; 17.2; 18.1.9.3; 18.1.9.4; 21 Add Section 23		05/21/2019
C	S. Cronin	09/10/2019	Revised Sections 1.1.1; 1.1.6; 1.1.7; 1.1.7.1-4; 1.1.8; 1.1.10.6; 1.1.11; 1.1.11.1-3; 1.1.12; 1.1.13; 1.2; 1.2.1-4; 1.2.6; 1.2.7; 1.2.8; 1.2.9; 1.3.1-1.3.10; 2; 3.2.2; 8.2.4 Revised Section 11.1.1; 11,1,2; 11.1.3; 11.2.1; 11.2.2; 11.2.3; 11.3.1.1; 11.3.1.3; 11.3.1.5; 11.3.2; 11.3.1.4; 11.3.3; 11.5.1.1 Added Section 11.5.4.2 Revised Sections 11.5.7.4; 11.5.7.5; 11.6.1; 11.7.2; 11.8; 12.1.6 Added Sections 12.1.6.1-12.1.6.4 Revised Sections 12.2.3.3; 12.2.6 Added Section 12.3.2.4		09/10/2019

			Revised Sections 12.3.6; 12.3.7 Added Section 12.3.9 Revised Sections 12.5.1; 12.5.12 Added Section 12.5.14 Revised Sections 12.5.15.10; 13.2.2; 14.1; 14.3.4; 14.4.3; 14.14; 15.8.1-15.8.4; 15.8.6; 15.8.7 Added Sections 15.8.8-15.8.12 Revised Section 15.9.3.10 Added Section 15.18 Revised Section 20.9		
C.1	S. Cronin	06/03/2020	BAFO Edition - Alstom Revised Sections 1.1.2; 1.1.3.1; 1.1.8; Added Section 1.4 Revised Sections 3.1.6; 3.1.7; 3.1.9 Added Sections 3.6; 3.7; 3.8 Revised Sections 4.4.2;8.6.2.4; 7.2.1; 7.3.1; 7.7; 8.6.2.6; 8.6.2.12; 8.6.2.13; Added Section 8.7.11 Revised Sections 9.3.1; 10.5.1; 11.1.1; 14.1 Added Section 14.17 Revised Section 15.1 Added Section 15.19 Revised Sections 16.1; 16.1.11; 16.2; 16.2.9 Added Section 16.2.14.5 Revised Sections 18.24.8; 18.25.4 Added Section 18.27 Revised Sections 19.2.2.12; 20.1.1; 20.6; 20.10.9 Add Section 20.11		06/03/2020
C.2	S. Cronin	06/24/2020	BAFO Edition – Alstom Revised Sections 1.4.1.3; 1.4.2.4; 15.6.1 Deleted Section 15.1.6.4 Revised Sections 15.7; 15.8.2; 15.9.3.10; 15.18		06/24/2020
C.3	S. Cronin	07/24/2020	BAFO Edition – Alstom Revised Sections 3.1.9.2; 6.1.2; 6.1.5; 6.1.6; 7.4; 8.6.2.12; 8.6.3.1; 9.3.1; 11.1.1; 11.2.2; 11.5.7.2; 12.6.1; 12.6.13.10; 12.6.13.12; 13.2.3; 13.2.3.3; 13.2.3.4; 13.7.1; 13.11; 14.1; 14.2.2; 14.2.3; 14.2.4; 14.2.5; 14.3.1; 14.3.2; 14.3.3; 14.3.4; 14.4.1; 14.4.2; 14.4.3; 14.5.1; 14.5.2; 14.5.3; 14.5.4;		07/24/2020

			14.6; 14.7.1; 14.8.1; 14.12.3; 15.3.2.1; 15.9.2.3; 15.10.1; 17.2.4; 18.21.7; 18.24.1; 18.25.4.5		
C.4	S. Cronin	12/16/2020	Revised Section 1.4.1.8		12/16/2020
D	A. Longshore (STV)	05/31/2022	Included Specification Requests approved through 05/09/2022 – See Index table on following page		

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Metra/VRE Conformed Specification Modification Legend & Specification Request Index

A. Current Specification Changes as of Version C.4:

1) BAFO/Negotiation
2) Red Text – Modification/Additions made by Metra
3) ~~Red Text~~ or Highlighted Red or Black Text – Modifications/Additions made by Alstom

B. Specification Changes after Version C.4:

1) Specification Approval Requests (SAR) – ~~Removed language~~ / Added Language **(SAR-XXX)**
2) Specification Change Requests (SCR) – ~~Removed language~~ / Added Language **(SAR-XXX)**
3) Specification Waiver Requests (SWR) – ~~Removed language~~ / Added Language **(SAR-XXX)**

Index of Included Specification Requests			
No.	**Request**	**Title**	**Spec Rev Added**
SARs			
1	SAR-012	Wheel Diameter	D
2	SAR-016	AAR No. 6 Coupler Operating Mechanism	D
3	SAR-019	AAR S-4020	D
4	SAR-062	Terminals	D
5	SAR-076	Air Conditioning - Refrigerant HVAC	E
6	SAR-092	AAR Journal Bearing	D
7	SAR-093	Air Conditioning	D
8	SAR-100	Wire and Cable Installation	D
9	SAR-134	Software Requirements	D
10	SAR-145	Grounding	D
11	SAR-147	Interior	D
12	SAR-148	Fire Safety - Toxicity	D
13	SAR-151	Windows	D
14	SAR-159	Inward Facing Camera	D
15	SAR-160	Third Microphone	E
16	SAR-167	Fire Safety	D
17	SAR-183	Interior Finish	E
18	SAR-191	Semiconductor Devices - TCMS	E
19	SAR-211	Electronic Components	E
20	SAR-215	Wiring Standards	E
21	SAR-220	Fire Safety - Transformer Wire	E
22	SAR-221	Terminals (Electro-box)	E
23	SAR-235	Piping & Tubing - Fastening	E
SCRs			
1	SCR-001	Stainless Steel Piping	E
2	SCR-002	Pneumatic Piping	E
3	SCR-007	AAR Signal Manual, Volume 2, Section 6	D
4	SCR-008	AAR S-669	D
5	SCR-009	Yoke	D
6	SCR-010	AAR RP-589	D
7	SCR-011	Journal Bearings	E
8	SCR-013	SAE-AMS-6858	D
9	SCR-014	APTA SS-E-005-98	D
10	SCR-015	NEMA AB1	D
11	SCR-020	General Requirements-Design Speed	D
12	SCR-021	General Requirements (Mock-Up)	D
13	SCR-022	Draft Arrangement, General Requirements	D
14	SCR-023	Coupler Carrier	D
15	SCR-024	Exterior Passenger Entrance Doors	D
16	SCR-026	Exterior Passenger Entrance Doors (Crew Switch)	D
17	SCR-027	ASTM E-119	D
18	SCR-028	ASTM G26/SAE J1885	D

19	SCR-030	Temperature Control	D
20	SCR-031	Temperature Control	E
21	SCR-032	Voltages	D
22	SCR-033	120 VAC Power Supply	D
23	SCR-034	APTA SS-E-013-99	D
24	SCR-035	Braking Power and Pressure	D
25	SCR-036	Truck General Requirements	D
26	SCR-037	Speed Indicator/Alerter/Event Recorder	D
27	SCR-038	Emergency Brake Valve	D
28	SCR-039	Cab Signal System	D
29	SCR-040	Cab Signal System (Speed Sensor)	D
30	SCR-042	SAE J1200	D
31	SCR-043	Underfloor and Roof Wiring Installation	D
32	SCR-044	Equipment Enclosures & Junction Boxes	E
33	SCR-045	Wire Identification & Terminal Markings	D
34	SCR-046	Printed Circuit Boards	D
35	SCR-047	Single Point Failures	D
36	SCR-048	Hazard Evaluation	D
37	SCR-050	Structural Framing	D
38	SCR-051	Terminals	D
39	SCR-052	Grounding	D
40	SCR-053	Heating	E
41	SCR-054	Motion of the Exterior Passenger Entrance	D
42	SCR-055	Flooring	D
43	SCR-056	Wire Locomotive Control Trainline	E
44	SCR-057	480 Volt and Control Trainlines	D
45	SCR-058	Materials and Workmanship – General	D
46	SCR-060	In Process Tests	D
47	SCR-061	Journal Bearings	D
48	SCR-062	Terminals	E
49	SCR-063	Reliability (New Components)	E
50	SCR-064	Reliability (Reliability Program)	D
51	SCR-065	Reliability (Reliability Program)	D
52	SCR-066	Reliability (Reliability Program - FMECA)	D
	~~SCR-067~~	~~Reliability (Reliability Program - Duration)~~	~~D~~
53	SCR-069	Battery Requirements	D
54	SCR-070	Handbrake or Parking Brake	D
55	SCR-071	Air Brake Equipment	D
56	SCR-073	Structural Framing	D
57	SCR-074	480 Volt Trainlines	D
58	SCR-075	Ventilation	E
59	SCR-077	Air Conditioning	D
60	SCR-078	Air Conditioning - Mounting	D
61	SCR-080	Temperature Control	D
62	SCR-081	Temperature Control	D
63	SCR-082	Disc Brake Actuator	D
64	SCR-084	Cab Digital Video Recording System	D
65	SCR-085	Exterior Passenger Entrance Doors	D
66	SCR-086	Exterior Passenger Entrance Doors – Doors	D
67	SCR-088	Relays and Contactors	D
68	SCR-089	IEC 249	D

69	SCR-090	ASTM E71	D
70	SCR-091	EN 50207	D
71	SCR-094	Battery Charger	D
72	SCR-095	Wire and Cable Insulation	D
73	SCR-098	120 VAC Power Supply	D
74	SCR-099	120 VAC Power Supply – GFCI Outlet	D
75	SCR-102	ANSI 117.7	D
76	SCR-103	Car Level Monitoring System	D
77	SCR-104	Passenger Compartment Digital Video	D
78	SCR-105	Air Brake Equipment	D
79	SCR-106	Fiber Cable (Digital Trainline) Backbone	D
80	SCR-107	Train Information Management System/ACORN	D
81	SCR-108	Air Brake Equipment	D
82	SCR-113	Insulation	D
83	SCR-114	Circuit Protection	D
84	SCR-115	EN Compact Fans Instead of NEMA Motors	D
85	SCR-119	Accessibility Provisions	D
86	SCR-120	Accessibility Provisions	D
87	SCR-125	Conductors	D
88	SCR-126	Horn	D
89	SCR-127	Controls	D
90	SCR-128	Brake System - General Requirements	D
91	SCR-130	Water Supply	D
92	SCR-132	Train Information Management System/ACORN	D
93	SCR-133	Public Address/Intercommunication System	D
94	SCR-135	Electrical – General Requirements	D
95	SCR-136	Cab Digital Video Recording System	D
96	SCR-137	Video Motion Detection	E
97	SCR-139	Cab DVRS	E
98	SCR-140	Exterior Lighting	D
99	SCR-141	PA & Intercommunication System/Audio Equipment	D
100	SCR-142	Lighting General Requirements - Exterior Lighting	E
101	SCR-143	In Process Test (All Cars) - Water Test	E
102	SCR-144	APTA Standard PR-C S-S-016-99	D
	~~SCR-145~~	~~Grounding~~	~~D~~
103	SCR-146	Training	D
104	SCR-149	Exterior Lighting	D
105	SCR-150	Toilet Room	D
106	SCR-152	Underfloor and Roof Wiring Installation	D
107	SCR-153	Windows	D
108	SCR-155	Train Radio	D
109	SCR-161	Materials Workmanship - General Requirements	D
110	SCR-162	Event Recorder	D
111	SCR-163	Tread Brake Units	E
112	SCR-169	Safety Appliances and Interior Handholds	D
113	SCR-170	Application & Installation	D
114	SCR-171	Conduit and Raceway Requirements	D
115	SCR-172	Wire Harnesses	D
116	SCR-180	Cab Digital Video System - EVR	E
117	SCR-182	Disk Brake Actuator	D
118	SCR-184	Journal Number Plates	D

119	SCR-186	Passenger Camera DVR Software	E
120	SCR-187	Train Information Management System	E
121	SCR-188	Casting Inspection	E
122	SCR-192	Camera Direction	D
	~~SCR-193~~	~~Semi-conductor/Integrated Circuit Requirements~~	~~D~~
123	SCR-202	Plating and Treatment of Fasteners	E
124	SCR-203	Parcel Racks	E
125	SCR-206	Cybersecurity Risk Assessment	E
126	SCR-207	Training Phases and Scheduling	E
127	SCR-208	Dimming Lights	E
128	SCR-222	NFPA 70, AAR S-538	E
129	SCR-226	Cab Signal Power Supply - UP Line	E
130	SCR-227	Cab Signal Power Supply	E
140	SCR-229	Fastener Specification	E
150	SCR-230	Air Brake Equipment	E
151	SCR-233	Number of Signals	E
152	SCR-238	HVAC General Conditions – Operating	E
153	SCR-239	Radio Use to Re-set the Alerter	E
SWRs			
1	SWR-101	Materials & Workmanship – Application	D
2	SWR-112	Seats	D
3	SWR-117	Welding, Brazing and Soldering	D
4	SWR-123	Welding Inspection and Examination - Inspection	D
5	SWR-124	Welding Inspection and Examination - Certification	E
6	SWR-131	Conductors	D
7	SWR-154	Communications Systems - Train Radio	D
8	SWR-157	DVR Audio Channel Inputs	D
9	SWR-164	Lighting System	E
10	SWR-165	Battery Cable Insulation and Terminal	E
11	SWR-176	Adhesives	D
12	SWR-178	Threaded Fasteners	D
13	SWR-204	Welding, Brazing, Soldering, Toilet	E
14	SWR-205	Water Supply	E
15	SWR-209	Welding Standards	E
16	SWR-216	Electrical Grounds	E
17	SWR-217	Circuit Protection	E
18	SWR-236	Cable Connectors	E

Table of Contents

1 GENERAL REQUIREMENTS

1.1 GENERAL REQUIREMENTS

1.1.1 This specification covers commuter passenger cars to be used in push-pull type passenger service transporting passengers in the greater Chicago Metropolitan Area and its environs. The cars are to be operated in trains that can range in size from two cars minimum to twelve cars maximum. The design of the cars shall provide a safe, comfortable ride at all speeds up to Metra's maximum authorized operating speed (79 mph). The car shell and trucks (excluding brakes) shall be designed for ~~natural frequency compatibility at~~ speeds up to 100 miles per hour. **(SCR-020)**

1.1.2 The cars shall be constructed so that they may be coupled to other conventional passenger cars, to include hotel power and locomotive control train line, and car control train line features. ~~The cars shall be constructed so that they may be, in emergency situations, coupled to other conventional passenger cars, except that provision of hotel power and locomotive control train line, and car control train line features shall not be required.~~ ***[VRESD V-1-01]*** *The cars shall be constructed so that they may be coupled to other conventional passenger cars, to include hotel power and locomotive control train line, and car control train line features.* ***[VRESD V-1-01]***

1.1.3 The cars shall be provided in two configurations: Cab Control Cars and Trailer Cars and shall be compatible in every respect with:

1.1.3.1 Metra's existing Cab Control/Trailer Cars

1.1.3.2 Metra's existing locomotives

1.1.3.3 ***[VRESD V-1-02]*** *VRE's existing locomotives* ***[VRESD V-1-02]***

1.1.3.4 ***[VRESD V-1-03]*** *VRE's existing Cab Control/Trailer Cars* ***[VRESD V-1-03]***

1.1.4 The cars are to be built in accordance with the requirements described in these specifications, and shall comply with all Federal Railroad Administration (FRA) regulations in effect at the time the Notice to Proceed is issued as well as the applicable standards of the Association of American Railroads (AAR) and/or American Public Transportation Association (APTA) in effect at the time the Notice to Proceed is issued.

1.1.5 All documents, correspondence, meetings, and technical information shall be offered and conducted in the English Language and using US customary system of weights and measures.

1.1.6 Drawings and other data contained herein are considered part of these specifications. In case of conflict, these specifications shall govern. Where these specifications conflict with FRA regulations and/or AAR & APTA standards (or conflict between regulations and standards) the following hierarchy shall apply: 1) FRA Regulations, 2) these Specifications, 3) APTA Standards, and 4) AAR Standards. The Contractor and the Contracting Authority will jointly resolve any conflicts that exist.

1.1.7 As part of the design review the Contractor shall submit the drawings and documentation as required in sections 1.6, 1.7 and elsewhere in this specification where terms "approved", "approved manner", "approved by the Contracting Authority", "subject to approval" and "The Contracting Authority approval" appear. Without limitation, the Contractor shall also provide additional information or documentation related to the design and production of the vehicles if requested to do so by the Contracting Authority.

Metra shall review all documents submitted. All submittals will be documented as:

1.1.7.1 Approved: defined as the Contracting Authority concurs with the information in its submitted form. The material may be incorporated into the program.

1.1.7.2 Approved/Conditionally: defined as the Contracting Authority agrees in principle with the submitted information. However some details must be revised to make the information fully approved. The material must be resubmitted in revised form for approval.

1.1.7.3 Disapproved: defined as the Contracting Authority does not concur with the submitted details. The Contractor shall not incorporate the material into the program. The Contracting Authority's objections must be reconciled and the material must be resubmitted in revised form for approval.

1.1.7.4 Insufficient Information: defined as the information provided was illegible or insufficient to enable a complete review.

The Contracting Authority will respond within 20 working days to any review submittal, calculated from the date of receipt of documents by Metra to the date a response is sent to the Contractor, provided the Contractor submits such review material in a reasonable time sequence and manageable volume.

Revisions to the Contracting Authority approved documents and the Contractor's internal change requests affecting the Contracting Authority approved documents, shall be submitted to the Contracting Authority for approval as they are issued. No more than three approved drawing alterations (change requests) shall remain unincorporated on any drawing at any time, and no approved change request shall remain unincorporated into a drawing for a period greater than two months from the date of approval.

The Contracting Authority's approval of a drawing or document is for a limited purpose and it is not an approval for a deviation. Approval does not relieve the Contractor of the obligation of meeting all the requirements of this Contract. Approval of a drawing which contains a deviation from, or violation of these Specifications does not constitute authority for that deviation or violation unless such deviations have been specifically requested in writing and specifically granted by the Contracting Authority in writing according to all contract requirements.

1.1.8 The Contractor shall prepare and submit to each Contracting Authority for approval, prior to construction of the cars, copies (electronically in searchable original PDF format and two (2) hard copies) of each drawing required by these specifications and all drawings necessary to demonstrate compliance with these specifications. This shall include, but not be limited to: clearance drawing, arrangement drawings, structural drawings, assembly drawings, sub-assembly drawings, integrated wiring schematics, and drawings of major equipment and apparatus. **[CDRL C-1-01]**

Drawings submitted by Subcontractors and Suppliers shall be thoroughly checked by the Contractor to ensure that they conform with the requirements of these specifications prior to submittal to the Contracting Authority.

Drawings shall be comprised of not more than four (4) sizes with "D" size (22" X 34") being the largest drawing size permissible.

1.1.9 The Contractor shall submit, prior to the car body testing, a stress analysis of the complete car body structure and supports for equipment weighing over two hundred (200) pounds. This analysis shall show the calculated stresses, allowable stresses and the margin of safety for all elements for the specified load conditions. All critical joints shall be included in this analysis (manual calculations if necessary). In addition conformance to all referenced standards shall be demonstrated. The analysis shall, as a minimum, consist of a finite element analysis using recognized computer programs (Nastran, Ansys, etc.). **[CDRL C-1-02]**

1.1.10 A post-award conference shall take place no later than 20 working days after Notice To Proceed, at Metra's or the Contractor's facilities, as directed by METRA, to accomplish the following:

1.1.10.1 Introduce Metra's key personnel to the Contractor

1.1.10.2 Confirm the Contractor's management team and key staff and the scope of supply of subcontractors

1.1.10.3 Establish formal channels of, and procedures for, communication (e.g. letter and meeting numbering)

1.1.10.4 Establish an understanding of the Contractor's project control methodology and plans for initial activities before the start of formal progress reporting

1.1.10.5 Discussion to familiarize the Contractor with Metra's intended operations and maintenance environment

1.1.10.6 Identify the early information needs and decisions required by the Contractor from the Contracting Authority

1.1.11 The Contractor shall hold formal design review meetings with the Contracting Authority. The purpose of these meetings is to insure that the requirements of these specifications are being met by the design. The schedule and location for these meetings shall be by mutual agreement. Design review material shall be submitted no later than 15 working days prior to each review meeting, and shall include the drawings, technical data, analyses, calculations and other items required for the review. Four types of design reviews shall be held:

1.1.11.1 Preliminary design review(PDR): Preliminary design review of system components shall be made at the 30% level of designs. The PDR shall include a review of the design concept, written descriptions of the functionality, schematics of the system wiring and drawings of each component showing dimensions and structural elements. The Contracting Authority retains the right to redline, comment, and request changes to improve design and/or functionality.

1.1.11.2 Intermediate design review (IDR): An intermediate design review (IDR) shall be held when the design of the car is approximately 60% complete. This shall represent an advancement of design of the car from the preliminary design stage to development of draft production drawings, arrangements, component and material specifications and schematics for all systems, subsystems and components, which will be used by the Contracting Authority to evaluate the proposed design of the car to a level of detail sufficient that the Contractor shall be able to proceed with the development of the car design to the 95% draft final stage.

1.1.11.3 Mockup development and review: Upon completion of the ~~IDR~~ PDR stage of the design review process, the Contractor shall complete the assembly of full size mockups hard mockups of the following areas and systems of the cars; according the drawings as reviewed and approved at the ~~IDR~~ PDR, for the Contracting Authority review and comment **(SCR-021)**:

1.1.11.3.1 Passenger seats

1.1.11.3.2 Workstation table between facing seats (if proposed) ***[VRESD V-1-04]*** *No work table or facing seats* ***[VRESD V-1-04]***

1.1.11.3.3 Overhead baggage rack

1.1.11.3.4 Wall panels, window and window mask

1.1.11.3.5 ADA lift unit

1.1.11.3.6 Lavatory

1.1.11.3.7 Electrical locker

1.1.11.3.8 Door operator systems

1.1.11.3.9 Cab compartment

1.1.11.4 Final design review (FDR): Final design review (FDR) of system components shall be held at 95% or greater level of design. The FDR shall include a review of all documents and plans for the design as revised, including the written descriptions of the functionality, schematics of the system wiring, drawings of each component showing dimensions and structural elements. Redlines and comments from the IDR and mockup review shall be reviewed. Metra retains the right to provide additional comments during this process as production progresses and concerns are brought to the Customer's attention.

1.1.12 Progress review meetings shall be held at mutually agreed to time periods either at the Contracting Authorities' headquarters or at the Contractor's (or its subcontractors') facilities as deemed necessary.

1.1.13 Whenever in this specification one or more brands, trade names, or catalog numbers of specific manufacturers are mentioned, it is in the intent of establishing identification, a basis of quality and durability and though the term "or approved equal" may not be inserted, it may be implied. Only substitutions equal to the specified items will be allowed and only when such substitution is necessary. Before furnishing and/or installing any product that is a substitution for the specified item, proof of equality shall be furnished by the Contractor, and the approval of the Contracting Authority's designated Mechanical officer must be obtained in writing before any such substitution is made.

1.2 PROJECT DRAWING DELIVERABLES

Project drawing deliverables shall comply with project specific specifications, the applicable Contracting Authority quality management plans, contractually required procurement documents, and this document. All contract drawing submittals to the Contracting Authority shall consist of both hardcopy and electronic formats, which shall conform to the requirements of this section.

1.2.1 Disposition for Problems, Questions, and Discrepancy

When problems, questions, and/or discrepancies are identified between this document, contractual documents, etc., the Contractor must inform the Contracting Authority and the work must be performed in accordance with the instruction for disposition from the Contracting Authority's Project Manager.

1.2.2 Submittal Intervals

As drawings for a project are developed, the Contractor shall periodically submit drawing set(s) to the Contracting Authority for review and comment. The submittal intervals shall be defined by the contract documents and/or agreement by the Contracting Authority with the Contractor.

1.2.3 Reviews and Approvals

Drawings will only be approved or accepted by the Contracting Authority as to arrangement and conformance to the specifications and related drawings. Approval or acceptance shall not be construed as relieving or mitigating the Contractor of their responsibility for design verification, dimensional accuracy, adequacy and suitability of materials and / or the equipment represented thereon, or for compliance with contract requirements.

1.2.4 Electronic Delivery Media.

Electronic delivery media shall be coordinated with the Contracting Authority's Project Manager to ensure compatibility with the the Contracting Authority's hardware and software. Accepted media or file transfer methods:

- USB 2.0 Drive or better
- Establishment of a secure FTP site

1.2.5 Media Labeling.

All media shall have a label containing, but not limited to:

1.2.5.1 Preparation date of the media.
1.2.5.2 The project description.
1.2.5.3 Contractor name and contract reference.
1.2.5.4 Contract transmittal number.
1.2.5.5 Quantity of files.

1.2.5.6 Operating System and version, and application software used to create the files.
1.2.5.7 The utility or command used to write the files to the media.

1.2.6 Electronic File Preparation.

All electronic files shall be delivered in the Contracting Authority approved formats. Deliverable file format shall be coordinated with the Contracting Authority's Project Manager to ensure the Contracting Authority's ability to use the delivered files. Before a file is placed on the electronic delivery media, the following procedures shall be performed:

1.2.6.1 Drawing files shall be in their native format, not DXF, or other neutral format. File format must be approved by the Contracting Authority.
1.2.6.2 Only one drawing or one model shall be included in each CADD file.
1.2.6.3 Remove all unnecessary graphics outside the drawing border area and set the active parameters to a standard setting of those in the seed or prototype file.
1.2.6.4 Ensure all external reference files are attached without device or directory specifications. Include a list of files included in the deliverable in a text document on the media.
1.2.6.5 All deliverables shall be certified virus-free.

1.2.7 Documentation.

All drawing packages submitted to the Contracting Authority shall include, but not be limited to, a transmittal containing the same information as on the external media label, and:

1.2.7.1 A hardcopy list of files included in the deliverable.
1.2.7.2 A full size hard copy plot of each drawing file submitted on the media.
1.2.7.3 Person designated as point of contact.
1.2.7.4 Certification in the form of a signed statement, that the delivery data is free of known computer viruses, including the name(s) and release date(s) of the virus scanning software used to check the media.

1.2.8 Quality

As part of their contractual requirements to the Contracting Authority, the Contractor will be responsible for the quality assurance and quality control of the drawings, CADD files and other documents submitted to the Contracting Authority as part of the contract. The Contractor shall ensure compliance to this document, the Contracting Authority project specifications, applicable Contracting Authority quality management plans, and other contractually required documents. The Contracting Authority's review of the submittals shall not be construed as relieving or mitigating the Contractor of this responsibility.

1.2.9 Ownership.

The following shall apply to the Contracting Authority contracts with electronic drawing deliverables:

The Contracting Authority shall have UNLIMITED RIGHTS to all information and materials developed for the Contracting Authority contracts and furnished to the Contracting Authority and documentation thereof, reports and listings, and all other items pertaining to the work and services pursuant to this agreement including any copyright. Unlimited rights are rights to use, to use, duplicate, or disclose text, data, drawings, and information, in whole or in part in any manner and for any purpose whatsoever without compensation to or approval from the Contractor. The Contracting Authority will at all reasonable times have the right to inspect the work and will have access to and the rights to make copies of the above-mentioned items. All digital files and data, and other products generated under the Contracting Authority contract shall become the property of the Contracting Authority. In no event shall the Contractor, Consultant or Vendor use its obligation to recognize and protect subcontractor or supplier as an excuse for failing to satisfy its contractual obligations to the Contracting Authority.

1.3 QUALITY ASSURANCE

1.3.1 The Contractor shall have a quality assurance program conforming to the Mechanical Department Quality Plan (MQP), the FTA Quality Management System Guidelines, FTA-PA-27-5194-12.1 issued December 2012 and the attached Quality Assurance Requirements. On a case by case basis, the Contracting Authority may approve the use of other quality guidelines recognized in the United States such as the quality assurance guidelines published by the Association of American Railroads. In addition, the Contractor's management's shall submit a declaration of their commitment to quality and the implementation of the contractually required MQP and FTA QMS guidelines.

1.3.2 The contractor shall submit a copy of their quality assurance plan to the Contracting Authority for review. Metra shall be the sole judge of compliance of the Contractor's quality assurance plan and program to the Contracting Authority's requirements and the appropriate quality assurance standards.

1.3.3 The Contractor shall provide an organizational chart to the Contracting Authority. The organizational chart shall depict the Contractor's overall management structure, reporting lines, authority and accountability among the Contractor's staff, subcontractors and the interfacing relationships between the Contracting Authority and the Contractor. A list of personnel assigned to the Contracting Authority's contract, their education, experience, accountability, and authority level shall also be provided.

1.3.4 Upon review by the Contracting Authority, any deviation or deficiencies in the quality assurance plan may render the bid non-responsive.

1.3.5 Submission of a bid gives the Contracting Authority the authority to perform assessments and inspections of the Contractor's and their subcontractor's facilities in order to perform a quality audit (s). Audit (s) shall be scheduled no later than 14 days from the Contracting Authority's notice to perform the audit.

1.3.5.1 The Contracting Authority may inspect tooling, procedure manuals, training programs, worker certification records, test gauges, inspection procedures, and subcontractor qualifications.

1.3.5.2 The audit will be styled after and include the items described in AAR Specification M-1003.

1.3.6 The Contracting Authority's authorized representative(s) shall have, at all reasonable times, access to the Contractor's and their subcontractor's facilities for the purpose of inspecting materials, workmanship, quality, and compliance to this specification. Refusal to permit such inspection may be construed as non-compliance with the Contracting Authority's specification and risks in cancellation of the bid.

1.3.7 The presence of the Contracting Authority's representative(s) at the contractor's facility shall not in any manner supplant the contractor's own inspection, nor lessen the responsibility to meet all requirements of this specification. The Contracting Authority shall have the right to reject all products, material and/or workmanship that does not conform to this specification or accepted practices.

1.3.8 The Contractor shall submit the following with their Bids for review, the Contracting Authority shall be the sole judge of compliance of the Contractor's submittals to the Contracting Authority's requirements and the appropriate quality assurance standards:

1.3.8.1 Contractor's Quality Assurance Manual and Procedures **[CDRL C-1-03]**
1.3.8.2 Contractor's organizational chart with personnel assigned to Metra's contract **[CDRL C-1-04]**
1.3.8.3 Contractor's management's declaration of their commitment to quality and the implementation of the contractually required MQP and FTA QMS guidelines **[CDRL C-1-05]**
1.3.8.4 Contractor's Project Quality Plan and Procedures **[CDRL C-1-06]**
1.3.8.5 Contractor's ratio of Inspection to Production Personnel **[CDRL C-1-07]**
1.3.8.6 Contractor's Software Quality Assurance Plan **[CDRL C-1-08]**
1.3.8.7 Contractor's Supplier and Subcontractor Qualification, Quality Compliance, and Management Plan and Procedures **[CDRL C-1-09]**
1.3.8.8 Contractor's List of all supplier and subcontractors, their qualifications, and quality certifications (ANSI-ASQ ISO) **[CDRL C-1-10]**
1.3.8.9 Contractor's First Article Inspection (FAI) Plan and Procedures **[CDRL C-1-11]**
1.3.8.10 Contractor's MRB Plan and Procedures **[CDRL C-1-12]**
1.3.8.11 Corrective and Preventative Plan and Procedures **[CDRL C-1-13]**

1.3.9 The bidder shall correct all deviations or deficiencies determined by the Contracting Authority. Failure to correct such deficiencies or repetitive notation of deficiencies shall be cause for cancellation of the contract.

1.3.10 Only substitutions equal (or better in comparison) to the specified items will be subject for approval by the Contracting Authority's designated Mechanical officer and only when such substitution is necessary. Before furnishing and/or installing any product that is a substitute for the specified item, proof of equality and quality shall be furnished by the Contractor. Then the written approval of the Contracting Authority's designated Mechanical officer must be obtained before any such decision is made. The Contacting Authority shall have the right to reject or accept the proposed substitution.

1.4 SYSTEM ASSURANCE

1.4.1 RELIABILITY PROGRAM

1.4.1.1 The Contractor shall incorporate reliability features into the car designs that minimize the type and impact of component failures, ~~eliminate~~ minimize **(SCR-064)** single point failures and identify critical components that affect system operation during the car useful life. These reliability features include:
1.4.1.1.1 Utilize mature designs for systems and components;
1.4.1.1.2 Select suppliers with effective parts control programs;
1.4.1.1.3 Minimize design complexity and dormant failure possibilities;
1.4.1.1.4 Consider parts obsolescence in design process;
1.4.1.1.5 Ensure component duty cycles do not exceed limits;
1.4.1.1.6 Ensure heat sources are properly insulated from critical components;
1.4.1.1.7 Ensure components are isolated to minimize shock and vibration:
1.4.1.1.8 Use EMI protection on all electronic equipment;
1.4.1.1.9 Use best reliability design practices.
1.4.1.2 The required reliability shall be achieved by utilizing components and subsystems of established and known reliability which have been demonstrated in revenue operation or by recognized standards for new components prior to Contract award. Per the reliability targets identified below, the Contractor shall use components and subsystems at less than their normal rating, in the environment in which the vehicles will be operated. **(SCR-063)**
1.4.1.3 The overall Mean Distance Between Component Failures (MDBCF) targets for the cars are as follows:

Cab Car 21,000 miles

Trailer Car 24,000 miles

The reliability (MDBCF) targets for the car subsystems during operation by Metra are shown in the following tables:

CAB CAR SYSTEM	MDBCF	
Coupler & Draft Gear	3,500,000	miles
Data Trainline Network	250,000	miles
Passenger Door System	150,000	miles
Communication System	220,000	miles
Lighting System	1,000,000	miles
HVAC System	250,000	miles
Auxiliary Power Supply System	200,000	miles
Carbody & Appointments	225,000	miles
Toilet System	500,000	miles
Trucks & Suspension	750,000	miles
Monitoring and Diagnostic Equipment	600,000	miles
Friction Brake System	200,000	miles
Cab Signal, ATC, Event Recorder	210,000	miles
Miscellaneous	350,000	miles

TRAILER CAR SYSTEM	MDBCF	
Couple & Draft Gear	3,500,000	miles
Data Trainline Network	250,000	miles
Passenger Door System	150,000	miles
Communication System	300,000	miles
Lighting System	1,000,000	miles
HVAC System	250,000	miles
Auxiliary Power Supply System	200,000	miles
Carbody & Appointments	225,000	miles
Toilet System (Toilet Car)	500,000	miles
Trucks & Suspension	750,000	miles
Monitoring and Diagnostic Equipment	650,000	miles
Friction Brake System	200,000	miles
Miscellaneous	350,000	miles

The average train speed is determined to be thirty (30) miles per hour. The value will be used to convert to and from Mean Distance Between Component Failures (MDBCF) and Mean Time Between Component Failures (MTBCF).

1.4.1.4 The overall Mean Distance Between Service Failures (MDBSF) targets for the cars are as follows:

Cab Car 200,000 miles
Trailer Car 225,000 miles

Service Delay failures are component failures that result in a six minute or greater service delay, including the following interruptions:

- initial train departure from maintenance yard
- in-route delay of train arrival at next station
- termination of train operations

Any component failure that does not affect revenue service or may be cut-out to enable the train to remain in service within the six-minute period will not be counted as a Service Failure.

1.4.1.5 The Contractor shall submit to the Program Manager for review and approval a Reliability Program Plan covering the design, manufacture, test and warranty phases of the project. **[CDRL C-1-14]**

The Plan shall include the following information as a minimum:

1.4.1.5.1 The identity of the Contractor's reliability engineer, the individual's qualifications, functions, responsibilities, and authority.

1.4.1.5.2 A description of the means by which the Contractor will control the design, manufacture, and testing of the vehicles to assure that they meet the reliability requirements of these Specifications.

1.4.1.5.3 The means by which this control will be exercised over subcontractors, suppliers, and vendors.

1.4.1.5.4 A description of the interfaces with other engineering activities and how they shall maximize the benefit of efficiency of all assigned engineering resources.

1.4.1.5.5 A description of the techniques to be used in the reliability analyses including reliability block diagrams that show equipment elements and interrelationships essential to the successful performance of the system and a reliability models and equations showing the relationships required for system success. Both the block diagrams and model shall be kept current with design iterations.

1.4.1.5.6 A Failure Reporting and Corrective Action System (FRACAS) with detailed plans for the reliability demonstration required by this section, including all procedures required to track defective parts, the equipment and facilities required for failure analyses, the procedures for developing corrective actions, and a discussion of the circumstances under which the Contractor will require and implement the corrective action.

1.4.1.5.7 A description of the interfaces with other engineering activities and how they shall maximize the benefit of efficiency of all assigned engineering resources. Other concurrent engineering activities addressed shall include maintainability, system safety and quality assurance.

1.4.1.6 The Contractor shall submit to the Program Manager for review and approval a Reliability Prediction Analysis report **[CDRL C-1-15]** for all car systems listed in section 1.1.3 and for the cars as a whole, demonstrating that the specified MDBSF and MDBCF requirements shall be achievable.

The analysis shall be performed to the Line Replaceable Unit (LRU) level. The reliability prediction for electronic systems shall use either MIL HDBK 217F parts count method and part stress method for the ground mobile environment, or IEC failure rate data or supplier data (field data). For piece parts not contained in MIL-HDBK 217, certified field failure data covering a period or distance ten times the claimed MTBCF or MDBCF shall be used. IITRI/RAC Document NPRD-2016 shall be used for non-electronic parts when field data is not available. Use of other prediction standards may be proposed for Program Manager review and approval, provided that the standards account for the environmental stress experienced in the Authority's application. Wherever possible, the reliability prediction shall be supplemented by actual field data for the system or subsystem. **(SCR-065)**

The Reliability Prediction Analysis shall be maintained and updated through the entire design phase. Updates shall report on design change, or problems that may affect car reliability.

1.4.1.7 The Contractor shall submit to the Program Manager for review and approval a Failure Mode Effects and Criticality Analysis (FMECA) **[CDRL C-1-16]** ~~at car level and~~ for the main subsystems of both trailer and cab cars. The FMECA will ~~be detailed to the LRU level~~ consider all component failures that impact service operation for each subsystem and identify the failure effects at the ~~LRU level, subsystem level and the~~ car level. The FMECA will be required to justify the Service Failure assumptions in the Reliability Prediction Analysis **(SCR-066)**.

1.4.1.8 The reliability of the cars, their components, and subsystems shall be demonstrated during revenue operation. The reliability demonstration shall commence with the Approval for Revenue Service of the first car and continue until two (2) years after the Final Acceptance of the last vehicle with a six (6) month grace period at the start of the reliability demonstration to

allow for any system interface issues, workmanship issues and infant mortality failures to be resolved before the failure data is chargeable. The FRB shall be active during this grace period. The system MDBCF and MBDSF values shall be calculated as a cumulative value over the time of the reliability demonstration. The demonstration results shall be documented in a Reliability Demonstration Report. **[CDRL C-1-17]** **(SCR-067)**

A Failure Review Board (FRB) shall be established. The FRB shall consist of representatives from Metra, from VRE and from the Contractor, and they shall review the failure report forms and logs to verify failure classifications and assign responsibility of failures. The FRB shall also continue to meet upon a mutually agreed upon interval after the conclusion of the reliability demonstration, specifically related to the failure of any items covered in the Warranty Period for Certain Components Section 2.7.3(1) of the Contract Terms and Conditions (i.e. carbody, door panels, floor materials, trucks).

1.4.2 MAINTAINABILITY PROGRAM

1.4.2.1 The Contractor shall incorporate maintainability features into the car designs that maximize the testability, reparability and ease of maintenance of equipment and components that affect system operation during the car useful life. These maintainability features include:

- 1.4.2.1.1 The use of modular design
- 1.4.2.1.2 Inter-changeability of components performing similar functions
- 1.4.2.1.3 Accessibility of components and fasteners
- 1.4.2.1.4 Movability of replaceable components
- 1.4.2.1.5 Reparability including appropriate Maintenance Manual data
- 1.4.2.1.6 Appropriate self-test features
- 1.4.2.1.7 Built-in quick disconnect test points for air and electrical systems
- 1.4.2.1.8 Design of simplified test equipment for use as trouble finding aids
- 1.4.2.1.9 Minimize the use of specialized tools in order to replace components
- 1.4.2.1.10 Equipment covers and access panels incorporate rugged, quick-removal fasteners

1.4.2.2 The Contractor may combine the details of the maintainability program into the Reliability Program Plan submittal.

1.4.2.3 The overall Mean Time to Repair (MTTR) targets for both the cab and trailer cars are 1.5 hours. The requirement for special tools and fixtures for maintenance shall be subject to the Project Manager approval.

1.4.2.4 Except for daily inspections or air filter replacement, the minimum preventive maintenance interval shall not be less than 90 days for cab cars and 180 days for trailer cars. ~~It should not be required to place the cars over a pit for safety inspections.~~

1.4.2.5 The Contractor shall submit to the Program Manager for review and approval a Maintainability Analysis report **[CDRL C-1-18]** for all car systems listed in section 1.1.3 and for the cars as a whole, demonstrating that the specified MTTR requirements shall be achievable based on all LRU failure rate as well as their repair times.

The report shall also include a scheduled maintenance analysis that identifies all required preventive maintenance activities, including inspections, tests, service tasks and equipment overhauls. This data shall be provided for all LRU's in each system where scheduled maintenance is required. The analysis must identify the maintenance tasks, task frequency, task times and support equipment required to perform the task. The data shall be summarized once by system and once by task frequency to identify all of the scheduled maintenance requirements. The Maintainability Analysis shall be maintained and updated through the entire design phase. Updates shall report on design change, or problems that may affect car maintainability.

1.4.2.6 A Maintainability Demonstration shall be performed on each vehicle type to verify that the scheduled and preventive task durations fall within the times established by the Maintainability

Analysis. A sample pool of demonstration tasks shall be provided to the Program Manager for selection and verification. The demonstration results shall be documented in a Maintainability Demonstration Report. **[CDRL C-1-19]**

1.4.3 SYSTEM SAFETY

1.4.3.1 The Contractor shall incorporate safety features into the car designs that minimize the type and impact of safety hazards, identify critical hazards and ~~eliminate~~ minimize single point failures that affect system safety during the car useful life. **(SCR-047)**

1.4.3.2 The Contractor shall submit to the Program Manager for review and approval a System Safety Program Plan covering the design, manufacture, test and warranty phases of the project. **[CDRL C-1-20]** The Plan shall include the following information as a minimum:

1.4.3.2.1 The identity of the Contractor's safety engineer, the individual's qualifications, functions, responsibilities, and authority

1.4.3.2.2 Details of the safety approach established by the Contractor in order to control the functional hazards of the new cars during their lifecycle

1.4.3.2.3 Detail procedures and resources established by the contractor in order to identify, document all hazards attributed to the new cars

1.4.3.2.4 Safety standards used by the Contractor in order to incorporate Safety during the design of the new cars

1.4.3.2.5 A specialized approach in order to evaluate all software hazards.

1.4.3.3 The Contractor shall submit to the Program Manager for review and approval a Preliminary Hazard Analysis **[CDRL C-1-21]** which will evaluate the control over the hazards identified during the design of the new cars. All hazards must be evaluated ~~both~~ at the ~~system level as well as the~~ car level per the requirements of MIL-STD-882. The analysis will be provided 30 days prior to PDR. **(SCR-048)**

1.4.3.4 The contractor must tabulate all known hazards from the Preliminary Hazard Analysis for all subsystems into a Hazard Tracking Log **[CDRL C-1-22**], which shall be submitted to the Program Manager for review and approval. All new hazards identified during the design process will be added to the Hazard Log to maintain master list of all hazards. All hazards will remain open until the contractor demonstrates that the hazards have been eliminated or mitigated to an acceptable level for Metra approval. The contractor will provide a status of the Hazard Log progress in the monthly management report.

1.4.3.5 The Contractor shall submit to the Program Manager for review and approval a Fault Tree Analysis **[CDRL C-1-23]** for all applicable Category I and II hazards identified in the Preliminary Hazard Analysis. The Fault Tree Analysis shall use the component failure rate data identified in the reliability analyses to develop the probability for these hazards.

1.5 CONTRACT DELIVERABLES REQUIREMENTS LIST

CDRL	Title
C-1-01	Drawing Submittals
C-1-02	Car-Body Stress Analysis
C-1-03	Contractor's Quality Assurance Manual and Procedures
C-1-04	Contractor's Organizational Chart with Personnel Assigned to Metra's Contract
C-1-05	Contractor's Management's Declaration of their Commitment to Quality and the Implementation of the Contractually Required MQP and FTA QMS Guidelines
C-1-06	Contractor's Project Quality Plan and Procedures
C-1-07	Contractor's Ratio of Inspection to Production Personnel
C-1-08	Contractor's Software Quality Assurance Plan
C-1-09	Contractor's Supplier and Subcontractor Qualification, Quality Compliance, and Management Plan and Procedures
C-1-10	Contractor's List of all supplier and subcontractors, their qualifications, and

	quality certifications (ANSI-ASQ ISO)
C-1-11	Contractor's First Article Inspection (FAI) Plan and Procedures
C-1-12	Contractor's MRB Plan and Procedures
C-1-13	Corrective and Preventative Plan and Procedures
C-1-14	Reliability Program Plan
C-1-15	Reliability Prediction Analysis
C-1-16	Failure Modes, Effects and Criticality Analysis
C-1-17	Reliability Demonstration Report
C-1-18	Maintainability Analysis
C-1-19	Maintainability Demonstration
C-1-20	System Safety Program Plan
C-1-21	Preliminary Hazard Analysis
C-1-22	Hazard Tracking Log
C-1-23	Fault Tree Analysis

2 ABBREVIATIONS AND DEFINITIONS

AAR	Refers to the Association of American Railroads
ADA	Americans with Disabilities Act of 1990 as amended
ACORN	Automated Communications and On-Board Reporting Network
AISI	Refers to the American Iron and Steel Institute
AMOLED	Active-Matrix Organic Light-Emitting Diode
Amtrak	Refers to the National Railroad Passenger Corporation
ANSI	Refers to the American National Standards Institute
APTA	Refers to the American Public Transportation Association (formally known as the American Public Transit Association)
ASME	Refers to American Society of Mechanical Engineers
ASTM	Refers to American Society for Testing Materials
AWS	Refers to American Welding Society
AW0	Actual weight of empty car, ready for revenue service, but with neither crew nor passengers aboard. Includes full fresh water supply and empty waste system.
AW1	Car at seated load and no standees. Seated load is defined as all the passenger seats occupied plus one crew member per car.
AW2	Car at normal full load. Normal full load is defined as seated load plus one standee per 3 ft^2 of clear floor space.
AW3	Car at crush load. Crush load is defined as seated load plus one standee per 1.5 ft^2 of clear floor space.
BNSF RR	Refers to the Burlington Northern Santa Fe Railroad
Contracting Authority	Refers to the agency with whom the carbuilder signs a contract with
FDR	Final Design Review
FRA	Refers to the Federal Railroad Administration of the United States Department of Transportation
ICDB	Refers to the Illinois Capital Development Board
IDR	Intermediate Design Review
IDOT	Refers to the Illinois Department of Transportation

IEEE	Refers to the Institute of Electrical and Electronic Engineers
LCD	Liquid Crystal Display
LED	Light-Emitting Diode
Low Voltage DC	Low voltage DC refers to nominal DC voltages of less than or equal to 80 VDC
Metra	Refers to the Commuter Rail Division of the Regional Transportation Authority
NEMA	Refers to the National Electrical Manufacturers Association
NS	Norfolk Southern Railroad
OLED	Organic Light-Emitting Diode
PDR	Preliminary Design Review
RTA	Refers to the Regional Transportation Authority
TFT	Thin-Film-Transistor
UP RR	Refers to the Union Pacific Railroad
US	United States of America
VRE	Refers to Virginia Railway Express, jointly owned and operated by the Northern Virginia Transportation Commission (NVTC)and the Potomac and Rappahannock Transportation Commission (PRTC)
Contractor	Refers to the firm with whom a contract is made by Metra for the construction of the cars described in this specification
OEM	Refers to the manufacturer of one or more components to be applied to the subject cars during the work performed under this specification
Sub-Contractor	Refers to any shop, manufacturer, or other company or agency performing work on the subject cars under this specification, under contract to, or for, the Contractor.

3 DIMENSIONS AND CLEARANCES

3.1 PRINCIPAL DIMENSIONS

The principal dimensions and dimensional requirements shall be as follows:

3.1.1 Coupled length: Not to exceed 85' on single unit

3.1.2 Width of Car: Not to exceed Metra Clearance Diagram M-544. Car width shall be submitted as required. **[PDRL P-3-01]** ***[VRESD V-3-01]*** *Width of Car: Not to exceed Amtrak Clearance Diagram B-066-0050 Rev. C. Car width shall be submitted as required.* ***[PDRL P-3-01] [VRESD V-3-01]***

3.1.3 Height of Car: Not to exceed Metra Clearance Diagram M-544. Car height hall be submitted as required. **[PDRL P-3-02]** ***[VRESD V-3-02]*** *Height of Car: Not to exceed Amtrak Clearance Diagram B-066-0050 Rev. C. Car height shall be submitted as required.* ***[PDRL P-3-02] [VRESD V-3-02]***

3.1.4 Centerline of Coupler above top of rail: 2' – 10 ½''

3.1.5 Track Gauge: 4' – 8 ½''

3.1.6 Seating Capacity: Seated capacity to be maximized **[PDRL P-3-03]** Seating capacity shall be designed to Appendix 3A (Alternative Proposal).

3.1.6.1 Cab Cars with Toilets: Seating diagram shall be submitted counting total seats and total seats + 2 ADA positions occupied.

3.1.6.2 Trailer Cars with Toilets: Seating diagram shall be submitted counting total seats and total seats + 2 ADA positions occupied.

3.1.6.3 Trailer Cars without Toilets: Seating diagram shall be submitted counting total seats and total seats + 2 ADA positions occupied.

3.1.7 General Arrangement: Interior layout design of seating, stairway(s), aisle(s), and door(s) shall be designed to allow the most efficient passenger flow possible. Along with providing general arrangement drawing, the proposer shall provide a passenger flow analysis for five different scenarios estimating the station stop time from the time doors open and passengers begin detraining/entraining until last person entrains/detrains and door closes. The five scenarios are below:**[PDRL P-3-04]** General arrangement shall be designed to Appendix 3B .

3.1.7.1 80 passengers entraining/ 0 detraining

3.1.7.2 80 passengers detraining/ 0 entraining

3.1.7.3 80 passengers entraining/ 1 ADA passenger entraining

3.1.7.4 60 passengers entraining/ 20 passengers detraining

3.1.7.5 60 passengers entraining/ 1 ADA passenger entraining/ 20 detraining

3.1.8 Crush Passenger Load: AW3.

3.1.9 Weight: Car total weight shall be minimized. Car weights shall be submitted at AW0, AW1, AW2 and AW3. All cars shall be weighed at Contractor's facility. Car estimated weight shall be submitted in proposal at AW0, AW1, AW2, and AW3. **[PDRL P-3-05]** Weight shall be designed to Appendix 3C.

3.1.9.1 Car weight end-to-end balance shall be within 5%

3.1.9.2 All cars shall be within ~~300 lbs~~. a specified weight range, to be mutually agreed upon between Metra and carbuilder during the design phase, of the first production car of each type of car.

3.1.10 Passenger Weight: 180 lbs. per passenger, includes seated or standees.

3.2 CLEARANCES

3.2.1 The cars, when coupled to each other shall be able to negotiate the following:

3.2.1.1 A 250’ radius curve

3.2.1.2 A No. 8 crossover, having 12' - 2" track centers when coupled to each other, or to Metra locomotive equipped with alignment control couplers

3.2.1.3 All yard or station tracks negotiated by existing equipment when coupled to each other, or to Metra locomotive equipped with alignment control couplers

3.2.2 The cars, and all appliances, shall conform to the clearance outlined in Metra drawing M-544 as well as the clearance outlines for the following carriers within Metra's jurisdiction: ***[VRESD V-3-03]*** *The cars, and all appliances, shall conform to the clearance outlined in Amtrak B-066-0050 Rev. C as well as clearance outlines for the for the following carriers within VRE’s jurisdiction:* ***[VRESD V-3-03]***

3.2.2.1 Amtrak (Chicago Union Station)

3.2.2.2 Burlington Northern Santa Fe

3.2.2.3 Canadian National (Illinois Div.)

3.2.2.4 Norfolk Southern (including Conrail)

3.2.2.5 Union Pacific

3.2.2.6 Canadian Pacific

3.2.2.7 ***[VRESD V-3-04]*** *Amtrak (Washington DC) Union Station* ***[VRESD V-3-04]***

3.2.2.8 ***[VRESD V-3-05]*** *CSX* ***[VRESD V-3-05]***

It is the responsibility of the Contractor to obtain current copies of the clearance outlines from these railroads. The clearance diagram for the car shall be submitted to the Contracting Authority for review and approval. **[CDRL C-3-01]**

3.2.3 Under worst condition of fully worn wheels, defective springs, crush passenger load, and maximum wear of parts, minimum allowable clearance above rail for car body and truck parts is as follows:

Truck parts 0' – 2 ½“

3.3 CAMBER

The cars shall be constructed so that when fully loaded (AW1), the center of the car shall not deflect below zero camber for the life of the car. Nor shall the camber have more than 3/4" symmetrical camber between bolsters when it is light (AW0).

3.4 PROPOSAL DELIVERABLES REQUIREMENT LIST

PDRL	**Title**
P-3-01	Car Height
P-3-02	Car Width
P-3-03	Seating Capacity
P-3-04	Passenger Flow
P-3-05	Car Weight

3.5 CONTRACT DELIVERABLES REQUIREMENT LIST

CDRL	**Title**

C-3-01	Clearance Diagram

3.6 APPENDIX 3A

Type of car	Layout Presented in November	Layout presented in February	Alternative proposal	
Trailer car with toilet	Number of seats : 134 Number of ADA : 2 Number of folded : 4	Number of seats: 134 + 8 Number of ADA : 2 Number of folded : 4 + 6	Number of seats:134 + 4 Number of ADA : 2 Number of folded : 4 + 6	Total Seats per car: 148 Seats
Trailler car without toilet	Number of seats : 139 Number of ADA : 2 Number of folded : 5	Number of seats : 139 + 8 Number of ADA : 2 Number of folded : 5 + 5	Number of seats:139 + 3 Number of ADA : 2 Number of folded : 5 + 5	Total Seats per car: 152 Seats
Cab Car	Number of seats : 122 Number of ADA : 2 Number of folded : 5	Number of seats : 122 + 4 Number of ADA : 2 Number of folded : 5 + 7	Number of seats 122 + 2 Number of ADA : 2 Number of folded : 5 + 5	Total Seats per car: 134 Seats

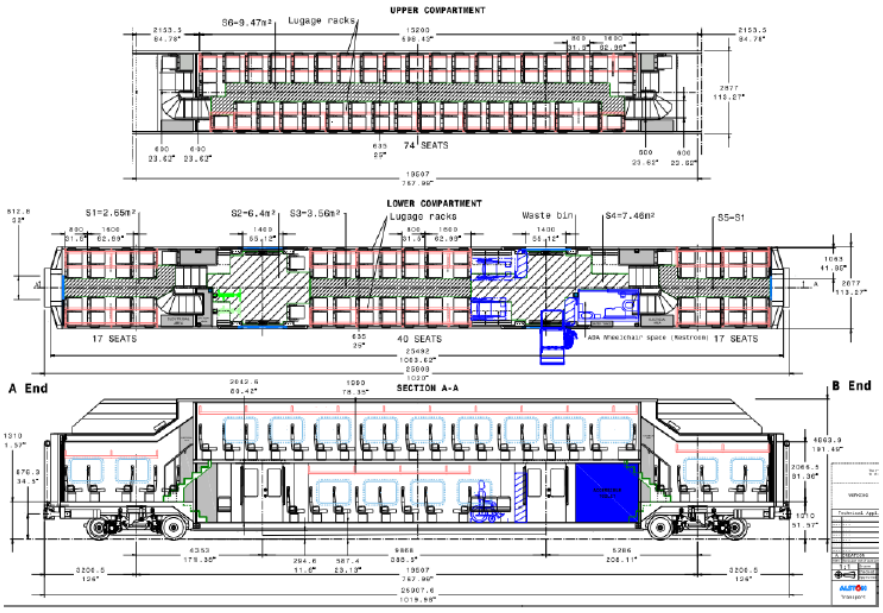
3.7 APPENDIX 3B

Alstom Feedback

In order to propose a clear sight path along the car, we have developed an alternative layout proposal,

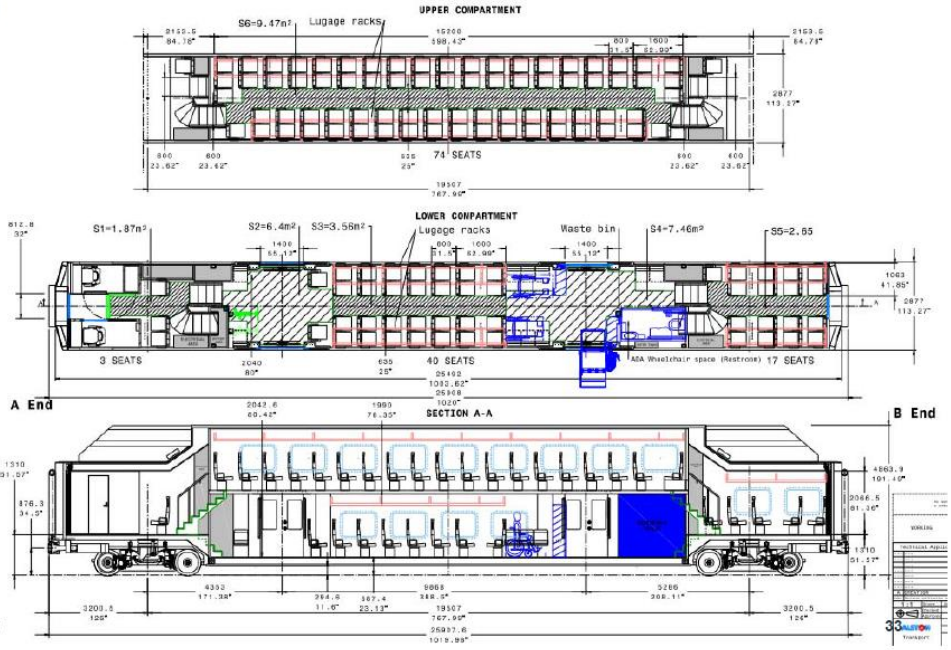
- Centered stairs for connecting the mezzanine to the lower floor
- Removing visual obstacles & avoiding alcoves along the car.

In this new proposal the aisle width between the seats has been increased to 25 inches to improve the flow.



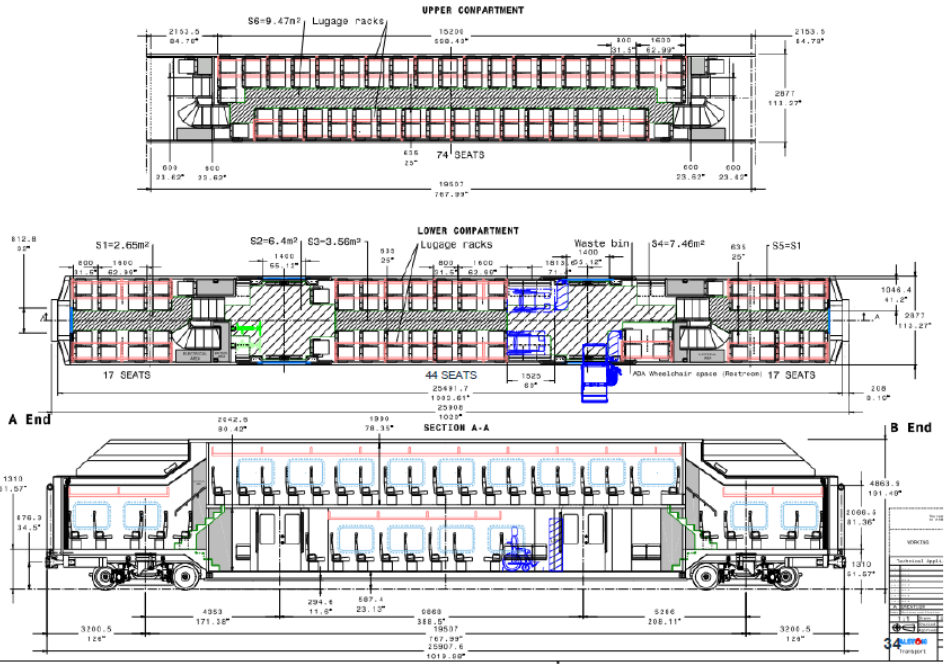
Alstom Response

Alternative proposal for the Cab Car :



Alstom Response

Alternative proposal for the Trailer Car without toilet :



3.8 APPENDIX 3C

Following are updated weight & balance estimates for each car type at each passenger load condition with new outboard disc truck weight and 6% tolerance (see next page) added on every component with the exception of the passenger load:

Weight in Lbs.	Trailer Car W/Toilet	Cab Car	Trailer Car without Toilet
AW0	118 032	122 489	116 263
AW1	147 159	149 316	146 156
AW2	166 873	168 839	165 748
AW3	186 395	188 361	185 339

- AW0 : *Working order – no passengers / car ready to go*
- AW1 : *All seats occupied with passengers*
- AW2 : *AW1 + 1 standee per 3 ft²*
- AW3 : *AW1 + 1 standee per 1,5 ft²*

The AW0 value is in the average range of multilevel cars with similar dimensions manufactured by Alstom in previous years.

4 CAR BODY EXTERIOR

4.1 STRUCTURAL FRAMING

4.1.1 The car exterior shall be constructed of stainless steel or other approved corrosion resistant material. The contractor shall submit as part of the proposal, a general arrangement drawing of proposed design and artist rendering of the exterior of car. The drawing shall include views to show details of end car arrangement and identify location of major components/systems. **[PDRL P-4-01]**

4.1.2 The structural members of the car framing shall be of American Iron and Steel Institute Types 301L stainless steel for concealed components, and 301L or 304L stainless steel for exposed components with carbon content not exceeding 0.03%. Non-structural stainless steel parts, not exposed, shall utilize similar types of stainless steel such as 300 or 400 series. Aluminum alloys may be proposed for the upper floor structure, and shall be type EN AW6005A-T6, and follow the requirements of APTA-PR-CS-S-015-99 "Standard for Aluminum and Aluminum Alloys for Passenger Equipment Car Body Construction". Metra will review alternate stainless steel types for non-welded structural application on a case-by-case basis as part of the design review. The Contractor shall include a structural diagram of the car body showing the locations of the principal framing members, their cross sectional area, and metal thickness. **[CDRL C-4-01] (SCR-073)**

The ultimate tensile strength of the materials shall vary from 80,000 pounds per square inch to 150,000 pounds per square inch, according to the imposed stresses on the individual member and the amount of formation required during manufacture. Critical buckling shall be considered in the design of all structural members.

4.1.3 All parts of the structure of the car shall equal or exceed the requirements of FRA Regulation 49 CFR Part 238 Subpart C and the latest revision of APTA Standard SS-C&S-034-99 ~~Rev 2~~ Rev.3 and any other applicable requirements in the CFR. Buff loading of 800,000 pounds shall be resisted without permanent deformation. Alternative compliance as specified in 49 CFR Part 238.201(b) may be proposed. The Contractor shall submit a test procedure that describes in detail the steps taken to prove the car-body structure is compliant with APTA and FRA regulations. **[CDRL C-4-02] (SCR-050)**

4.1.4 All parts of the roof shall have sufficient strength to support concentrated loads of 250 lbs., applied 30 inches apart in a 12" x 4" area without permanent deformation.

Emergency roof access shall be provided via structural weak points complying with the requirements of FRA Regulation 49 CFR Part 238 section 238.123. Design and layout of the emergency roof access shall be provided to Metra for review and approval. **[CDRL C-4-03]**

4.1.5 Side sheets shall be secured to the side posts and other side structural members by welding or any other approved method. If utilized, any exterior exposed welds made by a spot-welding process shall be arranged in regularly spaced patterns and shall be free of discoloration.

4.1.6 The car end structure shall be provided with two vertical collision posts constructed of high tensile stainless steel, one at either side of the end opening and located outboard of the end sheets. All end collision posts shall be made in accordance with the requirements for the control end of cab cars of APTA standard SS-C&S-034-99 ~~Rev. 2~~ Rev.3 by designing these members for an ultimate horizontal load of 200,000 pounds, which can be applied to each post vertically between the top of buffer sill and a plane 30 inches above the top of buffer sill and a

500,000 pound horizontal load at the top of the buffer sill. The applied loading can be angled, zero to fifteen degrees, with respect to the longitudinal axis through the post. Final design review of the end structure shall be submitted to Metra for review and approval. **[CDRL C-4-04] (SCR-050)**

The welding of collision posts to the buffer sill shall carry the end reaction developed by the collision post under the above loading. The torsional strains developed in the collision post shall be resisted by the buffer sill and a transverse beam constructed into the end frame.

Corner posts shall comply with the APTA Standard SS-C&S-034-99 Rev. 2.

4.1.7 The underframe shall be an integral unit conforming to the latest standards and recommended practices of APTA and the AAR. The draft sill arrangement and coupler shall be such as to meet the clearance requirements of section 3.2.1.

Final design review of the underframe shall be submitted to Metra for review and approval. **[CDRL C-4-05]**

All welds shall be inspected in accordance with the Contractor's quality control plan which shall be approved by Metra.

4.1.8 Both ends of cars shall have anti-climbing mechanism complying with FRA regulation 49 CFR Part 238.205 (a) & (b).

4.1.9 Eight (8) jacking pads shall be provided, one at both ends of each body bolster and one near each corner of the car body. The location of the jacking pads will be submitted to Metra for approval. **[CDRL C-4-06]**

In addition, reinforced lifting lugs will be provided in the upper portion of each collision post in an approved manner, suitable for attaching gear for lifting with a wrecking derrick.

4.1.10 Rain gutters shall be provided over the passenger side entrance doors, any exterior electronic devices, and over each diaphragm. The rain gutter shall be of such design to withstand the action of car washing machines. In addition, suitable baffles shall be placed at the ends of the roof to prevent the flow of water from running off onto the top of the diaphragm.

4.2 INSULATION

4.2.1 Thermal and acoustical insulation shall be provided in order to ensure reasonable operating costs and compliance with Sections 9.0 and 17.0 of these specifications. Samples of insulating materials shall be submitted to Metra for review and approval. **[CDRL C-4-07]**

4.2.2 Insulation must not support combustion, must not absorb moisture beyond its own weight, and when wet, must not cause corrosion. Insulation must not be subject to shaking down in long service and retained by a means adequate to ensure this requirement.

Insulation used must be non-corrosive to aluminum and must not require special surface treatment of aluminum. Insulation shall preferably be light in weight, and type and density shall be approved by Metra.

4.2.3 All cars shall be well insulated against sound transmission inside car to greatest extent practicable. The inside surface of the outer shell of the car, including sides, ends, roof and floor areas and the underside of all metal steps shall be ~~coated~~ insulated in accordance with manufacturers recommendations. **(SCR-113)**

For certain specific discreet areas, other materials approved by Metra may be used.

4.2.4 The floor, roof, sides and ends of the cars shall be insulated. The heat transfer through the car-body shall not exceed 1,200 Btu/hr/°F. The Contractor shall supply a thermal analysis

of a completed stationary car for Metra review and approval based on the environmental conditions that will be mutually agreed upon between the Contractor and Metra. **[CDRL C-4-08]**

4.2.5 Installation of HVAC duct and piping insulation shall be subject to Metra approval. **[CDRL C-4-09]**

4.3 DIAPHRAGM/BUFFER

4.3.1 An inner car diaphragm shall be provided at both ends of the cars. The diaphragm shall be black tubular rubber design or alternative method, which shall be subject to Metra design review and approval. Diaphragm shall be: water and oil resistant; acid and alkali resistant; and shall comply with the fire safety requirement of section 18.16 of these specifications.

4.3.2 A buffing device, meeting all horizontal loading requirements for a buffer beam contained in AAR Specifications for New Passenger Equipment Cars.
In addition, the car structure under the diaphragm shall be designed to resist the vertical coupler loads specified in the same AAR Specifications. Buffer supports shall be designed to prevent binding.

4.3.3 A full height vertical curtain of suitable vinyl plastic coated/impregnated material, equipped with safety release handles shall be provided at each end of car, with hardware for retention of a mating curtain from a coupled car. Engagement of curtains shall be designed for silence during train movement.

4.3.4 Slip resistant walkway plates shall be provided at each end of each car to provide a continuous walkway from car to car when coupled together. Plates shall be arranged to provide minimum overlap of 2 inch when the car is not coupled and buffer is fully extended.

4.3.5 The entire diaphragm/buffer arrangement, including construction details shall be subject to review and approval of Metra. **[CDRL C-4-10]**

4.4 WINDOWS

4.4.1 All windows including emergency sash, cab sliding sash and windshields shall be capable of withstanding external and internal pressure differentials caused by head-on pressures and passing trains, while the cars are at maximum operating speed. All glazing shall meet or exceed the requirements of FRA Regulations 49 CFR Part 223 and Part 238.

4.4.2 Passenger compartment side windows shall be single or double-paned, set in one piece and continuous. ~~If a double-paned window arrangement is proposed, a metal tube style breather shall be provided.~~ The arrangement shall utilize abrasion resistant material, gray tinted, complying with Section 18.8.1 of these specifications. The arrangement shall comply with FRA Type II requirements.

4.4.3 Ingress emergency windows shall be provided per 49 CFR Part 238.114. A decal providing instruction for window removal (ref. section 16.1.11) shall be applied to the exterior of the car, adjacent to each window. Location of these windows is subject to Metra approval. **[CDRL C-4-11]**

4.4.4 Egress emergency windows utilizing a bottom pivot escape sash, meeting the requirements of FRA Regulation 238.113 and 223 (Type II), shall be installed in each car. The egress windows shall be prominently identified to passengers, and in readily accessible

locations. The sash shall be designed to be opened in an emergency with ~~fifteen (15)~~ thirty (30) pounds plus/minus three (3) pounds of force, but shall not be dislodged except through emergency procedure. **(SCR-153)**

Final location and design of the escape sash is subject to approval. **[CDRL C-4-12]**

The glazing material for these sash shall be the same type as used in passenger compartment side windows (Section 4.4.2).

Instruction on the procedures to open the escape sash shall be posted on the operating bar of each escape sash in photo luminescent material along with pictorial instructions adjacent to the sash. The photo luminescent instructions shall comply with APTA Standard PR-PS-S-002-98, Rev. 3, Standard for Emergency Signage for Egress/Access of Passenger Rail Equipment.

4.4.5 The toilet room shall not be provided with a window

4.4.6 On cab control cars, single glazed, electrically heated windshields, complying with Section 18 of these specifications shall be provided in the end-sheet in front of the operator's and observer's positions. The arrangement shall comply with FRA Type I requirements. The windshields should preferably be replaceable from inside the car. **(SAR-151)**

4.4.7 On cab control cars, a horizontal sliding sash assembly shall be provided at the upper level on each side of the control station. The sash assembly shall suit the minimum structural opening. Left and right hand versions shall be provided such that the out board sliding section is forward to prevent air infiltration.

The sash shall meet FRA Type II requirements

4.4.8 All window components shall meet the flammability and smoke emission requirements of FRA Regulation 49 CFR Part 238 as well as Section 18.16 of this specification.

4.5 PROPOSAL DELIVERABLES REQUIREMENT LIST

PDRL	Title
P-4-01	Exterior General Arrangement and Rendering

4.6 CONTRACT DELIVERABLES REQUIREMENT LIST

CDRL	Title
C-4-01	Car-body Structural Diagram
C-4-02	Car-Body Strength Test Document
C-4-03	Emergency Roof Access
C-4-04	End Structure Design
C-4-05	Cross Bearer and Underframe Design
C-4-06	Jacking Pad Location
C-4-07	Insulation Samples.
C-4-08	Thermal Analysis
C-4-09	HVAC Duct and Piping Insulation Installation
C-4-10	Diaphragm Design and Installation
C-4-11	Ingress Emergency Window Layout
C-4-12	Egress Emergency Window Layout and Design

5 SAFETY APPLIANCES AND INTERIOR HANDHOLDS

5.1 GENERAL REQUIREMENTS

5.1.1 All safety appliances and interior handholds shall comply with all FRA requirements.

5.1.2 Side sill steps shall be installed at each corner of each car, along with lower side sill. Side sill steps shall be of forged stainless steel with a satin finish, and shall be applied with stainless steel bolts. Stepping surfaces of sill steps shall not have a satin finish, but a finish designed to minimize slipping.

5.1.3 Exterior handholds shall be provided in an approved manner and must be of approved design. The location, application and arrangement of all these assemblies are subject to approval by Metra. **[CDRL C-5-01]** Handholds finished ground size shall be 5/8" minimum diameter, type 302 stainless steel rod or equivalent, given polishing treatment after forging to remove burrs, surface defects and discoloration and shall be applied with stainless steel bolts or cap screws. The following handholds shall be installed on the outside of car:

5.1.3.1 Two (2) vertical handholds at each side entrance door opening

5.1.3.2 Two (2) horizontal handholds above each set of side sill steps;

5.1.3.3 Two (2) horizontal handholds on each end of each car at a height according to 49 CFR 231 requirements ~~approximately 44"~~ above top of rail on each side of coupler; **(SCR-169)**

5.1.3.4 Two (2) vertical handholds at each end door opening;

5.1.4 A safety device shall be supplied at car ends that a crew member can utilize to prevent unauthorized entry into another car, but shall not prevent emergency egress. Design of the safety device shall be subject to Metra design review and approval. **[CDRL C-5-02]**

5.1.5 The car interior must be provided with handholds, railings and stanchions as are required for safety and convenience of passengers and crew. The location, application and arrangement of all these assemblies are subject to approval by Metra. **[CDRL C-5-03]** All installations shall be free of rattles and squeaks and, comply with APTA standards for attachment of interior fittings, APTA Standard SS-C&S-006-98.

5.1.5.1 The passenger boarding/alighting area, immediately adjacent to each set of side doors, shall be provided with stanchions and/or handholds for passenger safety. The stanchions and handrails shall meet current ADA requirements.

5.1.5.2 The stairwells shall have a vertical full height continuous handrail, subject to approval by Metra. Each wall of the stairwell shall be equipped with an appropriately angled handrail. This handrail shall be surface mounted in order to maintain stepwell width.

5.2 CONTRACT DELIVERABLES REQUIREMENT LIST

CDRL	Title
C-5-01	Exterior Safety Appliance and Handhold Design and Installation
C-5-02	Safety Gate Design
C-5-03	Interior Safety Appliance and Handhold Design and Installation

6 DRAFT ARRANGEMENT

6.1 GENERAL REQUIREMENTS

6.1.1 Couplers and apparatus, including attachment to the car body and underframe, shall meet or exceed the requirements of FRA Regulation 49 CFR 238.207. Coupler, yoke, draft gear, and carrier design and their integration into the vehicle shall be submitted for approval. **[CDRL C-6-01]**

6.1.2 Both ends of the trailer car shall have one (1) twin cushion type rubber draft gear. The cab car shall have a push-back coupler at the ~~A~~B-end (~~cabine's side~~ cab end) and one (1) twin cushion type rubber draft gear ~~in the other side~~ on the opposite end. **(SCR-022)**

6.1.3 The couplers shall be type "H" tightlock, short shank, grade C or E high tensile steel coupler.

6.1.4 An ~~AAR~~ AAR Manual S-III, Standards S-129 and S-132 No. 6 coupler operating mechanism shall be provided at each end of the car. Operation of the coupler shall be from the left side of the car only when viewing either end of the car from outside. **(SAR-016)**

6.1.5 The yoke of the trailer car and the ~~B end~~ A-End of the cab car (opposite of the cab~~in's~~ side) shall be designed accommodate the twin cushion draft gear. Yoke material shall be grade C or E steel per AAR Specification ~~M-211~~ M-201. Wear plates shall be applied to the upper and lower yoke straps if grade C material is selected. The wear plates shall be constructed of type 304L stainless steel with stiffeners applied as appropriate. The cab car shall have a push-back coupler at the ~~A end~~ B-End (cab~~ine's~~ side). **(SCR-009)**

6.1.6 Each end underframe shall be fitted with a coupler carrier in accordance with AAR Manual of Standards and Recommended Practices, ~~latest revision~~Standard S-028 (1948), and FRA regulations. The carrier of the trailer car and the ~~B~~A-end of the cab car (opposite of the cabin's side) shall keep the coupler level at all positions of coupler swing. Stops shall be applied to keep the carrier level. A means of maintaining optimal coupler height shall be provided. The bearing surface between the coupler shank and the coupler carrier shall be type 309 stainless steel. The cab car shall have a push-back coupler at the ~~A~~B-end (cabin~~e~~'s side). **(SCR-023)**

6.1.7 The Contactor shall comply with AAR S920 (AAR CID) for draft arrangements and all required data fields shall be provided with each car history book electronically in Microsoft Excel or CSV format.

6.2 CONTRACT DELIVERABLES REQUIREMENT LIST

CDRL	Title
C-6-01	Coupler System Design

7 DOORS

7.1 GENERAL REQUIREMENTS

7.1.1 All side and end door systems shall be designed and manufactured with an emphasis on addressing the following areas of concern:

- Unsafe conditions for passengers or crew members
- Train delays from malfunctioning side door equipment
- System reliability in adverse operational and environmental conditions
- Time and effort required for troubleshooting and repairs

7.1.2 A proposal shall be submitted of all doors systems addressing the four bullet points above in 7.1.1. **[PDRL P-7-01]**

7.2 EXTERIOR PASSENGER ENTRANCE DOORS

7.2.1 Passenger side entrance doors are to be electrically operated bi-parting sliding type doors located on the side of the car. The doors shall slide in a straight line into door pockets placed on the inside or outside of the side walls. Exterior passenger entrance door systems shall utilize a linear door operator. The door system shall comply with the latest revision of APTA specification APTA PR-M-S-018-10, Standard for Powered Exterior Side Door System Design for New Passenger Cars. The door design configuration for side loading doors shall be submitted to Metra for review and acceptance. **[CDRL C-7-01]**

~~Minimum clear~~ Size and quantity of door openings shall be designed to load or unload a ADA bound passenger along with a regular passenger simultaneously. As a minimum, the door header shall provide no less than 5'- 10" clearance over the mobility aid lift platform when in the raised position. Door openings shall be designed in compliance with ADA & FRA requirements and allow safe passenger loading. If provision exists for passengers to operate doors, such as at a terminal, the provision shall be touchless for both interior and exterior of car. **(SCR-085)**

7.2.2 Door panels shall be constructed of stainless steel type 304 sheathing spot welded to an internal framing structure and joined into an integral unit by resistance welding to a peripheral framing structure. A composite panel that is a proven system used in other transit door applications, comprised of inner and outer fiberglass fabric reinforced skins impregnated with either polyester or a phenolic thermosetting resin and affixed to a balsa 'wood core shall be considered as an alternate. An aluminum panel that is a proven system used in other transit door applications may also be proposed. Door surfaces must be flat with slight curvature at the bottom and flat surfaces must be in plane within 1/8". **(SCR-024)**

The door panels shall have a window of clear abrasion resistant polycarbonate or equivalent set in one piece, vulcanized, rubber glazing strips or aluminum sash, as required to comply with FRA Type II regulations.

Doors shall be designed to provide sufficient strength and rigidity to withstand a force of 200 lbs. perpendicular to the door surface applied on an area 24" x 12", with a maximum deflection of 0.3" with the area's long axis parallel to that of the door, 2" from the door edge and centered within the height of the door.

All door edges and openings shall be thoroughly sealed against moisture ingress.

Each door shall be equipped with an interlocking rubber nosing, extending the full height of the door on the leading edge. When doors are closed the two interlocking nosing shall mate and form a weather-tight joint. Static seals shall be provided in the door opening to seal the door trailing edges when the doors are closed.

An approved recessed door pull shall be provided on each side of each door leaf. The door pulls shall be installed in such a manner as to prevent moisture from entering into the core of the door panel.

7.2.3 The doors shall be supported from the top by means of a hanger/track assembly and shall be guided at the bottom in a manner providing freedom from rattles and squeaks. The door support and guide arrangement shall be easily available for adjustment and maintenance through the use of access doors or removable panels.

Stops shall be provided at both ends of travel to protect the door and the operating mechanism. The stops shall be strong enough to withstand repeated 8 g. impact of the door mass without damage.

The door bottom guides shall be of a suitable type and the surface of the step tread shall be designed to minimize passenger slipping and tripping while allowing free movement of the doors. The design of both step tread and door guide shall provide for free drainage of moisture to the outside.

7.2.4 The linear door operator provided to operate the side doors shall be concealed so that it is not directly visible when the door is in the fully closed or open position.

7.2.5 The motion of the doors shall approximate simple harmonic motion and thereby provide cushioning in both opening and closing. ~~A sensitive edge mechanism~~ An obstacle detection feature, per APTA specification PR-M-S-018-10, shall be provided in the door system to immediately reactivate the opening cycle upon striking any object.

The speed of the doors shall be such that from the moment of actuating the appropriate door control buttons until the completion of the operation, including cushioning, the following times are obtained:

- Opening 2.0 to 3.0 seconds
- Closing 3.5 to 4.5 seconds, after time delay ~~(reference section 7.1.7)~~

Adjustment shall be provided to enable these items to be maintained throughout the door operator life and shall be readily accessible. **(SCR-054)**

7.2.6 The side entrance door control system shall be trainlined to permit operation of all side entrance doors on one side of the train from any individual car door control switch panel on the same side of the train. Each switch panel shall be fitted with six (6) push buttons arranged in two rows. Buttons shall be paired for opening and closing doors: 1) forward from the position, 2) locally and, 3) rearward from the position. Pairs of buttons shall be marked as follows: "LEFT", "LOCAL", and "RIGHT".

The control panel shall be equipped with a key (Metra's standard coach key, Drawing M-250) operated mechanism to lock the buttons thus protecting against unauthorized operation of the doors and should have an escutcheon for the key per Metra drawing M-1952. The construction of the mechanism shall allow the key to be removed in the “OFF” position only and shall not cause the train door to change their position.

The door control system shall feature a time delay for door closing. When a closing command is made (locally or trainlined) a door closing warning system consisting of an audio and visual alarm shall be activated immediately. The doors will begin closing four (4) seconds later. The door closing timing and announcement should match Metra’s current fleet configuration. The Contractor shall submit a design to Metra for review and approval. **[CDRL C-7-02]**

7.2.7 A door lock function shall positively retain the door panel in the closed position without relying on electrical power. The lock shall automatically engage when the door panels at a doorway reach the closed position. A manual release device accessible to passengers shall be provided at each door location to release the door lock and allow the door panels to be manually opened in an emergency. Instructions for opening doors in an emergency shall be

provided adjacent to the handle/device. Instructions shall be printed on photo luminescent material compliant with APTA Specification PR-PS-S-002-98, Rev. 3 or latest revision, Standard for Emergency Signage for Egress/Access of Passenger Rail Equipment.

7.2.8 External access for manual release of the door lock shall also be provided. Instructions for opening doors in an emergency shall be provided adjacent to the handle/device. Instructions shall be printed on retro-reflective material. The design and location of external manual releases shall be subject to Metra review and approval. **[CDRL C-7-03]**

7.2.9 Traction interlock with door controls is required. The Contractor shall submit a design to Metra for approval. **[CDRL C-7-04]**

7.2.10 Doors shall not open unless at zero speed, except a "This Door Only" or "Local" button shall function ~~at all speeds~~ up to 20mph when the Master Door Controller is keyed up. All doors shall close automatically when train motion is detected, except a door which has been opened by the "This Door Only" or "Local" button shall remain open if the Master Door Controller remains keyed on. **(SCR-086)**

7.2.11 The exterior passenger side loading doors shall have an emergency release mechanism that shall not require the availability of electric or pneumatic power per APTA standard APTA-PR-CS-S-012-02 latest revision. Neither shall the emergency release mechanism require the presence of any interlock signals (e.g. "low speed" or "zero speed" signals) for actuation. When actuated, the emergency release mechanism shall override any locks and it shall be possible to manually open the released door with a force not to exceed 35 lbf. The emergency release mechanism shall require manual resetting.

7.2.12 A system shall be provided to detect when the car is in motion per APTA Standard APTA-PR-M-S-018-10. Motion detection may be local or trainlined. When motion is detected, opening of all doors on the car (except crew doors) shall be prevented. The Contractor shall submit a design to Metra for approval. **[CDRL C-7-05]** An exterior with a key (Metra's standard coach key, Drawing M-250) operated crew switch shall be provided to open/close ~~for each~~ one set of side doors per side. The Contractor shall submit a design to Metra for approval. **(SCR-026)**

7.3 BODY END DOORS

7.3.1 Body end doors shall be capable of automatically (activation without touch) opening and closing, sliding type. Door system shall have a manual feature to open and close in case of loss of power. The automatic door shall operate the adjacent end door to enable passengers or crew members to move between cars. The doors shall slide in a straight line into door pockets placed on the inside of the end walls.

7.3.2 Door panels shall be stainless steel type 304 or of the same general construction as the side loading door panels.
All doors and edges shall be sealed against moisture ingress.
The door panel shall have a window of clear abrasion resistant polycarbonate set in one piece, vulcanized, rubber glazing strips or aluminum sash as required to comply with FRA Type I regulations.
Glazing retention shall meet FRA type I large object impact requirements per 49 CFR 223. Glazing/elastomer materials shall meet the flammability and smoke emission standards per FRA regulation 49CFR part 238.103 and toxicity requirements per Bombardier specification SMP 800-C. **(SAR-148)**
Doors shall be designed to provide sufficient strength and rigidity to withstand a force of 200 lbs. perpendicular to the door surface applied on an area 24" x 12", with a maximum deflection

of 0.3" with the area's long axis parallel to that of the door, 2" from the door edge and centered within the height of the door.
Each door shall be equipped with rubber nosing, extending the full height of the door on the leading edge. When the door is closed, the nosing shall form an air tight seal with the door jamb.

7.3.3 The door closing and opening device (or door operator) must be provided in a concealed but readily accessible for maintenance.

7.3.4 The doors shall be hung from the top by a hanger/track assembly and guided in a threshold track of a self-clearing design, providing minimum foot obstruction.

7.3.5 Body end doors shall be lockable from either side only by Metra's standard coach key (Drawing M-250).

7.3.6 An approved manually operated, rattle-free latching device shall be provided such that when in use, the device shall hold the doors in an open position.

7.4 PASSENGER COMPARTMENT DOORS (NOT APPLICABLE IN CURRENT DESIGN)

7.4.1 ~~Door panels shall be stainless steel type 304 sheathing bonded to an internally reinforced stainless steel honeycomb core conforming to Military Standard MIL-STD-401, latest revision or alternative construction subject to Metra design review and approval. The design and testing criteria for the passenger compartment door panels shall be subject to Metra review and approval if applicable.~~ ~~**[CDRL C-7-06]**~~ ~~The panels shall not be less than one inch thick. All doors and edges shall be thoroughly sealed against moisture ingress.~~

7.4.2 ~~The doors are to be hung from the top by a hanger/track assembly. The assembly shall incorporate a rack and pinion arrangement for the synchronous opening of each door leaf. The thresholds shall be of an approved self-clearing design providing minimum obstruction for the movement of mobility aids.~~

7.4.3 ~~An operator shall open and close each pair of doors. A sensitive edge mechanism shall be provided to immediately reactivate the opening cycle upon striking any object. The operator shall be low voltage DC and shall also incorporate a sensitive edge and timing circuit.~~
~~The door operating mechanism shall be locally controlled by push buttons located on both sides of one panel of each pair of doors. The push buttons shall be located such that they may be operated by both ambulatory and mobility aid confined patrons.~~
~~The push buttons shall of water proof design.~~

7.4.4 ~~The doors and associated mechanisms shall be rattle free.~~

7.4.5 ~~A device shall be provided to hold the doors in the open position. The design of such device is subject to the review and approval of Metra if applicable.~~ ~~**[CDRL C-7-07]**~~

7.5 ELECTRIC LOCKER DOORS/CREW LOCKER DOOR

Lockable doors shall be provided for all electric lockers and crew lockers. Aesthetics of the doors shall match interior design of the car. A recessed door pull shall be provided on the exterior face of each door. Electric locker doors shall be equipped with grilles at the top and bottom to allow circulation of air. Design of electric/crew locker doors shall be subject to Metra design review and approval. **[CDRL C-7-08]**

7.6 CONTROL STATION DOORS

On cab control cars, a door(s) shall be provided from the passenger area of the car to the control station. These door(s) shall be operable from outside the cab by a rotating handle and shall be operable from the inside by a panic crash bar, requiring no turning of a handle. The door(s) shall be lockable from the cab side with a manual slide, and on the passenger side by Metra's standard coach key. Each of the control station door(s) shall be designed with intrusion resistance that meets or is greater than that listed in Federal Aviation Administration (FAA) Advisory Circular (AC) 25.795-1A, dated 10/24/08. The Contractor shall submit the design of the control station door(s) for Metra review and approval. **[CDRL C-7-09]**
The door shall have a decal on the outside (facing into passenger compartment) per Metra drawing M-1968 stating "Warning – No Unauthorized Personnel Beyond This Point – Violators Will Be Prosecuted".

7.7 TOILET ROOM DOOR

The door from the passageway to the toilet room shall be automatically (activation without touch) open/close sliding type. Doors shall be designed to open and close manually in the event of power loss. The Contractor shall submit the design of the toilet room door system for Metra review and approval. **[CDRL C-7-10]** Minimum clear door opening per current ADA requirements, ANSI A117.1.
The door pull/passage set shall be lockable on the toilet side manually, and on the other side by Metra's standard coach key.

7.8 WEATHERSTRIPPING

Adequate weather stripping shall be provided to provide satisfactory seals at door openings where airtight weatherproof conditions are required.

7.9 HARDWARE

Recessed rubber bumpers are to be used on all hinged doors to prevent rattling. The bumpers are to be mounted with screws, or by other approved means. All exterior and interior lock sets, including cases, handles, pulls and escutcheons shall be of unpainted white bronze unless otherwise specified. Hinges shall be stainless steel.

7.10 FIRE SAFETY

All door components shall meet the flammability and smoke emission requirements of FRA Regulation 49 CFR Part 238 as well as Section 18.16 of this specification.

7.11 PROPOSAL DELIVERABLES REQUIREMENT LIST

PDRL	Title
P-7-01	Door System

7.12 CONTRACT DELIVERABLES REQUIREMENT LIST

CDRL	Title
C-7-01	Side Loading Door Design and Configuration
C-7-02	Side Loading Timing and Announcement
C-7-03	External Door Release Design
C-7-04	Traction Interlock
C-7-05	No Motion/Zero Speed System
C-7-06	Passenger Compartment Door Panel Design (If Applicable)
C-7-07	Passenger Compartment Door Hold Open (If Applicable)
C-7-08	Electric/Crew Locker Door
C-7-09	Cab Door Panel Design
C-7-10	End Door Design and Configuration

C-7-11	Toilet Door Design and Configuration

8 CAR BODY INTERIOR

8.1 INTERIOR FINISH

8.1.1 GENERAL

8.1.1.1 Interior renderings of all levels of the car shall be submitted with the proposal cross sectional views of the car interior (both longitudinal and transverse) shall be included. Proposer shall note plan on how small passenger baggage (computer bags, backpacks, purses) will be accommodated for in the car design, including what percentage of seated passengers will have a location that can accommodate small baggage. **[PDRL P-8-01]**

8.1.1.2 Plastic and plastic faced material shall be integrally colored in the exposed face. It shall be of low glare, suede, or equal finish unless otherwise specified.
Samples of all surface treatments that are exposed to Metra's passengers or operating crews shall be submitted for approval**. [CDRL C-8-01]**

8.1.1.3 All material must comply with applicable flammability and smoke emission requirements of FRA Regulation 49 CFR Part 238 as well as Section 18.16 of this specification.

8.1.2 SIDE FINISH

8.1.2.1 A formed panel made of thermoform plastic material, or alternative material meeting specified flammability and smoke emission standards, as stated in Section 18.16 shall form the window frame. The design and construction of the panel shall be subject to Metra review and approval. **[CDRL C-8-02]**

8.1.2.2 The interior surface of all toilet room walls are to be lined with stainless steel or a material suitable for this environment. Wall material shall be resistant to cleaner solutions, water, salt, other corrosive agents, etc.

8.1.2.3 The interior surface of all walls of the operator's stations in cab cars shall be lined with a non-glare material. Any area not conducive to non-glare material application, including desk and upper console, shall be painted flat black.

8.1.3 PARTITIONS, LOCKERS, ETC.

8.1.3.1 The air ducts in the vicinity of the overhead heaters (if used) shall be constructed of stainless steel.

8.1.3.2 A crew locker shall be provided in a location approved by Metra. One coat hook shall be provided inside wall in the crew locker.

8.1.3.3 Cab lockers shall be lockable with a Metra standard coach key. The Contractor shall submit design specifications and drawings of each internal design of both the Engineer's side and observer's side locker for Metra approval. **[CDRL C-8-03]**

8.1.3.4 On cab control cars, a locker to house cab signal protective system and other equipment shall be installed. The lockers shall be lockable with a Metra standard coach key.

8.2 FLOORING

8.2.1

The flooring shall meet the 49CFR238 Appendix B and Bombardier SMP 800-C for toxicity. **(SAR-148)** ~~including a~~ A sample vehicle floor assembly shall be subjected to a thirty-minute fire resistance test (testing to ASTM E119-00a) per 49CFR238 Appendix B and any additional requirements listed in NFPA 130 with the car builder's structural configuration. All floor panels shall be capable of withstanding the requirements of ASTM E119 when exposed for a minimum of 30 minutes ~~or greater~~ on the carbody underside. Test reports must refer to 49CFR238 Appendix B testing condition and criteria, as well as the ASTM codes, and must be provided to Metra for review and approval. **[CDRL C-8-04] (SCR-027)**

Floor panels shall be as large as possible, but should only be as wide as the compartment it is in. Cab floor panels shall be able to stay if replacing adjacent floor panel and vice versa.

Lavatory floor panel(s) shall not extend beyond the lavatory compartment. Floors shall be able to be replaced without cutting around lockers and compartments. Lower level panels shall extend full width of the car (where possible) with all joints located over structural members. Floor panels shall be bonded to the floor beams to isolate them from the carbody structure. The floor shall be leveled to provide a flat surface. Height variations between panels shall be no greater than 0.030 inch. Gaps between panels shall be sealed against incoming dirt, moisture, and water using appropriate flexible sealant that allows for thermal expansion and contraction of panels.
Design and details of the floor system shall be submitted to Metra for review and approval. **[CDRL C-8-05]**

8.2.2 The floor panels shall not deflect more than 1/250 of the shorter span between supports, up to a maximum of 0.170 inch, whichever is less, with a uniformly distributed AW3 load state.

8.2.3 Floor surfaces on all passenger and crew sections shall conform ASTM D2047 and ASTM C-1028 coefficient of friction shall be greater than or equal to 0.8 for both wet and dry conditions. Test reports must be provided to Metra for approval.
The floor surface shall be hard and highly durable in order to last 40 years in service without major repair.
Floor surface shall be easy to repair. Repaired area shall not be visibly detectable. Mechanical integrity of the floor panel shall be maintained after repair.
ADA passenger locations in the car shall be designated with the proper ADA signage embedded into the floor. Signage areas shall have the same wear and slip characteristics as the main floor and be flush. Signage shall not be able to delaminate separately from main floor for the life span of the floor.

8.2.4 All interior stairway shall have uniform riser heights and tread depths in accordance to ADA guidelines. Stairways shall be designed to minimize the accumulation of water and have the same slip resistant characteristics as the main flooring. Tread nosing shall be designed with an ADA compliant profile and visual contrast.
[CDRL C-8-06]
~~A center tactile finish strip in order to provide guidance for visually impaired passengers shall be done by showing a continuous path through the car's center, as well as a path to each doorway. The tactile finish shall not create a tripping hazard.~~ **(SCR-055)**
Cove moldings shall be either stainless steel or made of the same material and color as the floor surface. Coves shall have a minimum radius of 1" (25 mm) to ease cleaning, and shall be sealed to the floor surface.
Low level exit path marking (LLEPM), if supplied on flooring, shall be fully integrated into and flush with the floor surface to present no tripping hazard and not delaminate separate from the floor surface. LLEPM may be either active or passive and be compliant with APTA standards PR-PS-S-004-99 Revision 2. Passive LLEPM marking lines shall be High Performance Photo Luminescent material (HPPL) that complies with APTA standard PR-PS-S-002-98 Revision 3. Wear resistance of the HPPL locations shall be the same as the floor covering and integrated in order to be flush with the floor surface and to prevent any separation, delamination and water infiltration.
Floor surface inside the electric lockers need not conform to ADA guidelines for surface slip resistance.
The Contractor shall submit floor surface specifications and samples for Metra review and approval.

8.2.5 Floor layout of passenger areas for entraining and detraining shall be designed such that water drains out of car to prevent slip surfaces to the extent possible.

8.2.6 Heated flooring, located at the door entry areas, ~~(if provided),~~ shall be of construction with an integrated heating system. The heated flooring system shall be controlled and integrated into the vehicle's main HVAC system.

The performance of the heating system shall be demonstrated through a dielectric test in dry conditions (no default after 100 cycles of 1 minute at 2500 V), a dielectric test in wet conditions (conditioning in brine water for 60 min, no default at 2500 V for 1 minute), an electrical fatigue test (no default after 200,000 on/off cycles of 30 seconds each), a high-voltage insulation test (electric shock protection, resistance of more than 6 MΩ at 2500 V in dry conditions and more than 500 kΩ at 2500 V in wet conditions after 1 hour), and an impact test according to the UL 1693 standard (impact test with a 2" steel ball of 1.1 lbs dropped from a height of 79". Then, dry dielectric test requirements must be met. Ground fault/ shock hazard requirements per APTA requirements.

To the greatest extent possible, these panels shall be repairable without removing radiant floor heat panels from the car. An additional protection system LCDI - Leakage Current Detector Interrupter – shall be installed.

Design and details of the heated floor system shall be submitted to Metra for review and approval. **[COPL CO-8-01]**

8.3 PASSENGER SEATING

8.3.1 GENERAL REQUIREMENTS

8.3.1.1 All seats shall conform to APTA Standard PR-CS-S-016-99, latest revision. Seats shall also conform to the FRA's requirements for retention of seat components, 49 CFR Part 238.

8.3.1.2 All components used in the seat and cushion assemblies shall meet the flammability and smoke emission requirements of FRA Regulation 49 CFR Part 238 as well as Section 18.16 of this specification.

8.3.1.3 An engineering design and ergonomic analysis shall be performed by the Contractor in conjunction with the seat manufacturer on the proposed seat design arrangement and installation and shall be submitted for Metra's approval. The analysis shall take into account all aspects of the seat design, including as a minimum the materials used in the seat construction, human factor related dimensions, passenger ingress and egress, cushion contours including lumbar support, seat pitch, cushion comfort, seat attachment method, and maintenance. Final approval of the detail design of the seat shall be after review of proposed samples. **[CDRL C-8-07]**

8.3.1.4 Contractor shall submit an in-depth analysis on life-cycle cost and comfort level for passenger with an average ride length of 1 hour to a maximum passenger ride of 2 hours. **[CDRL C-8-07]**

8.3.1.5 Seats shall either face each other at all emergency sash locations or ~~have provisions to move seat~~ be positioned to allow correct size unobstructed opening per 49 CFR Part 238.113. ***[VRESD V-8-01]*** *Seats shall not face each other nor need to move to allow correct size unobstructed opening to meet 49 CFR Part 238.113.* ***[VRESD V-8-01]*** **(SCR-120)**

8.3.1.6 All seat bottom cushion and backrest assemblies shall be secured to the frame in accordance with FRA Regulation 49 CFR Part 238.233 (as clarified by the FRA in their January 30, 2008 letter). When installed, cushion and backrest assemblies shall be secure in place insuring that they shall not cause any noise during car operation whether occupied or unoccupied. Seat cushions shall not be removable by passengers, but shall be removable by maintenance personnel within one minute with the use of nothing more than simple hand tools. Each seat cushion assembly shall be interchangeable with like assemblies

Seat cushion covering shall be transportation grade material subject to Metra approval. Seat covering material shall be able to be cleaned by at least three widely available commercial industrial cleaning agents that are known to be chemically compatible. **[CDRL C-8-08]**

Seat covering physical properties shall be tested in accordance to the tests listed in Table 1.

Alternate testing methods with supporting documentation to superior testing methods can be submitted for Metra review and approval in lieu of listed tests

Table 1	
Physical Property	**Test Method**
Total Weight	CFFA-700D
Thickness	CFFA-700C
Tensile Strength	CFFA-17
Tearing Strength (Trapezoid)	CFFA-16C
Coating Fabric Bond	CFFA-3A
Stretch	CFFA-15
Abrasion Resistance	CFFA-1a Wyzenbeek
Crocking	CFFA-7, dry
Blocking	CFFA-4
Cold Resistance	CFFA-6A, 5# roller
Accelerated Weathering Resistance Test	CFFA-2, A1, (SAE-~~J1885~~ J2412) B1, (ASTM ~~G26-A~~ G155-13) C1, (ASTM D4329) **(SCR-028)**

Metra will indicate the colors to be provided after notice to proceed. Covers (both bottom cushions and backrests) shall not require the use of tacks or staples for attachment nor shall they become disengaged under normal use (including patrons placing their feet between the cushion and backrest).

8.3.2 SEAT DESIGN

8.3.2.1 All seating parts and hardware shall be corrosion resistant to but not limited to: water, commercially available cleaners, road salt, etc.

8.3.2.2 Seat assembly weight shall be minimized to the extent practical by the seat manufacturer. Two passenger seat assembly weight shall not exceed 127 pounds. Single passenger seat assembly weight shall not exceed 88 pounds.

8.3.2.3 Tops of seatbacks shall have a headrest for each passenger position. A diagonal slope at the aisle end shall accept a handgrip. The handgrip shall be rubber coated steel or alternate approved transit grade material suitable for the commuter car environment, subject to review and approval by Metra, and positioned such that no striking hazard to face or head of seated passengers is presented, even in the case of an emergency stop or other unusual condition. The aisle side handgrip should be attached to the seat such that the mounting hardware is recessed or hidden.

8.3.2.4 All passenger seatbacks shall be equipped with a stainless steel ticket holder to hold two separate tickets. Ticket holder placement shall be reviewed and approved by Metra.

8.3.2.5 Armrests shall be provided for all seating locations and may be static or foldable.
The foldable armrest(s), if supplied, shall be able to rotate in between the up and down positions and shall be flush with the seat back while in the up position.
Aisle side armrests shall be static and of close loop design as to prevent injury to passenger from catching passenger bags, clothing, etc.
The armrest shall be removable without requiring the disassembly of the seat in order to replace a damaged or defective armrest.

The armrest shall be approved transit grade material suitable for the commuter car environment and pass APTA and 49 CFR Part238.103 requirements. Design is subject to Metra review and approval.

8.3.2.6 A cup holder shall be provided for each seating location. The cup holder opening shall be able to accommodate a range of beverage containers readily used the food industry and travel style containers up to a diameter of 3-1/2 inches.

8.3.2.7 Seat backrest cushion assembly design shall be submitted to Metra for review and approval.

The seatback cushion assembly-to-frame latching mechanism shall be easily disengaged by hand without tools. The latch/release mechanism shall be easily accessible to Metra personnel but concealed from passenger view. The latch mechanism shall be demonstrated for approval after award of the contract.

8.3.2.8 Low Level Exit Path Marking (LLEPM) shall be incorporated on the seat assembly. Marking design and high performance photo luminescent (HPPL) material shall meet all APTA requirements and must be submitted to Metra for review and approval.

8.3.3 FOLDING SEAT

Folding seats shall be provided where necessary and subject to all APTA and FRA tests. Design is subject to review and approval by Metra.

8.3.4 Seat construction, components, and attachments shall be of sufficient strength to withstand without permanent deformation (defined as + 0.125 inches) the testing requirements of APTA Standard PR-CS-S-016-99, ~~latest revision~~ Revision 3 or the loads listed below, whichever is more stringent **[CDRL C-8-09]**:

8.3.4.1 APTA ~~5~~3.1.1 Backrest Strength: 300 lbs. per passenger uniformly distributed perpendicular to the plane of the seat back in the rearward and forward direction, three (3) inches below the top of the back or 36 inches above floor, whichever is lower

8.3.4.2 APTA ~~5~~3.1.2 Grab Handle Strength: 300 lbs. on hand grip in a horizontal direction, rearward and forward.

8.3.4.3 APTA ~~5~~3.1.3 Vertical Seat Strength: 450 lbs. per passenger uniformly distributed vertically downward on the front edges of the seat cushion.

8.3.4.4 APTA ~~5~~3.1.4 Armrest Strength: 250 lbs. horizontal to the armrests in both directions on the armrests. 150 lbs. for folding center armrest(s) if applicable.

8.3.4.5 APTA ~~5~~3.1.4 Armrest Strength: 250 lbs. vertically downward on the armrests. 150 lbs. for folding center armrest(s) if applicable.

8.3.4.6 APTA ~~5~~3.1.5 – ~~5~~3.1.7: As applicable with optional supplied equipment. Performed as dictated in APTA Standard PR-CS-S-016-99, ~~latest revision~~ Revision 3

8.3.4.7 APTA ~~5~~3.2 Dynamic Sled Testing: Performed as dictated in APTA Standard PR-CS-S-016-99, ~~latest revision~~ Revision 3

8.3.4.8 APTA ~~5~~3.3.2 Lateral Seat Attachment Test: Performed as dictated in APTA Standard PR-CS-S-016-99, ~~latest revision~~ Revision 3

8.3.4.9 APTA ~~5~~3.3.3 Vertical Seat Attachment Test: Performed as dictated in APTA Standard PR-CS-S-016-99, ~~latest revision~~ Revision 3

8.3.4.10 APTA ~~5~~3.3.4 Forward-Facing Seat Attachment Test: Performed as dictated in APTA Standard PR-CS-S-016-99, ~~latest revision~~ Revision 3

8.3.4.11 APTA ~~6~~C.2.1 Mechanisms: As applicable with optional supplied equipment. Life cycle test criteria shall be submitted to Metra for review and approval prior to APTA testing.

8.3.4.12 APTA ~~6~~C.2.2 Cushions and Upholstery: Each unique seat assembly shall be dynamically tested, jounce and squirm as follows:

180 pound load on bottom cushion
110 pound load on back cushion
200,000 jounce cycles @ 100 cycles per minute
4,000 squirm cycles @ ~~4~~ 2 cycles per minute

Foam should show no signs of tearing, shearing, or significant loss of height. Cushion covering shall show no signs of tearing or ripping and should remain attached to cushion pan or structure. Seat covering stitching should show no signs of unraveling or breakage. **(SCR-144)**

8.3.5 Contract Optional Proposal Equipment List

8.3.5.1 The seat shall have an option to incorporate USB ports, location subject to Metra approval (reference Section 11.6.3). The USB parts shall be removable without having to disassemble the seat. **[COPL CO-8-02]**

8.3.5.2 A foot rest can be provided in each seating location as applicable. The design is subject to Metra review and approval **[COPL CO-8-03]**

8.3.5.3 A tray table can be provided in each seating location as applicable. The tray table shall be able to be locked and stowed when not in use. The design is subject to Metra review and approval **[COPL CO-8-04]**

8.3.5.4 Future provisions for expansion of equipment for passenger in seating location detecting, automatic ticketing verifying. **[COPL CO-8-05]**

8.3.5.5 A seat reservation system that will give status of train seats through an LED lighting system such as free, reserved, or occupied (Not an option for VRE Cars) **[COPL CO-8-06]**

8.3.5.6 Other technologies available in the transit industry.

8.4 PARCEL RACKS

8.4.1 A continuous ~~closed type~~ parcel rack, extending to the longest length practical, shall be provided in each side of the lower and upper level coach sections (if applicable) and shall incorporate longitudinal restraints, with mounting brackets providing lateral restraints. Parcel racks shall be sized to fit a typical computer bag, back pack, small carryon luggage, etc that passengers may bring in revenue service. A parcel racks should be sized to accommodate storage for a maximum amount of seated passengers. The Contractor shall submit the parcel rack design to Metra for review and approval. [CDRL C-8-10] **(SCR-203)**

8.5 ACCESSIBILITY PROVISIONS

8.5.1 The cars built to these specifications shall comply with regulation 49 CFR Part 38, subpart E. All provisions for passengers with disabilities must be documented, including passage and turning routes, and all clearances for mobility aids shall be submitted with proposal. **[PDRL P-8-02]** The Contractor shall also be guided by the latest issue of the following, to the extent that the following do not conflict with other specification requirements or the above requirements, which shall govern: **(SCR-102)**

8.5.1.1 Title 49, Code of Federal Regulations, Part 37 Transportation for Individuals with Disabilities.

8.5.1.2 Title 49, Code of Federal Regulations, Part 609 (Transportation for Elderly and Handicapped Persons)

8.5.1.3 ICDB Accessibility Standards Illustrated manual.

8.5.1.4 ANSI A117.1, American National Standard for buildings and facilities - providing accessibility and usability for physically handicapped people.

8.5.2 All entry and exit, passage, and turning routes to and from mobility aid positions shall conform to the requirements of the ANSI A117.1 as to clearances, turning radii and pathway impediments. All requirements for reaching, control and device activation, and other use of manual dexterity imposed by car-borne equipment shall also comply with ANSI A117.1. In all cases, the Contractor shall take into account all potential hazards related to hand, knuckle and finger clearances of persons operating mobility aids, as well as potential hazards to others created by mobility aid operation.

Bulkheads and partitions in the route of mobility aids between the entryway and the mobility aids positions shall not incorporate any wings protruding into the aisle.

8.5.3 The lower level of the car shall have provisions for two (2) ADA designated locations. An approved number of retractable jump seats, or alternative design, as described in section 8.3, shall be provided in each ADA position for use by ambulatory passengers when mobility aids are not present.

8.5.4 The width of each passageway shall be dictated by the needs of the ADA lift mounting. The stanchion assembly shall be located in such a manner as to avoid potential hazards related to the hands of patrons while the mobility aid lift is in use. The mobility aid lift shall be installed such that a continuous threshold/lower track is maintained for the entire width of the side entrance door opening.

8.5.5 An mobility aid lift shall be provided on each side of each car, to permit the raising and lowering of passengers in mobility aids, or between station platform level and car level floor height. The ADA lift system and setup shall be subject to Metra review and approval. **[CDRL C-8-11]**

The station platform height shall be assumed by the Contractor to range from between top of rail to 8'' above top of rail. The lift shall stow in an enclosure when not in use.

The entire lift shall be modular in design to facilitate removal of the lift for servicing. Weather resistant enclosure(s), with provisions to drain any accumulation of moisture shall be provided to protect components. The enclosure supporting frame should be designed to allow full access of the ADA lift for maintenance.

The lift platform shall conform to the length and width requirements of 49 CFR Part 38 Subpart E Paragraph 38.95[b][6]. The surface of platform shall be treated with an approved skid resistant material. The lift platform shall be equipped with a barrier at both the inner and outer ends, which shall automatically rise to contain a mobility aid and prevent roll off during operation (either in powered or manual modes). When lift platform has been fully lowered, the outer barrier flap shall lower and shall serve as a transition surface between the mobility aid lift and the station platform. When the lift is fully raised, the inner barrier shall lower and aid in transition between lift and vestibule. Side rails shall be permanently fixed to the platform to prevent side roll off.

The platform shall be capable of safely lifting and lowering loads of up to 800 pounds (363 Kilograms) in either powered or manual modes, without lift platform deflection in excess of 3 degrees. There shall be no failure mode, in either manual or powered, loaded or unloaded operation, in which the lift platform is capable of uncontrolled free fall.

Handrails shall be provided on both sides of the platform for safety of the rider when the lift is in use and for the safety of other passengers when it is not. The handrails shall not contain any electrical circuitry or switches.

8.5.6 The mobility aid lifts shall be circuit breaker protected. Control of the lifts shall be local and side-specific. The lift controls shall be interlocked with the car's air brake system and locomotive control system.

A switch, keyed to Metra's standard coach key, shall be provided for each lift in an approved location. When in the "on" position, power is provided to the lift (enabling its controls), ~~a magnet valve~~ an electronic input is energized to apply brakes to the individual car, a signal is provided to the controlling cab and the amber indicator lights (one next to the switch, with sun shield and the exterior pilot lights) are energized. These events will also be triggered when the key switch is in the off position and the lift is manually deployed (pulled out). **(SCR-119)**

Two (2) sets of operating controls shall be provided for each lift. The first set of operating controls shall be mounted in the enclosure or interior of the car. The second set of operating

controls shall be the same as above but mounted in an enclosure in the carbody in the vicinity of the doors (when facing the doors from the outside).
The enclosure shall have a weatherproof cover. A lock, keyed to Metra's standard coach key shall retain the cover in the closed position. When the cover is opened, the controls in the enclosure shall be activated, with the controls in the enclosure or interior disabled.
An audible signal shall be activated when the mobility aid lift is activated.
The logic circuitry of the mobility aid lift shall prevent a lift platform from being lowered unless it has been fully deployed. It shall be possible, however to stow a lift in powered mode in any position.
When raising the lift under power from the lowered position the outer barrier shall automatically close and will operate normally regardless if the barrier was lowered automatically or manually. No manual correction will be required to reposition the barrier.
In the event of a lift failure or a power failure, it shall be possible to operate the lift to and from any position in the raise/lower cycle, whether loaded or unloaded, and to stow and deploy the lift platform by hand if it is unloaded. Operation in this manual mode shall not damage the lift or any of its components.
Under powered operation, a complete cycle of deploying the platform, lowering the lift platform to station platform height, raising it to floor height, and stowing the lift platform, shall take a minimum amount of time.
In manual mode, this operation shall take no longer than three times the maximum time allowed for the powered cycle, when operated by a person of average manual dexterity. Any operation in manual mode, including operation under load, shall require no more than average strength, with no more than the equivalent of 40 pounds (18 kilograms) lifting force required, except that the force required to initially breakaway to deploy can be up to 60 pounds (27 kilograms).

8.5.7 A pilot light (reference section 10.4.2) shall be installed on each side of the car directly below door open indicator. These shall illuminate on both sides of the car when a wheel-chair lift is energized, regardless of the actual position of the lift.

8.6 TOILET ROOM

8.6.1 The toilet room shall be in a location that is easily accessible for ADA passengers.

8.6.1.1 The spatial arrangement and equipment provided shall conform to the requirements of regulation 49 CFR Part 38 and ANSI Standard A117.1 latest revision with the following exceptions:

- The minimum clear floor area of 59 inches by 60 inches (Section 604.9.2.1).
- The maneuvering clearances of 42 inches at the toilet sliding door (Section 404.2.3).
- Toe clearance (Section 604.9.5).
- Clear floor space at the wash basin (Section 606.2). **(SCR-102)**

and is subject to approval of Metra. **[CDRL C-8-12]** ~~A hinged~~ An access door shall be provided in the toilet room for servicing of the water tank and other related equipment. **(SCR-150)**

8.6.2 One (1) set of equipment, as listed below, shall be provided in the toilet room:

8.6.2.1 One (1) toilet, meeting latest U.S. Public Health standards. The flush button shall be wall mounted.

8.6.2.2 One (1) retention tank having a minimum usable capacity of 40 gallons. The tank shall be heated and the heaters activated when ambient temperature is less than 40 degrees Fahrenheit, see section 9.6.2. The tank shall be constructed of 12 gage stainless steel and equipped with clean-outs and emptying provisions. The tank shall also have an approved sight or liquid level meter to indicate an approximately full retention tank. In addition, the tank shall be equipped with a sensor that will illuminate an LED indication in the vicinity of the toilet empty line that will indicate when the toilet retention tank is at 75% capacity. The design of the

system provided shall be subject to Metra approval. **[CDRL C-8-13]** ***[VRESD V-8-02]*** *One (1) waste treatment tank having a minimum usable capacity of 40 gallons. The tank shall be heated and the heaters activated when ambient temperature is less than 40 degrees Fahrenheit, see section 9.6.2. The tank shall be constructed of 12 gage stainless steel and equipped with clean-outs and emptying provisions. The tank shall also have an approved sight or liquid level meter to indicate an approximately full retention tank. In addition, the tank shall be equipped with a sensor that will illuminate an LED indication in the vicinity of the toilet empty line that will indicate when the toilet retention tank is at 75% capacity. The design of the system provided shall be subject to VRE approval.****[VRESD V-8-02]***

8.6.2.3 Lines between the tank and the toilet shall be stainless steel pipe, with stainless steel fittings. Lines shall be as short as possible, pitched toward the tank and free of "traps". The tank, the lines between the tank and the toilet, plus the emptying line shall be heated to prevent freeze-up. Emptying line shall be equipped with a 4 inch "Camloc" fitting and dust cover.

8.6.2.4 One (1) approved wall mount soap dispenser with touchless activation. Soap dispenser shall be mounted near the sink. ~~One (1) approved wall mount dispenser for waterless hand cleaner. Hand cleaner dispenser should be mounted above the soiled towel receptacle~~. ***[VRESD V-8-03]*** *One (1) approved wall mount soap dispenser. Soap dispenser should be mounted near the sink.* ***[VRESD V-8-03]***

8.6.2.5 One (1) approved 2 roll toilet paper holder.

8.6.2.6 One (1) ~~approved~~ Dyson hand dryer with touchless activation or approved equivalent ~~One (1) center pull dispenser for roll towels~~ ***[VRESD V-8-04]*** *One (1) ~~approved~~ Dyson hand dryer or approved equivalent* ***[VRESD V-8-04]*** **(SCR-150)**

8.6.2.7 One (1) soiled towel receptacle

8.6.2.8 One (1) approved folding type coat and hat hook.

8.6.2.9 One (1) mirror of 1/4" coated polycarbonate set in a rolled stainless steel frame. The mirror shall be at least 9" wide by 12" high.

8.6.2.10 Stainless steel, 1-1/2 in. dia. Handholds properly oriented for ADA passenger use

8.6.2.11 One (1) fold-down transfer seat designed per ADA requirements.

8.6.2.12 One optical smoke sensing ~~ionization sensor~~ type smoke alarm operating from ~~120 VAC~~ 64VDC with a low voltage battery 64VDC ~~9V~~ battery back-up (main car battery).

8.6.2.13 One (1) approved wall mount stainless steel sink. Sink shall have touchless activation. ***[VRESD V-8-05]*** *One (1) approved wall mount stainless steel sink* ***[VRESD V-8-05]***

8.6.3 WATER SUPPLY

8.6.3.1 The supply side of the water system shall be designed for non-potable water ~~conforming to FDA (Food and Drug Administration) regulations~~. Water shall also be provided for flushing the toilet and supplying the sink (if applicable). A placard shall be placed near the sink stating, "Warning - Not Drinking Water". The sign shall be readable in braille. Placard design shall be submitted to Metra for approval. ~~The water system and tank are to be cleaned before the cars are delivered in accordance with United States Public Health regulations.~~ **(SCR-130)**

8.6.3.2 The entire system, with the exception of the water tank (which is to be isolated) shall be pressurized to ~~150~~ 45 lbs. and checked for leaks. **(SCR-150)**

8.6.3.3 A single stainless steel water tank shall be furnished. Service water capacity shall be a minimum of approximately thirty five (35) gallons. The tank shall be suitably insulated to prevent the formation of condensate on its exterior. The tank shall be vented to the roof, permitting the fill pipes to drain. Access to the tank shall be provided for maintenance. A grille, will permit circulation of heated or cooled air around the water tank. The water tank shall be designed to withstand a hydrostatic test of fifty (50) pounds per square inch. **(SWR-205)**

8.6.3.4 Two (2) approved water filling nozzles shall be provided. They should be located at the toilet end of the car, one on each side. One nozzle is to be used as a fill and the other to act

as an overflow drain. These shall be enclosed in a self-draining stainless steel box, covered by a spring-loaded hinged stainless steel door for sanitary protection.

8.6.3.5 A suitably-sized interconnecting network of insulated copper piping shall be furnished, using sweat type fittings except where removal of components dictates the use of compression fittings. Piping shall be joined, using silver solder or approved equal. It shall be suitably clamped to prevent rattles.

8.6.3.6 A combination shut-off / drain valve with metal identification tag shall be provided adjacent to the toilet. Location of the valve is subject to Metra approval. **[CDRL C-8-14]**

8.6.3.7 All piping must be installed in such a manner as to avoid formation of air pockets or, water pockets when the system is drained.

8.7 MISCELLANEOUS INTERIOR

8.7.1 Coat hooks shall be provided for as many seating locations as possible. Style and location subject to review and approval by Metra.

8.7.2 Ticket clips shall be provided for passenger seating (one holder for every two seats) and for the flip seats at the mobility aid positions. The location and design of ticket clips shall be approved by Metra. **[CDRL C-8-15]**

8.7.3 Waste receptacles, a minimum of two (2), shall be installed in each car. The receptacle location and mounting is subject to the approval of Metra. **[CDRL C-8-16]**

8.7.4 Two Metra Standard Coach Keys (drawing M-250) per car shall be provided. Two (2) appropriate keys shall be provided per car for any other locking devices used other than pencil locks. ***[VRESD V-8-06]*** *Two VRE Standard Coach Keys per car shall be provided. Two (2) appropriate keys shall be provided per car for any other locking devices. Pencil locks shall not be utilized.* ***[VRESD V-8-06]***

8.7.5 Each car shall be equipped with two (2) emergency tool kits, one on each end of the car or level consisting of the following: 1 ea. dry chemical type fire extinguisher; 1 ea. 18 inch ripping chisel, 1 ea. LED Flashlight, and 10-pack box of glow sticks. On B-end only, 1 ea. Hot box stick shall be included in emergency tool kit.
The tools shall be mounted in a case with a clear plastic front. The clear plastic shall be etched in an "X" to facilitate access in emergency situations. The case shall be sized to accommodate the above equipment plus Metra's standard first aid kit (applied by Metra.). The chisel and flashlight kit shall be marked with "Property of Metra".

8.7.6 Two announcement holders, per Metra Drawing M-166 and made of polycarbonate shall be provided on each car.***[VRESD V-8-07]*** *VRE shall provide two announcement holders made of polycarbonate for each car.****[VRESD V-8-07]***

8.7.7 Two schedule holders, per Metra Drawing M-599, shall be provided on each car. ***[VRESD V-8-08]*** *VRE shall provide two schedule holders for each car.* ***[VRESD V-8-08]***

8.7.8 On cab control cars, provision shall be made for the installation of a flush mount enclosure for an automated external defibrillator. Defibrillator enclosure should primarily be constructed of stainless. Any glazing shall be mounted to allow replacement of the glazing. Appropriate signage shall identify the location of the AED unit. Details of location and installation of the defibrillator shall be submitted to Metra for review and approval. **[CDRL C-8-17]** The alarm of the defibrillator cabinet shall be designed to accommodate standard AA or AAA batteries that easily can be replaced on an annual basis. ***[VRESD V-8-09]*** *On cab control*

cars, provision shall be made for the installation of a flush mount enclosure for an automated external defibrillator. Defibrillator enclosure should primarily be constructed of stainless. Any glazing shall be mounted to allow replacement of the glazing. Appropriate signage shall identify the location of the AED unit. Details of location and installation of the defibrillator shall be submitted to VRE for review and approval. ***[CDRL C-8-17]*** *The alarm of the defibrillator cabinet shall be designed to use car battery power.* ***[VRESD V-8-09]***

8.7.9 The Contractor shall propose a bicycle rack system that shall be able to handle between two and five (5) bicycles in the Priority Seating Areas if those areas are not being utilized for passengers. The bicycle racks shall be capable of storing bicycles without any bicycle component interfering with passenger circulation in the main lower level aisle way. Bike racks shall have the capability to lock the frame of a bicycle to the rack assembly using a standard U-shaped type lock. Bike racks shall designed to accommodate bicycles with tires up to 2.5 in. wide. The Contractor shall submit the design of this system to Metra for review and approval. **[CDRL C-8-18]**

8.7.10 As an option, Proposer may propose convenience items for passengers. Items could include baby changing stations in toilet room or devices that can allow passengers to do in train purchases, i.e. beverage or food (Not an option for VRE Cars) **[COPL CO-8-07]**

8.7.11 A minimum of two (2) touchless hand sanitizer dispensing units shall be installed in each car, at least one (1) on each end of the car. Touchless hand sanitizer units shall be battery or car low voltage circuit operated and hold hand sanitizing packets with a minimum of a 700 mL packet.

8.8 PROPOSAL DELIVERABLES REQUIREMENT LIST

PDRL	Title
P-8-01	Carbody Interior
P-8-02	Accessibility (ADA) Provisions

8.9 CONTRACT DELIVERABLES REQUIREMENT LIST

CDRL	Title
C-8-01	Interior Material Samples
C-8-02	Wall Panels
C-8-03	Cab Locker Designs (Engineer and Fireman Side)
C-8-04	Floor Fire Test
C-8-05	Flooring System
C-8-06	Anti-Skid Design
C-8-07	Seat Ergonomic Assessment
C-8-08	Cushion Covering and Material
C-8-09	Seat Dynamic and Static Testing
C-8-10	Parcel Rack Design
C-8-11	Mobility Aid Lift System
C-8-12	Toilet Room/Equipment Arrangement
C-8-13	Retention Tank Level Indication
C-8-14	Toilet Shut-Off/ Drain Valve
C-8-15	Ticket Clip Installation and Design
C-8-16	Waste Receptacle

C-8-17	Automated External Defibrillator
C-8-18	Bicycle Racks

8.10 CONTRACT OPTIONAL PROPOSAL LIST

COPL	Title
CO-8-01	Heated Floor
CO-8-02	USB/Outlets in Seats
CO-8-03	Foot Rests for Seats
CO-8-04	Tray Table for Seats
CO-8-05	Ticket Verification at Seats
CO-8-06	Seat Reservation
CO-8-07	Convenience Items

9 HEATING, VENTILATION AND AIR CONDITIONING

9.1 GENERAL REQUIREMENTS

Each car shall be equipped with a heating, ventilation and air conditioning system to automatically provide the specified interior temperatures specified herein. These systems shall perform this function with or without the variable internal heat loads such as passengers, lighting and miscellaneous electrical apparatus, or external factors such as solar heat gain and frequency of door openings. All material must comply with applicable flammability and smoke emission requirements of FRA Regulation 49 CFR Part 238 as well as Section 18.16 of this specification. Proposer shall propose general description and requirements for the HVAC section specified herein.**[PDRL P-9-01]**

The HVAC system shall maintain the car's interior temperature, including the engineer's cab (if applicable), to a specified programmable temperature range parameter in all circumstances specified above.

The car temperature shall recover within 4 degrees F of the required interior vehicle temperature within three minutes and thirty seconds maximum following a ~~two minute~~ thirty seconds door opening of all doors on one side of the car. It shall be demonstrated that this requirement can be met during two hours of continuous door cycling of thirty seconds open and ~~2~~ 3 ½ minutes closed for 1 hour at the design conditions in both heating and cooling modes. **(SCR-238)**

All system components shall be service-proven and supported by design and test data, adequate to demonstrate compliance with the specified requirements. Details of the system capacity and performance calculation, design, arrangement, installation, and operation of the HVAC system shall be submitted to Metra for review and approval. **[CDRL C-9-01]**

9.2 HEATING

9.2.1 The cars shall be electrically heated using 480 volt, 3-phase, 60 Hz A.C. supplied from a source outside of the car.

The system shall be thermostatically controlled having floor level radiant heat operating in conjunction with forced air heaters.

9.2.2 The heating system shall be designed and adequately sized to maintain interior temperature as specified herein. Main heat shall be divided into stages, or shall be a single stage operating with a modulating switching device. If multi-stage heat is chosen, the stages shall be designed to minimize the cycling of heat contactors.

Floor heat shall be provided either by electric heaters mounted behind heater guards, or an industry proven floor surface heating solution. If a floor surface heating solution is proposed, details of the design, installation, and arrangement of the floor surface heating solution shall be submitted to Metra for review and approval. **[CDRL C-9-02]** If conventional floor heating is utilized, the heater guards shall be of special design to prevent the surfaces coming in contact with passengers from exceeding 125 degrees F and shall be designed to maximize passenger foot space to the greatest extent possible.

The forced air heaters and radiant floor heaters shall be protected against over temperature.

9.2.3 Layover heat will be manually activated after the car is parked, and is connected to a source of head end power. Layover heat control is to be part of the HVAC automatic controls, using regulation and sensors.

Layover heat shall be provided by the radiant floor level heaters and shall close the fresh air damper. Layover heat shall not operate the evaporator fans for forced air heat. Layover heat shall maintain an interior temperature of 50 degrees F ± 5 degrees F. This set layover

temperature shall be made programmable through the Crew Display Unit ~~control panel~~. **(SCR-053)**

9.2.4 On cars with a control station at one end, two manually controlled heaters shall be provided, one on each side. These heaters shall be controlled by a single switch located on the operator's side. The Contractor shall propose a method of heating and cooling the control station by using the car's main HVAC system. ***[VRESD V-9-01]*** *On cars with a control station at one end, two manually controlled heaters shall be provided, one on each side. These heaters shall be independently controlled switch located on each side. The Contractor shall propose a method of heating and cooling the control station by using the car's main HVAC system.* ***[VRESD V-9-01]***

9.3 VENTILATION

9.3.1 The ventilation system shall be designed to maintain a uniform temperature throughout the car. The temperature within that unit measured at 30 inches above seat cushion shall not vary between any two seat locations by more than 7 ~~5~~ degrees F under all ambient conditions (-20° F. to + 120°F). The passenger areas are each considered separately when calculating the temperature gradient performance [A-end intermediate floor, B-end intermediate floor, Lower floor (green) and the Upper floor (red)]
All ducts and plenum chambers shall be insulated to prevent the formation of condensate on their exterior.

9.3.2 Fresh air shall enter through fresh air ducts fitted to the HVAC unit ~~openings in the car body. Thermostatically controlled d~~ Dampers shall be provided to control the amount of fresh air based on passenger loading and the regulation mode. A switch shall be incorporated to override the fresh air vent control to close the vents with an override expiring after 30 minutes. The fresh air car body openings shall be designed to prevent infiltration of snow and water. **(SCR075)**

9.3.3 Flexible transition ducts of approved material shall connect the passenger supply distribution ducts to each evaporator blower
All flexible transition ducts shall be installed so that it is not under stress and shall be clear of surrounding obstruction when units are in operation. The ducts shall be equipped to allow it to clip on at least one end to ensure ease of replacement or HVAC unit removal. These ducts shall withstand, without damage, the minimum and maximum temperatures and the flexing experienced.

9.3.4 Air ducting shall be insulated and constructed of an approved material. All insulation shall be applied to the outside of the duct.

9.3.5 All air diffusers shall be integrated with the tube light fixture and designed for the minimization and ease of required cleaning, and so as not to accumulate dust, soot, and debris. Air flow values through the diffusers and their final design shall be subject to approval.

9.3.6 Ventilation system shall be balanced so as to provide pressurization for the car body (body doors closed) of 0.025" of water at 0 mph and positive pressure at any speed, with the dampers open and the evaporator blowers for both ends of the car operating.

9.3.7 Filter elements (filters) shall be provided in the air intake of each unit and shall be located just ahead of the evaporator blower unit so that re-circulated air and fresh air are filtered before being passed through the blowers. The filters shall be accessible for replacement without requiring the opening of any pipe fittings, shall not be located in inaccessible locations for routine maintenance access, and shall be removable from inside the car. The filters shall be disposable pleated, MERV 13 rated or better and shall be common production variety easily available through various sources. The filters shall meet MERV 13 performance characteristics when tested in accordance with ASHRAE Standard 52.2 (latest revision).The size of these filters shall be 2" x 16" x 20". The Contractor may propose other solutions for air filtration that meets or exceeds a MERV 13 rated filtration. ASHRAE® 52.2 (latest revision) test reports, performed by an independent lab, which also includes results of conditioning steps outlined in ASHRAE® 52.2-2012 Appendix J (or latest revision) shall be submitted. The test reports shall include the MERV rating in addition to the MERV-A rating that indicates the performance of the filters after conditioning. In addition, the test reports shall include the average arrestance and dust holding capacity as outline in ASHRAE® 52.2 (latest revision).

9.3.8 A fan-driven exhaust outlet above the toilet shall be provided. The fan shall be grounded, and mounted resiliently to minimize noise and vibration. The exhaust air shall pass through a grille in the toilet room ceiling and be ducted to atmosphere. The design, location and size of the exhaust fan shall be subject to Metra review and approval. **[CDRL C-9-03]**

9.4 AIR CONDITIONING

9.4.1 All subject cars shall be equipped with air conditioning equipment comprising of a minimum of two (2) self-contained compact units. The units shall be roof mounted or located in a location for ease of maintainability and replacement.
Each self-contained unit shall be removable in less than 4 hours and require minimal tooling and facilities. Each unit shall consist of one or more compressor/condenser sections and one or more evaporator sections with electric heating, a controller inside the unit and ~~an independent control~~ crew display panel. Each occupied area of the car supplied by the HVAC units shall be arranged such that conditioned air will be evenly distributed to all areas in the event of a failure of one of the HVAC units. **(SCR-077)**
Each of the units shall be capable of serving a minimum of half the required capacity for the area served, in the event of failure of either unit. The total refrigeration capacity for the car shall be not be less than 244,000 B.T.U. per hour. The air conditioning system shall be designed and adequately sized to maintain interior car temperature as specified measured at the return air grille at the normal ambient conditions. For ambient temperatures at or above 110°F Dry Bulb / 76°F Wet Bulb, with air entering the condenser above 120°F, the air conditioning system shall be capable of maintaining cooling at a reduced capacity, but in no case shall the average interior temperature be more than 25°F below the outside temperature. Refrigerant for these units may be R-407C or an approved alternative refrigerant that conforms to 40 CFR Part 42. Type of refrigerant shall be subject to Metra review and approval. **(SAR-076)**

9.4.2 The units shall be constructed using stainless steel or aluminum to the greatest extent possible. They shall be mounted resiliently, such that in the event of failure of a bolt, the unit shall be retained by a support bracket of approved design. The safety support bracket shall not interfere with maintenance or normal unit removal.
The mounting bolts shall be secured ~~with safety wire~~ to prevent loosening and shall be appropriately torqued, with provision for ease of bolt removal in the case of bolt failure and cracking.

~~The mounting of the air conditioning units shall incorporate damping to cushion and limit longitudinal movement.~~ The units shall be equipped with vibration isolator inside the HVAC unit, sized to eliminate transmission of vibration of the units to the car body.
Each package air conditioning unit shall be individually removable by either one of two methods. Either the Contractor shall propose an option to remove the air conditioning unit through an opening on the sides of the car-body, or the air conditioning units shall be individually removable by a lifting apparatus through a pair of hatches in the car roof. Metra would prefer an option where the air conditioning units could be removed by forklift and not by overhead crane. It is preferred that electrical connections be made through the use of quick disconnect type connectors. The installation and removal process, including removing and installing all mounting hardware, and electrical connections, shall be included in submittal 9-04 listed below.
The structure of the units shall permit the entire unit to be removed without damage, and appropriate lifting lugs or eyes shall be incorporated. HVAC unit shall be designed to remove ~~condenser fan, compressor, filter dryer, expansion valves and~~ the solenoid valves~~s~~ coils without the removal of entire unit from car. The entire arrangement is subject to Metra review and approval. **[CDRL C-9-04] (SCR-078)**

9.4.3 The power for the air conditioning system shall be 480 volt, 3 phase, 60 Hertz alternating current. Power for the control of the air conditioning system shall be 120 volt single phase alternating current. Low voltage DC control power may be used with the approval of Metra. **(SAR-093)**
All motors for the evaporator, condenser and compressor shall have overload protection of all three phases, mechanically interlocked to remove all power to the devices on activation in order to prevent a single phase condition. All component and devices must operate satisfactorily within the voltage variation parameters as established by the National Electrical Code, without any effect on the longevity of the components or devices.

9.4.4 The refrigerant compressors shall be accessible hermetic (semi-hermetic) reciprocating or scroll type, sized to the proper capacity required of the HVAC system. The Contactor may propose an HVAC unit with multiple compressors working in tandem. Eliminators shall be provided in an approved manner to prevent transmission of compressor vibration to the air conditioning unit frame and suspension.

9.4.5 Condenser and evaporator coils shall be constructed of seamless copper tubing, copper headers with copper fins or aluminum and stainless steel side plates and framing. No crevices or closures shall be permitted, which would hinder cleaning. The Contractor may propose alternative coil materials and fin layouts.
The condenser car body inlet shall be screened to preclude entry of debris and shall be hinged to provide access for inspection and cleaning.

9.4.6 The condenser fan shall be powered by 480 VAC totally enclosed motor of a standard NEMA frame and be of washdown type for hostile environment or an EN type motor with a minimum protection of IP54. Motor shall have a stainless steel shaft if exposed directly to the outside environment. The bearings shall be double sealed with an L-10 rating of 26,000 hours minimum. Motor shall be protected against corrosion, including both end plates' rabbets sealed. Contacting lipseal and shaft slinger shall be provided when shaft is exposed directly to the rain. **(SCR-115)**

9.4.7 Direct (not belt driven) driven condenser fan and evaporator blower utilizing a 480 VAC standard NEMA frame motor or an EN type motor shall be provided. A motorized impeller with an integrated motor may also be provided. The blower assembly shall be balanced in accordance with IEEE standard 11 or equivalent. **(SCR-115)**

Evaporator blower housings shall be fastened in manner that focuses on secureness and ease of replacement.

9.4.8 The units shall also have within the self-contained assembly at least the following:
9.4.8.1 Filter drier;
9.4.8.2 Moisture indicator;
9.4.8.3 ~~Suction and discharge shutoff valves (liquid line);~~**(SCR-079)**
9.4.8.4 Refrigeration charging valves;
9.4.8.5 Receiver tank; **(only if R407C is used) (SCR-079)**
9.4.8.6 Solid state high and low safety pressure switches and modulation pressure switch (or sensors with a microprocessor control system);
9.4.8.7 Test gauges, liquid filled, suitable for vibration and shock of the railroad environment;
9.4.8.8 ~~A test switch with a test position to override temperature control signals;~~ **(SCR-079)**

All refrigeration piping shall be type K quarter-hard temper copper tubing. The tubing shall be pre-formed where possible and shall be assembled with as few fittings as practical.

9.4.9 If roof mounted units are proposed, the bottoms of each unit shall have removable collection pans under the evaporator section and the condensing section. A 1 1/4 inch minimum, inside diameter stainless steel pipe shall be provided to the evaporator pan and two such lines to the condenser pans. Each pipe shall be routed to the nearest side of the car. Horizontal runs shall have a downward pitch.
The drain lines shall be routed to the underside of the car, located so that the condensate shall drain clear of all underfloor equipment and running rails. The number of fittings and bends shall be minimized and, where used, shall be of large radii for ease of unplugging. The drain piping shall be insulated to preclude condensation.
A flexible hose transition shall be provided between the drain pan outlet and the carbody drain line, using approved hose clamps and hose fittings to avoid any leakage.
The evaporator and condenser pans, along with all surfaces of the unit shall be insulated to prevent condensation.

9.5 TEMPERATURE CONTROL

9.5.1 The heating and cooling controls shall consist of using the crew Display Unit and the controller inside the HVAC unit. ~~a single heating and cooling control panel.~~ The controller ~~control panels~~ shall be arranged for automatic changeover from heating to cooling. **(SCR-080)**

9.5.2 Each crew display unit ~~temperature control panel~~ shall be equipped with a digital crew-operated switch that toggles the HVAC system between the normal “ON” operating mode, the layover mode, and an off mode. The off mode shall not disable the operation of the anti-freeze protection circuits. The target temperature for the normal operating mode shall be set to achieve an interior temperature of 72 degrees F. The target temperature shall be programmable by personnel with privileges within the range of 68 degrees F to 76 degrees F, if alterations are necessary. **(SCR-030)**

9.5.3 The controls shall be an electronic based, positive, non-hunting type to ensure proper operation of the air comfort sub-systems. The design and arrangement of the controls shall be subject to Metra review and approval. [CDRL C-9-05] The use of programmable logic controllers and/or microprocessors is preferred. The controls should be equipped with non-proprietary Portable Test Equipment (PTE) software/ports that would enable personnel with higher levels of access to adjust the temperature parameters for heating, modulated cooling and cooling, and accessing diagnostic data such as fault and download history.

Temperature sensors shall be located behind the return air screen in the return air duct, at the fresh air inlet (may be used for anti-freeze protection), supply air sensor at the HVAC main duct, and at minimum one in the passenger area. ~~Evaporator coil s~~ Sensors shall be used to detect the build-up of ice on the evaporator coil. All sensors shall be properly utilized by the controller to optimize temperature control and provide diagnostic data for maintenance, servicing, and testing.
Pressure transducers shall be provided to allow the temperature controller to monitor and indicate the suction and discharge line pressures. The temperature controller shall be capable of displaying diagnostic data or uploading diagnostic data via the PTE software program. Faults and download history shall be logged and accessible to technicians.
Automatic damper controls shall be furnished as part of the temperature control system. **(SCR-031)**

9.5.4 ~~An indicator and monitor panel~~ A Crew Display Unit and LED indicators on the face of the controller shall be furnished in to indicate the status of the heating and cooling equipment. Digital displays may be proposed. The ~~panels~~ indicators shall be located ~~in the same locker or lockers as the climate control panels~~ on the face of the controller which is located inside the HVAC unit and can be accessed by removing a ceiling panel. The ~~panel or panels~~ indicators and/or the Crew Display Unit shall indicate which stages of heating or cooling have been called for by the settings of the climate control panels, and shall indicate whether the heating or cooling being called for is functioning. The ~~panel or panels~~ Crew Display Unit shall also indicate fresh air temperature, supply air temperature, return air temperature, suction line pressure and discharge pressure, and any on-going faults. **(SCR-081)**

9.6 ANTI-FREEZE PROTECTION

9.6.1 Anti-freeze protection shall be provided at each side entrance door and shall be of sufficient capacity to prevent the formation of ice at these locations (> 40° F. surface temperature @ -20° F.). The design of such system shall be included in door system design review and shall be subject to Metra design review and approval. **[CDRL C-7-01]**

9.6.2 Anti-freeze protection shall be provided in the door pockets of each side loading door and shall be of sufficient capacity to prevent the formation of ice at these locations (> 40° F. surface temperature @ -20° F.). The design of such system shall be included in door system design review and shall be subject to Metra design review and approval. **[CDRL C-7-01]**

9.6.3 Anti-freeze protection shall also be provided for the water tank, piping from the tank to the basin and toilet, the drain from the water basin in the toilet room, water filling pipes, and the water line and retention tank under the car. Design for heating of the retention tank shall either be an immersion heater, Metra preferred, or a heating pad. Design of system shall be subject to Metra design review and approval. **[CDRL C-9-06]**

9.6.4 A water freeze dump valve shall be provided for the toilet water system. This freeze dump valve shall be designed in a location to separate it from the outside weather as much as possible and shall be kept heated with either an external heat tape or a 120VAC heater on the valve itself. The location and the specific heating system used for the water freeze dump valve shall be subject to Metra review and approval. **[CDRL C-9-07]**

9.6.5 All heaters shall be 120 VAC and shall activate antifreeze circuits at ambient temperatures of 40 degrees F or below, and shall de-activate antifreeze circuits when ambient temperatures rise above 50 degrees F.

9.7 PROPOSAL DELIVERABLES REQUIREMENT LIST

PDRL	Title
P-9-01	HVAC System

9.8 CONTRACT DELIVERABLES REQUIREMENT LIST

CDRL	Title
C-9-01	HVAC System – Design and Installation
C-9-02	Floor Surface Heating Solution (If Applicable)
C-9-03	Toilet Room Exhaust
C-9-04	HVAC Unit Lifting Provision
C-9-05	Temperature Control Arrangement
C-9-06	Retention Tank Heater
C-9-07	Water Freeze Dump Valve

10 LIGHTING

10.1 GENERAL REQUIREMENTS

10.1.1 This section describes interior and exterior lighting that shall be provided on both trailer type and cab car type railcars.

10.1.2 Interior lighting shall be designed to enhance passenger comfort visually, and illuminate areas evenly without glare or dark areas at critical locations. The lighting shall enhance the appeal of interior furnishings, while providing for maximum passenger and crewmember safety. All interior and exterior lighting shall conform to the latest applicable APTA standards and FRA regulations. All interior and exterior lighting shall have proven service in North American railroad operations.

10.1.3 Exterior lighting shall feature maximum and efficient illumination and indication to passengers and crew members.

10.1.4 Lighting shall be provided in a minimum of two modes: Normal and Emergency.

10.1.5 Lighting shall be provided using energy efficient Light Emitting Diode (LED) technology in all instances with the possible exception of exterior cab headlights and ditch lights.

10.1.6 All lighting components shall use efficient and environmentally sustainable components, as well as being recyclable to the greatest extent practicable.

10.1.7 `For each type of car proposed, the Contractor shall provide Metra a detailed interior and exterior lighting plan for Metra to review. The plan shall include the type of lighting, lighting arrangement (including any switches, ballast, control, lamp styles), fixture type, voltage, color temperatures, illumination levels in the interior of the car at specified locations for all lighting modes, and compliance with appropriate emergency lighting and signage regulations, standards, and recommended practices. A description of power consumption and voltage levels in the various modes of operation shall be included in the proposal. The details of the design, installation, and arrangement of the lighting solution shall be submitted to Metra for review and approval. **[CDRL C-10-01]**

10.1.8 The proposer shall detail at a minimum in their proposal: description of interior, exterior, and emergency lighting system; diagram of lighting arrangement; description of all light fixtures. Diagram containing voltage and operating modes of all lighting. **[PDRL P-10-01]**

10.1.9 All lighting and associated lighting 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 criteria shall be provided by the contractor upon the request of Metra. **[CDRL C-10-02]**

10.2 INTERIOR AND PASSENGER COMPARTMENT LIGHTING

10.2.1 The upper and lower coach sections shall be provided with an approved arrangement of LED fixtures. Alternate lighting technology, such as service-proven OLED lighting, may be proposed for Metra review and approval.

10.2.2 The lighting system shall: not produce objectionable glare, not deteriorate rapidly in effectiveness through the collection of dirt, permit easy cleaning and renewal of lighting elements, and be free of rattles and vibration when in service.

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 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. Re-lamping and/or ballast replacement 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 SS-E-013-99~~ APTA PR-E-S-013-99. The emergency lighting system shall be tested to exceed emergency light levels specified in the latest revision ~~(at the time of delivery)~~ 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] (SCR-034)**

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 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 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 interior or exterior of the car (providing light levels 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]. (SCR-140)**

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. These lights shall be operated on battery or independent power source voltage.
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.

10.4.5 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.
The headlamp shall be accessible from the exterior ~~in the control station~~**(SCR-142)**, 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 rotary selector switch, with “OFF”, “DIM” and “BRIGHT” positions shall be provided to control the headlights. **(SCR-208)** A headlight dimming resistor, or dimming mechanism 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]

10.4.6 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.

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 event recorder/alerter system. 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.
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 leave Mars light on or off (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. **(SCR-208)**

10.4.7 On the control end of cab cars only, a single oscillating light, or LED light that can follow an oscillating or pulsing pattern, shall be located in the vicinity of the headlight. A low voltage D.C. sealed beam incandescent lamp, halogen lamp or LED lamp shall be utilized, LED lighting is the preferred option. The oscillating or pulsing light circuit shall be protected against burnout due to high battery charging voltage. ~~A dimming resistor, or dimming mechanism subject to Metra review and approval , shall also be provided, included in CDRL 10-06.~~ A control switch assembly shall be provided. The oscillating or pulsing light system design shall be subject to Metra review and approval, included in CDRL 10-05.
~~A rotary selector switch, with "OFF", "DIM" and "BRIGHT" positions shall be provided to control the headlights, ditch lights and oscillating or pulsing light.~~ **(SCR-208)** ***[VRESD V-10-01]*** *Not required on VRE cars.* ***[VRESD V-10-01]*** **(SCR-149)**

10.4.8 On the control end of cab cars only, two (2) lights shall be operated from a low voltage D.C. power source. Each lamp shall be LED PAR 46 lamp. Red lenses must be used. The entire arrangement shall comply with FRA regulations, as stated in 49 CFR Part 221.

10.4.9 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. The burnout detector panel shall have provisions to monitor the oscillating light, 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 or active illumination low location and exit path marking system that complies with the requirements of APTA SS-PS-004-99 Rev 2 and APTA PR-PS-S-002-98, Rev. 3. If a passive system is proposed, the system shall use HPPL marking material as specified in Section 16.2.22 of this specification. The system shall be detailed in the proposal. **[PDRL P-10-02]**
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.
The Contractor shall propose the techniques and options for integration of passive HPPL elements or active 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]**

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

10.6 PROPOSAL DELIVERABLES REQUIREMENT LIST

PDRL	Title
P-10-01	Lighting Plan and Description
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

11.1.1 The electrical power, except for the low voltage battery circuits, shall be supplied from a locomotive not included in this specification, supplying 480VAC, 3-phase, 60 Hz A.C., 750 Amps per phase maximum continuous current rating, 500 kW power output, for a maximum of twelve cars or from a wayside 480VAC power source. Metra locomotives utilize a conventional HEP generator (non-inverter type) to supply 3 phase 480VAC power to the train consist. Power can be cycled on and off at any time. The train consist that is connected to the locomotive will determine the power quality characteristics of the network. Metra's locomotive HEP generators are not equipped with power quality compensation or correction devices. In order for a 12 car train consist to be powered by Metra's existing locomotive HEP generator, the contractor may need to consider a scheme to restart certain loads on each car (notably the battery charger) with a reduced current load for a period of time after restoration of HEP in order to minimize the short-term startup HEP load. The contractor may also propose alternative schemes. If the contractor cannot meet the 12 car train consist requirement outlined in this section, the contractor may propose a specification deviation. The deviation request shall include a detailed explanation with supporting data that decisively concludes why a 12 car train consist cannot be powered by an existing Metra locomotive with the parameters specified in this section. If a deviation request is submitted to Metra, the maximum train consist proposed shall be no less than an 11 car train consist. The proposer technical offer can consider a maximum twelve-car train consist (11 trailer cars + 1 cab car) in its power balance. At low temperature -4°F (heating mode, design point 1, refer to Technical Description / Section 9.2.2), the maximum electrical power consumption drawn by HVAC unit + Heaters + Floor heaters in order to achieve an interior temperature of 72°F in passenger areas is assessed as 55kW + 5% ~~53.5kW / 57kVA~~ per car. Considering the heating and the other loads, the maximum electrical power consumption drawn is calculated around ~~839 kW~~ 940 kW (including 5%) for twelve cars.
At high temperature 92°F (cooling mode, design point 3, refer to Technical Description / Section 9.4.2), the maximum electrical power consumption drawn by HVAC unit in order to achieve an interior temperature of 72°F in passenger areas is assessed as49kW +5% ~~48kW / 56kVA~~ per
car. Considering the cooling and the other loads, the maximum electrical power consumption drawn is calculated around ~~742kW~~ 790kW (including 5%) for twelve cars.
In both cases, the electrical power consumption exceeds the 500kW HEP power output limit which involves the non-compliancy. ~~Note that the 500kW power output limit can be met providing that maximum seven-car train consist at low temperature (heating mode, design point 1) and maximum eight-car train consist at high temperature (cooling mode, design point 3) are considered.~~
In order to not exceed the 500kW HEP power output limit for twelve-car train consist, based on inputs entered in each car by the operator (number of cars), Alstom's control system will automatically reduce the cooling / heating performances at car level depending on the train length for train consist. ~~with more than seven cars (heating mode / design point 1) and more than eight cars (cooling mode / design point 3).~~ The proposed scheme shall be subject to Metra review and approval.

11.1.2 Complete circuit diagrams shall be submitted to Metra for approval prior to construction. **[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", latest revision of APTA standard PR-E-RP-002-98 "Recommend Practice for Wiring of Passenger Equipment", and latest revision of APTA standard PR-E-S-001-98 "Standard for Insulation Integrity". **(SAR-215)** 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.

11.1.3 An electrical load study detailing the electrical loads on each AC phase for 480 VAC and 120 VAC, DC voltage loads and Battery 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]**

11.1.4 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 CENELEC 50128/50657 "Railways Applications – Rolling stock applications – Software on Board Rolling Stock". **[CDRL C-11-03] (SCR-135)**

11.2 VOLTAGES

11.2.1 The A.C. trainline voltage shall be 480 volts, 3-phase, 60 Hz A.C. for heating, air conditioning, ventilation, battery charging, and other loads as agreed upon by Metra and the contractor. Where applicable, equipment connecting to the 480VAC trainline should follow guidelines in accordance with the latest revision of IEEE standard 519 "Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems".

11.2.2 ~~Trainline~~ Low voltage D.C. or 480VAC reduced by transformers to 120 volts A.C. shall be provided for lighting if applicable, air conditioning controls, heating controls, mobility aid lifts, power to USB ports, passenger outlet receptacles and Train Information Management System (TIMS) signs. There shall be an additional 25% extra capacity above the calculated power load for future installation of 120VAC loads by Metra. Where applicable, equipment connecting to the 120VAC circuit should follow guidelines in accordance with the latest revision of IEEE standard 519 "Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems". **(SCR-032)**

11.2.3 The batteries and battery charger shall provide D.C. voltage for exterior lights, door closing lights, mobility aid lift indicator lights, TIMS controls, PA System, door controls, door motors, lighting if applicable, and all cab operational equipment if applicable, and other loads proposed by the contractor and agreed upon by Metra. The contractor shall propose a 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]**

As an option, the battery circuit shall be trainlined in order to distribute DC power for redundancy in case of adjacent car's battery charger & battery failure. If such a design is included in the proposal, the trainlined battery voltage shall be protected by a circuit breaker. The DC voltage power system design shall be subject to Metra review and approval. **[COPL CO-11-01]**

11.2.4 64 volts D.C. trainline from locomotive battery (72 - 76 volts from the locomotive auxiliary generator) in the 27 conductor traction control trainline shall be used for the electric signal buzzer circuit and the Train Communications System.

11.3 LOW VOLTAGE DC POWER SUPPLY

11.3.1 Battery Requirements

11.3.1.1 The battery system shall be sized to carry the full DC load under emergency conditions (defined as after loss of HEP) 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, loco battery trainline backup power for the following: [TIMS, Passenger intercom(s), PA System, train radio (cabs only)] ~~TIMS~~, door closing lights, TIMS destination signs, PA System, Passenger emergency intercom (s), door control circuits, door motors, 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~~ TCMS, passenger seating camera system, lighting if applicable, and additional loads as agreed upon between the contractor and Metra. There shall be an additional 25% extra capacity above the calculated power load for future installation of additional battery loads by Metra. **(SCR-069)**

It is the responsibility of the Contractor to calculate the emergency condition load and verify the size the batteries specified below is adequate to maintain all DC loads for not less than two hours until the calculated aging life of the batteries has been exceeded.

11.3.1.2 Selection and sizing shall meet the load and duration requirement of this specification for each type of car under the following conditions and considerations:

Battery temperature ranging from -5° F to +130° F (The battery charging rate will be reduced when battery temperature rises above 113° F). **(SCR-069)**

The aging factor used to calculate the battery capacity

The recommended state of charge (S.O.C.) from the battery manufacturer based as it relates to the application and the experience of the battery supplier.

Frequent HEP power interruptions in typical train operation and servicing. Batteries cycle frequently between charging and discharging modes while in service.

11.3.1.3 The contractor shall submit a service proven reliable battery design that provides the latest available technology in passenger rail and provides the longest life-cycle cost effective system. The contractor shall select a battery chemistry optimized for Metra's passenger rail application, and shall be subject to Metra review and approval. Battery design shall be in accordance with latest revision APTA PR-E-RP-007-98 - "Recommended Practice for Storage Batteries and Battery Compartments". The contractor shall state in their proposal the appropriate rail passenger vehicle standard(s) being followed for battery sizing for the battery chemistry chosen. If wet cell battery technology is proposed the clear see- through battery case is preferred. If wet cell battery technology is proposed the batteries shall be a low-maintenance type and shall not require the frequent addition of electrolyte, and may utilize a centralized electrolyte fill apparatus. Interval between water toppings shall not be less than 6 months at average Chicago temperature conditions without using recombination vents. Vent caps shall be spring loaded to open with positive latching to close. The battery system design shall be subject to Metra review and approval.

11.3.1.4 The batteries shall have a design service life of not less than 15 years and shall be capable of withstanding a minimum of 1000 deep cycles without failure. The battery design and battery charging shall be sufficient to return fully discharged batteries to the S.O.C. condition in no greater than 5 hours duration based on the recommendation from the battery manufacturer.

Charging profile, such as single rate or dual rate, shall also be based on the recommendation of the battery manufacturer.

11.3.1.5 A load shedding device shall be provided to disconnect all DC loads so the car battery is not damaged running the cell voltage to 0V. The device shall allow at minimum all emergency and vital loads to remain powered by the battery until rated discharge voltage as specified by the battery manufacturer. When the battery discharge voltage is attained the load shed device shall automatically operate to disconnect all loads from the battery. Upon restoration of power by the user, the load shed device shall automatically re-engage all DC loads without requiring any user interaction. A plan for the vital loads and the loads to be shed shall be submitted to Metra for review and approval. **[CDRL C-11-03]**

11.3.2 The batteries shall be installed in a ventilated box. The batteries shall be housed in cases of a fire-retardant design. The boxes shall be so arranged that no product of normal battery charging or any products of combustion, in the event of such occurring in the battery box may enter the car body. At a minimum but not limited to, each battery cell or battery unit shall be permanently marked with the following information: manufacturer's name, battery type, part number, nominal rated capacity, serial number, date manufactured, customer name, customer part number, warning and safety precautions, blank space where installation date can be written. Battery markings shall follow the latest revision of APTA PR-E-RP-007-98 - "Recommended Practice for Storage Batteries and Battery Compartments". Markings shall be resistant to the chemical and mechanical environment encountered in service for the design life of the cell. Battery markings shall be made easily visible to maintenance personnel. Polarity of the positive cell terminal shall be identified by a red post insulator or bushing and/or a plainly marked, P, POS or + symbol. Polarity or the negative post shall be identified with a black post insulator or bushing and/or a plainly marked N, NEG, or – symbol.
The battery box shall be designed to accommodate the batteries selected, shall be easy to access for maintenance, readily and easily allow for visual inspection of the batteries, readily and easily allow for battery replacement, and shall be constructed of stainless steel, subject to Metra design review and approval. **[CDRL C-11-04]**

11.3.3 Battery Charger
A battery charger shall be provided. The charger shall convert the 60 Hz nominal (tolerance range 56Hz-64Hz) 480 +10%/-15% VAC / 3φ input voltage to a regulated DC output voltage to supply the onboard electrical DC loads and to charge the car batteries. The battery charger shall start and operate normally regardless of 480VAC phase rotation sensed at the input of the charger. The battery charger shall feature temperature compensation, which shall vary battery charger output voltage according to battery temperature conditions sensed at the battery. The contractor shall supply the temperature sensor. All loads connected to the battery charger output shall operate normally over the entire voltage range of charging down to battery load shed voltage without damage and without affecting the reliability and serviceable life of each load. The charger shall be self-regulating and circuit breaker protected. At minimum the charger shall be self-protected against the following fault conditions: open circuited battery or wiring, short circuited battery or wiring, ~~battery~~ LV bus ground fault, temperature sensor fault, low input voltage, input phase loss, reversed battery connections, system overload, voltage or current over limit, and other items as agreed upon by Metra and the contractor. Independent LV+ and LV- ground fault detection shall be provided, but ground faults will not cause system power down. The tolerance on output voltage is ±1%, and tolerance on output current ~~output~~ is ±1A or ±5% whichever is greater ~~± 2%~~. The nominal charger output current limit shall be as recommended by the battery manufacturer, and taking into account the contractor's load study. The charger shall be sized with sufficient capacity to simultaneously recharge the battery from a fully discharged state and to support the maximum possible DC bus loads plus a 25% extra capacity reserve beyond the worst case continuous load condition in order to support future DC power loads installed by Metra.. Upon loss of 480VAC, the loads shall be transferred automatically to the batteries instantaneously in order to prevent electrical power interruption to electronic equipment. In case of complete battery charger failure, the DC loads shall

automatically continue to be powered by the car battery without interruption. The battery charger shall have the ability to automatically recharge the battery from any state of discharge, including 0 volts across the battery terminals. The battery charger shall have ~~an~~ virtual indicator panel (using the Crew Display Unit) to display voltages, currents, and have individual indicators to display battery charger status. ~~A lamp test pushbutton shall be provided, which when pressed will cause all lamps to light. An additional push button shall be equipped to start/stop a maintenance charge according to the voltage, current, and time duration parameters as configured by the PTE software by the end user.~~ PTE software shall be provided along with the battery charger, and be developed for use on a laptop with the latest version of windows installed. Settings shall be user adjustable with provided PTE software, without requiring a firmware update to the battery charger. Any settings adjusted by the end user shall be stored in non-volatile memory. Any user adjusted settings shall be saved and maintained even under conditions of power cycling or extended power loss. An example of user adjustable settings are: the ability to adjust output voltage set points, adjust output current limit set points, adjust charging algorithm for single rate or dual rate charging, ability to set a user defined output voltage, output current limit, ~~and time duration for the purpose of completing a maintenance charge~~, and adjustment of temperature sensor compensation parameters, and other items as agreed upon by Metra and the contractor. Temperature compensation and low voltage shutdown features are to be provided. It is the responsibility between the contractor and car builder, and subject to Metra review and approval, to determine the optimum cooling scheme for the battery charger that is most appropriate for the application. It is also the responsibility between the contractor and car builder, and is subject to Metra review and approval, to propose an appropriate efficiency target for the battery charger. **(SCR-094)**

The battery charger shall meet at minimum the performance standards:

Altitude	A2 range of EN 50125-1, up to 1000m
External air temperature	-20F / +130F
Storage temperature	-20F / +150F
Humidity	EN 50125-1, 0 to 100% humidity
~~Solar radiation~~	~~Up to 300W/m^2~~
Vibration	IEC 61373, Category 1 Class B. FEA analysis and calculation report to be provided This equipment is expected to work normally after these kind of vibrations.
Shocks	IEC 61373, Category 1 Class B. FEA analysis and calculation report provided. This equipment is expected to work normally after these kind of shocks.
Dust	EN 60721-3-5 / EN50125-1
Static Load Test	APTA SS-C&S-034-99 Static Load Factor: -Longitudinal +-8g -Vertical +-4g -Lateral +-4g This equipment is expected to work normally after these kind of static load tests.
EMC	50121-3-2
Electronics	EN 50155
~~Input Voltage~~	~~50163, over voltage due to lightning~~
Power Converter	~~CEI~~ IEC 61287-1, ~~EN 50207~~ For power converter tests **(SCR-091)**
Quality Assurance	ISO 9001
Input Over Voltage	~~2800V peak during 20mS (with a minimum HEP source impedance of 50 ohms)~~

	~~This input overvoltage transient requirement is based on a previously existing battery charger product specification for existing Metra Nippon Sharyo Gallery Cab Cars.~~ APTA PR-E-RP-015-99 paragraph 8 (Appendix A) and EIC 62236-3-2
Inrush Current Limitation	~~<2*In (nominal input current)~~ 75% x 1/12 of low end of locomotive HEP circuit breaker trip curve.
~~IP Mechanical Protection~~	~~Minimum IP 65 or better, with the requirement of no permitted water or dust ingress~~
Insulation Test	Insulation integrity for dielectric between the ground and all 3 phases of the 480VAC input, between ground and battery charger output (s). Minimum insulation test requirement shall be 2500VRMS, 60Hz, 60 seconds between input connections connected together and the ground.
Ripple	~~Maximum allowable 100~~ goal of 300mV peak to peak, with 1V absolute maximum pk-to-pk. **(SCR-094)**

The design of the battery charger is subject to Metra review and approval. **[CDRL C-11-05]**

11.3.4 Batteries and battery compartments shall comply with APTA PR-E-RP-007-98 Recommended Practice for Storage Batteries and Battery Compartments.

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 the Main Circuit Breaker Locker and the Electric Lockers on each end of the car.

All switches, circuit breakers, relays, resistors, etc., shall be identified by plastic nameplates clearly identifying the electrical circuit it controls. The ampere rating for each circuit breaker shall be indicated on the toggle lever. All circuit breakers and switches shall be indicated ON with toggle up and OFF with toggle down.

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.

The circuit breaker panels shall be dead front type, with removable front covers, of a design such that all components are front serviceable. Circuit breakers shall be arranged so that the handles move vertically, with the ON position up. 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.

The panels shall be conveniently located, in the electrical locker, for ease of access by service personnel. Reduced wiring and ease of maintenance shall be of prime consideration. If it is impractical to house all circuit breakers in the electrical locker, additional circuit breaker panels may be proposed for Metra approval.

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.

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

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. The proposal shall exhibit solutions for built-in trainline redundancy and interfacing with Metra's current locomotive trainline configuration. **[COPL CO-11-02]** ***[VRESD V-11-01]*** *All trainline systems described below in Sections 11.5.1-11.5.7 shall be subject to VRE design review and approval.* ***[CDRL C-11-07]*** *The 27 wire locomotive control trainline, door control trainline, and communications trainline systems may not be built in to the digital IP based trainline system.* ***[VRESD V-11-01]***

11.5.1 480 Volt Trainlines

11.5.1.1 A 480 volt nominal, 3-phase, 60 Hz A.C. power trainline consisting of six ~~500 MCM~~ 535 MCM cables arranged as two parallel 3-phase circuits shall be provided per car. All 480VAC jumpers and receptacles in material composition and construction shall meet or exceed specifications in latest revision of APTA PR-E-RP-018-99 and APTA-PR-E-RP-016-99 and shall be compatible with existing locomotives. **(SCR-074)**

A power control trainline consisting of two 6-conductor 12 AWG cables shall also be provided on each car.

11.5.1.2 Two 3/3 pole receptacles shall be provided at both ends of the cars. The receptacles shall be mounted on the car ends, one on each side of the car with the jumper assemblies adjacent to each receptacle.

11.5.1.3 Two 3/3 pole hard wired jumper assemblies shall be provided at both ends of the car. The jumper plugs shall be yellow in color.

11.5.1.4 At the end of the car in the train, the two jumper plugs must be inserted into the adjacent receptacles to complete the control circuit, permitting the main trainline contactor in the head-end power car to close.

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 27 Wire Locomotive Control Trainline

11.5.3.1 All cars shall be provided with one (1) 27 wire trainline to control the operation of the locomotive from the operator's station in cab control cars. The wire size, functions and pin assignments are shown in Appendix "A". In addition, four spare conductors shall be provided, except in jumpers. All 27 wire locomotive control trainline jumpers and receptacles in material composition and construction shall meet or exceed applicable specifications in latest revision of APTA PR-E-RP-017-99 and/or APTA PR-E-RP-019-99.

11.5.3.2 This trainline shall be arranged in a wireway with protective covers ~~conduit~~ under the floor of all cars and terminate in a weatherproof junction box located at each end of the car. **(SCR-056)**

11.5.3.3 The locomotive control current shall be trainlined between cars, and between cars and locomotives, by means of a jumper cable on the left side of the longitudinal center line of car when facing car exterior on "B" end. The jumper shall be hard-wired to the "B" end of each car.

A dummy receptacle, with pins, shall be provided adjacent to the hard-wired jumper. The jumper head shall be integrally colored orange. The dummy receptacle shall be integrally colored white.

11.5.3.4 A locomotive control receptacle, including male connections and weatherproof housing shall be provided on the "A" end of each car. The receptacle shall be integrally colored orange.

11.5.4 Communications Trainlines

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

11.5.4.2 The proposer's solution shall be compatible with Metra's locomotive communication trainline connections. The proposer's solution shall allow for all connections from the locomotive to be physically connected to the railcars. However, functionality of Metra's legacy PA1 and PA2 signals are not required to be maintained along the consist.

11.5.5 All junction boxes shall be stainless steel, water tight and weather proof. The inside of the box shall be painted with an insulating paint or varnish. All wires shall be terminate using ring tongue lugs, mounted onto terminal blocks in the junction boxes. The face of all end junction boxes shall be angled such all receptacles are angled downward ~~30~~ 15 degrees. **(SCR-057)**

11.5.6 Where applicable, all connections between car trainlines and, receptacles and jumpers shall be made in the end junction boxes by means of terminal boards.

11.5.7 Digital Trainlines

11.5.7.1 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.

11.5.7.2 ~~Fiber cable (digital trainline) backbone~~

~~The car shall have two multimode fiber optic cables (digital train line), or Metra approved alternative equivalent technology, to make the communication backbone in the car. Each fiber optic cable will extend from one optical switch to the location of the next optical switch on the opposite end of the car. The fiber cables shall be placed in conduit in the car between the points of connection.~~ **(SCR-106)**

11.5.7.3 Ethernet cable (Digital trainline)

On each end of the car shall be a digital trainline receptacle. Cabling shall go from the receptacle to the ends of the car on the upper level inside of the carbody where it will terminate at the ~~optical~~ switch. This cable shall be Full-Duplex Gigabit Ethernet compliant with IEEE Standard 802.3-1999. The digital trainline shall be two separate Ethernet links. The contractor shall supply a jumper cable to go between cars from the receptacle of one car to the receptacle of the adjacent car for car-to-car communications. The jumper and receptacle shall be at a minimum an IP67 grade connector when mated. The jumper and receptacle shall feature a locking mechanism for quick coupling and un-mating and shall be tolerant to high vibrations. The jumpers will be designed with keyways to ensure that there is only one way to connect the jumper and so prevent damage to internal connectors. The jumper or receptacle 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 fixed receptacle will have a cover plate that will automatically close to prevent water ingress to the connector surface and damage to the connectors. 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 with an industrial woven, close fitting, sleeve that will ensure mechanical protection 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 continuous over 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. The contractor shall clearly indicate in design documentation the earthing point that should be used and this shall be approved by Metra. The digital trainline shall have a total bandwidth of no less than 1000 Mb/s. **(SCR-106)**

11.5.7.4 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]**

11.5.7.5 ~~Trainline Optical Switch~~

~~The Contractor will make provision for the installation of the trainline optical switches (2 per car) located at each end of the car near the access points. Low voltage D.C. or 120VAC power shall be supplied for each optical switch. The mechanical footprint of the electrical switches shall be minimized. The trainline optical switches will be the terminating point for digital communications equipment as agreed to by Metra and the Contractor~~ **(SCR-106)**

11.6 120 VAC POWER SUPPLY

11.6.1 ~~Three, single~~ One three-phase, 480/120 volt A.C. transformer~~s~~ connected delta to wye with neutral ~~delta or other contractor proposed equivalent alternative~~ shall be provided to supply 120 VAC to applicable loads ~~volt, single-phase A.C. for lighting, temperature control, etc~~. from head end power source on all cars. Calculations shall be provided to demonstrate that the transformers have the sufficient capacity to supply their intended loads. All inputs and outputs shall be circuit breaker protected. Transformers shall be derated at least 10% for current, or other appropriate approved factor based upon duty cycle. The contractor shall demonstrate by calculation that there is sufficient ventilation to prevent transformer failure and/or damage resulting from excessive heat buildup, during all operating conditions. **(SCR-098)**

11.6.2 A surge protective device (SPD) shall be provided to offer overvoltage/transient suppression on 120 volt A.C. line to line and line to chassis circuitry. The SPD shall be at minimum UL 1449 3rd Edition Listed and provide an LED protection status light that indicates when the device is functioning properly. The design of this device shall be subject to Metra review and approval. **[CDRL C-11-08]**

11.6.3 A 120 volt A.C. receptacles shall be provided in passenger area or electric locker area on each end of each car. The receptacles shall be equally dispersed on both levels of each passenger compartment. 120 volt A.C. receptacles shall be provided on cab control cars located within the cab signal locker to provide power for the water cooler and for downloading

event recorder data. Location and arrangement of all receptacles are subject to Metra approval. All receptacles shall be hospital grade. Passenger outlets supplying 120 Volt, 60 Hz type power shall be protected via a UL-approved GFCI outlet ~~circuit breaker~~ intended for personal protection and shall have a ground pin that shall be grounded to the chassis of the car-body per the latest revision of APTA specification APTA PR-E-S-005-98. **(SCR-099)**

11.6.4 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 port shall be a minimum of dual 5 amp (shared) outlets and shall be compatible with all Apple and Android mobile devices. ***[VRESD V-11-02]*** *USB and/or 120VAC outlet charging port may be proposed for each seating position, except flip seats where not possible. USB port shall be a minimum of dual 5 amp (shared) outlets and shall be compatible with all Apple and Android mobile devices.* ***[VRESD V-11-02]*** **(SCR-033)**

11.7 CONDUIT

11.7.1 Conduits shall be in accordance with APTA PR-E-RP-002-98 “Recommended Practice for Wiring of Passenger Equipment”. An exception may apply for trainline cables which may be cleated to the underfloor structure, in such manner as to prevent wire chafing. Aluminum conduit is not acceptable for this application.

11.7.2 All conduit located overhead within the car body shall be arranged so that it is not located in the air duct. 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 conduit 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. All conduit fittings and junction boxes shall be provided with gasketed covers. The conduit arrangement shall be subject to Metra review and approval.

11.8 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~~ PR-E-S-005-98. **(SCR-014)** **(SAR-216)**

11.9 CAR LEVEL MONITORING SYSTEM

11.9.1 A car level monitoring system shall be proposed. **[PDRL P-11-02]** 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, review saved logs, and download saved logs when connected to the monitoring system. The car level 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 POE 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

car level 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 include a ~~removable 120GB or larger capacity solid state drive (SSD)~~ a minimum archiving capacity of 120 GB. 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 car-level monitoring system shall be subject to Metra design review and approval. **[CDRL C-11-10] (SCR-103)**

11.9.2 The contractor shall propose, as an option, a condition-based remote monitoring and diagnostic system. This system shall capture and analyze data from components and subsystems aboard the railcar and report a course of recommended action (such as inspection, repair, maintenance, or replacement) in order to prevent a breakdown or failure of Metra Equipment while in service. The remote monitoring and diagnostic system shall be able to update software on the systems on the railcar without having to physically access the units. This system shall have a flexible software interface to allow integration into a wide variety of Back Office based systems. The data that is monitored shall apply to the systems described in 11.9.1 and shall include: process data such as temperature, amperage, 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-11-03]**

11.10 PROPOSAL DELIVERABLES REQUIREMENT LIST

PDRL	**Title**
P-11-01	Electrical System and Load Study
P-11-02	Car Level Monitoring System

11.11 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

11.12 CONTRACT OPTIONAL PROPOSAL LIST

COPL	**Title**

CO-11-01	Trainline Battery System
CO-11-02	Integrated Digital Trainline
CO-11-03	Remote Monitoring System

12 COMMUNICATION SYSTEMS

12.1 GENERAL REQUIREMENTS

12.1.1 The system shall communicate between railcars 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 engine control station to the passengers (Public Address System, Paging);

12.1.4.2 Two-way private communication between the engine control station and the train crew (Intercommunication System Function);

12.1.4.3 Two-way communication between passengers and the train crew/engine control station (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.

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]**

12.1.5 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. **(SWR-154)**

12.1.6 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:

12.1.6.1 Clever Devices IVN-R, 32G GPS Part #404-2185-0001

12.1.6.2 Clever Devices Bracket, IVN4 Part #101-120-0130

12.1.6.3 Clever Devices Transit Control Head, Rail Part #103-300-0009

12.1.6.4 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 18.16 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.

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.

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.

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

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

12.2.3.2 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.

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

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.

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

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

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.

12.2.3.3 There shall be a minimum of one (1) speaker in each compartment where a passenger may reside in, including passenger seating areas (which likely require more than one speaker) and in each passenger boarding/alighting area. 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]**

There shall be a minimum of one (1) speaker on the exterior on each side of the car. They shall be high performance loudspeakers.

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.

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

The volume levels of each passenger area, including the exterior speakers, shall be adjustable

independently by a maintenance person.
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.
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-60268-202~~-16~~ when measured in an ~~quiet,~~ empty car at standstill, with the air conditioning system stopped. **(SCR-133)**

12.2.3.4 An AAR Base, if required for the design, shall be provided in each car, to serve as a junction box for wiring to the P.A. System. The car and train wiring shall terminate on barrier terminal strips. The AAR Base may also serve as an amplifier mounting base. An alternate mounting arrangement may be proposed to Metra for approval.

12.2.3.5 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:

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

12.2.3.5.2 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.

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

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

12.2.3.5.5 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.

12.2.3.5.6 The EPIU shall auto-disconnect after a predetermined time subject to Metra approval beyond completion of the conversation.

12.2.3.5.7 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.

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

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

12.2.3.6.1 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: **(SCR-141)**

12.2.3.6.2 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.

12.2.3.6.3 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.~~ **(SCR-141)**

12.2.3.6.4 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.

12.2.3.6.5 A speaker assembly shall be provided on the operator's side of the cab. 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 11.5.7 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 The Public Address system shall be compatible with Metra's existing locomotive fleet 16-pin communication trainline.

12.3 TRAIN RADIO

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]**

12.3.1 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.

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

12.3.2 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.

12.3.2.1 Clean cab mounting plate to be provided.

12.3.2.2 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.

12.3.2.3 The radio requires a handset hang-up cup (or alternate Metra-approved design) ~~shall include a radio control reverting switch.~~ **(SCR-155)**

12.3.2.4 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

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

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

12.3.5 The cab radio shall meet AAR S-9401 Vehicle Interior Cab standards (or Metra approved equivalent) for Humidity, Vibration, Mechanical Shock, and Abrasive Environment. **(SWR-154)**

12.3.6 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).

12.3.7 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.

12.3.8 A full functional qualification test of the train radio shall be completed. The qualification test procedure shall be subject to Metra review and approval. **(SWR-154)**

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

12.4 BUZZER SYSTEM

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

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

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

12.4.3 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

[VRESD V-12-01] *Compatible with the VREs current system provided by ISC, or the contractor may propose a different solution that can be adapted on the existing fleet of 100 Gallery IV cars.* ***[VRESD V-12-01]***

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.

The programmable controller unit is to be mounted in the vicinity of the passenger boarding/alighting areas, adjacent to the door control panel, in a secure enclosure. A lock keyed to Metra's standard coach key is preferred.

12.5.8 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 up-dates 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.

12.5.9 The system shall allow for ~~live~~ text to speech announcements sent directly from the base station server. **(SCR-132)**

12.5.10 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]**
The contractor shall propose additional infotainment options to Metra if they are available. **[COPL CO-12-01]**

12.5.11 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.

12.5.12 The system shall feature advanced features to assist ADA passengers with hearing and visual impairments, such as: speech to text of announcements, text-to-speech of announcements, and assistive listening or induction loop systems. The proposer shall describe the design and functionality of the ADA features for ADA passengers with hearing and visual impairments in their proposal as part of the Proposal Deliverable **[PDRL P-12-01]** for Metra review and approval.
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]**

12.5.13 The system will provide the following announcements automatically over the train's public address system and signage system for the selected train number:
Train destination and scheduled station stops prior to departure from the initial terminal;
12.5.13.1 Train destination and scheduled station stops repeated along with emergency exit announcement after exiting the initial terminal;
12.5.13.2 Emergency exit announcement prior to the arrival at the final destination;
12.5.13.3 Announce an upcoming station prior to arrival;
12.5.13.4 Announce the next station stop upon departure from a station (The signs shall continuously display this until the next arrival message is prompted);
12.5.13.5 Announce delay when a train is behind schedule and announce the reason for the delay if available and;
12.5.13.6 Announce any modifications to the normal schedule and any special announcements programmed.
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.

12.5.14 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 provided that the consist is a continuous series of Alstom cars. 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 ‘___’.” **(SCR-187)**

12.5.15

12.5.16 Interior/Exterior Signs

12.5.16.1 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.

12.5.16.2 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.

12.5.16.3 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.

12.5.16.4 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.

12.5.16.5 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.

12.5.16.6 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.

12.5.16.7 The interior signs shall be capable of featuring emergency messages and run off a backup power source in the event of a power failure situation.

12.5.16.8 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.

12.5.16.9 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.

12.5.16.10 Optionally, the contractor shall provide exterior information signs on the car. These signs shall provide information to passengers on the platforms such as: train number, car passenger load, restrooms onboard, ADA areas full, and advertisements. Short duration advertisements shall be able to be programmed/uploaded by Metra to be displayed periodically between displays of more vital passenger information. It is not expected that all of the aforementioned information will be displayed simultaneously. Exterior signs shall by proposed as an option. **[COPL CO-12-03]**

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

12.5.17 As much as possible, the ~~The~~ system shall utilize ~~an open architecture to provide~~ Commercially Off The Shelf solutions 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. **(SCR-107)**

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 or passenger boarding/alighting areas and all applicable interconnections. The DVR system shall be powered from a separate circuit breaker (on the breaker panel). ~~A terminal board panel will be applied in a dry location near the DVR for all DVR (power and signal) connections to be made.~~ 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 railcar 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~~ have the capability to use an existing train-to-ground connection (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. **(SCR-104)**

12.6.12 The video archive is desired 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 railcar 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 Upon starting the software, the main screen shall automatically (and without user interaction) display in real time live video viewports of all the cameras simultaneously. The viewports of all the video channels shall be visible simultaneously and without obstructions to the user on the main screen. The user shall not be required to make any clicks, minimize or maximize windows to cycle through to view video camera channels. 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. 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~~ operating configuration parameters as needs change and shall not be locked into the requirements as defined in this section. **(SCR-186)**

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 railcar'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	Additional Infotainment Options
CO-12-02	ADA Passenger Enhancement Options
CO-12-03	Exterior Digital Signage
CO-12-04	Passenger Wi-Fi

13 BRAKE SYSTEM

13.1 GENERAL REQUIREMENTS

13.1.1 A conventional pneumatic brake system with microprocessor controls shall be provided on all cars unless specified otherwise by Metra. The braking system shall include a system for service and emergency brake applications for all cars in the train, control equipment to be installed on the cab car to provide braking control for the train brakes and a parking or hand brake. Brake system proposal shall include brake system schematics and basic system description. **[PDRL P-13-01]**

All brake equipment shall be completely compatible with Type 26C/26L air brake equipment and all North American locomotive electronic air brake equipment systems, currently in use in Metra & VRE commuter rail service. The air brake system shall be capable of running in conventional service in graduated release mode.

The Contractor shall provide detailed description of proposed brake system (including all components), its functionality and interaction with other systems for Metra review and approval. **[CDRL C-13-01]**

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.~~ Primary brake control valve portions and secondary valves where applicable shall be manifold mounted for easy of removal and replacement. **(SCR-128)**

13.2 BRAKING POWER AND PRESSURE

13.2.1 The braking ratio shall be equal to that of existing cars. The braking ratio of existing cars with composition shoes is 42.4% at the emergency pressure of 92 P.S.I. and 27.6% at 60 P.S.I. full service. Brake system proposal shall include design calculations of the proposed system brake ratios for emergency and full service application **[PDRL P-13-02]**

13.2.2 Anti-skid/wheel slide provisions in regards to braking are not required, but can be proposed by the Contractor. If a wheel slide system is proposed, the system and its installation shall be submitted to Metra for review and approval. **[CDRL C-13-02] [VRESD V-13-01]** *A wheel-slide protective system, WABCO type E-7, Knorr type MGS2, or approved equal, shall be provided, with electronic control equipment mounted underfloor in weather-proof boxes.* **[VRESD V-13-01]**

13.2.3 The following shall be the nominal working pressures of the air brake system, in pounds per square inch considering a minimum air quality provided by the locomotive to be of Class 4.3.4 according to ISO 8573:

13.2.3.1 Brake Pipe 90-110 P.S.I.

13.2.3.2 Main Reservoir 130-140 P.S.I.

13.2.3.3 ~~Brake Cylinder (Full Serv.) 60 P.S.I.~~ The nominal working pressures of the air brake cylinders in Full Service applications may be adjusted to ensure the aforementioned braking ratio of existing cars.

13.2.3.4 ~~Brake Cylinder (Emergency) 90 P.S.I.~~ The nominal working pressures of the air brake cylinders in Emergency applications may be adjusted to ensure the aforementioned braking ratio of existing cars.

13.2.3.5 Minimum Brake Pipe to obtain an emergency brake application 50 P.S.I.

13.2.4 ~~Variable load or load weigh equipment may be provided.~~ **(SCR-035)**

13.3 TRUCK COMPONENTS

13.3.1 The car shall be equipped with a combination disc and tread brake equipment. The axle mounted brake disc shall incorporate cooling ribs that are arranged between the friction surfaces in order to provide adequate heat dissipation while the train is moving. Friction surfaces shall have a shoulder or indicator around the edge to show when the disc surface is worn to the condemning limit. The disc shall be manufactured from material suitable for the expected temperatures experienced under operating conditions, which shall be demonstrated via a brake disc thermal calculations for the rates, conditions, and vehicle weights as specified in Section 3.1.8.

The actuators for the disc brakes and tread brakes shall operate at the same air pressure from the same air source.

Brake effort contributions from disc and tread brakes shall be specified to avoid wheel thermal cracking and brake disc damage. Under all circumstances, the brake performance defined in this specification shall be achieved. ***[VRESD V-13-02]*** *The car shall be equipped with tread brake equipment only.* ***[VRESD V-13-02]***

13.3.2 Disc Brake Actuator

An air actuated caliper mounted on the truck frame shall be used in conjunction with each disc to develop braking effort. Automatic slack adjusters shall maintain a ~~0.03 in. to 0.06 in~~ 0.039 to 0.079 in. clearance between the pad and the disc when brakes are released. **(SCR-182)**

Pad holders and disc pads shall be equipped with a locking device. The slack adjuster shall have sufficient capacity to maintain nominal shoe clearance and piston travel through the full range of new to worn discs and brake pads.

Disc brake actuators shall be capable of handling pressure up to 140 psig without damaging the actuator, disc, brake rigging or any other system or component on the vehicle.

~~One disc brake equipment on each axle of the B-end truck shall be equipped with hand brake linkage or parking brake actuator.~~ **(SCR-082)**

13.3.3 Tread Brake Units

A truck mounted air actuated tread brake unit, with integral ~~single acting~~ slack adjuster shall be applied at each wheel. The tread brake unit shall operate in conjunction with the adjacent disc brake caliper from the same air source.

Tread and disc brake system shall be designed for the ~~equivalent of 150% braking of the~~ ready-to-run weight of the car. All cars shall be provided with truck mounted (4 per truck) unit tread brakes operated by ~~diaphragms~~ pistons. Installation and design shall be subject to Metra review and approval [CDRL C-13-03]

The slack adjuster shall have sufficient capacity to maintain nominal shoe clearance and piston travel through the full range of new to worn wheels and brake shoes, and shall provide sufficient clearance to install a 2 inch brake shoe against a new wheel. **(SCR-163)**

13.4 PIPING AND FITTINGS

One tread brake ~~union~~ **or disc brake unit on** each axle ~~of the B-end truck~~ **(SCR-001, SCR-002)** shall be equipped with hand brake linkage or parking brake actuator piping and fittings.

13.4.1 Brake pipe shall be 1 1/4 inch AAR standard pipe, or equivalent. Each car shall receive a brake pipe restriction test.

13.4.2 The main reservoir equalizing pipe shall be one (1) inch AAR standard pipe, or APTA-PR-M-S-029-21 equivalent. **(SCR-001, SCR-002)**

13.4.3 All branch air piping shall be AAR standard pipe, or APTA-PR-M-S-029-21 equivalent, **(SCR-001, SCR-002)** below floor level. Type "K" copper tubing may be used above the floor level as an alternate.

All fittings shall be of AAR type malleable iron or copper, or APTA-PR-M-S-029-21 equivalent, to suit the particular pipe application requirements and shall be socket weld type, when appropriate. **(SCR-001, SCR-002)**
Prior to installation of any air brake system valves and accessories, the piping shall be cleaned. After all cutting, fabrication, and bending is complete, piping must be deburred**, and** blown out ~~with steam, and simultaneously pounded~~ **(SCR-001, SCR-002),** blown out with steam, and simultaneously pounded to remove scale or dirt before application to car. All pipe openings must be capped or plugged until connected into the system
During application to the car and prior to connection to the brake equipment, all piping must be blown out with air using a minimum pressure of 50 psi and a minimum duration of 20 seconds. All pipe routes shall be designed to eliminate water traps.

13.4.4 AAR ~~standard~~ AAR Manual Section E, Standard S-4020 test gauge fittings, for single car testing shall be supplied in the brake cylinder pipe, one at each end of the car. **(SAR-019)**

13.4.5 Reservoirs of the capacity necessary to meet the performance requirements shall be provided. On cab cars, the possible need for air for the horn and bell shall be recognized and additional main reservoir capacity shall be provided for this purpose and to permit ~~fast~~ normal recharge of Brake Pipe per approved system design. They shall be mounted with a slope toward one end where a self-locking drain valve shall be installed, accessible for draining. All reservoirs at main reservoir pressure shall be drilled according to FRA standards. The main reservoirs shall be designed with a safety factor of five times the normal working pressure. All other reservoirs shall be designed with a safety factor of four times the normal working pressure in accordance with ASME pressure vessel standards. The details of size and installation of all reservoirs shall be reviewed and approved by Metra. **[CDRL C-13-04]**

13.5 END CONNECTIONS

13.5.1 All cars shall be provided with two (2) 1 1/4" self-locking ball type cocks on the brake pipe trainline.

13.5.2 The following hoses shall be provided for the brake pipe trainline:
13.5.2.1 Two (2) hoses (Brake pipe intermediate)
13.5.2.2 Two (2) hoses with FP-5 coupling (Brake pipe end);

13.5.3 All cars shall be provided with the following equipment in order to charge the main reservoir on the last car of the train (cab control car) based on a train consisting of up to twelve (12) cars:
13.5.3.1 Two (2) 1" self-vented ball type cut-out cocks with locking handle (MRE pipe), with cock open handle perpendicular to the pipe;
13.5.3.2 Two (2) hoses (MRE pipe intermediate);
13.5.3.3 Two (2) hoses with LS-4 coupling (MRE pipe end);

13.5.4 Brake pipe and main reservoir hoses shall be AAR approved and dated. The hoses shall not part or distort when coupled with a car or locomotive and negotiating the curves described in section 3.2.1.

13.5.5 A suitable pipe rack shall be furnished to keep the inter-car connections from fouling under all operating conditions, when such connections are not independent of the coupler.

13.5.6 E & L vented type and F dummy couplings shall be provided.

13.6 EMERGENCY BRAKE VALVE

13.6.1 The car shall be provided with two valves per car located in diagonally opposite corners ~~of~~ near passenger boarding/alighting areas. The valves, when actuated, shall cause an emergency brake application to all cars in the train. They shall be marked "Emergency Brake Valve". **(SCR-038)**

13.6.2 An emergency brake valve shall be provided in the observer's side of the cab of cab control cars.

13.7 HAND BRAKE OR PARKING BRAKE

13.7.1 All cars shall be provided with one (1) electric handbrake or parking brake with hand operated controls ~~lever-type or push button handle~~ for manual operation. Handbrake or parking brake hand controls shall be located at a position and of a type to be agreed upon between Contractor and Metra in CDRL C-13-01. **(SCR-070)**

13.7.2 A combination of disc and/or tread brake units of sufficient quantity shall be equipped for hand brake linkage or parking brake actuators to meet the grade holding requirements of Section 13.7.3. **(SCR-082)**

13.7.3 Each handbrake or parking brake with associated rigging, if required, must be capable of applying the brakes on each axle of the adjacent truck, and of holding a fully loaded (AW3) car on a four and one-half percent (4.5%) grade with a force of not more than 125 pounds applied on the handbrake ~~handle~~ manual controls. As part of the design review, the Contractor shall provide to Metra a calculation of braking forces to demonstrate compliance with these specifications. [CDRL 13-05] These calculations shall conform to APTA Standard PR-M-S-006-98 Rev. ~~2~~3, Standard for Parking Brakes for New Passenger Locomotives and Cars. **(SCR-070)**

13.7.4 The hand brake or parking brake rigging if so equipped, both car body and truck, shall clear all piping, conduit and undercar equipment. Rigging components shall be sized and arranged to prevent binding. **(SCR-070)**

13.8 BACK-UP FEATURE

A permanent back-up pipe and valve shall be provided on the cab control end. The valve shall consist of a valve and whistle in one assembly.

13.9 AAR S920 COMPLIANCE

The Contactor shall comply with AAR S920 (AAR CID) for and all required data fields shall be provided with each car history book electronically in Microsoft Excel or CSV format.

13.10 PROPOSAL DELIVERABLES REQUIREMENT LIST

PDRL	Title
P-13-01	Braking System
P-13-02	Braking Performance Calculation

13.11 CONTRACT DELIVERABLES REQUIREMENT LIST

CDRL	Title
C-13-01	Brake System Description
C-13-02	Wheel Slide System Protection Design (If Applicable)
C-13-03	Tread Brake Unit Design and Installation
C-13-04	Reservoir Design and Installation

C-13-05	Handbrake or Parking Brake Force Calculation
C-13-06	Disc Brake Design and Installation

14 TRUCKS

14.1 GENERAL REQUIREMENTS

~~The trucks shall be cast steel inside swing hanger type single equalized, or fabricated outside frame type. They shall be four wheel trucks with coil spring primary and secondary suspension. The trucks shall be equipped for truck frame mounted unit tread brakes and outboard axle mounted disc brakes. The roller bearings shall be of a rotating end cap design.~~ Proposed Truck system will be cast steel utilizing a single forged "I" beam equalizer design. Bearing will be inboard and disc outboard. Truck will be based on GSI Comet-SEPTA architecture design managed by a US manufacturer compliant to AAR requirements. The maximum design speed of the truck (excluding brakes) ~~shall be designed to remain stable up to~~ is 100mph. Secondary suspension is air-spring, positioned between the car body and bolster. Swing hanger, crossbars, spring planks, and side bearings are not used. The Contractor shall follow all of the guidelines provided in APTA Standard RP-M-009-98, to demonstrate thorough design, analysis, and testing that the truck conforms to the requirements of this Specification. A structural validation plan should be established and followed according to EN 15827, Section 9. The validation plan should describe in detail the list of steps planned to demonstrate structural safety and compliance with the requirements defined in this specification. The validation plan should be submitted to Metra for review and approval. The extent of laboratory and on-track testing will depend on how design loads are established (degree of uncertainty or conservatism), the stress analysis approach, degree of modification of existing service proven components, maintenance and inspection intervals, and the level of safety margin in the stress analysis results. Details of the design, arrangement, installation, and testing of the truck components and assembly shall be submitted to Metra for review and approval. **[CDRL C-14-01]** Truck system proposal shall include a basic general arrangement drawing, service history, and basic description of system function. **[PDRL P-14-01] (SCR-036)**

Only trucks manufactured by a supplier with successful experience in railway passenger truck design and manufacture shall be acceptable. Final assembly needs not be done at an AAR certified shop, however, manufacture of wheels and axles and their mounting shall be performed at AAR certified facilities. Trucks and components shall be only of a service proven design, which has operated in similar service in the United States. The Contractor shall submit the service history of the truck, noting any deviation for this application to Metra for review and approval, prior to selection of truck. **[CDRL C-14-02]**

The trucks shall provide a safe and secure support and guidance system, transmitting accelerating and braking forces to the car body, and must provide comfortable riding quality up to 79 mph and comply with vehicle/track interaction safety limits defined in 49 CFR 213 at all speeds up to 100 miles per hour on track appropriately certified by FRA. The design, arrangement and equipment of the trucks shall be such as to prevent "hunting" or "nosing" at all speeds, and to minimize rocking of truck frame on equalizer springs at critical speeds. **(SCR-036)**

The design stresses in truck parts shall be chosen to provide a conservative factor of safety, consistent with proven truck design practice for heavy duty railway passenger service. In the design of all truck parts, all forces and combinations of forces, including braking forces, must be taken into account. Multiplication of forces due to accelerations and shocks, and non-uniform distribution of vertical loading due to track irregularities and super elevation, must be considered. The design center bearing load for both trucks shall be determined from the heaviest end of the car, using AW3 load, plus train supplies, less truck weight. To this dead

weight must be added all dynamic loads and multiplying factors. The trucks shall be designed and manufactured to perform satisfactorily for a minimum of 40 years. All structural components of truck assembly shall have a minimum design life of 40 years of operation at full seated passenger load (AW1). The design and the selection of materials shall prevent corrosion damage, including the effects of extreme weather conditions, during the 40-year design life.
~~For fabricated trucks, all structural and load bearing members of the truck shall be of steel. The maximum stress recorded at any location shall not exceed: 80% of the yield strength in the truck static test; yield strength in the truck overload (AW3 vertical load,+ lateral load = 25% vertical, & + longitudinal = 15% vertical) analysis; and 60% of the endurance limit (50% to 85% AW1 vertical load,+ lateral load = 25% vertical, & + longitudinal = 15% vertical) for the fatigue analysis.~~
For cast trucks, truck castings are to be radiographically inspected in accordance with ~~ASTM E71~~ ASTM E446. Metra will accept statistical method of radiographically inspecting truck castings as an alternate to inspecting all truck castings upon Metra's review and approval of the Contractor's (or Subcontractor's) inspection plan. **(SCR-090)**
All castings shall be visually inspected using Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.'s standard MSS-SP-55 latest revision as pass/fail criteria, or the bidder shall provide an equivalent inspection plan with pass/fail criteria to Metra for approval. For machined surfaces, the bidder shall provide inspection procedures with pass/fail criteria to Metra for approval. For truck castings other than truck frames, bolsters, and spring plank, both Radiographic and Magnetic Particle Inspections are required per ASTM E-446 and ASTM E-125. Upon Metra/VRE approval, radiographic inspections may be replaced by Saw Cutting for solidity evaluation based on the evaluation method and acceptance criteria established by AAR M-211 Appendix I. The bidder shall provide procedures pass/fail criteria to Metra for approval. **(SCR-188)**
The arrangement of the trucks must provide for maintenance of the design center bearing height for any condition of normal wheel and suspension system wear. The Contractor shall be allowed to shim only on the bolster springs, the equalizer springs and when approved by Metra on the center plate to correct car height or lean. In no case will the Contractor be allowed to shim on the journal housing
The Contractor shall ensure that manufacturers of truck and brake components coordinate to provide full compatibility.
Trucks shall be designed to Appendix 14A.

14.2 DIMENSIONS

The following truck dimensions shall be incorporated in the truck designs:

14.2.1	Wheel Base	8' - 6"
14.2.2	Journal Bearing Size	6-1/2" x 12" Journal Bearing size Class ~~F~~ K Inboard journal style. **(SCR-011)**
14.2.3	Pedestal Opening (cast truck)	~~13-3/8"~~ Pedestal Openings will be 10-9/16".
14.2.4	Wheel Size	~~33"~~ 32" or 36" **(SAR-012)**
14.2.5	Center Bearing Diameter	~~16"~~ 24"
14.2.6	Minimum Clearance of Truck Parts above top of Rail (worst case)	2-1/2"

14.3 TRUCK FRAME

14.3.1 Truck frames shall be stress relieved; ~~cast alloy steel~~, one piece cast, low alloy nickel, steel structure, normalized and tempered, or welded steel fabrication of adequate cross sectional area at all locations. Junction of cross members to side members must be proportioned and shaped to eliminate stress points. Truck frame shall have as much strength and capability of resisting twisting and uneven distribution of loading as possible.

14.3.2 Truck pedestals, shall have austenitic manganese steel liners welded to pedestals. ~~Lugs or projections cast integral with frame for support of pin connected parts (such as swing hangers) must have hardened steel bushings.~~ Pedestal stops shall be secured in an approved manner.

14.3.3 The hangers, brackets and bolts by which the brake equipment is attached to the truck frame shall have an adequate factor of safety for withstanding forces to which equipment will be subjected. The trucks shall accommodate truck mount tread brake units. The dimension between the center of brake shoes shall be at least ~~60"~~ 59.44'' and the brake shoes shall not touch the wheel flange.

14.3.4 The first truck frame shall be tested as described in Section 19.2.2.1. On-track testing of the truck frame and equalizer beam may also be required per the truck validation plan.

14.4 TRUCK BOLSTER

14.4.1 Truck Bolster shall be a one piece cast low alloy Nickel steel structure. ~~The truck bolster shall be an alloy/steel casting, stress relieved, normalized and tempered or welded steel fabrication, of adequate cross sectional area at all locations.~~ The junction of cross members to side members must be proportioned and shaped to eliminate stress points. A longitudinal bolster anchor bolster attachments shall be between the carbody and bolster. ~~A longitudinal bolster anchor on each side shall stabilize the bolster with respect to horizontal movement, utilizing rubber cushioned truck frame and bolster attachments.~~

14.4.2 ~~The bolster shall include an integral center plate. A three piece locking center pin shall be accommodated. A manganese steel vertical wear liner shall be applied to center plate. A composition or polyolefin horizontal wear liner shall be provided.~~ The bolster shall include an integral central bearing between the bolster and truck frame. Two piece locking pin shall be utilized between the truck frame and bolster. Vertical and Horizontal wear liner shall be a polymer material with previous service history and excellent maintenance performance.

14.4.3 The first truck bolster shall be tested as described in Section 19.2.2.1. On-track testing of the bolster may also be required per the truck validation plan.

14.5 SPRING PLANK, SWING HANGERS AND CROSS AXLES (IF UTILIZED)

14.5.1 ~~Swing hangers shall be forged carbon steel to AAR Specification M-126, latest revision, Grade F. Swing hanger pins and bushings shall be of case hardened carbon steel.~~

14.5.2 ~~Swing hanger cross bars and bearings (cast trucks) shall be forged alloy steel.~~

14.5.3 ~~Spring planks shall be one piece, cast alloy steel normalized and tempered, or welded steel fabrication, of adequate cross sectional area. No bolster roll stabilizer is to be provided.~~

14.5.4 ~~Two spring plank safety straps, bolted to lugs in the truck frame, shall be provided per truck.~~

14.6 SIDE BEARINGS

~~The truck shall be provided with two friction type side bearings per truck, having a cast base and rubber insert supporting a cast manganese steel bearing surface. Side bearings shall be designed to contact the car body wear liner but not be under load.~~ Truck frame shall have side bearing pads located between the truck frame and bolster that are provided with a replaceable steel liner. An air gap is specified between the bolster and steel liner to limit lean in extreme conditions and does not contact during normal service. Side bearing pads provide a safety or hard stop for extreme cases of carbody lean.

14.7 EQUALIZERS (CAST TRUCKS)

14.7.1 ~~Equalizer bars shall be "I" beam type.~~ The equalizer shall be ~~drop~~ single forged~~, alloy~~ steel and shall conform to AAR Specification M-127, Grade A, latest revision. The equalizer must be normalized and tempered as called for in that specification.

14.7.2 Equalizer spring seats must be made from low carbon cast steel conforming to AAR Specification M-201, latest revision, Grade B. Design must provide ample strength, and all fillets and corners must have large radii. Equalizer spring seats must be a good fit on equalizer and be attached thereto with adequate size tight fit bolts and lock units.

14.8 SUSPENSION

14.8.1 The truck shall be provided with primary and secondary air springs of adequate capacity to suit the car weight and loading distribution. Trucks are to be designed for coil primary and secondary air springs of suitable proportions for attainment of good riding quality and long life. To this end, springs must be designed on basis of conservative working load stress. Working load for spring design shall be taken as dead load of end of car and truck parts plus proportion of seated load.

There must be an adequate reserve of deflection remaining in the springs. Solid load stress in springs must be well below yield strength of material. Spring material shall be alloy steel, in accordance with AAR Specification M-114 and AISI Specification 5160H.

Springs must have stamped marking indicating manufacturer and date of manufacture on the outside surface.

14.8.2 At a minimum, each truck shall be provided with two shock absorbers to control the vertical motion of the truck bolster.

14.9 TRUCK-TO-CAR ATTACHMENT MECHANISM

The truck-to-car attachment mechanism shall be designed with a minimum 250,000 pounds ultimate shear strength in locked configuration, for locking bolster to car body. The arrangement shall provide for lifting of trucks when the car body is lifted without disengagement of the mechanism.

Entire mechanism shall be in accordance with FRA Regulation 49 CFR Part 238 and APTA Standard PR-CS-S-034-99 Rev. 2, Section 5.6.

14.10 SOUND DEADENING

Fiber reinforced elastomeric sound deadening pads shall be provided in an approved manner between equalizer feet and journal bearing mounting seats (cast trucks). Sound deadening pads, 1/4" thick shall be provided at the top and bottom of all coil springs.

14.11 JOURNAL NUMBER PLATES

The trucks of all cars shall be provided with cast number plates applied at the center of the pedestal opening on truck frames above the journal boxes or in an alternate location if

approved by Metra. The journals shall be numbered according to the AAR Standard "Designation of Sides, Ends, Journals and Journal Box Locations on Passenger Train Cars", alternate (a), such that facing the "B" end of the car from the exterior, the journals shall be numbered, from the "B" end to the "A" end, with Number 1 on the right and Number 2 on the left, and Number 7 on the right and Number 8 on the left at the extreme "A" end. **(SCR-184)**

14.12 WHEEL AND AXLE ASSEMBLIES

14.12.1 AXLES

The axles shall be AAR Class F (except for journal centers and overall length). The Contractor shall confirm the size of the axle by an approved stress analysis.

The axles shall be manufactured in accordance with AAR Specification M-101, latest revision, and finished in accordance with AAR Recommended Practice. Axles must have a fine grain structure. Axles shall have standard AAR end stamping for passenger car roller bearing axles. A record of all heat numbers shall be included in car serial records. Certified copy of chemical and physical tests as specified in AAR Specification M-101, latest revision, Grade F, Item 17, must be made and results sent to Metra. Axles shall be ultrasonically tested according to AAR Specification M-101A, latest revision.

The wheel seats shall be machined in accordance with AAR Wheel and Axle Manual.

Both ends of all axles shall be furnished with a spline.

14.12.2 JOURNAL BEARINGS

The cars shall receive ~~6 ½ X 12, AP-Class F~~ 6 ½ X 9, Class K **(SAR-011)**, or equal~~, integrally housed, rotating end cap, Timken ECO-Turn©~~ Brenco Tru-Guard **(SAR-011)** or equivalent hydrodynamic labyrinth type back seal, grease lubricated roller bearings. Roller bearing races, fingers, seal rings, cones, spacers and other parts placed on axles must be properly assembled or pressed in place, in accordance with bearing manufacturer's and AAR recommendations in AAR Wheel and Axle Manual Section G Part II.

Bearings and all subcomponents (including seals) shall be fully approved by the AAR Manual Section H, Standard M-934 and Standard M-959 and shall be service proven with at least 5 years of passenger railroad service in the US. **(SAR-092)**

~~End cap shall have a 1-1/2 inch hole with a pipe plug applied to facilitate wheel truing.~~

If required, for wheel slide detection system, one hundred toothed magnetic pick-up phonic wheels ~~end caps~~ shall be applied to ~~both ends of all~~ each axle~~s~~. Wiring to journal pickup sensors shall be carefully arranged to permit ready replacement of sensors, and to resist breakage from truck motion and wayside debris. A one-piece integral cable and connector assembly shall be provided to connect between the car-body wiring and the speed sensor ~~transducer assemblies~~ installed on both axles of each truck. Arrangement and details of sensor and lead wiring shall be submitted to Metra for review and acceptance. **[CDRL C-14-03] (SCR-061)**

The bearings shall be designed with a minimum B-10 life of 500,000 miles. The Contractor shall confirm the size by an approved analysis, in conformance with AAR Manual Section H, Standard M-934 size, weight, and speed relationship. **(SAR-092)**

An appropriate bearing housing shall be provided by the bearing manufacturer to accommodate a 10 9/16 ~~13 3/8~~ inches pedestal opening. There shall be no metallic rubbing surfaces other than journal pedestals. The housing shall be equipped with manganese steel liners. **(SCR-061)**

The bearings shall be grease lubricated in accordance with ~~latest AAR specifications~~ Manual H, Standard M-942, and shall require no field lubrication between scheduled bearing overhauls. **(SAR-092)**

The bearings shall be able to be overhauled to OEM and AAR requirements in the US by Metra at multiple companies and shops.

14.12.3 WHEELS

Wheels shall be ~~36" or 33"~~ 32'' diameter, wrought steel, multiple wear, heat-treated, curved plate design conforming to AAR Specification M-107/M-208, latest revision for Class B wheels, with 2 ½" minimum rim thickness, as specified in the AAR Manual of Standards and Recommended Practices. Mill scale shall be removed from the entire wheel so that inspection can be made before application. The wheel profile shall be a narrow flange APTA 220 wheel profile as specified in APTA PR-M-S-015-06 based on AAR-1B ~~(AAR S-669)~~, 1:20 taper, modified for 5.5 inch wheel width. Wheels shall be balanced to the design requirements in accordance with the procedures specified in recognized industry standards. ***[VRESD V-14-01]*** *Wheels shall be ~~36" or 33"~~ 32'' diameter, wrought steel, multiple wear, heat-treated, curved plate design conforming to AAR Specification M-107/M-208, latest revision for Class B wheels, with 2 ½" minimum rim thickness, as specified in the AAR Manual of Standards and Recommended Practices. Mill scale shall be removed from the entire wheel so that inspection can be made before application. The wheel profile shall be a Wide flange AAR type P33 or K36 respectively with 1:20 taper.* ***[VRESD V-14-01]*** **(SCR-008)**

14.12.4 Before assembling wheel and axle sets, the pairs of wheels must be matched as to tape size according to AAR Wheel and Axle Manual, and all operations of boring wheels, assembly, and pressing same on axle, and press tonnages obtained, must be in accordance with recommendations in AAR Wheel and Axle Manual.

Wheels must be statically balanced to with 1.3 Lbs at outside rim diameter and the amount of imbalance to be marked or stenciled on the back of rim face at point of maximum imbalance.

Radial, plane and parallelism for the mounted wheels shall be per AAR requirements. In the absence of such requirements the following shall apply: Radial - .008", Plane - .015", Parallelism - 0.150".

Bearing press charts shall be provided with each mounting wheelset report in addition to the reporting requirements specified in the AAR Wheel and Axle Manual.

14.13 TRUCK GROUNDS

A Metra approved flexible ground strap system shall be provided between the car body and each truck frame. The design and placement of truck ground strap shall be subject to Metra review and approval. **[CDRL C-14-04]**

14.14 ~~AAR S920 COMPLIANCE~~

~~The Contactor shall comply with AAR S920 (AAR CID) for wheelsets as well as truck, draft arrangements, and brake components. Scanned Data shall be provided with each car history book electronically.~~ **(SCR-242)**

14.15 PROPOSAL DELIVERABLES REQUIREMENT LIST

PDRL	Title
P-14-01	Truck System
P-14-02	Ride Quality Simulation

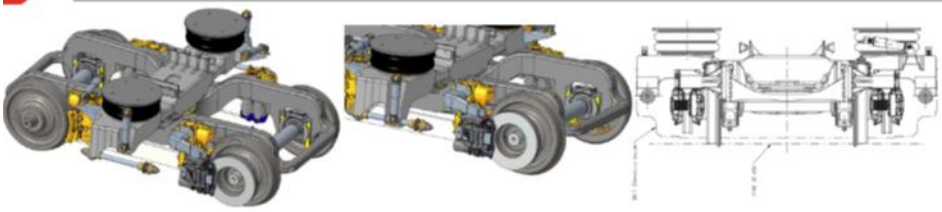
14.16 CONTRACT DELIVERABLES REQUIREMENT LIST

CDRL	Title
C-14-01	Truck Design Review
C-14-02	Service History of Truck
C-14-03	Sensor Arrangement and Wiring (If Applicable)
C-14-04	Truck Ground Strap

14.17 APPENDIX 14A

Truck architecture – alternative architecture

Would Alstom consider an alternative truck arrangement to allow external disc brakes?



AT can proposed an alternative truck design based **SEPTA Silverliner V** truck architecture

- Outboard disc integration confirmed with 2 potential DBU supplier
- Motor and gear box of SEPTA truck removed which allow to accept the over axle load
- SEPTA Design proven for Metra application:
  - Performance compliant to Metra RFP (speed, gauge, track, …)
  - Global architecture of components proven (based on Comet design, AAR compliant,…)
  - Numerical simulation (FEA, Dynamic simulation,…) and validation test will be performed
- Few alternatives design Vs Metra RFQ

Characteristic of Proven Solution	SEPTA adaptation (AT Alternative)
Max D Speed	100MPh (145 Km/h)
Track gauge	4'8,5" (1435 mm)
Wheelbase	102" (2591 mm)
Wheel Diam	32" (813mm)
truck Weight	15800 Lb (7,166 T)
Center plate Load capacity	70 KLbs (31,75 T) → 74 KLbs (33,6T) ok
Axle load	43,9 KLbs (19,9T) → 48K Lbs: 21,8T ok
Max height truck (from rail)	46" (1168,5mm)
Min Curve Rad	250' (76,2m)
Frame	Casted with air tank
Carbody connection	Bolster + air bag + traction rod
Equalizer	Forged
Bearing	Class F Inboard
Damper	2 VS + 2 TS
Primary susp	Spring w/Eq

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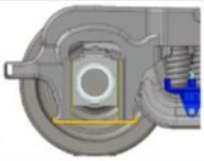
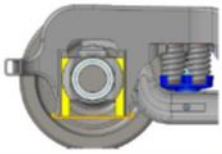
Truck architecture – alternative architecture

Would Alstom consider an alternative truck arrangement to allow external disc brakes?
Could they not find a supplier that provided outboard disc braking, or they just did not want to?

#14.12.2 Pedestal Opening
*An appropriate bearing housing shall be provided by the bearing manufacturer to accommodate a **13 3/8** inches pedestal opening*





Alternative solution : (Service proven) pedestal opening change to **10-9/16"**

Benefits
+ Narrow pedestal opening provides adequate clearance for bearing housing to equalizer beam primary suspension location closer to axle centerline benefits wheel unloading performance
+ Inboard Journal bearing housing size can be minimized to reduce truck weight and weight of components.

#14.2.5 & 14.6 Center Bearing Diameter and Side bearing
- *Center Bearing **Diameter - 16"***
- *The truck shall be provided with two friction type side bearings per truck,*

Alternative solution : (Service proven)
- *Center Bearing **Diameter - 24"***
- *No Side bearing functionally needed **can be add In Option***

Benefits
+ The larger 24" dia. central bearing provides sufficient rotational resistance for running stability. Thereby it 's eliminating the need for friction side bearings saving maintenance cost and time
+ The larger 24" dia. central bearing fully supports heaviest bolster loading further eliminating the need for side bearing units

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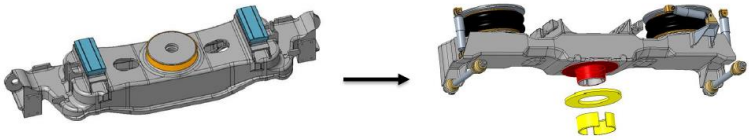
Truck architecture – alternative architecture

Would Alstom consider an alternative truck arrangement to allow external disc brakes?
Could they not find a supplier that provided outboard disc braking, or they just did not want to?

#14.4.2 Center plate
The bolster shall include an integral center plate



Alternative solution : (Service proven)
Cast integral Center plate is provided on the bolster with truck swivel occurring between the truck frame and bolster:

Benefits
+ Polymer wear liners are easy replaced with no tools required with same life time than manganese liner on Gallery
+ Visual inspection of the horizontal liner thickness can be performed on a fully assembled truck
NB: Wheel wear compensation shim are forecasted to be done at central bearing between bolster and horizontal wear liner (*yellow ring*)

#14.4.5 & 14.8.1 Secondary Suspension
- Spring Plank, Swing Hanger and cross axles is requested
- The truck shall be provided with steel coil type primary and secondary springs

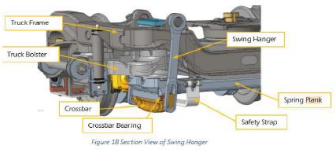
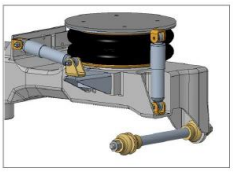


Figure 18 Section View of Swing Hanger



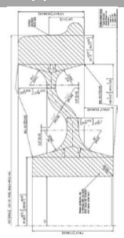
Alternative solution : (Service proven)
Air bag, lateral bumpers and lateral and vertical shock absorbers on a bolster

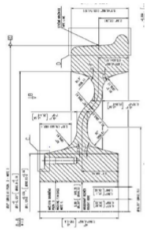
Benefits
+ Better damping of lateral acceleration improving passenger comfort
+ Better vertical filtration with rubber elements reducing vibration and noise transmission from truck to carbody
+ Air springs improve rider comfort over coil springs
+ Air spring provide a consistent carbody height under all loading conditions.

Truck architecture – alternative architecture

Would Alstom consider an alternative truck arrangement to allow external disc brakes?
Could they not find a supplier that provided outboard disc braking, or they just did not want to?

#14.12.3 Wheel diameter
Wheels shall be 36" or 33" diameter
Wheel profile as specified in APTA PR-M-S-015-06 based on AAR-1B (AAR S-669), 1:20 taper, modified for 5.5 inch wheel width.





Alternative solution : (Service proven)
Wheel diameter will be 32"

Benefits
- No impact on maintenance as wheel wear capacity remain the same 1,5"
- APTA 220 profile will be adapted and VRE

NB: 33" can be adapted but will impact the frame design and increase the wheel base of 1" (102" to 103")

With RFP exceptions described

*SEPTA Silverliner V truck design , **PROVEN,** can be proposed in order to:*

- *Integrate outboard disc*
- *Improve Metra performance*

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15 CAB CONTROL STATION

15.1 GENERAL REQUIREMENTS

An operating station shall be located on the lead end of all cab control cars. It shall have an Engineer's position on the right side (when looking out the windshield) and an observer's position on the left side.

The control station shall conform to the FRA and AAR standards for cab arrangements, to the greatest extent possible, considering the requirements of this specification.

The Engineer's operating controls shall be arranged in and on a desk-top console to the front of the engineer's seat and immediately below the windshield. All switches, circuit breakers and alike shall be arranged to permit a one man operation from the engineer's position. Details of the design of the cab, arrangement of the cab, and the locomotive controls, to include a mock-up of the cab, shall be submitted to Metra for review and approval. **[CDRL C-15-01]**

Cab Height shall be designed per Appendix 15A.

15.2 CAB SEATS

The control cab shall be equipped with two seats, one on each respective side. The seats shall comply with the requirements of APTA Standard PR-CS-S-011-99, latest revision and FRA Regulations 49 CFR Part 238.103 and 49 CFR Part 229.119. In addition to the two seats in the cab, a jump seat may be proposed as a third seat in the cab. The cab seat design and layout shall be subject to Metra review and approval. **[CDRL C-15-02]**

15.3 AIR BRAKE EQUIPMENT

15.3.1 The air brake system shall have an application portion to provide single reduction full service penalty applications in conjunction with speed control, ~~train stop~~, overspeed and safety control features, and shall have necessary equipment to establish suppression of speed control, train control, overspeed and safety control applications. Suppression shall be established with a full service brake pipe reduction, if such reduction has been commenced within the eight second time period, the condition acknowledged, if required, and if such reduction is maintained until the condition is corrected. **(SCR-105)**

Recovery from an emergency brake application shall be delayed 30 seconds. There shall be no delay on recovery from a penalty application.

15.3.2 Equipment to be provided as follows:

15.3.2.1 One (1) desk top ~~automatic~~ electronic brake ~~valve and appropriate control~~ handle unit;

15.3.2.2 Two (2) ~~One (1) duplex air gauge~~ digital display mechanisms integrated into the Driver Display Unit (main reservoir and equalizing reservoir) ~~with test gauge fitting;~~ Provisions for verifying the calibration of pressure readings must be included in the air system. **(SCR-230)**

15.3.2.3 Three (3) ~~One (1) duplex air gauge~~ digital mechanisms integrated into the Driver Display Unit (brake pipe and brake cylinder on each truck) ~~with test gauge fitting;~~ Provisions for verifying the calibration of pressure readings must be included in the air system. **(SCR-230)**

15.3.2.4 ~~One (1) duplex air gauge (application and suppression) with test gauge fitting~~

15.3.2.5 One (1) B-3-B emergency brake valve (on left side, looking out windshield);

15.3.2.6 One (1) ~~Type D-1 diaphragm~~ Deadman foot valve;

15.3.2.7 ~~One (1) P-2-A brake application valve;~~

15.3.2.8 ~~One (1) Power knock down pressure switch.~~ **(SCR-071)**

15.3.3 Appropriate safety control, ~~train stop,~~ locomotive overspeed and speed control interface equipment shall be provided. ~~The E.P. Valve shall be equipped with a lock.~~ A key operated switch shall be provided to isolate the ATC system from generation of penalty brake application

when operating in non-cab signal territory. This lock shall be a multi-blade tumbler type and shall allow the key to be removed in both the "Cut-in" and “cut-out” positions. The key shall be single bitted. Distinct keying shall be used for each car, with no master keying required. **(SCR-108)**

Three (3) keys shall be provided for each cab-control car.

"Deadman" feature shall be provided with appropriate sealable cutout switch.

15.4 CONTROL EQUIPMENT

15.4.1 A master, non-dynamic Electro-Mechanical controller shall be provided in the control station to permit forward or reverse control of the train and throttle control of the diesel locomotive through the 27-wire TRAINLINE.

15.4.2 Power Knock/Out (PKO) will occur in response to emergency or penalty brake application. Automatic unloading and return to idle speed of engine, or unloading of locomotive traction power without affecting engine speed, as appropriate to head end power supply requirements, will occur in the event that emergency brake application is made, or a service application is instituted through the safety control, overspeed, ~~train stop~~ or speed control systems. The MU propulsion system will receive the PKO signal from the brake system and immediately remove traction power by deenergizing the GF, A, B, C, and D valve control trainlines. Also, a light shall be provided to indicate when the "PC" switch is open. **(SCR-105)**

15.4.3 Equipment to be provided as follows:

15.4.3.1 One (1) generator field switch;

15.4.3.2 One (1) engine run switch;

15.4.3.3 One (1) attendant call switch (pushbutton or spring return switch);

15.4.3.4 One (1) Control and Fuel Pump Switch.

15.4.3.5 One (1) Head End Power Trainline Control (TLC) Reset

15.5 SPEED INDICATOR/ALERTER/EVENT RECORDER

15.5.1 A solid state speed indicator shall be provided. The indicator shall be mounted in the lower console in the general line of sight, while facing forward.

The indicating system shall include multiple overspeed (underspeed) settings. Overspeed shall be set for 82 MPH and underspeed set for 3 MPH.

15.5.2 An event recorder shall be installed to record operating parameters of the car to interface with the PTC event recorder. The event recorder shall be fully compliant with 49 CFR Part 229.135. [***VRESD V-15-01]*** *VRE will provide its event recorder system kit. The Contractor shall be responsible for all ancillary equipment and materials needed to complete the installation of the event recorder system. Contractor will be responsible for the successful completion of the on-board diagnostic testing prior to delivery to VRE. The Contractor shall work with VRE to determine the best locations for event recorder equipment and submit a final design for review and approval by VRE.* ***[VRESD V-15-01]***

The following parameters, at a minimum, shall be measured:

CHANNEL	TYPE	DESCRIPTION
1	Digital	BCP < 15 PSI
2	Digital	Manual Reset
3	Digital	Equalizing Reservoir
4	Digital	~~Not used~~ Low Horn **(SCR-162)**
5	Digital	Bell

6	Digital	Horn
7	Digital	Self-Test
8	Digital	Override Switch
~~9~~	~~Digital~~	PTT ~~Radio **(SCR-037) (SCR-039)**~~
10	Digital	Gen. Field
11	Digital	Throttle Sol. A
12	Digital	Throttle Sol. B
13	Digital	Throttle Sol. C
14	Digital	Throttle Sol. D
15	Digital	Forward
16	Digital	Reverse
17	Digital	~~Not used~~ High Horn
18	Digital	Lift Deployed Override
19	Digital	Alerter Penalty
20	Digital	Osc. Headlight
21	Digital	Lift Deployed Signal
22	Digital	Door Closed Light
23	Digital	Train Control Penalty
24	Digital	Cab Signal Green
25	Digital	Cab Signal Yel/Grn
26	Digital	Cab Signal Yellow
27	Digital	Cab Signal Red/Yel
28	Digital	~~Not used~~ Ditch light on
29	Digital	~~Not used~~ Ditch light Flash
30	Digital	~~Not used~~ Ditch light Flash Auto
31	Digital	~~Not used~~ All doors closed bypass
32	Digital	Not used
33	Digital	Not used
34	Digital	Not used
35	Digital	Not used
36	Digital	Not used
1	Analog	Brake Cylinder Pres.
2	Analog	Brake Pipe Pressure
3	Analog	~~Headlight Voltage~~ Not used (Spare Pressure)
4	Analog	~~Ditch light on~~ Headlight Voltage
5	Analog	~~Ditch light Flash~~ Power Supply Monitoring
6	Analog	~~Ditch light Flash Auto~~ Not used
7	Analog	Not used
8	Analog	Not used
1	Frequency	Speed
2	Frequency	~~Not Used~~ Speed
3	~~Frequency~~	~~Not Used~~
4	~~Frequency~~	~~Not Used~~ **(SCR-162)**

15.5.3 The event recorder shall include an alerter system which monitors the action of the operator. If the alerter is not reset, a visual and an audible warning shall be made on the systems alarm panel (flashing visual light and increasing level of audible alarm).After the initial allowance time of 20 seconds upon system activation, the reset time shall inversely relate to speed. The alerter penalty application shall be capable of reset with a "running release". The details of the alerter system shall be submitted to Metra for review and approval. **[CDRL C-15-03]**

The alerter shall be reset through the following operator's actions:

15.5.3.1 Throttle Change

15.5.3.2 Horn Use
15.5.3.3 Change in Direction of Travel
15.5.3.4 Independent Brake Application
15.5.3.5 Automatic Brake Application or release (more than 5 psi)
15.5.3.6 Alerter Reset Button
15.5.3.7 Bell Use
15.5.3.8 Change of State of the Headlight Switch
15.5.3.9 ~~Radio Use~~**(SCR-239)**

A dedicated cutout function, with seal, shall be provided in a visually accessible location to cutout the alerter magnet valve in case of failure.

Alerter reset intervals shall be speed dependent; as locomotive speed increases, the alerter must be acknowledged more frequently. Per 49 CFR Part 229.140, alerter warning timing cycle interval shall be within 10 seconds of the calculated setting utilizing the formula (timing cycle specified in seconds = 2400 ÷ track speed specified in miles per hour). For locomotives operating at speeds below 20 mph, the interval shall be between 110 seconds and 130 seconds.

The reset timing shall be as follows:

SPEED (MPH)	TIME (SEC.)
0.5-1.9	120
2.0	120
10	120
20	120
30	80
40	60
50	48
60	40
70	35
80	30

15.5.4 The event recorder shall provide, through solid state relays, control for the following ditch light operating modes:
15.5.4.1 Continuous
15.5.4.2 Flashing
15.5.4.3 Flashing after horn/bell.

15.6 CAB SIGNAL SYSTEM

15.6.1 A microprocessor based cab signal and speed control system shall be provided. ~~In addition an intermittent inductive train stop system shall also be provided.~~ Details of the design, installation and arrangement of the cab signal system shall be submitted to Metra for review and approval. **[CDRL C-15-04]** The arrangement shall provide for complete operation of the following systems:
15.6.1.1 Four aspect cab signal system, using 0-75-120-180 codes, as operated on the BNSF RR between Chicago, IL and Aurora, IL.
15.6.1.2 Four aspect cab signal system, using 0-75-120-180 codes, as operated on Metra's Rock Island District between Chicago, IL and Joliet, IL.
15.6.1.3 Two aspect non-coded cab signal and automatic train control system, as operated on the UP RR between Chicago, IL and Elburn, IL.
15.6.1.4 ~~Intermittent inductive train stop system as operated on the UP RR between Chicago, IL. and Harvard, IL, and between Chicago, IL and Kenosha, WI.~~

15.6.2 An aspect display similar to the display on Metra 8500 and 8600 series cab cars and incorporating a white motion light shall be installed behind the head light housing. Final location

shall require Metra approval. ~~The display shall provide the connections for the event recorder inputs~~. **(SCR-039)**

15.6.3 An audible warning device to indicate an overspeed condition due to a change in aspect shall be provided.

15.6.4 Penalty brake application system and the necessary equipment to suppress a penalty application by acknowledging and/or service brake application, within a time period shall be included for the signal systems ~~operated on the UPRR~~. **(SCR-226)**

15.6.5 Speed signal to the cab signal system shall come from the speed sensors ~~speed indicator's axle generator through an isolation amplifier~~**.** **(SCR-040)**

15.6.6 Power for the operation of these systems shall come from the low voltage power source ~~through a continuous duty solid state converter~~. An internal ~~The~~ converter shall be used exclusively for the cab signal system. **(SCR-227)**

15.6.7 A cab signal~~/train stop~~ mode selector switch incorporating seven pin tumbler type cylinder lock shall be provided. Two keys are to be ~~to~~ provided per cab car, one attached by a chain to storage box adjacent to the selector switch, the other shipped loose to Metra. All cars are to be keyed alike. **(SCR-105)**

15.7 POSITIVE TRAIN CONTROL

Metra will provide its Wabtec I-ETMS Positive Train Control System kit, with Graham White PTC Air Brake Interface Module, data radio, antennas and filters. As an option, the Contractor can propose to procure the Wabtec I-ETMS Positive Train Control System kit, with Graham White PTC Air Brake Interface Module, data radio, antennas and filters and supplt to Metra and VRE. **[COPL CO-15-01]** The Contractor shall be responsible for all ancillary equipment and materials needed to complete the installation of the PTC system. Contractor will be responsible for the successful completion of the on-board diagnostic testing prior to delivery to Metra. The Contractor shall work with Metra to determine the best locations for PTC equipment and submit a final design for review and approval by Metra. **[CDRL C-15-05]** ***[VRESD V-15-02]*** *VRE will provide its Wabtec PTC-IETMS Positive Train Control System kit, with Graham White PTC Air Brake Interface Module, data radio, antennas and filters. The Contractor shall be responsible for all ancillary equipment and materials needed to complete the installation of the PTC system. Contractor will be responsible for the successful completion of the on-board diagnostic testing prior to delivery to VRE. The Contractor shall work with VRE to determine the best locations for PTC equipment and submit a final design for review and approval by VRE.* ***[VRESD V-15-02]***

15.8 CAB DIGITAL VIDEO RECORDING SYSTEM

[VRESD V-15-03] *VRE will provide its cab digital video recording system kit. The Contractor shall be responsible for all ancillary equipment and materials needed to complete the installation of the cab digital video recording system. Contractor will be responsible for the successful completion of the on-board diagnostic testing prior to delivery to VRE. The Contractor shall work with VRE to determine the best locations for cab digital video recording system equipment and submit a final design for review and approval by VRE.* ***[VRESD V-15-03]***

15.8.1 The Contractor shall propose a new CDVRS system. The Contractor will provide its Cab Digital Video Recording System kit, with LDVR, microphones and cameras. The contractor shall comply with all applicable FRA requirements in effect at the time the bids are submitted. In addition the contractor will be required to meet or exceed language contained in the FAST Act Sec. 11411 and notice of proposed rule making (NPRM) for Locomotive Image and Audio Recording Devices for Passenger Trains. The Contractor shall be responsible for all ancillary

equipment and materials needed to complete the installation of the CDVRS. Contractor shall be responsible for the successful completion of the on-board diagnostic testing prior to delivery to Metra. The Contractor shall work with Metra to determine the best locations for CDVRS equipment and submit a final design for review and approval by Metra. **[CDRL C-15-06]**

15.8.2 The CDVRS shall be composed of one central recorder, ~~dual~~ two forward-facing camera, two rearward-facing cameras, one on engineer's side and one on fireman's side, at a minimum two inward facing cab camera(s), two exterior mounted microphones, one cab mounted microphone, solid state drive storage memory, crash hardened memory and all applicable interconnections. An option for a fatigue recognition system may be proposed **[COPL CO-15-02]**. The CDVRS system shall be powered from a separate low voltage circuit breaker (on the breaker panel). A terminal board panel will be applied in a dry location near the central recorder for all CDVRS (power and signal) connections to be made. Hardware is to exhibit the smallest area footprint inside the cab cars and use the least mounted hardware as possible. The inputs and outputs of the DVR are to exhibit railroad grade connections. The design and arrangement of the CDVRS shall be approved by Metra prior to build of the first cab car. **(SCR-136)**

15.8.3 The DVR recorder shall be a digital Internet Protocol (IP) based system and support digital IP cameras. The recorder shall have no less than 8 IP video channel inputs. The recorder shall have no less than 3 audio channel inputs. The DVR recorder video channels shall be used to capture and record video from multiple connected cameras simultaneously. The recorder audio channels shall be used to capture and record bell sounds, horn sounds, and have the ability to record cab compartment audio from multiple connected microphones simultaneously. The DVR recorder shall be capable of simultaneous playback, remote access, and recording. A removable hard drive shall be incorporated into the DVR recorder unit. The removable drive shall have security measures to allow only authorized personnel to remove the drive. The DVR recorder shall have a minimum of 1TB solid state storage capacity and the capacity to record at least 12-hour continuous recording capability per 49 U.S.C 20168(b)(1) and the recordings must accessible for review during an accident or incident investigation per 49 U.S.C 20168(b)(3). The hard drive capacity shall be sized to archive not less than 10 calendar days of video. The DVR recorder shall ~~have Wi-Fi capabilities~~ use the on-board Wi-Fi for ease of downloading in the case of accident or incidents when the DVR cannot be safely accessed in the rolling stock~~. The DVR recorder~~ The crash hardened memory module of the CDVRS shall have crash and fire protections for any in-cab image recordings that are stored in the cab car operating compartment per 49 U.S.C 20168(b)(2). Frame rates and resolutions shall be customizable for each camera and be made accessible by Metra. **(SCR-139)** ~~The recorder shall feature video motion detection. Video motion detection sensitivity shall be adjustable, customizable, and shall be capable of being enabled or disabled by Metra~~ The recorder shall permanently record when the car is switched "On". When the car is switched off, the DVR shall be automatically activated when any door is detected as being open. **(SCR-137)** The DVR system shall have the ability to utilize GPS data for location data and time synchronization. The DVR shall interface, access and download existing event recorder data. The recorder shall have a power input for all voltage ranges experienced by its power connection to the railcar and shall feature overvoltage and transient protection. The DVR recorder shall be capable of normal recording operations during momentary power losses, defined as 1 second or less, without: sustaining data loss, causing the DVR to reset due to momentary power loss, recording failure due to momentary power loss, or the DVR recorder entering a fault state requiring maintenance due to momentary power loss. The DVR recorder shall have a "self-test" and 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. **(SWR-157)**

15.8.4 The forward facing camera shall be capable of clearly recording railroad signal aspects in all types of weather, day, or nighttime conditions. The forward facing camera shall be used to

record the right of way, incidents, and railroad signal aspects of wayside signals. The cameras shall be aimed parallel to the centerline of tangent track within the gauge. The railroad signal aspects (colors) shall be clearly discernible during video playback. The camera shall be a high definition digital IP type camera. The camera shall be powered by Power over Ethernet (PoE). ~~The forward facing camera shall feature a dual lens, one for wide view, and one for narrow view~~ The CDVRS shall include one forward camera for wide view and one camera for narrow view. The focal length of the wide camera lens shall be 6mm. The focal length of the narrow camera lens shall be 16mm. Alternative focal lengths may be considered. The camera shall be mounted inside the cab, on the engineer's side dash-board in a Metra-approved enclosure. The camera shall be adjustable to allow for camera positioning. **(SCR-136)**

15.8.5 The rear-facing camera shall be a high definition digital IP type camera. The camera shall be powered by PoE. The focal length shall be determined during the design review. The camera shall be mounted outside the cab near the wind deflector on the observer's side in a weather-proof enclosure.

15.8.6 Two cameras shall be "inward facing" and used to record the cabin compartment of a cab car. Each inward facing camera shall be adjustable to allow for camera positioning. Each inward facing camera shall be a high definition digital IP type camera. Each inward facing camera shall be powered by PoE). The inward facing cameras shall be capable of recording black and white, as well as color. The settings shall be made accessible and adjustable to Metra. Each inward facing camera shall have 1 lens. Each inward facing camera shall have an adjustable lens. The camera lens focal length shall be set at 2.5mm or Metra-approved alternative. **(SAR-159)** Each inward facing camera shall be housed in a compact vandal resistant enclosure. The inward facing cameras shall be suitable for indoor ~~and outdoor~~ installations. The inward facing cameras shall be capable of recording in any weather, day, or nighttime conditions. Each inward facing camera shall include an Infrared illumination (IR) feature for night vision video capture capability which can be enabled or disabled by Metra. **(SCR-192)**

15.8.7 The dedicated microphones will have a "quick-disconnect" threaded, environmental-rated circular connector. The contractor will use the appropriate mating connector as well as non-metallic flexible ½" conduit, ½" NPT connectors and UNEF circular connector adaptor for ~~the final two (2) feet of conduit~~ connection to each microphone. Each dedicated microphone shall be rated for exterior outdoor use. One dedicated microphone will be mounted within three (3) feet of the bell. A new ~~rigid metal~~ PMA flexible ½" conduit will be run from the recorder location to the location of the microphone. The second dedicated microphone will be mounted on the roof within three (3) feet of the air-horn. A new ~~rigid metal~~ PMA flexible ½" conduit will run from the recorder location to the location of the microphone. The roof microphone and associated conduit will not interfere with any removable roof panels. A third microphone will be mounted in the cab and shall be capable of recording cab compartment audio. This microphone shall be capable of being enabled or disabled by Metra. **(SCR-084) (SAR-160)**

15.8.8 In addition to the solid state hard drive storage media, a separate crash hardened memory module shall be priced for use with the DVR system. The crash hardened memory module may be internal or external. The crash hardened memory shall be sized to archive 12 hours of video. The DVR shall be already configured to accept crash hardened memory with "plug and play" functionality. The crash hardened memory module shall be a field replaceable component by Metra personnel without requiring the assistance of the contractor. The crash hardened memory module shall be upgradeable in the future to higher capacities.

15.8.9 Crash hardened memory module supplied shall be DOT certified to FRA 49 CFR Part 229.

15.8.10 The solid state hard drive shall be mechanically and functionally uniform and interchangeable across all cab compartment DVR systems defined in this specification. The hard drive shall be upgradeable in the future to higher capacities.

15.8.11 The crash hardened memory module shall be mechanically and functionally uniform and interchangeable across all cab compartment DVR systems defined in this specification.

15.8.12 On the video playback, The DVR system shall display a time and date stamp on all downloaded data. The time shall be synchronized with the time clock used by the ~~event recorder~~ Train Control & Monitoring System. On the playback software, the system shall display ~~event recorder~~ Train Control & Monitoring System data concurrent with video downloads. A minimum number ~~of 4~~ of 6**(SCR-233)** ~~event recorder channels~~ signals shall be recorded: speed (SPD), Brake Pipe Pressure (BPP), Brake Cylinder Pressure (BCP), ~~and~~ **(SCR-233)** Throttle (THR), Bell, and Horn**(SCR-233)**. 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. The software shall allow the user to specify specific dates and times in order to control the length of the video clips downloaded. 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. The software shall have the capability to export all video and audio channels (including dedicated audio channels) into 1 file with all video and audio channels synchronized. Each audio/video clip shall contain at minimum a time stamp with date, time, name of DVR system, and associated video channel names that are overlaid onto the image and synchronized with video and audio. Upon starting the software, the main screen shall automatically (and without user interaction) display in real time live video viewports of all the cameras simultaneously. The viewports of all the video channels shall be visible simultaneously and without obstructions to the user on the main screen. The user shall not be required to make any clicks, minimize or maximize windows to cycle through to view video camera channels. 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. All computer software supplied to Metra by the Contractor shall include an unlimited use license agreement for unlimited installations and use. The ability for Metra personnel to install and configure all supplied software without contractor assistance or interaction shall be required. The software interface design shall be subject to Metra approval as part of [CDRL C-15-06]. **(SCR-180)**

15.9 CONTROL CONSOLE AND CONTROL ARRANGEMENT

15.9.1 A desk top console and a console above the windshield shall be provided. The consoles shall be of steel construction with a matte finish. The Car Contractor may propose alternative materials, which are subject to approval. The console shall be readily removable to permit access to mounted components, wiring and piping. The console shall not loosen during normal operations, move, or creep. No recesses, crevices or joints, which shall permit the incursion or accumulation of dirt, dust, or liquids, shall be permitted.

It is desired that the console surface shall be of one-piece construction. As an alternative, the console may have separately removable inserts to contain and enclose the various controls and indications.

The console shall not interfere with the Engineer's vision in any direction, nor with replacement of or maintenance to the windshield or other appurtenances. It shall provide a clear view of all indications and ease of reach and manipulation of all controls and switches.

15.9.2 Controls:

15.9.2.1 Controller, with single throttle handle;

15.9.2.2 Reverser, with removal handle (integral with the controller);

15.9.2.3 ~~Brake valve with automatic & park brake handles or push buttons;~~ Electrical cab brake handle unit;
15.9.2.4 Sand operating push button;
15.9.2.5 Bell operating ~~valve~~ push button(s);
15.9.2.6 Horn Operating ~~valve~~ toggle switch(s); **(SCR-127)**
15.9.2.7 Alerter reset switch;
15.9.2.8 Headlight/ditch light control switch;
15.9.2.9 Ditch light selector switch;
15.9.2.10 Signal (Mars) light selector switch;
15.9.2.11 PA/IC control panel;
15.9.2.12 Cab signal cutout switch;
15.9.2.13 Lift over-ride switch;
15.9.2.14 Desk light switch;
15.9.2.15 Radio Control Head;
15.9.2.16 Attendant Call Switch;
15.9.2.17 Engine RUN/STOP Switch:
15.9.2.18 Gage Light Switch;
15.9.2.19 Gage Light Dimmer Switch;
15.9.2.20 Engine Run Switch;
15.9.2.21 Generator Field Switch:
15.9.2.22 Control & Fuel Pump Switch;
15.9.2.23 Defroster Switch.
15.9.2.24 Cab Signal Selector Switch;
15.9.2.25 Cab Signal On-Board Test Unit;
15.9.2.26 Rear Warning Light Switch;
15.9.2.27 Door Mode Indicator Switch;
15.9.2.28 Cab Signal System Switch;
15.9.2.29 Video System Switch;
15.9.2.30 Door Mode Indicator Circuit Breaker;
15.9.2.31 Speed Indicator System Circuit Breaker;
15.9.2.32 Cab Signal System Circuit Breaker;
15.9.2.33 Train Radio Circuit Breaker;
15.9.2.34 Video System Circuit Breaker;
15.9.2.35 Train Control reset push button;
15.9.2.36 Train Control acknowledge push button

15.9.3 Indicators:
15.9.3.1 Speed indicator;
15.9.3.2 Air Gages;
15.9.3.3 Ground Relay light;
15.9.3.4 PCS Open light;
15.9.3.5 Wheel Slip light;
15.9.3.6 Door Closed light;
15.9.3.7 Lift Deployed light;
15.9.3.8 Lift Override light.
15.9.3.9 PTC Display
15.9.3.10 Rear View Monitor; **[COPL CO-15-03]**
15.9.3.11 Crew Alertness Display;
15.9.3.12 No Battery Charge Tri-Color (G-Y-R) Light;

All indicator lights shall be of the "push to test" variety and shall be shielded from sunlight to greatest extent possible.

15.10 BUZZERS

15.10.1 An approved high tone buzzer (powered by one of Locomotive's trainlines / 27-Loco-signals) shall be furnished in the control console to convey the following warnings:

15.10.1.1 Low propulsion engine oil;
15.10.1.2 Hot propulsion engine;
15.10.1.3 Low engine water;
15.10.1.4 No battery charge (locomotive);
15.10.1.5 Ground relay tripped;
15.10.1.6 Attendant's call;
15.10.1.7 Main generator fault relay tripped;
15.10.1.8 Head end power fault relay tripped (alarm sounds for six seconds only).

15.10.2 An override circuit shall be provided to allow the engineer to silence a continuous warning.

15.11 MISCELLANEOUS CAB EQUIPMENT

Equipment to be provided as follows:

15.11.1 Two (2) sun visors (one on each windshield) shall be provided. Each visor shall have 3 leafs hinged together. The lower leaf shall be transparent with an approved tint.

15.11.2 An electro static chest type cooler for bottled water shall be mounted in the control station within reach of the engineer's position. Water cooler shall be equipped with a drain to the outside of the car. The water cooler shall be powered by a 120 VAC.

15.11.3 Two (2) single cup holders integral to the raised area over the lower level aisle shall be provided, one the operator's side and one on the observer's side.

15.11.4 Two (2) sun visors (one over each sliding sash) shall be provided.

15.11.5 Two spring-clip holders with a writing pad shall be desk mounted; one on the operator's console and one on the observer's desk.

15.11.6 One (1) stainless steel enclosure with keyed lock for the storage of reverser handles.

15.11.7 A total of two (2) cab card holders shall be provided in the cab. A 9 inch x 12 inch card holder, and a 3-slot holder shall be applied in an approved location on the operator's side cab door.

15.11.8 A waste container, capable of holding a plastic liner, shall be provided in the cab behind the operator.

15.11.9 One (1) paper towel holder shall be provided in the cab.

15.11.10 One dry chemical type fire extinguisher shall be applied in an approved location.

15.11.11 One Emergency Response Book Holder per Metra Drawing M-524 shall be provided on the back wall of the cab.

15.12 HORN

15.12.1 A chime horn shall be provided. The horn shall be mounted over the observer's side, such that the horn fits within the clearance limits described in Section 3.0 of these Specifications. A three (3) chime horn shall be used. The horn shall be removable from a flange. A horn heating system shall be provided. At a minimum, the center chime must be heated. The heating system for the horn assembly shall be subject to Metra review and approval. **[CDRL C-15-07]**
The portion of the horn that protrudes over the roof line shall be protected by a stainless steel guard.

15.12.2 The horn shall be electro-pneumatically activated by two (2) ~~valves~~ toggle switches, one on the engineer's console and one on the observer's desk. **(SCR-126)**

15.12.3 The horn on all cab cars shall be tested in accordance to and comply with FRA regulation 49 CFR Part 229.129. All test reports must be submitted to Metra.

15.13 EXTERIOR BELL

15.13.1 One electric bell shall be provided, mounted under the floor as high as possible, under the "B" end of the car. The bell type and the installation location of the bell shall be subject to Metra review and approval. **[CDRL C-15-08]**

15.13.2 The bell shall be operated by two (2) operating switches, one switch located on each side of the cab.
Controls shall be arranged so that the bell operated manually at any time or actuated by horn operation. If the horn is blown from the operator's side, the bell must be manually shutoff on the operator's side. If the horn is blown from the observer's side, the bell must be manually shutoff on the observer's side.

15.14 WINDSHIELD WIPERS

15.14.1 One (1) pneumatically or electrically operated windshield wiper system (motor and arm assembly) shall be located at each window in front of the control station. An electric windshield wiper system is the Metra preferred option. The windshield wiper system proposed shall be subject to Metra review and approval. **[CDRL C-15-09]** If pneumatic, noise from the motor's exhaust shall be reduced in an approved manner. The wipers shall operate satisfactorily at speeds up to 100 mph in a thirty-five (35) mph opposing head wind. The wipers shall have a parallel motion covering the full width of the glass and utilizing the largest blade that can be accommodated. Each wiper assembly should contain a lever that allows manual operation of wiper by operator in cab in the event of a pneumatic or electric failure.

15.14.2 A windshield wiper control switch or valve, depending on the system proposed, shall be provided in the operator's console and on the observer's work desk. The operator shall have the ability to control both the engineer's side and fireman's side wiper assemblies. The wiper operating mechanisms shall be easily accessible, and the controls located in the operating compartment. The mechanism shall provide for variable speed and for a "park" position. The park position shall be approved by Metra. The wiper shall return to the park position each time the wiper system is turned off regardless of the position of the wiper blade.

15.15 REAR VIEW MIRRORS
A rear view mirror shall be provided at the front of the sliding sash cab windows on each side of the cab control car.

15.16 PILOT

At the lead end of cab control cars, a body mounted, high profile, snow plow type pilot of Metra approved design, shall be provided. **[CDRL C-15-10]** The pilot shall be securely attached to the car structure and shall be adjustable for height. The design of the pilot shall accommodate and afford maximum protection for the cab signal receivers and TRAINLINE junction boxes.

15.17 CONTRACT DELIVERABLES REQUIREMENT LIST

CDRL	Title
C-15-01	Locomotive Control – Design and Arrangement of Cab Car
C-15-02	Cab Seating
C-15-03	Alerter Operation
C-15-04	Cab Signal System
C-15-05	PTC Installation
C-15-06	Cab Digital Video Recording System
C-15-07	Horn Heating System
C-15-08	Electric Bell
C-15-09	Windshield Wiper System
C-15-10	Pilot Design

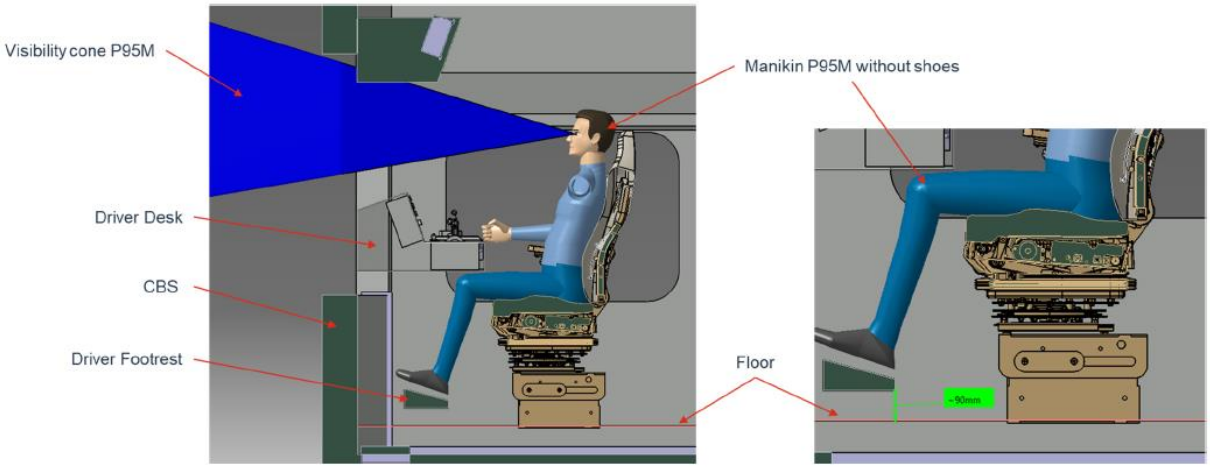
15.18 CONTRACT OPTIONAL PROPOSAL LIST

COPL	Title
CO-15-01	Wabtec IETMS System
CO-15-02	Fatigue Recognition System
CO-15-03	Rear View Monitor

15.19 APPENDIX 15A

Alstom Response

The cab floor height can be increased by 3-1/2", and the driver's seat re-positioned to allow a 95th percentile male engineer to have complete viewing range out the windshield.



Alstom Response

CAB HEIGHT CONSIDERATIONS:

- As indicated in Alstom's original proposal and in our responses to Metra's original questions, the cab car's F-end will be fitted with anticlimber crash energy absorbers and an energy-absorbing push-back coupler to ensure the engineer's safety in the event of an F-end impact. Alstom will comply with 49CFR238.201 Sub part Appendix G - Alternative Requirements for Evaluating the Crashworthiness and Occupant Protection Performance of Tier I Passenger Trainsets.
- The cab's original unraised position is common for modern bilevel coaches in service throughout North America.
- Increasing the cab's floor height beyond what is shown on the previous page will have a significant impact on the following items:
  - Air duct network and air distribution,
  - HVAC unit location and configuration,
  - Cab structure and stair arrangement which will include impact to seating arrangement and capacity.
- While Alstom strongly recommends keeping the engineers cab floor height as shown on the previous page, Alstom is also open to discuss other vehicle configuration changes specific to Metra's requests to accommodate their operational safety needs.

16 PAINTING,SIGNAGE, AND EXTERIOR

The decorative treatment (interior and exterior) of all cars shall be agreed upon between Contractor and Metra. A signage plan shall be submitted to Metra for review and approval. **[CDRL C-16-01]** Edge sealer shall be used on all exterior vinyl decals.

16.1 ~~INTERIOR~~ EXTERIOR

16.1.1 If the roof, sides, ends, and floor are constructed of stainless steel shall be unpainted. Parts under the floor or attached to the car which are constructed of metal other than stainless steel, such as underfloor equipment and trucks (except for wheel treads, axles, rubber parts, etc.), shall receive one (1) coat of primer and one (1) color coat of light bodied paint to a dry film thickness of three (3) mils. The end underframe assemblies shall receive one (1) coat of primer on both the inside and outside surfaces.
Where one of the above items requiring paint is furnished by a vendor, a coat of primer shall be applied at the vendor's plant and the color coat shall be applied by the Contractor. Exterior paint shall be supplied and applied to commercial acceptable standards. All paint and primer used shall be lead free.

16.1.2 Metra's standard 12' x 2' letter boards shall be applied in an approved location, adequately sealed and secured with reasonably theft proof fasteners. The letter board shall be stainless steel covered blue film. A white Metra logo (15" over the"M") per drawing M-271 shall be applied in an approved location. ***[VRESD V-16-01]*** *Virginia Railway Express standard letter boards shall be applied in an approved location and secured with reasonably theft proof fasteners. Flag banners shall be applied in an approved location* ***[VRESD V-16-01]***

16.1.3 The car number shall be applied to in an approved location to exterior side of car. All numbers shall be ten (10) inches high, black vinyl film. The style of the numerals shall be as agreed between Contractor and Metra.

16.1.4 A black eight inch RTA logo per drawing M-272 shall be applied to an approved location of the car exterior. ***[VRESD V-16-02]*** *Not required on VRE cars* ***[VRESD V-16-02]***

16.1.5 A stainless steel sign with the car number, 2" high, sand etched and painted black shall be provided on each body end door, both inside and outside, located immediately below the window.

16.1.6 All cars shall be provided with two "Owner Plates" per Metra drawing M-318. The plates shall be located to the left of each side entrance doorway when facing car from the exterior, on the skirting.

16.1.7 The water filling boxes located under the floor shall be marked by use of vinyl signs located on the side sill adjacent to the box or valve location.

16.1.8 All valves on the underside of car shall be tagged with a stainless steel plate having depressed letters. The plates shall be securely fastened to a suitable bracket adjacent to the valve.

16.1.9 An instructional decal for emergency door operation per APTA and FRA requirements shall be applied on the exterior of the car where applicable.

16.1.10 An instructional decal for removing windows in an emergency per APTA and FRA requirements shall be applied on the car body below each emergency ingress/egress window equipped with a pull grip on filler strip.

16.1.11 A decal with the words "Step Down Ahead" per drawing M-551 shall be applied on the exterior of each end door adjacent to the window.

16.1.12 A decal with the words "Door Opens Quickly" per drawing M-359 shall be applied on each exterior lift switch cover.

16.1.13 A black letter "F" per drawing M-286 shall appear in an approved location on lower deadlight or side sill, directly under the side cab windows of cab control cars, visible to a person on the ground. It shall be applied to resist peeling in the normal operating environment.

16.1.14 The B - end of cab control cars shall receive alternate red and white 12 inch wide reflective striping arranged in 45 degree diagonal pattern. [***VRESD V-16-03]*** *The B-end of cab control cars shall receive alternate black and orange 12 inch wide reflective striping arranged in a 45 degree diagonal pattern.* ***[VRESD V-16-03]***

16.2 ~~EXTERIOR~~ INTERIOR

16.2.1 All decorative interior surfaces shall not require painting except where an approved application of interior finish material requires painting, as the application dictates. The material shall be primed and finished with two coats of approved synthetic enamel to commercially acceptable standards. **(SAR-147)**
On all cars, carbon steel parts located in the electric lockers shall be galvanized or prime painted prior to installation. **(SAR-183)**

16.2.2 Electrical lockers shall be finished inside with a top coat of white insulating paint. The edges of grille cutouts and hardware located on the inside surfaces of the locker doors shall be painted with aluminum colored synthetic enamel.

16.2.3 Two (2) Contractor's nameplates may be provided in the car. These shall be located above the passenger side entrance openings in an approved location.

16.2.4 The car number shall be applied in an approved manner, using two (2) inch high numbers near the car Contractor's plate, over each set of side entrance doors inside the car.

16.2.5 Aluminum plates painted black with engraved white lettering shall be provided at the switchboard and panels to designate the switches, circuit breakers, relays, resistors, etc.

16.2.6 Interior of electric locker door shall contain stainless steel plate with car number, identity and class, date built and location of manufacture, etched and painted black. Inside of locker door shall be furnished with Yellow Card holders.

16.2.7 Four (4) stainless steel "No Smoking Please" signs, per drawing M-384 shall be provided in locations approved by Metra.

16.2.8 A stainless steel "Watch Your Step" sign shall be provided on the top riser of each section of each set of passenger entrance steps on both sides of the car.
Letters shall be sand etched and painted black.

16.2.9 The cover of the emergency tool cases shall be labeled with appropriate access instructions. An "Illinois Law" decal, per drawing M-1186 shall be placed adjacent to each emergency tool case. The perimeter of the emergency tool cases shall be marked with APTA compliant HPPL material. In addition, tool case signage and locator decals manufactured of APTA compliant HPPL material shall be provided. ***[VRESD V-16-04]*** *The cover of the emergency tool cases shall be labeled with appropriate access instructions, shall be placed adjacent to each emergency tool case.* ***[VRESD V-16-04]***

16.2.10 "Watch Your Step" signs with black letters on yellow vinyl film per drawing M-281 shall be applied to the stairway walls.

16.2.11 A "Priority Seating" decals per drawing M-1681 and M-1682 shall be provided in an approved location on each side of the car at the ADA positions.

16.2.12 Electric Locker Doors shall be labeled "Danger 480-Volts" vinyl decal per drawing M-282.

16.2.13 A decal with the words "Emergency Exit" per drawing M-310 shall be provided at each emergency window per APTA & FRA requirements

16.2.14 The following decals of photo luminescent material complying with FRA requirements and APTA standards shall be provided:

16.2.14.1 Exit, per drawing M-1145 above each end door;

16.2.14.2 Emergency sash operating instructions on each emergency sash, braille sign shall be applied in addition;

16.2.14.3 Pictorial emergency sash operating instructions adjacent to each emergency sash;

16.2.14.4 Instruction for opening side entrance door in an emergency. Braille sign shall be applied in addition to.

16.2.14.5 Emergency Exit Route Evacuation Maps (Signs) and shall be provided and constructed of HPPL material per APTA requirements.

16.2.15 One (1) "Emergency Brake Valve" decal and one (1) "Danger Do Not Touch" decal, shall be applied adjacent to each B-3-B valve.

16.2.16 Two (2) emergency exit placards shall be applied. Placard graphics and location are subject to Metra's approval.

16.2.17 Two (2) International Handicap Symbol Decals shall be applied where applicable.

16.2.18 The following items shall be labeled with an approved vinyl decal:

16.2.18.1 Overhead Heaters;

16.2.18.2 Air Filters;

16.2.18.3 Electrical Lockers (labeled with designation only).

16.2.19 "Please Keep Feet on Floor" decals per drawing M-307 or approved equal shall be placed where applicable

16.2.20 "WARNING" decals, per drawing M-537 or approved equal shall be applied where applicable.

16.2.21 A "Caution Please Do Not Lean On The Doors" decal, per drawing M-532 shall applied to the inside surface of each side loading door leaf, just below the door window.

16.2.22 Low-Location Exit Path Marking (LLEPM), complying with APTA-SS-PS-004-99 shall be provided using High Performance Photo Luminescent Material.
End doors, passenger compartment doors and entrance doors shall be marked in accordance with Sections 6.2 and 6.3 of APTA Standard SS-PS-004-99. The entire arrangement shall be subject to Metra's approval.

16.2.23 On cab control cars, all controls and indicators shall be labeled in an approved manner.

16.2.24 On cab control cars, a stainless steel nameplate with the wording "Emergency Brake Valve", etched and painted red, shall be provided adjacent to the emergency brake valve on the observer's side of the control station.

16.2.25 A stainless steel sign with the car number, 2" high, sand etched and painted black, shall be provided in an approved location in the cab.

16.2.26 A "Please Do Not Put Personal Belongings In Front Of Door" sign, per drawing M-225 shall be applied in an approved manner to passenger compartment side of each cab door and end doors.

16.2.27 A "Lavatory" sign, per drawing, M-397, shall be applied to the toilet room door in an approved manner.

16.2.28 A digital display sign shall be used on the exterior of the car body to display the "Metra" logo and other advertisements. Display shall be easily programmable and link to the cars GPS, passenger counting, and infotainment system. **[COPL CO-16-01]**

16.3 CONTRACT DELIVERABLES REQUIREMENT LIST

CDRL	Title
C-16-01	Signage Plan

16.4 CONTRACT OPTIONAL PROPOSAL LIST

COPL	Title
CO-16-01	Exterior Digital Display Sign

17 ENVIRONMENTAL EFFECTS

17.1 GENERAL REQUIREMENTS

The Contractor shall ensure that the railcar and its equipment are designed and built so that the noise criteria outlined in this section of the specifications are not exceeded. Methods shall be incorporated into the car design to attenuate equipment noise which does not meet the noise level limitations indicated.

Unless otherwise stated, noise herein shall mean a sound pressure level as defined in the latest revision to American National Standards Institute (ANSI) S1.4 for General Purpose Sound Level Meters. All noise levels listed are in decibels referred to 0.0002 microbar as measured on the "A" scale of a standard sound level meter, abbreviated "dbA" respectively. Unless otherwise specified, the "slow" meter scale shall be used.

Noise criteria specified are based on measurements taken in essentially a free field environment, as per the U.S. Environmental Protection Agency, Office of Noise Abatement and Control, Washington, D.C., Railroad Noise Emission Standards, Title 40, Part 201, Subpart C, entitled "Measurement Criteria". The free field environment, such as outdoors, will be away from any reflective surfaces other than ballast and tie track bed and the adjacent ground. The subject cars shall comply with any FRA noise criteria which may be in effect at the time of construction.

For tests and measurements, the Contractor shall use a sound level meter which complies with the requirements of the latest revision of ANSI S1.4, Specifications for General Sound Level Meters.

17.2 AUDIBLE NOISE REQUIREMENTS

The Contractor shall verify to Metra that all cars built to the specification set forth herein, meet the requirements for noise abatement of this section. Sound insulation should be a continuous improvement task in the design of new vehicles.

An audible noise proposal shall include estimated noise levels at a location one (1) foot away from any car body surface, while the car is parked, without any passengers on board, and all systems operating (including the air conditioning system at maximum capacity) and estimated interior noise levels at a location one (1) foot away from any car body surface, excluding the return air grill, while the car is operating at 65 MPH without any passengers on board, and all systems operating (including air conditioning system at maximum capacity). In addition, Proposal shall include documentation demonstrating the ability to have designed and built passenger Cars with low interior noise levels (and improvements over specified maximums). **[PDRL P-17-01]**

The subject cars shall comply with any FRA noise criteria which may be in effect at the time of construction, including, but not limited to, 49 CFR 210 and 49 CFR 229.

Builder shall develop and submit for Metra's approval, the procedures for conducting this test. **[CDRL C-17-01]**

17.2.1

Verification exterior sound level measurements shall be taken at one hundred (100) feet perpendicular to the longitudinal centerline of the car, on both sides of the car, at a point five (5) feet above top of rail, while the car is parked, with all systems operating (including the air conditioning system at maximum capacity). The noise levels shall not exceed 70 dbA.

17.2.2

Interior noise levels shall not exceed 65 dbA at a minimum at a location one (1) foot away from any car body surface, while the car is parked, without any passengers on board, and all systems operating (including the air conditioning system at maximum capacity). Metra would prefer that that noise levels inside the compartment not exceed 60dBA in a steady and/or steady but intermittent sound level classification and a preference that noise levels not exceed 70dBA in a time varying and impulsive sound classification.

17.2.3 Below is an example of sound classifications and operational activities:

17.2.3.1 Steady sound levels (such as from onboard HVAC equipment).

17.2.3.2 Steady, but intermittent sound levels (such as from consist locomotive).

17.2.3.3 Time varying sound (such as trains passing on an adjacent track, wheel squeal through curved track, movement over switches, frogs and at grade crossings).

17.2.3.4 Impulsive sound signals (such as consist stopping, starting and coupling).

17.2.4 Interior noise levels shall not exceed 70 dbA at a location one (1) foot away from any car body surface, with track quality compliant to international standard ISO 3095:2013 Section 6.2.5 and to ISO 3095:2013 Section 6.3.6, excluding the return air grill, while the car is operating at 65 MPH without any passengers on board, and all systems operating (including air conditioning system at maximum capacity).

17.2.5 The passenger boarding/alighting area is to be included as part of the car interior for audible noise criteria. The noise level for the passenger boarding/alighting area (with the car standing and all systems operating) shall not exceed 75 dbA.

17.2.6 All equipment shall be designed to eliminate rattling and resonance at all speeds up to the maximum running speed by the use of damping, gaskets, resilient mounts or similar methods. Included in this requirement, but not limiting the generality thereof, are the following accessories:

17.2.6.1 Windows
17.2.6.2 Seats
17.2.6.3 Wiring
17.2.6.4 Ventilating Ducts
17.2.6.5 Doors
17.2.6.6 Parcel Racks
17.2.6.7 Light Fixtures
17.2.6.8 Stanchions
17.2.6.9 Partitions
17.2.6.10 Fire Extinguishers
17.2.6.11 Panels
17.2.6.12 Air Conditioning Units

17.3 PROPOSAL DELIVERABLES REQUIREMENT LIST

PDRL	Title
P-17-01	Audible Noise Proposal

17.4 CONTRACT DELIVERABLES REQUIREMENT LIST

CDRL	Title
C-17-01	Noise Level Test Procedure

18 MATERIALS AND WORKMANSHIP

18.1 GENERAL REQUIREMENTS

18.1.1 Workmanship and Quality shall conform to the best manufacturing practices in all respects. All work shall be performed by qualified personnel, using correct tooling and procedures, and be properly trained and skilled in the tasks they will be performing.

18.1.2 Surfaces exposed to passengers, crew, or maintainers shall be smooth and free of burrs, sharp edges or corners, and dangerous protrusions. The vehicle design shall avoid pinch points, tripping hazards, snagging points, water traps, and debris accumulation points.

18.1.3 Car body structural parts that are permanently covered and concealed after assembly shall not be made of copper, copper bearing aluminum alloys, brass, bronze, silver, or nickel.

18.1.4 Foreign matter, such as shavings, chips, etc., shall be completely removed from all parts of the vehicle, its components, assemblies and subassemblies, whether hidden or exposed.

18.1.5 Materials for the construction of the vehicle shall be in accord with the stated specification or cited standard, unless the Contractor obtains Metra's approval for a substitution in writing. Alternate standards may be proposed, but must be supplied in English, with a narrative comparing both standards, and citing justification why the substitution is equivalent.

18.1.6 All materials shall perform safely and satisfactorily within their operating environment and in accordance with their intended function.

18.1.7 Whenever a commercial material is not covered by a specification or standard, the Contractor shall identify the material by the commercial trademark, name, and address of the supplier. The Contractor shall submit a description, and the technical data specifications, of the material composition for approval. The Contractor shall maintain records that trace all materials to their manufacturers, and shall verify compliance with quality standards specified or cited in these Provisions.

18.1.8 Single-source materials shall not be permitted unless approved by Metra. Approval shall be determined on a case-by-case basis. Specification equivalency and benefit data for any substitution to a cited standard shall be submitted to Metra for review and approval.

18.1.9 The following materials shall not be used or shall be limited (if no other technical alternative is available) in the construction of the vehicle:

18.1.9.1 PVC
18.1.9.2 Asbestos
18.1.9.3 Cadmium (except for battery)
18.1.9.4 Lead (except for lead solder on the printed circuit boards)
18.1.9.5 PCBs
18.1.9.6 Application of occupational exposure limits for carcinogenic materials as listed by current Publication of American Conference of Governmental Industrial Hygienists (ACGIH)
18.1.9.7 Application of occupational exposure limits for materials listed in 29 CFR 1910.19
18.1.9.8 All CFC and HCFC compounds except R-22 and R134a
18.1.9.9 Urethane Foam **(SWR-112)**

18.1.9.10 Chlorinated fluorocarbons that may cause environmental problems or handling hazards

18.1.9.11 Materials that, in their normal installed state, emit products that are known to be toxic or irritants

18.1.9.12 Materials that, in their normal installed state, emit products that are known to be toxic or irritative

18.1.9.13 Beryllium

18.1.9.14 In addition, Metra does not accept other restricted materials (restricted due to safety, environmental, and/or regulatory reasons) as well as materials that require stringent Personal protective equipment (PPE) such as face protection, special cloths during handling, removal and/or application (excluding safety goggles and gloves) by Metra. On a limited and case by case basis, Metra may approve the use of such material and in these cases the Contractor shall be required to submit a waiver in writing to Metra for approval prior to any use of such material. The Contractor's waiver request shall include the justification(s) for using the material, total weight of the material, location(s) and distribution on the vehicles, material safety and data sheets, and current test reports. ~~In addition, the Contractor shall submit a letter from an independent material safety professional indicating their review of the Contractor's waiver request and their professional conclusions regarding the request and the safety, environmental and regulatory implications involved for Metra throughout the life of the vehicles.~~ **(SCR-058)**

18.1.10 The Contractor shall keep on file Safety Data Sheets (SDS) for all chemical materials (paints, solvents, adhesives, caulking, etc) used in the manufacture of the vehicle, and provide SDS information as requested by Metra for any additional material in question. A copy of each SDS shall be submitted to Metra for review and approval.

18.1.11 All materials utilized in the construction of the vehicle shall be subject to the approval of Metra. The Contractor shall keep a running list of all materials used in the vehicle in matrix format (matrix shall contain; material name, specification or material ID number, application, approval status, correspondence number, etc.). The Contractor shall submit this matrix along with material certifications and material property test reports to Metra for review. **[CDRL C-18-01]**

18.1.12 The Contractor shall submit for approval joining and fastening data, specifications, and standards for all types and methods of fastening and joining used.

18.1.13 All name and rating plates shall be permanently attached using mechanical fasteners. Exceptions may be made for small components and circuit boards.

18.1.14 All materials shall be new and of recent manufacture. Material, which is found to be defective and subsequently repaired, cannot be used unless specific approval is granted by Metra.

18.1.15 All materials used shall be inherently corrosion resistant, or be suitably finished with a corrosion resistant finish to minimize corrosion and degradation of appearance or function.

18.1.16 Materials that require overhaul/reconditioning periodically shall be available in the United States and overhaul/reconditioning shall be performed in the United States. All repair or replacement for major electric/electronic equipment shall be completed within one (1) months. **(SCR-161)**

18.2 STORAGE OF MATERIAL

18.2.1 All stored material subject to corrosion shall be adequately protected by waterproof covers, coatings, or packaging to prevent damage.

18.2.2 Equipment covers, cable entrances, and openings shall be suitably closed to prevent ingress of water or dirt.

18.2.3 All dated material shall have the expiration date clearly marked. Expired material shall not be used.

18.2.4 Material or components, which require maintenance during storage, shall be properly maintained per the component(s) manufacturer's instructions. The Contractor shall document such maintenance, and provide these records as requested by Metra. **[CDRL C-18-02]**

18.2.5 Rejected or damaged material shall be clearly marked, dispositioned, and stored separately from all other material.

18.3 STAINLESS STEEL

When used, types and grades of stainless steel shall be stated in all drawings. Material certifications and test reports including chemical analysis, physical properties shall be submitted to Metra. **[CDRL C-18-03]**

18.3.1 Certified copies of test reports covering each coil of steel to be used shall be submitted to Metra by the Contractor. Each test report shall list chemical analysis, physical properties, weight, mill coil number, invoice number, date and mill order number of each coil. For sheet stock, a ladle analysis and single physical property test on each heat and each size shall be made and shall be submitted. **[CDRL C-18-04]** All austenitic stainless steel shall be free from precipitated carbides, and all stainless steel shall be free from scale.

18.3.2 General requirements for stainless steel are:

18.3.2.1 Gauge tolerance (standard for industry);
18.3.2.2 Color and finish (must match samples);
18.3.2.3 Flatness - coil stock (standard mill flatness);
18.3.2.4 Flatness - sheet stock (stretcher level quality);
18.3.2.5 Camber (standard for industry).

18.3.3 Buffing and polishing of stainless steel, if required, shall be done without any use of composition containing iron or iron oxide.

18.4 LOW ALLOY HIGH TENSILE STEEL

Low alloy, high tensile steel sheet shall be of the Cr-Si-Cu-Ni-P composition, corrosion resistant types, conforming to SMA570WQ per JIS G 3114 (Japanese Industrial Standard), ASTM Specification A656 Grade 80 or equivalent specification approved by Metra.

Types and grades of steel shall be stated in each drawings.
Material certifications and test reports including chemical analysis, physical properties shall be submitted to Metra.

18.5 STEEL/STAINLESS STEEL CASTINGS (if used)

The contractor shall provide casting specifications/procedures, requirements, test requirements/methods and acceptable criteria including cast surface and machining surface if steel or stainless castings are used. Metra may add extra requirements.

18.5.1 Weld repairs of castings shall be allowed, provided that repairs are performed in accordance with an approved written procedure, and by welders qualified to ASTM A488. For stainless steel casting, provide written procedure and its justification.

18.6 ALUMINUM (if used)

When used types and grades of aluminum shall be stated in each drawing. Metra may request the material certification and test report including chemical analysis, physical properties.
Aluminum forgings shall comply with ASTM B247 or Aluminum Association Standards for Aluminum Mill Products, alloy, and temper 6061-T6.
Aluminum castings shall comply with ASTM B26, ASTM B85, ASTM B108, or Aluminum Association Standards for Aluminum Mill Products alloy and temper 356-T6, 364-T5, or 356-T6 respectively, and shall be free from blowholes, cracks, shrinkage, and other defects.
Dissimilar materials such as aluminum and stainless steel may not contact directly. Bolts and nuts, screws or other fasteners used with aluminum alloys shall be aluminum alloy (not containing copper) or shall be well galvanized, unless otherwise approved

18.7 ELASTOMERS

The Contractor shall submit test reports for all elastomers proposed.
Glazing strips for side and end windows shall be molded or extruded Neoprene conforming to ASTM C-542, with ends vulcanized together to form one continuous piece.
Elastomers must comply with applicable flammability and smoke emission requirements of FRA Regulation 49 CFR Part 238 as well as Section 18.16 of this specification.

18.8 GLAZING MATERIALS

Glazing materials shall be proposed and approved by Metra. Window glazing facing to outside of the car shall meet 49 CFR 238 Part 223. The end door under/next to the cab control room if any, the end door shall meet 49 CFR 238 Part 223 large impact test with retention.
All material must comply with applicable flammability and smoke emission requirements of FRA Regulation 49 CFR Part 238 as well as Section 18.16 of this specification

18.9 WOOD, PLYWOOD, PLYMETAL, COMPOSITE MATERIALS (if used)

18.9.1 Wood

Any pieces of wood entering into construction of cars shall be select grade, shall be thoroughly seasoned by air of kiln drying, and shall be dressed on all surfaces to dimensions.

18.9.2 Plywood

All plywood must be exterior "BB" grade, DFPA marked, 100% waterproof bond, formed from Group II wood species for inside finish panels, as described in the American Plywood Association, Specification PS 1-83 (or later revision).
Except where used in the construction of plymetal panels, all plywood must be treated to resist decay and mold. Treatment materials must be nontoxic to man and non-corrosive to car body materials.

18.9.3 Metal Faced Plywood - Plymetal

The term plymetal refers to metal faced plywood (described above) which conforms to the last published revision of Bombardier Plymetal Specification SMP 209-D. Whenever the

metal surface of a plymetal panel is faced Melamine, it shall be applied in accordance with Section 18.10 of these specifications.
Plymetal panels shall also meet the test criteria listed in Table 18-2 below:

Table 18-2

Minimum Metal to Wood Test	Minimum Value
Dry Shear	250 lbf/in2 (1.72N/mm2) to 80% wood failure
Boil shear, 3 hrs boil, tested at 68°F	150 lbf/ in2 (1.03N/mm2) to 80% wood failure
Wet shear, 48 hrs. soak, 68°F	150 lbf/ in2 (1.03N/mm2) to 80% wood failure
Creep, under static load for 48 hrs, 68°F	250 lbf/in2 (1.72N/mm2) to 80% wood failure

All exposed edges of the panels, drilled holes, fastener heads, openings, or cutouts within the panels shall be waterproofed and sealed with an approved epoxy paint/coating as soon as possible after fabrication, and prior to installation.
The overall flatness shall not exceed a maximum deviation of 0.015" per lineal foot, with a maximum of 0.125” deviation of any point on the panel measured from a reference plane taken from any three corners. The overall deviation of the panel thickness shall not exceed 0.031" (1/32").
All material must comply with applicable flammability and smoke emission requirements of FRA Regulation 49 CFR Part 238 as well as Section 18.16 of this specification.

18.9.4 Metal Faced Composite Materials

Metal faced composite materials shall perform ASTM C297 testing for boding strength to avoid delamination. A minimum of 6 samples shall be tested each category. The metal faced panels shall meet the test criteria listed in Table 18-XX below:

Table 18-3

Minimum Metal to Composite Test	Minimum Value
Dry	250 lbf/in2 (1.72N/mm2)
Wet, 48 hrs. soak, 68°F	150 lbf/ in2 (1.03N/mm2)
Creep, under static load for 48 hrs, 68°F	250 lbf/in2 (1.72N/mm2)

18.10 PLATICS (if used)

18.10.1 Thermoplastics

Thermoplastic sheet shall be homogeneous and extruded from virgin stock which does not include any regrinding of vacuum formed parts. Color pigments shall be UV stabilized. The color and surface finish of parts, manufactured from this material, shall be approved by Metra prior to a production run of parts. [CDRL 18-09] Finished parts shall be free of waves and quilting. Voids, lumps and contamination shall be no larger than 0.01 in with a maximum of one defect in a 4.0 ft2 area.
Thermoplastic materials shall comply with applicable flammability and smoke emission requirements of FRA Regulation 49 CFR Part 238 as well as Section 18.16 of this specification, and with the requirements listed in Table 18-3 below:

Table 18-4

Physical Property	Test Method	Performance Requirement Value
Specific Gravity	ASTM D792	1.20 to 1.36
Hardness, Rockwell	ASTM D785	90 to 100, R-Scale
Tensile Strength	ASTM D638	5,500 psi (38 MN/m^2) minimum at 73°F (23°C)
Flexural Modulus	ASTM D790	320,000 psi (2206 MN/ m^2) minimum elasticity at 73°F (23°C)
Flexural Strength	ASTM D790	10,000 psi (68,947.6 kPa) minimum @ 73°F (23°C)
Impact Strength (@ 73°F notched IZOD)	ASTM D256	6.6 foot pounds per inch of notch minimum.
Heat Shrinkage	None	15% maximum, 10 minutes @ 380°F (193°C)
Thickness	None	3/32 inch (2.38 mm) minimum

Independent laboratory test certificates shall be provided stating that the thermoplastic sheet complies with the requirements of the following standards. **[CDRL C-18-10]**

18.10.2 Fiberglass Reinforced Plastics

This material shall be laminated polymeric reinforced material. Resins shall be thermosetting, fire-resistant polyester. Fiberglass content by weight shall be 25% minimum unless otherwise specified. Parts may be produced by resin transfer molding or compression molding.

Exposed fiberglass surfaces shall have a smooth matte finish. Embossed surface will be permitted in order to assure that finished surfaces are resin rich to obtain uniform color without visible glass fibers.

All material must comply with applicable flammability and smoke emission requirements of FRA Regulation 49 CFR Part 238 as well as Section 18.16 of this specification.

The Contractor shall submit for approval certificates verifying that reinforced plastic materials comply with the minimum requirements specified in Table 18-4 below. **[CDRL C-18-11]**

Pre-test conditioning of test specimens shall conform to ASTM D618.

Table 18-5

Mechanical Property	Test Method	Method #1	Method #2
Tensile Strength	ASTM D638	13,000 psi	18,000 psi
Compressive Strength	ASTM D695	22,000 psi	32,000 psi
Flexural Strength	ASTM D790	21,000 psi	28,000 psi
Impact	ASTM D256	10 ft-lbs/ in of notch	13 ft-lbs/ in of notch
Hardness	ASTM D2583	45 Barcol	45 Barcol
Heat	None	175°F Continuous	-
Thickness	None	0.125 in, minimum	0.125 in, minimum
Gelcoat Thickness	None	0.014" or 14 mils, ± 2 mils.	N/A

18.10.3 Melamine

Melamine shall be laminated to aluminum sheets. The melamine impregnated, colored papers shall be directly molded to aluminum sheets at a temperature not less than 270 degrees F and at a pressure not less than 1,000 psi. The characteristics shall not be less than that required of general purpose type in NEMA Standard LD-3-2005 (or latest revision). Gloss finish melamine shall not be used unless otherwise approved, and melamine with a rough textured finish is likewise restricted.

All material must comply with applicable flammability and smoke emission requirements of FRA Regulation 49 CFR Part 238 as well as Section 18.16 of this specification. The Contractor shall submit for approval certificates verifying that bond between the melamine

and the aluminum complies with the minimum requirements specified in Table 18-5 below. **[CDRL C-18-12]**

Table 18-6

Mechanical Property	Test Method	Performance Requirement Value
Tensile Strength	ASTM D638	with grain: 22,300 psi minimum cross grain: 20,300 psi minimum
Modulus of Elasticity	ASTM D790	with grain: 2.8 x 10^6 psi minimum cross grain: 3.1 x 10^6 psi minimum
Flexural Strength	ASTM D790	with grain: 15,000 psi minimum cross grain: 25,300 psi minimum
Internal Bond	ASTM D952	2,600 psi

Un-backed balanced melamine panels may be used in the car interior. The characteristics shall not be less than that required of general purpose type in NEMA Standard LD-3-2005 (or latest revision).

The bond between the melamine and the aluminum shall meet the following:

Test Category	Test	Min. Requirements
Internal Bond	ASTM Test D952	2,600 pounds per square inch
Tensile Strength	ASTM Test Properties D638	22,300 lbs per square inch, with the grain
Flexural Properties	ASTM Test D790-71	Flexural modulus of elasticity, 2.8 x 106 pounds per square inch, with grain

18.11 UPHOLSTERY MATERIAL

Upholstery material for vehicle sears shall be approved transportation grade material and shall be able to be cleaned by at least three widely available commercial industrial cleaning agents that are known to be chemically compatible. The contractor shall propose the material with technical information including physical properties. All material must comply with applicable flammability and smoke emission requirements of FRA Regulation 49 CFR Part 238 as well as Section 18.16 of this specification.

18.12 PIPING, TUBING AND PRESSURE VESSELS

Air or hydraulic hose applications shall not be permitted in locations where adequate visual inspections cannot be made. Hose installations shall be located/arranged in such a manner as to prevent accidental cross connections to other hoses located in the same general area.

Hose installations shall be such that kinking, rubbing, straining, and unnecessary swinging are precluded. Routing that requires other piping, or cables, as the sole means of support shall not be accepted.

The Contractor shall perform a leak test on the final air or hydraulic piping system, with all components installed, on each vehicle in accordance with IEC 61133. The Contractor shall submit a copy of the test procedure for approval. **[CDRL C-18-13**] A copy of the test report for each vehicle, including retest reports if appropriate, shall be included with each Vehicle History Book.

Loss of main reservoir air pressure due to cumulative leakage in the entire pneumatic system, not including that required for system functioning, per vehicle, shall not exceed 10 psig in 15 minutes,

following a 5-minute settlement period from the point at which the system was fully charged and the air compressor was shut off.
The Contractor shall submit piping, tubing, and pressure vessel specifications and data for approval. **[CDRL C-18-14]**

18.12.1 Piping and Tubing

Piping and tubing shall be adequately supported at least every 24 inches [610 mm] throughout its length and at connections, and must not interfere with the removal of or access to other components. A minimum clearance of 3 mm [0.125 in] shall be maintained on all piping and tubing used in the vehicle.
Attachment shall be by securely fastening with elastomeric or polymeric lined, steel clamps, or an approved equivalent, between the pipe and clamp to prevent chafing and vibration. **(SAR-235)**
All piping shall be seamless stainless steel or precision steel as determined by the application. All brake piping shall be seamless stainless steel pipe.
Stainless steel fittings must be used with stainless steel piping and tubing. Forged steel fittings, zinc plated to ASTM B633, Type II, Yellow, SC3 / SC4, may be substituted upon Metra approval.
All piping, tubing, valves, fittings, installation and testing methods, shall comply with ASME B31.1.
Joints that serve the sole purpose of connecting straight runs of pipe shall not be used. Unavoidable joints in piping shall be made in an approved manner. All inaccessible runs of tubing or piping shall be without joints.
Piping segments shall be deburred and blown out after cutting, and thoroughly cleaned and capped after fabrication. Metra reserve the right to verify piping cleanliness is to its satisfaction at any time during the production process.
After full installation on the vehicle, and before connection or installation of system components, the piping system shall be completely flushed with a suitable liquid solution, using appropriate pressure and velocity to fully dissolve all contaminants from manufacture and installation. The piping systems shall be cleaned a second time, following completion of component installation, using approved procedures. The Contractor shall submit for approval by Metra the proposed flushing and cleaning procedures for the piping and piping system. **[CDRL C-18-15]**
Following installation, piping systems shall be pressure tested in accordance with ASME B31.1 or other approved method.
All leaks, which appear during pressure testing, shall be repaired to the Metra's approval and re-tested until acceptable under the approved test criteria.
All hoses used shall comply with AAR M-618. All hose fittings shall be of an approved reusable type. Iron pipe fittings used with steel piping shall be AAR approved, with additional corrosion resistance as approved by Metra.
All piping shall be installed in accordance with AAR 2518 as incorporated in Standard S-400 (AAR Manual E) and in such a manner as to provide drainage to prevent freezing.

18.12.2 Air Filters

The filter element shall be a common production type, commonly available through various sources.
Access to the filter element for replacement purposes shall be possible without requiring the opening of any pipe fittings. Filters shall not be located in inaccessible locations for routine maintenance access.

18.12.3 Pressure Vessels

Unfired pressure vessels shall comply with Section VIII and IX of the ASME Boiler and Pressure Vessel Code for Unfired Pressure Vessels.

A test report shall accompany each pressure vessel received by the Contractor, and a copy of the test report shall be included in the appropriate Vehicle History Book. Each pressure vessel shall be stamped by the testing facility, whether it is the manufacturer or a third party, as verification of unit testing. Any data plates mounted to a pressure vessel must be sealed to prevent corrosion between the pressure vessel and the data plate mounted to it.

18.12.4 Drain cocks shall be provided at the low points of all reservoirs.

18.13 BEARINGS AND LUBRICATION

18.13.1 All bearings and lubricants shall be readily available in the United States. US Standard grease fittings or plugs shall be provided for all bearings not internally splash- or bath-lubricated.

18.13.2 All rotary shafts shall be supported by cylindrical or tapered roller bearings where practicable. Ball bearings may be used, subject to approval. Rotary / Motor shafts shall be suitably protected against corrosion to allow unencumbered removal of bearings.

18.13.3 Bearings subject to atmospheric or liquid contamination shall be sealed by labyrinth, lip, or face seals. Bearings installed in a vertical application shall have suitable protection to prevent moisture or contaminants from accumulating on, or entering, bearing.

18.13.4 Bearings that are not splash- or bath-lubricated shall be provided with standard grease fittings and drain plugs or pressure-release devices for re-lubrication. Ball bearings of 25 mm [1-in] shaft size and smaller may be factory lubricated-for-life, subject to approval.

18.13.5 Bearings shall be installed and removed without major disassembly of related components. Thrust style bearings shall be used whenever there is an axial load on the rotating shaft carried across rolling elements.

18.13.6 Sleeve bearings shall be used for shafts with rotary motion of less than one full revolution. Sleeve bearings shall be adequately lubricated. Sleeve bearings supporting ferrous shafts shall be composed of bronze, brass, or aluminum alloys as approved. Sleeve bearings may be used to support rotary shafts if space limitations preclude the use of anti-friction bearings.

18.13.7 Self-lubricated bushings (sintered metal) shall be used in accordance with the manufacturer's recommendations, but shall not be used for shafts with speeds greater than 500 rpm.

18.13.8 The Contractor shall submit bearing specifications and data for approval. **[CDRL C-18-16]**

18.13.9 All lubricants shall be products approved by the supplier of the parts on which the lubricant is to be used. All lubricants shall, as a minimum, conform to applicable ANSI and ASTM specifications. Multi-purpose lubricants shall be used where possible. The Contractor shall submit for approval data on lubricants recommended for bearings and bushings.

18.14 CURED MATERIALS

All materials that are applied prior to curing shall be applied according to the OEMs full recommendations, including surface preparation, mixing criteria, application temperature, shelf life limits, pot life limits, curing temperature, curing exposure (before handling, or loading), etc. All uncured material shall be stored and applied according to the OEM’s full recommendations.

All materials shall be used within the specified shelf life limits; material that has exceeded the shelf life shall not be used.
Preparation prior to bonding or painting the surface shall be prepared according to ASTM D2651.

18.14.1 Paint & Primer

All paint with the exception of powder coat must be compatible with the Authorities' present paint application apparatus and system, and must be fully repairable within the parameters of restrictive air quality zones and the local, governing air quality management authority. The Contractor shall submit for approval data on all paints, primers, and application processes or procedures to be used for the Authorities vehicle. The undercoating material shall be applied according to the manufacturer's instructions.
All dents, roughness, or other surface imperfections shall be corrected prior to the application of the priming coat.
Primer, finish paint, and related components shall be supplied as a complete system, manufactured by a single manufacturer. All mixed paint materials shall be used within the first 70% of the mixed pot-life time. Paint shall be applied within the manufacturer's recommended temperature range, but at a temperature no less than 55□F.
Preparation for paint application shall follow the paint manufacturer's recommendations. As a minimum, prior to paint application, surfaces shall be cleaned to remove all traces of contamination, and properly treated to promote paint adhesion.
Paint shall be applied evenly, and the finished surface shall be free of dirt, runs, "orange peel", or other imperfections. Paint inspection and acceptance criteria subject to Metra approval.
[CDRL C-18-17] Paint quality control samples may be proposed to establish Cosmetic coatings of paint shall have specified gloss levels for the appearance desired. The gloss levels shown in Table 18-7 are defined according to common terminology, with the following criteria based upon the ASTM D 523 – 60° axis angle with equivalents shown for 80° and 20°.visual acceptance criteria, subject to Metra approval.

Table 18-7

Gloss Level Definition	Glossmeter Setting and Gloss Value		
	20 degree	60 degree	85 degree
- High Gloss	85-90%	90-95%	95-100%
- Semi Gloss	0-10%	20-30%	50-60%
- Flat Gloss	0%	0-10%	10-20%

At least two coats of finish paint shall be applied, with appropriate surface preparation between coats.
Touch-up paint shall be identical in all respects to the original paint. Color chips for color match may be provided by the contractor for Metra approval, to establish acceptable color match tolerances. It is the Contractor's responsibility to ensure that the color match is acceptable. It may be required that the color match be made according to ASTM D 2244. In no case shall color mismatch detract from the overall appearance of the equipment.
Prior to assembly, all low-alloy steel areas shall be painted with one coat of an approved etching primer followed by one coat of an approved sealer to prevent rusting.
All coatings used are to be EPA compliant.
Painted surfaces shall develop full adhesion to the substrate to which they are applied. Testing for adhesion between the paint and the substrate surface will be done on a random basis and shall conform to ASTM D 3359, 3a Classification, using Permacell□ #99 adhesion test tape.

18.14.2 Powder Coating

Powder coating if used, shall be epoxy based for interior surfaces and polyester based for exterior surfaces. Finished film thickness shall be 3.5 mil (0.089mm) □ 1.0 mil (0.025mm). The surface preparation and pre-treatment shall be according to the powder manufacturer's recommendations.

Powder coating finish gloss level for cosmetic surfaces shall be according to Powder Coating Institute, Gloss Level Standard(s) – 7 to 10.

18.14.3 Adhesives

Adhesives to be used for installation of floor covering, panels, insulation, and vibration isolation materials shall have a satisfactory history of performance in a rail transit environment. A list of all adhesives to be used, including location, material safety data sheets, technical data & specification sheets, and flammability properties, shall be submitted for approval. **[CDRL C-18-18]** Adhesives used in small quantities may not require flammability data, subject to Authorities approval.

Joining of components by adhesives shall be completed within the maximum working times as follows; the application and aligning of bonded components shall be completed within 70% of the adhesives maximum working time, considering application conditions. When two-part compounds are being used, only the amount of adhesive that can be used within 70% of the maximum recommended pot life shall be mixed.

Adhesives that use atmospheric or humidity cure shall be installed such that the air circulation to fully cure the adhesive is possible.

Adhesive selection and bonded joint design shall consider MIL-HDBK-691B. **(SWR-176)**

18.14.4 Sealants and Caulking

The use of caulking and sealing compounds shall be minimized.

Caulking and sealing compounds shall be applied in accordance with the manufacturer's instructions and recommendations, shall be non-staining, and shall be supplied in colors closely matching those of adjacent materials and surfaces. Caulking used in exterior applications shall be ultraviolet light (UV) resistant. If butyl-type is used, it shall be extruded polyisobutylene sealer compound of 100 percent solids.

Caulking primers shall be quick-drying, colorless, non-staining sealers of a type and consistency recommended by manufacturers of caulking materials for the particular surface involved.

Packing (backstop) shall be non-staining, resilient material, such as fiberglass roving, neoprene, butyl, closed-cell foams, or other compressible materials compatible with the caulking compound used. Joints, spaces, and junctures to be packed and caulked or sealed shall be completely cleaned of dirt, dust, oil, and other foreign materials that would adversely affect caulking quality. Suitable primer shall be used to achieve full adhesive bond.

Surfaces shall be thoroughly dry before caulking compounds are applied. Caulking compound application shall be compatible with prior or subsequent paint application. When so stipulated by the sealant manufacturer, paint and other protective coatings shall be removed from surfaces to be caulked prior to priming and application of sealants.

Compounds shall be applied with pneumatic guns. Where the use of a caulking gun is impracticable, suitable hand tools shall be used.

Unless otherwise indicated, the entire perimeter of each opening shall be caulked. The finish of caulking joints on flush surfaces and in internal corners shall be neatly pointed; excess material shall be removed; and, where exposed, the caulking shall be free of wrinkles and uniformly smooth.

Application of polysulfide or silicone compounds shall be in accordance with the OEM's instructions and recommendations.

Compounds shall not be used when they become too gelled to be discharged in a continuous flow or exceed their stated shelf life, and they shall not be modified by addition of liquids, solids, or powders. Compounds shall be installed within the manufacturer's defined temperature range.

Installation and working of compounds shall be completed within the maximum working times as follows; the application and working of caulking material shall be completed within 70% of the minimum "skin" time, considering application conditions. When two-part compounds are

being used, only the amount of caulking that can be installed within 70% of the maximum recommended pot life shall be mixed.
Adjoining surfaces, finishes, and fixtures shall be carefully protected throughout caulking operations. Stains, marks, or damage as a result of caulking and sealing work shall be removed.

18.15 INSULATION

Insulating materials shall be fire-retardant, non-carcinogenic, non-hygroscopic, resistant to fungus, and provided with a vapor barrier as required to prevent the entry of moisture, oil, gases, and dust. The materials shall not absorb fluids and gases and shall possess the required properties to meet the noise and vibration requirements of this specification.
The method of insulation retention in the car-shell, for all insulating materials, shall be subject to Metra approval.
The Contractor shall submit for approval data on thermal and acoustic insulation materials and application processes. **[CDRL C-18-19]**

18.15.1 Acoustic Insulation

Sound damping material used in the fabrication of the vehicle shall be resistant to diluted acids, greases, gasolines, fuel oils, aliphatic oils, and vermin; and must be resistant to fungus; and must not support combustion. The material shall not be affected by sunlight or ozone, and shall not become brittle with age

18.15.2 Thermal Insulation

Thermal insulation materials shall be transportation grade of the rigid, non-rigid, or spray-on type. Insulation shall be installed with a vapor barrier to preclude moisture accumulation. The type of thermal insulation to be used shall not be susceptible to mold or rot and shall not absorb water. Metals, which are attached to the insulation, shall be corrosion resistant, and not settle under vehicle vibration. The vehicle thermal insulation shall not have an odor or be capable of absorbing odors, and shall not sustain vermin. Urethane foam insulation is expressly prohibited.
Thermal insulation material shall have a thermal conductivity of not greater than 13,000 J/hr-m2-Co/cm (0.25 Btu/hr-ft2-Fo/in) when tested in accordance with ASTM C177.

18.16 FIRE SAFETY

18.16.1 All materials used in the cars shall be selected to minimize combustion and propagation of fire both inside and outside cars. The Contractor shall ensure that all materials which are subject to specific fire safety requirements and guidelines in 49 CFR Part 238.103[c] and NFPA 130 have been properly tested and certified by a recognized independent laboratory. All test reports shall be submitted to Metra for approval and shall include Pass/Fail conclusions per the applicable performance criteria and shall include certification from the recognized independent laboratory that the test results were obtained after testing in accordance with the procedures and equipment specified in the test methods.

18.16.2 All test reports shall also be accompanied by a certification from the Contractor that representative samples of combustible materials has been tested by a recognized independent testing laboratory and that the results show the representative samples comply with the 49 CFR Part 238.103[c] and NFPA 130 requirements as well as the Toxicity requirements of this specification.

18.16.3 The name, address, qualifications, and contacts of all laboratories used shall be provided to Metra in advance of testing and the laboratory selected shall be subject to Metra's approval.

18.16.4 Additional testing would be required if the test reports submitted by the Contractor are not accepted by Metra. Reasons for Metra not accepting test reports may include, testing of representative material was not performed, compliance criteria and conclusions are not provided in the test reports, certifications not provided, test reports are over 5 years old, regulations/requirements have changes since testing was conducted etc. Metra has the sole right to determine if test reports are acceptable or if additional testing is required.

18.16.5 All materials used in the subject cars shall be in compliance and be tested in accordance with FRA Regulation 49 CFR Part 238, Section 238.103 and NFPA 130. The fire safety and flammability tests shall also be performed for sealants, caulking, and adhesive materials. In case materials are not listed in these standards, the Contractor shall contact Metra for approval with the proposed performance criteria they plan to use. In addition the Contractor shall conduct the fire safety analysis as required by Section 238.103[c].

18.16.6 All test results should be completed and submitted to Metra prior to delivery of the first vehicle in the order. No vehicle will be utilized in revenue service until all test results have been submitted, reviewed and approved by Metra and a complete fire safety analysis per 238.103[c] and NFPA 130 has been submitted, reviewed and approved by Metra. **[CDRL C-18-20]**

18.16.7 All materials used in car construction shall be tested for the emission of toxic gases during combustion using the NBS Smoke Chamber, bellows pump, and the appropriate Draeger tubes for the gases involved. Bombardier SMP 800-C maximum values shall be used to determine the acceptability of products. **(SAR-148)**

18.16.8 The tests are to be run in the flaming mode, with sampling done after 240 seconds. The test report shall show the maximum concentration (ppm) for each of the following gases:

18.16.8.1 Carbon Monoxide (CO)
18.16.8.2 Sulfur Dioxide (SO2)
18.16.8.3 Hydrogen Cyanide (HCN)
18.16.8.4 Carbon Dioxide (CO2)
18.16.8.5 Hydrogen Chloride (HCl)
18.16.8.6 Oxides of Nitrogen (NOX)
18.16.8.7 Hydrogen Fluorine (HF)
18.16.8.8 Hydrogen Bromide (HBr)

18.16.9 On a limited and case by case basis, Metra may approve the use of material that have been verified as not having alternatives and have not passed the specified performance requirements. In these cases the Contractor shall be required to submit a waiver in writing to Metra for approval prior to any use of such material. The Contractor's waiver request shall include the justification(s) for using the material, total weight of the material, location(s) and distribution on the vehicles, material safety and data sheets, and current test reports. In addition, the Contractor shall submit a letter from an independent material fire safety professional indicating their review of the Contractor's waiver request and their professional safety analysis and conclusions regarding the request and the safety, environmental and regulatory implications involved for Metra throughout the life of the vehicles.

18.17 JOINING AND FASTENING

No protruding screws, rivets, mounting bolts, or similar items shall be permitted on the exterior of the vehicle, except where approved by Metra. The use of exposed fasteners on the vehicle interior shall be minimized. Interior fasteners shall be countersunk where possible or low profile heads where countersink is not possible. Interior fasteners shall not protrude enough to become a tripping or snagging hazard.

18.17.1 Fastening to Structural Members

Fastening to structural members shall be done only on the low stress portion of the member and shall not be located within 3/4'" (17mm) from the open edge of the structural member. The Contractor shall ensure that any fastening or joining to structural members does not result in moisture accumulation within any structural member. To this end, fastenings to hollow, closed section structural members shall not be accomplished using drilled holes in the structural member.

18.17.2 Threaded Fasteners

The number of different sizes and styles of fasteners used shall be minimized. A single standard, US (ANSI/SAE/IFI), shall be adopted for the fasteners used. Fasteners shall be properly marked per the system adopted. All threaded fasteners shall comply with ANSI B1.1 class 2 requirements, unless otherwise specified or approved. All structural threaded fasteners shall have rolled threads.

Self-tapping or thread forming screws may be used with Metra approval only, on a case-by-case basis.

Use of threaded inserts or special or non-standard fasteners shall require Metra approval.

At least 1 1/2 threads shall be visible beyond all nuts. Bolts smaller than 6 mm [0.25 in] shall not project more than 1 1/2 thread plus 6 mm [0.25 in]. Bolts 6 mm [0.25 in] or larger shall not project by more than 8 threads.

Fasteners exposed to public view shall be treated as follows: **(SWR-178)**

18.17.2.1 On the vehicle interior, all exposed fasteners shall be stainless steel with flat or oval heads, properly countersunk.

18.17.2.2 On the vehicle exterior, all exposed fasteners shall be stainless steel, unless otherwise specified.

18.17.2.3 Exposed screws shall be of an approved tamper-proof type.

18.17.2.4 Fasteners and fastener components used on the vehicle underfloor or roof areas shall be stainless steel except in cases where high strength fasteners such as SAE grade 8 are required. The contractor shall provide a list of all threaded fasteners, fastener classification, material, finish, and location used, for Metra approval. **[CDRL C-18-21]**

18.17.3 Fastener Materials

Fastener component materials (screws, nuts, washers, etc.) shall be properly selected for the application and shall not be mixed within an assembly unless approved by Metra. All fasteners shall be stainless steel, or steel finished with protective coating such as passivation, dichromate, or zinc plating, depending on the specific application.

Threaded aluminum fasteners shall not be used except in tapped holes in solid aluminum structures, subject to approval.

Stainless steel nuts and bolts shall be used for stainless-to-stainless joints. Anti-seize compounds shall be used on all stainless steel fasteners threaded into stainless steel, or using stainless steel nuts.

18.17.4 US Standard

Threaded fasteners shall conform to current SAE J429/ASTM A574 standards for externally threaded fasteners and SAE J995 standards for internally threaded fasteners. Steel fasteners ¼" diameter and above shall be SAE grade 5 minimum.

Stainless steel fasteners shall be manufactured from austenitic stainless steel alloys, according to ASTM F 593, with a nominal tensile strength of 100 ksi. All fasteners shall be clean and free of manufacturing scale.

Non-structural screws, such as Phillips or slotted head screws smaller than ¼" diameter may be SAE grade 2 minimum. **(SCR-229)**

18.17.5 Locking Requirements

All threaded fasteners shall be self-locking or provided with locking devices. Locking devices shall be lockwire, lock washers, torque patch, or prevailing torque type locknuts as appropriate for the application or service. Lockwire, if used, shall be stainless steel.
Prevailing torque locknuts shall be of the nylon collar insert type. Previously installed and removed locknuts shall not be re-used. High temperature applications may use metallic distorted thread locknuts upon Metra approval.
Bolts for use with locknuts shall not be drilled for cotter pins or in heat related applications.
All locknuts shall comply with the Industrial Fasteners Institute requirements regarding to locking ability.
When oversized or slotted holes are provided for installation tolerance allowance, flat washers, of suitable size to cover oversized holes, or slots shall be used in all locations adjacent to the hole. In this case, at least one hole shall be of close tolerance to ensure accurate positioning of component. If slotted holes are provided as a means of adjusting a piece of equipment, a secure method of fixing the adjustment shall be provided, such as adjustment screws, ribbed or toothed adjustment washers, Drilled holes and pins, etc.

18.17.6 Plating & Treatment of Fasteners

All steel fasteners shall be zinc plated with the highest protective service condition available per thread configuration. Stainless steel fasteners shall be passivated. If stripping and re plating of fasteners is required to meet the aforementioned criteria, documentation must be made available to verify that all applicable post plating treatments and standards have been met. Metra may require batch testing of stripped and re-plated fasteners to ensure there is no hydrogen embrittlement.
After manufacturing, steel fasteners shall be electroplated, zinc with a yellow chromate conversion per ASTM B633, Type II - Yellow (please refer to table for thickness).
After manufacturing, steel fasteners shall be electroplated, zinc with a yellow chromate conversion per ISO 4042, (refer to Table 18-8 for plating thickness). Coating per ASTM F3393 Class E is an acceptable alternative for fasteners not regularly accessed for maintenance and will be approved on a case-by-case basis by Metra/VRE. **(SCR-202)**

Table 18-8

Plating Thickness for Steel Fasteners, Zinc, Yellow Chromate Conversion			
Bolt size	**Metric DIN 267**	**US ASTM B633**	**Thickness (Micro meter / inch)**
Dia, up to #8 (M3)	A1L	-	3µm / .00012"
Dia. >#8 (M3) to 5/16" (M8)	A2C or A2L	SC1	5µm / .00020"
Dia. >5/16" (M8) to 7/8" (M22)	A3C	SC2	8µm / .00031"
Dia. >7/8" (M22) to 1-1/8" (M33)	A4C	SC3	13µm / .00051"
Dia. >1-1/8" (M33) and greater	A5C	-	15µm / .00059"

18.17.7 Hydrogen Embrittlement

Fasteners or fastener components with hardness greater than or equal to 320 HV (32 HRC) are susceptible to hydrogen embrittlement when these parts are pickled and/or electroplated. This may cause these fasteners to fail at relatively low loads even if stress relief annealing (baking) is performed after plating. Examples of hardened fasteners are steel bolts - US Grade 8, hardened steel washers, spring washers, etc. These types of fasteners shall be mechanically plated to avoid hydrogen embrittlement.

18.17.8 Torque Marking/Indexing

The Contractor shall ensure the proper application of all threaded fasteners. Torque marks or stripes extending from the secured hardware to the surrounding surface shall be applied to all safety related hardware, including truck, door, and brake equipment bolts. Tightening indication may be required on other non-safety related hardware upon the Authorities' request.

18.17.9 Bolts and Nuts

All threaded fasteners falling into this category used in this project shall require a submittal of Certifications of Compliance (C of C) with each shipment of hardware to the end user. The C of C shall be traceable to a manufacturer.

High strength fasteners such as SAE grade 8 hardware shall be used for mounting the traction motors to the trucks, and for all truck mounted appurtenances, unless specifically allowed otherwise by Metra.

18.17.10 Electrical and High Temperature Connections

Plated steel screws or bolts, nuts, flat washers, and lock-washers used in mounting and in making connections to resistors and other heat-producing apparatus shall be suitable for high temperatures without degradation of the strength of the hardware or its corrosion resistance. Flat washers shall be used on both sides of all electrical connections (under bolt head and under nut).

18.17.11 Riveting

Rivet holes shall be accurately sized, located, and aligned for the intended rivet. Rivet holes that have been repaired, or the rivet removed shall be reamed to the next larger rivet size, and the next larger rivet installed. Rivets exposed to passengers on the outside of the vehicle shall be stainless steel.

Hand-driven steel rivets shall be driven hot and shall completely fill the holes.

Two part rivets consisting of a pin and collar (such as Huck-Bolt types) shall be installed such that the pin breaks flush with the end of the collar.

Blind rivets may be used subject to Metra approval. Blind rivet materials may be stainless steel, or plated carbon steel with plated steel or stainless steel mandrels compliant with ~~SAE J1200~~ IFI 114. The mandrel shall break flush or slightly below the surface of the rivet head, but shall remain locked in place as a structural part of the rivet assembly. All rivets shall be installed according to the rivet manufacturer's instructions, using equipment approved by the rivet manufacturer. **(SCR-042)**

Rivet nuts shall be of the positive locking variety, with either exterior serrations or hex cross sections to preclude spinning once installed. The rivet nut hole shall be made per the rivet nut manufacturer’s recommendations.

Aluminum alloy rivets shall comply with Aluminum Association Standards for Aluminum Mill Products alloys and tempers 6061-T6 or 6053-T61.

18.18 WELDING, BRAZING AND SOLDERING

All welding practice not specifically covered in this Section shall be in accordance with the applicable requirements and recommendations of the American Welding Society (AWS), as contained in the latest revisions of the "Structural Welding Code" (AWS D1.1), "Aluminum Welding Code" (AWS D1.2), "Structural Welding Code - Sheet Steel" (AWS D1.3), Structural Welding Code – Stainless Steel (AWS D1.6), “Sheet Metal Welding Code” (D9.1), “Recommended Practices for Resistance Welding" (AWS C1.1), "Railroad Welding Specification" (AWS D15.1) and the AWS "Welding Handbook" (AWS WHB). Where non-AWS welding is used, the supplier shall demonstrate equivalence. The contractor shall demonstrate compliance with AWS welding requirements and standards.

The Contractor shall be responsible for the quality of all welding and brazing, including the welding and brazing of its suppliers and subcontractors.

Prior to welding, all surfaces shall be thoroughly cleaned to remove corrosion, rust, scale, slag,

grease, oil, water, paint, and other foreign materials in accordance with applicable parts of D1.1, Section 8.5 on Workmanship and Technique.
Parts to be joined by welding shall be supported and held in position by tables, jigs, or fixtures to prevent warping. Weld joint design and welding method shall be selected to include provisions for shrinkage and warping due to the welding process. Welding shall be applied in a manner to minimize distortion. Acceptable distortion levels shall be submitted for Metra approval.
All Weld quality shall be in accord with acceptable weld criteria as defined in AWS welding Codes.
The Contractor shall submit welding procedures specifications (WPS) and Procedure Qualification Records (PQR) to Metra for review and approval. **[CDRL C-18-22] (SWR-117, SWR-204, SWR-209)**

18.18.1 Welder Qualification

Welders shall be tested and certified to verify their proficiency for producing sound welds, for each weld type performed by the welder to each applicable Welding Procedure Specification (WPS). Welder qualification tests shall be performed in accordance with the applicable requirements of AWS standards, or other approved equivalent standards. Welder qualification tests for pressure vessel welding shall be in accord with applicable requirements of ASME Section IX, or other approved specifications.
Welders shall be certified to AWS or equivalent welding societies and an identification number from the society shall be provided.
The Contractor and all suppliers and subcontractors shall retain records of welder qualifications and shall make these records available to Metra upon request.
Metra shall have the right to require the making of test welds by any welder, whether under the direct control of the Contractor or a supplier or subcontractor, to ascertain his/her competence and to determine the suitability of the welding procedure used.

18.18.2 Welding Procedures

All welding practices not specifically covered in other sections shall comply with AWS-D1.1, AWS-D1.2, or AWS-D1.3 and the AWS Welding Codes as appropriate to the applicable AWS welding standard(s). Requirements for dynamically loaded structures shall be applied.
Resistance welding shall be in accordance with ~~SAE-AMS-W-6858~~ AWS D17.2. Resistance welding operations shall be undertaken using only equipment fitted with meters or readouts and adjustments for time, current, and pressure. **(SCR-013)**
The method used in depositing weld metal shall be one that reduces warping and residual stresses. To achieve this, tack welding, offset welding, skip welding, and other devices and sequences well known to the craft shall be used where appropriate.
Machine welds of any thickness may be made with one or more passes as per the Procedure Qualifications Record (PQR) for the weld joint.
The Contractor shall submit a procedure qualification record (PQR) for all weld joints to be used or pre-qualified per AWS codes and all Weld Procedure Specifications (WPS) for the project.
Procedures used for the welding of metal combinations not specifically covered by the AWS standards (i.e. stainless steel to steel) shall be approved by Metra. Stainless steel to steel welds shall use austenitic stainless steel filler metal.

18.18.3 Welding Electrodes

The choice of welding rod or wire filler metal shall be made with consideration of the make, type, size, composition, and suitability to the application and shall be in accordance with "Specification for Filler Metal" AWS A5.0. Welding electrodes shall be stored in a dry, closed environment to prevent contamination in accordance with AWS recommended practices for filler material storage. Welding electrodes shall be clearly marked. All low-hydrogen electrodes shall be kept in a dry-rod oven to keep moisture from the electrodes. The electrodes shall now

be exposed to the atmosphere for longer than a period of four hours. Low-hydrogen electrodes soak atmospheric moisture and stays in the flux. When welding with an electrode with moisture in the flux can cause excessive surface and/or subsurface porosity and can cause slag entrapment.

18.18.4 Weld Repairs

Weld repairs shall be performed in accordance with approved procedures, which comply with AWS D1.1 or the AWS Code applicable to the welded material. When a production weld has been determined to be substandard, all production since the previous acceptable production quality control test shall be segregated, and disposition shall be recommended to Metra for approval. All parts with substandard welds shall be rejected or repaired by weld removal, re-weld, and inspection. Re-weld, inspection, and any Non-Destructive Examinations (NDE) required by the applicable AWS welding standard regarding repairs.

18.18.5 Welding Inspection and Examination

The Contractor shall inspect all welds. Welds shall be inspected to verify compliance with these provisions and specifications.

Welding inspection procedures and welding inspector qualification tests shall be performed in accordance with the applicable requirements of the AWS standards for weld inspection.

The Contractor shall use and demonstrate the use of personnel qualified to perform weld inspection. An AWS Certified Senior CWI shall lead all welding matters. An AWS Certified Welding Inspector (CWI) shall be utilized for inspection and oversight of welding inspection. All welding must be inspected by a CWI and the CWI stamped inspection reports shall be provided. This requirement applies to all welding work performed under the contract. **(SWR-123)**

Non-destructive examination and testing of welds and welder qualification tests shall be performed in accordance with the applicable requirements of the AWS Welding and Brazing Handbook and the requirements of the applicable AWS standard the Welding Procedure Specification (WPS) is written to.

Personnel performing NDT shall have documented qualifications in accordance with American Society of Non-destructive Testing (ASNT), TC-1A.

In addition to visual inspection requirements specified by the AWS welding codes, non-destructive surface inspection (dye penetrant or magnetic particle methods, as appropriate) shall be used to inspect all first-production welds.

The Contractor shall specify additional non-destructive inspection requirements for subsequent welds. If the Contractor elects to inspect less than 100 percent, then the Contractor shall submit a random sampling inspection plan for approval by Metra. In no case shall the length of weld non-destructively inspected be less than one percent of the total weld length.

All welds designed to carry primary stresses in members such as side sills, end frames, bolsters and other important truck and frame members, shall be inspected by the Contractor for defective welding.

Critical areas of all such welds shall be magnetic particle or dye penetrant or ultrasonic tested and radiographic tests shall be used on a random sample basis.

The following defects in excess of limits indicated or established in the approved procedures shall be cause for rejection of the work affected: cracks, regardless of length, magnitude or location; overlaps; lack of penetration; incomplete fusion; inclusions except if they do not materially affect the strength of the welded joint and do not indicate improper technique or an unsatisfactory procedure; undercuts; poor surface appearance; or improper size of weld.

On the first structure or component, all full-penetration welds shall be non-destructively, volumetrically inspected (ultrasonic or radiographic methods). The Contractor shall specify a random sampling plan for volumetric inspection of subsequent full-penetration welds for approval by Metra. [CDRL C-18-23]

With the approval of Metra, destructive sectioning and metallurgical examination may be substituted for some or all of the required volumetric inspection requirements. **(SWR-124)**

18.18.6 Heat Treatment

Where required by specifications or drawings, welded assemblies shall be stress-relieved by heat-treating in accordance with AWS D1.1. Chapter 4, Part A. Heat treatment procedures shall be documented and submitted for review for first piece/part processing. All heat treatment documentation (results) shall be retained by the Contractor.

18.18.7 Brazing

The Contractor shall maintain a brazing program similar to the welding program specified in the welding portion of this specification.
All brazing, qualification of braziers, and repair of brazing defects shall be in accordance with the requirements and recommendations specified in the AWS Welding and Brazing Handbook. The Contractor shall maintain quality control procedures necessary to ensure high-quality brazing. The Contractor shall submit brazing specifications, procedures, and certifications to Metra for review and approval. **[CDRL C-18-24]**

18.18.8 Soldering

Soldering of electronic equipment shall comply with the requirements of ANSI J-STD-001B. The Contractor shall submit soldering specifications, procedures, and certifications for approval.

18.19 CORROSION CONTROL

18.19.1 All materials used shall be either inherently corrosion resistant, or suitably treated, or coated to resist corrosion. Equipment located in areas highly susceptible to corrosion shall be made from inherently corrosion resistant materials. Areas exposed to corrosive fluids or cleaning solutions shall be protected with coatings resistant to those fluids. The Contractor shall be responsible for verifying that all such areas are protected through communications with Metra.

18.19.2 Except as otherwise indicated, all aluminum exposed to view in finished work in the interior of the vehicle shall have a protective anodized coating.

18.19.3 The recommendations contained in "a Corrosion Control Manual for Rail Rapid Transit", UMTA-DC-06-0152-83-1, shall be used, except as otherwise directed by Metra.

18.19.4 The Contractor shall prepare a Corrosion Control Plan, which shall locate all materials that require treatment to prevent corrosion due to atmospheric exposure, and areas of dissimilar metal or other material joining which could result in galvanic action and material deterioration. This plan shall document the methods used to preclude failure due to corrosion for any of the above conditions. The Contractor shall update this document as materials and treatments change. The Corrosion Control Plan shall be submitted to Metra for review and comment. **[CDRL C-18-25]**

18.20 DISSIMILAR METAL TREATMENT

18.20.1 Direct contact between electrically dissimilar metals is prohibited except as approved by Metra for electrical connections between copper and aluminum where appropriate joint compounds are used as specified herein. Isolating and moisture-proofing materials, appropriate to the materials being joined, shall be used at all times.

18.20.2 All metals used in the fabrication process shall be surface treated with corrosion-resistant materials prior to assembly, with consideration being given to the severity of exposure to which the surface shall be subjected.

18.20.3 The joining of incompatible metals and materials shall be minimized as much as possible. When such metals must be joined, provision shall be made in accordance with MIL-STD-889 to prevent chemical reactions between the metals.

18.20.4 Surfaces of aluminum alloy parts secured to ferrous parts shall be protected with one-part polysulfide or silicone sealant used as joint compound, or with joint material that is non-hygroscopic and is free from chlorides and heavy metal ions.

18.20.5 Fibrous joint material shall be impregnated with bitumen or other water-repellant substance, which shall completely cover interfacing surfaces.

18.20.6 All ferrous metal surfaces, other than stainless steel, shall be protected by painting or zinc plating as defined in this specification, unless otherwise specified. Steel surfaces not requiring protection shall be galvanized by the methods and requirements described in ASTM A123. Minor damage to galvanized coatings shall be repaired with an approved zinc rich paint.

18.21 WIRING REQUIREMENTS

Wire sizes, insulation requirements, materials, shielding methods, and identification of wire and cable used for primary, auxiliary, control, and communications applications shall be based on the current carrying capacity, voltage drop, mechanical strength, temperature, and flexibility requirements of AAR, ASTM, ICEA, NFPA, or MIL, ~~or NFPA 70~~ specifications. **(SCR-222)**

Wire, cable, and bus bars shall be copper. All wiring not explicitly referenced in other parts of this specification shall meet at a minimum the latest revision of APTA specification PR-E-RP-009-98, Recommended Practice for Wire Used on Passenger Equipment.

All wire and cable insulation shall meet the flame and smoke test requirements of the Flammability, Smoke Emission & Toxicity section of this specification, and shall be substantially free of halogens. The wire and cable selected shall be rated by the manufacture to last the life of the vehicle.

The Contractor shall mark each wire, by wire type, at an interval of 12 inches, and mark each wire end with a function code using a scheme subject to approval by Metra.

Metra shall approve all electrical wire and cable used in the vehicle. The Contractor shall submit samples and specifications of each size and type of wire and cable proposed for use in the vehicle for Metra approval. **[CDRL C-18-26]**

Braided copper wire, or wire rope, shall be used in all ground strap applications. Flexible stranded copper wire is acceptable in other applications.

All conductors of multi-conductor cables shall be terminated.

18.21.1 Conductors

Maximum current capacities shall conform to ~~National Electric Code, NFPA 70, ampacity table 310-16~~ APTA PR-E-RP-009-98. **(SCR-114)**

Except as otherwise specified, conductors shall be of soft, annealed, tinned copper stranded in accordance with ASTM B33.

Stranding and conductor construction for all wires and cables No. 18 AWG and larger shall comply with ~~of~~ either NEMA WC 70, NEMA WC 71, and AAR RP-585, as is appropriate for the application. Stranding shall be per ~~ASTM B174; Class I or equivalent - 10 to 7 AWG, and Class K or equivalent - 18 to 12 AWG.~~

~~Stranding and conductor construction for wires and cables No. 20 and No. 22 AWG shall be of 19-strand construction as appropriate for the usage requirements~~ AAR RP-585 for 10 and 8

AWG. Stranding shall be of 19-strand construction per AAR RP-585 and ASTM B286 for 22 to 12 AWG. **(SCR-125) (SWR-131)**

18.21.2 Wire & Cable Insulation

Each conductor shall be separately covered with insulation. Flat cables are prohibited, except for specific data/communications applications where other arrangements are impractical.

Wire and cable insulation used for car-body wiring shall be flexible, crosslinked polyolefin, or equivalent. Wire and cable shall comply with the requirements of NFPA 130. Wire and cable shall comply with applicable sections of NEMA WC 70, NEMA WC 71, and AAR RP-585 as is appropriate for the application and subject to Metra review.

Wires within enclosed equipment or suitably protected locations shall comply with MIL-W-81044, or as otherwise approved.

For general-purpose wire and cable, the insulation shall be of heat and moisture proof material suitable for a continuous temperature rating of 167□F (75□C) minimum in dry and wet locations. For high-temperature applications, such as connecting to heaters and resistors, the insulation shall be suitable for a maximum conductor temperature of 230□F (110□C).

Asbestos, urethane, and polyvinylchloride (PVC) based insulations or jacket materials shall not be used.

Outer jacket material of multi-conductor cable shall be the same as that used to insulate individual conductors, unless physical considerations indicate a different material with superior characteristics.

Multi-conductor cables shall provide at least 10 percent spare wires and at least one spare of each wire type and size.

Shielding shall be used over multi-conductor cable for safety-critical circuits. Shielding material shall be woven wire providing not less than 60 percent coverage and shall be soft, annealed, tinned copper of an area equal to or greater than the largest conductor.

Non-conducting separators and fillers may be applied between conductor and insulation on conductor sizes greater than No. 5 AWG.

Leakage between primary wiring and vehicle body shall be measured in accordance with IEEE 16 ~~11~~. ~~The leakage shall be at least 10 megOhms when measured with 1,000-volt megOhmeter~~.

Hi-Pot shall be accomplished on all primary power wiring ~~at 2,500 VAC~~ for 1 minute per IEEE 16 ~~11~~. **(SCR-095)**

General car-body wiring insulation shall be flame-retardant, extra-flexible, cross-linked polyolefin material. General car-body wiring insulation and/or jacketing shall be free of halogens, phosphorus, sulphur, and nitrogen (combined to less than 1% by weights), or otherwise be subject to Bombardier SMP 800-C test criteria. **(SAR-100,148, 165, 167, 220)**

18.21.3 High-Temperature Wire & Cable

Insulation for all wires in high-temperature applications, including but not limited to those connecting with heaters, resistors, or lights shall conform to the following:

For wire sizes No. 16 AWG and larger, the insulation shall be silicone rubber in accordance with AAR RP-587, RP-588 and ~~RP-589~~ RP-586, 110°□C irradiated cross-linked polyolefin, or abrasion-resistant extruded PTFE (polytetrafluoroethylene) Teflon meeting MIL-W-22759/6B. **(SCR-010)**

For wire sizes No. 18 AWG and smaller, the insulation shall be abrasion-resistant extruded TFE Teflon meeting MIL-W-22759/6B. When used for interconnecting pieces of apparatus, this type of wire shall be bundled and shall have a protective covering.

18.21.4 Communications Wire & Cable

The communications system manufacturer shall approve all car-body wire and cable applicable to the communications equipment.

All communications wire and cable shall be installed in raceways, conduits or as otherwise approved.
The jacket shall be waterproof and abrasion-resistant, and shall provide insulation resistance greater than 1 MOhm/ft between shield and water.

18.21.5 Conduit & Wire Channel

All conduits and wire ways shall be free of burrs, sharp edges, and square corners. Conduit welded into the ca-rbody shall not have any burn-through of weld, or any other penetration into the interior of the conduit. The ends of the conduits and wireways shall be suitably rounded to prevent edge contact with the wire. Conduit radius shall be sufficiently large enough to allow easy pulling of the wire.
Wires and cables installed in flexing applications shall be housed in abrasion resistant, flexible conduit or sheathing designed for the application, and installed such that there is no pinching, stretching, or kinking under all ranges of motion.
The Contractor shall ensure that wireways, conduits, and piping, that is susceptible to corrosion shall be suitably protected from corrosion such as zinc plating per ASTM B633 Type II yellow, SC4, or receive a minimum of two coats of primer and two coats of an approved paint. This priming and painting can be accomplished either before or after installation of the item on the car-body.

18.21.6 Application & Installation

All wiring shall be performed and directed by experienced personnel using appropriate tools for stripping insulation, cutting, soldering, and attaching mechanical crimp-type terminals with correct dies.
All car wiring connected to a given piece of electrical apparatus shall be insulated for the highest voltage supplied to that apparatus. ~~Wires operating with potential differences of 50 volts or more shall not be cabled or routed together. Signaling, LVDC, AC, and HVDC wiring shall be separated~~ Wire harnesses and cable assemblies shall follow the guidelines detailed by APTA PR-E-RP-002-98_R2 for physical wire separation. **(SCR-170)**
Wiring for any communications system equipment shall be done in an approved manner to conform to the requirements established by the supplier of that equipment.
All circuits shall be adequately protected and insulated from ground. All circuits and branches must be separable by a switch or terminal board to isolate their grounds when trouble-shooting is required.
Wiring shall be fabricated into standard harnesses, and installed in prefabricated groupings, and standardized locations in the vehicles.
Car wiring shall comply with APTA-PR-E-RP-002-98 Revision 2 ~~NEC Code, Chapter 3 (NFPA 70), and with the AAR Manual of Standards, Section F, S-538, Wiring Practice, and Rolling Stock Standard~~, **(SCR-222)** except where otherwise specified. **(SWR-101)**
Circuit protection shall comply with NEC Code, Chapter 2.
Electrical circuits and associated cabling shall be designed with clearance and creepage distance between voltage potentials and car-body ground in accordance with the environmental conditions to which the circuits and cabling will be subjected, and in accordance with NFPA 130, Chapter 4 or equivalent IEC standards.
Electric apparatus shall be housed in sealed enclosures to remain clean and dry. Cooling air shall be filtered to remove all conductive and non-conductive dust.
The layout of wiring shall be designed in advance of its installation and in cooperation with those furnishing the related equipment.

18.21.7 Undercar and Roof Wiring Installation

All wiring shall be run in ~~insulated~~ grounded **(SCR-043)** metal raceways and/or wire ducts ~~with securely fastened but easily removable metal covers~~. **(SCR-152)**

Wire and cable shall be securely anchored in an approved manner in the ducts to prevent chafing from relative motion.
Minimum wire size for under car wiring shall be 14 AWG for power and 16 AWG for control circuits. Within equipment enclosures, minimum wire size shall be 22 AWG.
When physical strength is required, No. 6 AWG or larger wires may be used and supported in place without any type of enclosure by using molded rubber cable support blocks. This method is also acceptable in protected areas that may be subject to damage or vandalism.
~~The wire ducts and conduits shall be of waterproof construction. Watertight strain-relief bushings with insulated throat liners shall be provided at duct entrance and exit points. Bushings shall be sized such that the wire and lug may be removed through the bushing~~. **(SCR-043)**
Wires or cables shall not pass over or through the battery compartment.
Floor wiring shall be run in conduits or ducts and may be run through partitions, but only if suitable bushings are provided at such points of passage.
Sufficient slack and wire length shall be provided to prevent breaking or pulling out of bushings or terminals, and to allow for a serviceability loop long enough for three re-terminations.
Drip loops shall be provided where appropriate.

18.21.8 Power Cables

HVDC power cables (with the exception of cables passing through or above the floor) that are No. 6 or larger shall be cleated in place.
The cleats shall be positioned at intervals no greater than 257 mm (1.5 ft), and adequate clearance shall be maintained between cables and any structural members, components, or items of equipment.
Where mechanical protection is required, short lengths of conduit may be employed, one conduit per wire, subject to approval.

18.21.9 Cable Connectors

All cable connectors shall be of watertight design, unless enclosed in interior watertight cabinets and approved by Metra, with removable / replaceable crimp contacts of the correct size for the wire being terminated.
Cable connectors shall be equipped with sealing gaskets. Extension bodies shall be used if necessary to ensure that there is sufficient room to terminate the cable wires within the connector body.
The cable jacket shall extend within the body, shall be held by a clamp, and shall have a gasket seal at the entrance.
Unused connector pin positions shall be sealed with either connector contacts or plastic sealing plugs designed for that purpose.
Adjacent connectors shall either use different inserts or different insert orientations to prevent erroneous connections.
Connectors installed in exterior locations shall comply with MIL-DTL-5015. All other connectors shall comply with an equivalent standard, as approved by Metra. **(SWR-236)**

18.21.10 Terminals

Terminations and connections throughout the vehicle shall be with insulated ring tongue connectors of the compression (crimp) type and cage clamp terminal blocks for signal distribution. **(SCR-051)**
Quick-disconnect (fast-on) terminals with locking features may be used, subject to approval, provided that the type of fast-on has demonstrated a satisfactory service in a similar fashion. **(SAR-062, SAR-221)**
Materials such as phosphor bronze shall be shown to be suitable for repeated use.
Terminals shall not utilize PVC insulation.

Terminals shall be attached to the wiring with the crimping tools and dies recommended by the connector manufacturer.
The terminal used shall be of the type that securely grips and holds the insulation of No. 10 AWG wire or smaller. The crimp terminal shall be rated to match the wire conductor diameter and the insulation diameter.
Conductors that will be subjected to motion shall utilize the proper strain relief mechanism recommended by the manufacturer.
Spare terminals shall be provided for each terminal assembly in an amount equal to at least 10 percent of all terminals, with at least one spare terminal provided for each terminal size. Spare conductors in a multi-core cable need not be terminated at spare terminal strip locations.

18.21.11 Conduit and Raceway Requirements

All car wiring shall be housed in metal raceways. Open metal raceways and their elbows, couplings, nipples, bushings, locknuts, universal joints, expansion joints, and other conduit fittings shall be so designed that the sections can be mechanically and electrically coupled, while the wires are protected from abrasion.
High voltage wiring, (i.e., wiring in excess of 120 volts) shall not be run in the same cable ducts, conduits, or raceways as low voltage wiring unless metallic separators are used to separate the circuit classes. **(SCR-171)**
All conduits shall be arranged to prevent moisture traps and shall drain toward control boxes, and shall be supported to the car body at least every 610 mm (24 in).
Wires in conduits, ducts, and raceways shall be free of kinks, insulation abrasions, and insulation skinning.
If a conduit is designed to come through the flooring of the vehicle and into equipment boxes located at the passenger compartment level, the conduit must extend 25 mm (1 in) above floor level to prevent water or cleaning chemicals from draining onto the below-floor cables.

18.21.12 Wire Harness

The layout of wiring, for both vehicles and equipment, shall be designed in advance of its installation and in cooperation with the suppliers of the related equipment. Wiring shall be pre-fabricated into standard harnesses, wrapped and tied with nylon wire ties or a high strength, waxed lacing cord designed not to invade the wire insulation. Harnesses shall be installed with identical arrangement and location in each vehicle having similar equipment. ~~Separate harnesses shall be provided for major circuit groups or types, or as required for specified circuit separation~~ Separate Harnesses shall be provided for major circuit groups or types or as required for specific circuit separation and shall comply with guidelines detailed by APTA PR-E-RP-002-98_R2 for physical wire and harness separation. All circuits and branches shall be separable by means of terminal boards to isolate portions from others for troubleshooting. All circuits subject to periodic high potential tests shall be arranged so that they can be conveniently isolated for the tests. **(SCR-172)**
Alternative methods for fabricating and installing wiring, which are standard car builder practice, will be submitted for consideration at the appropriate design review.
Harnessed wires shall not be installed in conduit. Wires from different conduits or other openings shall not be harnessed together with wires running within the box or entering the box through another entrance point. Each harness or group of wires between equipment enclosures shall contain a minimum of 10% spares, but no fewer than 2 spares for each wire size.

18.21.13 Cleating

Split block cleats of molded neoprene rubber or an approved equivalent shall cleat all cable and wiring not installed in conduits. A nonflammable insulating material with a durometer reading of 50 to 60 Shore A hardness, shall be used for cleating.

The holes in the cleat shall be sized for the individual wires and cables. Hole edges shall be radiused to prevent square edge contact with cable insulation.
Each cleat shall have a stiffener on the side away from the mounting bracket that will act to spread the bolt clamping force over the entire length of the cleat.
Bolts shall have lock nuts of approved design.
Cable and wiring, other than HVDC, using cleating shall be supported to the car body at least every 610 mm (24 in).

18.21.14 Equipment Enclosures & Junction Boxes & Fittings

Boxes, covers, and fittings of ferrous metal shall be galvanized inside and outside after fabrication. All underfloor junction box covers and underfloor box covers (SCR-044) shall be marked with the vehicle number, all like covers shall be interchangeable. The box covers shall be held in place with latches or blunt end screws. Self-tapping screws shall not be used for box covers.
Screws and other hardware shall be made of stainless steel.
All undercar and roof-mounted junction boxes shall be waterproofed and vented, and shall protect enclosed equipment and connected conduits from water seepage.
The interiors of all equipment enclosures and junction boxes shall be protected with an electrically insulating; white, or light color paint.

18.21.15 Wire Identification & Terminal Markings

Wire terminal designations shall be assigned to all electrical conductors, whether individual wires or cables, within the entire car.
~~All wires and cable shall be marked within 305 mm (12 in) of the end of the wire and every 305 mm (12 in) along the entire length of the wire.~~ All wires and cables shall be marked at each end of the wire with circuit function, wire number, wire segment and gauge.
All wires and cable shall be marked (only wire number) within 305 mm (12 in) of the end of the wire and every 305 mm (12 in) along the entire length of the wire.
~~Wires shall be identified according to circuit function, wire number, wire segment, and gauge.~~
Wire identification shall be subject to approval by Metra. **(SCR-045)**

18.21.16 Splicing and Taping

Splicing and taping shall not be allowed unless expressively approved by Metra on a case by case basis.

18.22 CIRCUIT PROTECTION

18.22.1 Handles shall indicate ON, OFF, and TRIPPED positions. Circuit breakers shall be molded-case type, single- or multi-pole, with frame size suitable for continuous current and interrupting duty.

18.22.2 Each pole shall be equipped with a trip mechanism consisting of an inverse time element for overload protection and an instantaneous magnetic element for short circuit protection.

18.22.3 Each pole shall be equipped with adequate means of arc extinction to prevent flashover.

18.22.4 Multi-pole breakers shall operate contacts simultaneously.

18.22.5 Breaker current rating shall be clearly visible after installation and shall comply with ~~NEMA AB1~~ UL 489, ANSI C37.13, C37.14, or C37.16. **(SCR-015)**

18.22.6 Continuous current rating shall be selected in accordance with ~~NFPA 70~~ APTA PR-E-RP-009-98 for load and type of service indicated. **(SCR-114)** **(SAR-217)**

18.22.7 Electrically controlled breakers shall be equipped for operation from the LVPS

18.22.8 Circuit breakers shall be properly coordinated with protective devices.

18.22.9 Other than high speed circuit breakers (HSCBs) used for HVDC circuits, circuit breakers shall not be used for protection on HVDC circuits.

18.22.10 Fuses shall not be used except for indicator type fuses within electronic assemblies, high voltage circuit protection, and special applications with approval.

18.23 GROUNDING

18.23.1 Grounding connections shall be made through copper or bronze pads, tinned, and silver soldered to the car body.

18.23.2 The copper pads shall be tinned or silver electroplated after attachment. Stainless steel ground pads may also be used, subject to Metra approval. **(SAR-145)**

18.23.3 Low voltage and high voltage circuits shall not be grounded to the same grounding pad, if such grounding is permitted by this specification.

18.23.4 All ground pads shall be visible and accessible for inspection and troubleshooting. The ground connections shall be attached by an approved bolt, washer, and nut designed for the purpose.

18.23.5 Resiliently-mounted equipment shall be grounded with flexible strap-type grounding leads bolted between a car body grounding pad and the equipment's grounding pad. Strap flexibility and length shall be sufficient to prevent failure from fatigue. Fixed equipment maybe grounded by flexible straps or properly terminated wire of the same type used for car wiring.

18.23.6 The ground strap termination method shall form a gas-tight, uniformly distributed connection with the conductive surface. Current density shall not exceed bonding requirements below.

18.23.7 All grounding and bonding jumpers and straps shall be sized to handle fault current and lightning discharge current, for which the voltage drop shall not exceed 50 volts. The bonding method employed shall not produce a DC resistance in excess of 0.0025 ohms, or more than 0.025 ohms at 150 kilohertz for any applied AC voltage.

18.23.8 All ground pads shall be readily visible and accessible for inspection and troubleshooting.

18.23.9 All equipment enclosures and shock-mounted equipment shall be grounded with tinned, braided copper, flexible strap grounding leads bolted to a car body grounding pad.

18.23.10 Ground cables and shunts shall be extra-flexible, tinned, non-insulated, stranded copper cable meeting the additional requirements of 18.19.1, ~~TP19.11.2~~, and shall be terminated by approved crimped ring terminals on both ends. **(SCR-052)**

18.23.11 Ground cables and shunts shall be sized to withstand, without failure, the maximum failure current that could be anticipated should the return wiring totally fail.

18.23.12 In no case shall the size of a ground cable or shunt be less than No. 10 AWG.

18.23.13 The Contractor shall ensure that all metal parts inside and outside the vehicle that could be touched by passengers or operating personnel, including equipment boxes, panels, and test receptacles in the passenger or operator areas, shall never exceed car body potential.

18.24 ELECTRICAL COMPONENTS

Electrical components, which are singly replaceable, shall be connected to car wiring through individual, removable connections, or "pigtails" with connectors. Replaceable components shall not be connected to car wiring using soldered connections. Electrical components installed on the vehicle without protective enclosures, including, but not limited to inductors, transformers, resistors and capacitors, shall be designed, selected and installed to make them impervious to the effects of Metra's railroad environment and operations. This shall include, as a minimum, the effects of extreme weather, water, snow and ice, extreme temperature swings and possible impact by debris. Exceptions to this requirement may be granted on a case-by-case basis, upon approval by Metra.

18.24.1 Relays and Contactors

Contactors and relays shall meet or exceed IEC 60077.

Low-current relays (less than 10 Amp per pole) shall have silver-alloy contacts.

Very low current relays (1 Amp and less) shall have ~~gold-plated~~, silver-alloy contacts. **(SCR-088)**

Relays and contactors that have not been proven in rail service shall comply with MIL-PRF-6106.

Relays shall be capable of at least one million electrical operations at rated contact capacity with the exception of those operating on the order of 1000 times per day being capable of at least ten million electrical operations at rated capacity.

Plug-in relays shall be secured in their sockets by mechanical restraint.

Relay and contactor coils shall be suppressed to mitigate transient voltage spikes, with the suppressing network mounted as close to the coil as possible.

Relays and contactors, except low-power miniature relays mounted on printed-circuit boards, shall incorporate means of either visually or by contactor monitoring to determine ~~determining~~ whether contacts are picked up or dropped out for functional operation or maintenance activities.

Relays used in safety-critical circuits with single point failures shall comply with the ~~AAR~~ AREMA Signal Manual, Volume 2, Section 6, unless otherwise approved. **(SCR-007)**

Contactors used to interrupt HVDC circuits shall be equipped with blowout coils or other means of arc suppression in accordance with TP 12.

18.24.2 Pushbutton Switches and Indicators

Switches shall be heavy-duty, with electrical characteristics, ratings, and accessories as required for circuit application.

Pushbutton (including illuminated) switches shall have silver-plated or silver-alloy terminals.

Indicators and pushbutton switches shall have insulation resistance of at least 1 MOhm to case at 500 VDC. Re-lamping of indicators shall be from front.

Contacts shall have maximum resistance of 0.10 ohm at 3 VDC and 10ma load. Minimum open contact resistance shall be 50 MOhm.

Contact shall be rated for inductive loads. The contacts shall normally operate at not more than 20 percent of the manufacturer's inductive rating for 25,000 cycles of operation at 25o C. The electrical-contact material shall be silver or silver with a gold flash or gold plate, and be normally a break-before-make type.

Indicators shall be LED type where possible.

18.24.3 Inductors

Power inductors shall have vacuum-impregnated windings and be rated to withstand at least twice the maximum peak-to-peak voltage expected in normal operation.

18.24.4 Transformers

Transformers shall have vacuum-impregnated windings and have a minimum inter-winding breakdown voltage of 1,500 VDC. Exceptions to this requirement may be granted on a case by case basis, upon approval by Metra.

18.24.5 Resistors

Resistors other than power/braking resistors shall be derated 50 percent minimum. **(SWR-164)**

18.24.6 Capacitors

Capacitors shall be rated for transients of at least twice the maximum peak voltage expected in normal operation and be applied at continuous voltages not greater than 80 percent of rated working voltages. Exceptions to this requirement may be granted on a case-by-case basis, upon approval by Metra. **(SWR-164, SWR-179)**

18.24.7 Motor Starters

Starters shall be rated for continuous duty at service indicated, shall be equipped with magnetic holding coils, and shall be capable of resetting automatically upon loss of supply voltage. Starters shall be equipped with sufficient auxiliary contacts to comply with requirements for annunciator circuits, as indicated. Thermal overload protection shall be provided. Three-phase starters shall be three-pole.

18.24.8 Environmental Conditions for Electronic Systems

When not in conflict with or specified otherwise in component portions of this specification, "normal railroad operating environment" for electronic systems shall be defined by referring to criteria in relevant sections of standard EN 50155 Railway applications – Electronic equipment used on rolling stock, including:
IEC/EN 61373 Railway applications – Rolling stock equipment – Shock and vibration tests
EN 50121-3-2 Railway applications – Electromagnetic compatibility: Rolling stock – Electronic subsystems, Metra requires test procedures and reports to demonstrate EMC compatibility. Prior procedures and reports may be reviewed by Metra if the contractor demonstrates that the subsystem or device has not changed. If, upon review, Metra finds that the testing procedure is not sufficient or there are demonstrable changes in form, fit, or function, contractor to submit revised test procedure and perform testing for this project.~~Apparatus~~
~~Metra will not require test reports for the above standards unless stated at the component/system level.~~
APTA, AAR, and applicable North American standards take precedence where any conflicts arise.

18.25 ELECTRONIC COMPONENTS

Electronic components shall be free of storage and handling damage. Where possible, components shall be clearly and permanently labeled with values or type identification. Semiconductor devices shall be available from two or more qualified manufacturers. Exceptions to this requirement may be granted on a case-by-case basis, upon approval by Metra. **(SAR-191, SAR-211)**
Carbon resistors shall not be used on printed circuit boards. Metra may grant the use of carbon resistors on printed circuit boards that have previously been approved by Metra and are currently being supplied to Metra.
Components as applied in their circuits shall be derated by at least 25 percent from manufacturer's ratings.
For power semiconductors, derating of current shall be such that manufacturer's maximum

junction temperature is not exceeded with 25 percent increase in semiconductor current above that required for performance

18.25.1 . Printed Circuit Boards

Printed circuit boards (PCBs) shall be of glass epoxy construction, complying with NEMA LI1, grade FR-4, or equivalent standard such as ~~IEC 249~~ IPC 4101. **(SCR-089)**
PCBs shall be uniformly coated.
Conductor materials shall be determined on the basis of current carrying capacity and in accordance with IEC 326-3, IEC 61188 OR IPC 2221. **(SCR-046)**
Edge connectors and boards shall be keyed to prevent insertion of any board in wrong a position, and mounted for ease of board removal and replacement.
To the greatest extent practicable, component labeling shall be provided on PCBs.

18.25.2 Semiconductor/Integrated Circuits Requirements

The Contractor shall be responsible for ensuring that all electrical and electronic circuitry, including those of suppliers and subcontractors, as a minimum meet the criteria for the use of semiconductors and/or integrated circuits listed in this section, unless otherwise approved.
Suppression devices shall be provided to protect the devices and limit the circuit voltage.
Non-JEDEC registered devices which carry more than 100 Amps may be used with prior approval, based on submission of complete procurement specifications defining each such device and evidence of availability from two or more manufacturers.
All semiconductor/integrated circuits shall be rated to properly perform in the range -40 to +85 C [-40 to +185 F]. For the Automated Passenger Control (APC) System, it shall properly perform in the range of -25 to +70 C [-13 to +158 F] in operating conditions. **(SCR-193)**
Transistors and other solid-state power devices operated from nominal battery supply shall have minimum breakdown ratings of four times the maximum circuit voltage. **(SWR-164)**
Suppression devices shall be provided to protect the devices and limit the circuit voltage.
All integrated circuits shall be screened for defects. The Contractor shall submit for approval screening methods based on a minimum of a 48-hour burn-in for the completed assembly.
Alternate screening methods may be submitted to Metra for review and approval.

18.25.3 Microprocessor-Based System Requirements

Microprocessor-based components, assemblies, and power supplies shall be provided with voltage/current regulation and protection to ensure proper operation.
All interfacing wiring shall be protected against interference from other on-car or wayside electrical radiation.
The microprocessor shall be of a family shown to be suitable for the rugged environmental conditions encountered in rail applications, and shall be supported by software development language and diagnostic programs, which are acceptable to Metra.
The microprocessor assembly shall be housed in an enclosure, which shields the microprocessor assembly and the surrounding circuits from EMI radiation and interference.
The microprocessor shall have external buffers provided, and shall be protected from external voltage and current transients and EMI.

18.25.4 Software Requirements

Where the software is essentially a modification of an existing product to meet the Metra's requirements, the design process, and documentation, shall be submitted for review and approval by Metra.
~~For newly developed software,~~ The Contractor and/or supplier shall submit a Software Quality Assurance Plan **[CDRL C-18-27]** for approval complying with IEEE 730 or equivalent, and containing, as a minimum, the following documentation requirements:

18.25.4.1 Software Requirements Specification
18.25.4.2 Software Design Description

18.25.4.3 Software Verification and Validation Plan
18.25.4.4 Software Verification and Validation Report
18.25.4.5 User Documentation

Source code shall be written in a high-level language such as C. All source code, properly documented, shall be placed in Agency approved third-party escrow when the last vehicle exits its warranty period.

The Software Design Description, in (b) above, shall comply with IEEE 1016 or equivalent.

The requirements of this section shall be presented to Metra at the Design Reviews. Metra shall be properly notified of meetings and reviews scheduled to determine progress with respect to the software requirements and the software design description by the Contractor. It is recommended that the Contractor establish a Software Management Plan.

The contractor shall support a Windows 10 Operating System software compatibility on future operating system on laptop. **(SAR-134)**

18.26 CONTRACT DELIVERABLES REQUIREMENT LIST

CDRL	Title
C-18-01	Material Certifications
C-18-02	Material Maintenance
C-18-03	Interior and Exterior Stainless Steel Samples
C-18-04	Stainless Steel Coil Test Reports
C-18-05	LAHT Tension and Bend Test Reports
C-18-06	Casting Qualification Report
C-18-07	Elastomer Certification
C-18-08	Visual Inspection Criteria for Glazing
C-18-09	Thermoplastic Sheet Color and Surface Finish Samples
C-18-10	Thermoplastic Test Certifications
C-18-11	Fiberglass Reinforced Plastic Test Certifications
C-18-12	Melamine Test Certifications
C-18-13	Leak Test for Air and Hydraulic Piping System
C-18-14	Piping, Tubing, and Pressure Vessel Specifications
C-18-15	Proposed Flushing and Cleaning Procedure for Pipe
C-18-16	Bearing Specification and Data
C-18-17	Paint Inspection and Acceptance Criteria
C-18-18	Adhesives Utilized
C-18-19	Insulation Application, Retention, and Data
C-18-20	Fire Safety Analysis
C-18-21	Threaded Fastener Data
C-18-22	Welding Documentation
C-18-23	Welding Inspection Plan
C-18-24	Brazing Documentation
C-18-25	Corrosion Control Plan
C-18-26	Wire and Cable Data and Specifications
C-18-27	Software Quality Assurance Plan

18.27 APPENDIX 18A

Software Appendix
Alstom will provide software documents requested in the RFP and according EN50128 (questions 1 & 6)
The documents are listed in the following :
- SwRS Software Requirements Specification
- SDD => SwDS Software Design Specification + ICD (Interface Control Document) L2
- SVVP => SwVerP Software Verification Plan + SwValP Software Validation Plan
- SVVR => SwQAVR Software Quality Assurance Verification Report
- Software Requirements Traceability Matrices (SRTM)
- SQAP => SwQAP Software Quality Assurance Plan

Software is provided with an associated release note.

The table (questions 2 & 3 & 4) with SCI's with configurable items (configurable function and / or parameters) will be provided during the design phase and will be aligned with the implementation supplied for Metra. Several products are standard and potentially not configurable for safety / security reasons linked to the context of use.

SW Quality :
• Software Quality Plans T0 + 12 months

Control Engineering:
• Train Functional Architectures (x Functions) T0 +12 months
• Software Requirements Specification T0 + 18 months
• Software Architecture Specification T0 + 18 months
• Software Design Specification (x Functions) T0 + 18 months
• Interface Control Document (x Device on Network) T0 + 18 months

Sw Development Engineering :
• Implement Software (x Functions) T0 + 23 months

Sw Verification & Test Engineering :
• Software Overall Test Specification T0 + 23 months
• Software Integration Test Specifications T0 + 18 months
• Software Hardware Integration Test Specifications T0 + 18 months
• Network Integration Test Specifications T0 + 18 months
• Functional Integration Test Specifications T0 + 18 months
• Software Overall Test Reports T0 + 26 months
• Software Integration Test Reports T0 + 26 months
• Software Hardware Integration Test Reports T0 + 26 months
• Network Integration Test Reports T0 + 26 months
• Functional Integration Test Specifications T0 +26 months
• Software Source Code Verification Report T0 + 23 months

As part of the project execution, Alstom will submit to Metra a Software Management Plan and Software Quality Assurance Plan according to the IEEE standards referenced in the Metra RFP.

19 INSPECTION AND TESTS

19.1 INSPECTION

19.1.1 It is the intent of these Specifications that inspection of the car and its components be the responsibility of the Contractor and the Manufacturers, and that inspections be performed at the plants of the Contractor and the Manufacturers so that corrections can be made under factory conditions.

19.1.2 Metra shall have one or more duly authorized inspectors in the Contractor's plant or any sub-contractor's plant to check on and review all details involved in the construction of the cars and to be responsible for engineering liaison between Contractor and Metra and for approval of designated changes as necessary.

The Contractor shall provide adequate work space and provide copies of all designs and drawings (minimum two sets of 11" X 17" prints in three ring binders), and testing facilities, as necessary for execution of representative's inspection.

The scheduling of Metra personnel for station inspection and in-process testing shall be done in a timely fashion, with not less than 24 hours notice (written or oral) being given by the Contractor. Requests for weekend coverage shall be made only when absolutely necessary. Such requests must be made in writing by 3:00 PM of the preceding Thursday, and must contain eight (8) hours of inspection and/or test work for Metra personnel.

The Contractor's gauges and other measuring and testing devices shall be made available for use by Metra to verify that the cars conform to all specification requirements. If necessary, the Contractor's personnel shall be made available to operate the devices and to verify their condition and accuracy.

19.1.3 Inspection stations shall be at the best locations to provide for the work contents and characteristics to be inspected. Stations shall provide the facilities and equipment to inspect structural, electrical, pneumatic, and other components and assemblies for compliance with the design requirements. Stations shall also be at the best locations to inspect or test characteristics before they are concealed by subsequent fabrication or assembly operations. Metra reserves the right to establish as many inspection stations it deems necessary. Metra also reserves the right to conduct such inspections independent of the manufacturer's representative or with a restricted number of the Contractor's personnel.

19.1.4 The presence of Metra's representative in the plants of the Contractor shall not in any way supplant the Contractor's own inspection nor lessen the responsibility of said Contractor in respect to meeting all requirements of these Specifications.

19.1.5 Metra shall have the right to reject any design, workmanship or material which does not conform to accepted practice, to the design of the Contractor or any subcontractor supplying materials or components to the Contractor, or to these Specifications. Any such rejection shall be corrected by the Contractor to the satisfaction of Metra. Repetitious rejections may be the cause for Metra to order discontinuance of all or a portion of the design and/or manufacturing work. Such discontinuance shall not relieve the Contractor from schedule compliance requirements, pending resolution satisfactory to Metra.

19.1.6 Inspections of the first article produced, of certain major components and assemblies shall be made at the Manufacturer or Subcontractor source or at the Contractor's shop. The Contractor shall notify Metra at least ten (10) working days in advance of the date on which inspection by representatives of Metra may be made, of the first article produced at the source plant or Contractor's shop, of the following components and assemblies: wheel and axle assemblies; truck frames; truck bolsters; complete trucks: couplers and coupler parts; coupler

yokes; draft gear; air conditioning units; seats; door controls; door panels; climate controls; lighting; batteries; battery chargers; air brake equipment; and mobility aid lifts.

19.1.7 The Contractor shall notify Metra at least twenty (20) working days prior to completion of the first car at which time a sample car inspection will be made at the plant of all parts and performance, including such running tests as can be made at the Contractor's plant. All clearances and dimensions shall also be checked.
Representatives of the manufacturers and subcontractors, and any others, Contractor or Metra feels are necessary, shall be present at the sample car inspection at Contractor's shop.

19.1.8 Metra's Chief Mechanical Officer, Program Manager, Project Manager or their duly authorized representative shall be authorized to release the cars for delivery and shall be authorized to approve the pre-delivery acceptance tests. Upon request to the quality assurance supervisors, Metra inspectors shall have access to the Contractor's quality assurance files related to this procurement. These files shall include drawings, assembly procedures, material standards, parts lists, inspection processing and reports, and record of defects.

19.1.9 All requests from regulatory and other agencies to inspect any of the work shall be made through Metra rather than directly to Contractor.

19.1.10 Inspection costs incurred by Metra shall be borne by Metra, and no provision for such costs shall be made by Contractor in its bid price.

19.2 TESTS

19.2.1 The Contractor shall perform all tests specified herein unless the Contractor can furnish test reports acceptable to Metra which indicate that the equipment furnished under this contract is identical to equipment which has been tested for the same application and that these tests demonstrate compliance with the requirements of these specifications.
The Contractor shall prepare and submit a Master Test Plan to Metra for review and acceptance. **[CDRL C-19-01]** It shall be the Contractors responsibility to prepare a test plan, which includes all necessary testing to prove compliance with all requirements of this Specification.
The Contractor and his subcontractors may, at their option, conduct additional tests as part of their Quality Assurance program.
Unless indicated otherwise, all costs associated with any of the tests performed shall be borne by the Contractor. In the event of failure to meet the specification requirements in any test, the Contractor, at his expense shall make the necessary correction and rerun the test in its entirety (again at his expense). The Contractor shall give at least a twenty (20) working day notice to Metra prior to the start of any test.
The cost for train crews and alike used to perform qualification tests shall be borne by Metra for the first set of such tests. For any re-testing required, Metra shall invoice the Contractor for such services.
The Contractor shall prepare detailed procedures for all tests described herein. Each procedure shall be submitted to Metra for review and approval not less than sixty (60) calendar days prior to the first test. **[CDRL C-19-02]**
The Contractor shall provide a written report of each test, including all test data, to Metra. In the case of tests which are performed on all cars or all components, the report of tests shall be included in the appropriate car history book. All testing shall be for this contract. (Previous test reports not accepted). Pass/Fail conclusions must be stated in each test report.

19.2.2 QUALIFICATION TESTS (One Time Tests)
Metra may add additional qualification tests dependent upon final design of the car.

19.2.2.1 The first truck frame and bolster shall be stress tested under load conditions to approximate the conditions to be encountered in service (including impact loads, curving forces and braking forces). A minimum of one hundred (100) strain gauges shall be used. Strain gauges shall be located based on stress calculations, stress-coat testing and previous experience. Measured stress exceeding 80% of the yield strength of the material used, permanent deformation, cracks and fractures shall be cause for rejection. Metra shall be advised at least twenty (20) days prior to this test.

19.2.2.2 The first car body structure shall be compression tested to ensure that cars will meet AAR Standards and FRA Regulations. The test load of 800,000 lbs. shall be applied to the rear draft stops at the centerline of draft. The load shall be applied horizontally on the car longitudinal centerline and shall be applied in 100,000 lb. increments. There shall be not visible permanent deformation, fractures, cracks or separation in car structure. A structural member shall be considered as having developed permanent deformation if the yield strength in the appropriate direction (tension or compression) is reached or exceeded.

In addition to the above, the following tests as described in APTA standard APTA SS-C&S-034-99 shall be conducted on the first car shell: Compression Load Test on the buffer beam, with a load test of 500,000 lbs.; Elastic Test on collision posts with loads as detailed in section 5.3.1.3.1 of the APTA Standard; and; Elastic Test on end corner posts with loads as detailed in section 5.3.2.3.2 of the APTA Standard.

19.2.2.3 An electric heating system test (Cold Room Test) shall be conducted on a single car to demonstrate continuous operation and specification compliance of the heating system under the extreme ambient environment for at least eight (8) hours continuous. The test chamber shall be capable of maintaining any temperature from 50oF to -20oF for this test. Electrical power consumption shall be recorded.

19.2.2.4 An air conditioning (Hot Room) Test shall be conducted on a single car to demonstrate continuous operation and specification compliance of the air conditioning and ventilation system under extreme ambient environment for at least eight (8) hours continuous. The test chamber shall be capable of maintaining any temperature from 110oF to 70oF and a relative humidity of 30% to 90%. Electrical power consumption shall be recorded.

19.2.2.5 An air flow test shall be conducted with all of the car's doors and windows closed and the ventilation system operating at normal capacity. Total Fresh Air Flow, Total Return Air Flow and Pressurization shall be recorded:

19.2.2.6 In conjunction with both the Hot Room and Cold Room the mobility aid lift (if equipped) shall be tested to verify operation at extreme temperatures.

19.2.2.7 The intensity of the various lighting systems, including emergency lighting, shall be measured and verified with the illumination levels specified herein.

19.2.2.8 The sound levels in the cab and in the passenger seating area shall be measured and verified with the levels specified herein. Tests shall be conducted with all systems running. Tests shall be run both statically and as part of a running test.

19.2.2.9 In addition, an air brake system performance test of a six-car consist, shall be conducted on Metra property to demonstrate compliance with specified braking performance parameters and to verify system design and component interaction characteristics. Testing shall be scheduled at times convenient for Contractor and Metra jointly. If equipped, a wheel slide system test shall be performed. In order to provide a test of the operation of the wheel slide protection system under actual operation conditions, facilities shall be provided for a test of this system during the road brake tests. Wheel slides shall be induced by apparatus installed on the vehicle that will spray a water soap solution on the track ahead of the lead wheels on each truck.

19.2.2.10 A curve negotiating and clearance test shall be conducted on three coupled cars and the cars shall successfully pass this test to comply with the requirements as described in Section 3.2.

19.2.2.11 Metra shall request to verify conformance to the ride quality requirements, one of the first pilot cars shall be subjected to ride quality road tests. At a minimum, the ride quality tests shall consist of testing of one or more cars on minimally compliant track that conforms with all FRA track standards for the classes of track over which the cars are designed to operate. The car or cars shall also be tested on a major segment of track over which the cars are intended to operate in revenue service, making all local stops while operating at normal scheduled speed, under AW0 and AW1 load conditions. The Contractor shall submit a Ride Quality Testing Plan for submittal to Metra for review and approval, specifying the start and end points, speeds, test methodology, measurement parameters and criteria, and method of instrumentation for the ride quality tests. Results from previous ride quality tests that closely simulate Metra's revenue service environment may, at the sole discretion of Metra, be accepted in lieu of additional ride quality testing.

Instrumentation capable of measuring and charting the magnitude and frequency of the vertical and lateral shocks expected, up to 1.00 g (0.04 oz) and 0.5 to 50 Hertz, shall be provided and operated by the Contractor, who shall reduce the raw data for presentation to Metra. Sensing units shall be located on the car floor above the intersection of the car longitudinal center line and each truck transverse center line. Weights used in simulating the AW1 load, as well as their loading and unloading, shall be provided by the Contractor.

In the event, the dynamic behavior of the cars is non-compliant in any respect with requirements, the Contractor shall submit to Metra within 30 calendar days, a program containing mathematical analysis of the problem and a course of action for its correction. If Metra approves the analysis and corrective measures, those corrective measures shall be made effective on the pilot cars within 90 calendar days at the expense of the Contractor, the car shall be retested, and if the measures are successful, they shall be applied to all cars. If not, the analysis and correction steps shall be repeated, resubmitted and retested until success is attained.

19.2.2.12 EMI/EMC Test.

Contractor shall develop and submit to Metra for review and approval an Electromagnetic Compatibility Control Plan (EMCCP) which describes the Contractor's organization to achieve EMC in accordance with APTA PR-E-S-010-98. **[CDRL C-19-03]** The Contractor shall conduct and document all plan requirements to the integrated vehicle, all subsystems, and suppliers. The Contractor shall ensure that all equipment, both individually and as part of the railcar assembly, complies with the EMC requirements.

The EMCCP shall address all requirements in the Specification and in 49 CFR 238 including scope, purpose, project organization, schedule deliverables, EMC design reports, EMI Safety Analysis, and emissions limit test procedures and plans and testing. The plan shall include requirements for system integration and cover all EMC critical components and electronic subsystems for each vehicle type.

19.2.2.13 Carbody Shell Water Tightness Test

Carbody water tightness tests shall be conducted on the first ten (10) carbody shells for proof of design to demonstrate that the industrial process for constructing the carbody is robust. **(SCR-143)**

19.2.3 IN-PROCESS TESTS (All Cars)

Each car shall successfully pass the following tests conducted in accordance with an approved test procedure:

19.2.3.1 ~~Car body~~ Water tightness tests shall be conducted on all cars after a point of assembly where all external installations are completed in a production manner to seal the vehicle. ~~the car body shell and the completed car. The shell test is intended to demonstrate water tightness or car body construction before application of thermal insulation and finish~~

~~panels. Complete~~ The environmentally enclosed car test shall demonstrate water tightness of finished car simulating passage through rainstorm at maximum speed of 79 MPH. **(SCR-143)**

19.2.3.2 Air brakes shall be statically tested per FRA Regulations to verify all functions of the brake system under all conditions (service, emergency, release, and charging, function, conductor's valves, and all other combinations).

19.2.3.3 All circuits, including locomotive and car control elements, are to be tested for continuity, grounds, voltage drop, and function. Tests shall be conducted individually as well as simultaneously. Megger and high potential tests will be conducted on all circuits and equipment as appropriate

19.2.3.4 Functional tests of the following systems shall be conducted to demonstrate compliance with these specifications. Metra may add additional functional tests:

19.2.3.4.1 Communication System
19.2.3.4.2 Air Conditioning
19.2.3.4.3 ADA System
19.2.3.4.4 Heating System
19.2.3.4.5 Emergency Lighting System
19.2.3.4.6 Pressurization
19.2.3.4.7 Door operation
19.2.3.4.8 Handbrake / Parking Brake **(SCR-060)**
19.2.3.4.9 Anti-Freeze System
19.2.3.4.10 Video System (cab cars)
19.2.3.4.11 Dimensional Testing
19.2.3.4.12 Cab Signal System (cab cars)
19.2.3.4.13 Alerter/Event Recorder (cab cars)
19.2.3.4.14 Locomotive Control (cab cars)
19.2.3.4.15 Headlights, Ditch lights, Oscillating light, Marker lights (cab cars, includes aiming of headlight & ditch lights)
19.2.3.4.16 Horn Testing per 49 CFR Part 229.129 (cab cars) using Metra Horn Sound Level Test Form
19.2.3.4.17 Emergency Signage for Egress/Access of Passenger Rail Equipment per APTA Standard PR-PS-S-002-989 Rev. 3 (Batch of Cars) Batteries and Battery Charger (& LVPS on cab cars)
19.2.3.4.18 Positive Train Control System (cab cars)
19.2.3.4.19 Emergency Lighting Standards per APTA standard PR-E-S-013-99 Rev. 1 (Batch of Cars) using Metra Form RC100212, latest revision
19.2.3.4.20 LLEPM Standards per APTA Standard PR-PS-S-004-99 Rev. 2 (Batch of Cars)
19.2.3.4.21 Wheel Slide System (If Equipped)
19.2.3.4.22 Electrical Function
19.2.3.4.23 Water System/Toilet System
19.2.3.4.24 TIMS
19.2.3.4.25 Trainline
19.2.3.4.26 Carbody Dimensional Measurement

19.2.4 POST-DELIVERY TESTS: CONDITIONAL ACCEPTANCE
Metra may add additional post-delivery qualification tests.

19.2.4.1 In accordance with 49 CFR Part 238.111 Metra will conduct acceptance tests on each delivered car. Metra shall complete these tests completed within fifteen (15) calendar days after notice of fitness for testing is issued and shall be conducted in accordance with written test plans. These tests will also identify defects that have become apparent between the time of the car's release and delivery to Metra. The post-delivery tests shall include visual inspection and operations. Generally, post-delivery test shall apply criteria that are similar to the criteria applied in an analogous IN-PROGRESS test (if any). However, Metra reserves the

right to conduct any additional test to ensure that the completed cars have attained the desired quality and have met the requirements of these specifications.

Reports covering Conditional Acceptance testing shall be prepared by the Contractor.

19.2.4.2 Tests will include, but are not limited to the following:

19.2.4.2.1 Communication Equipment (including Information Systems)
19.2.4.2.2 Trainline Compatibility
19.2.4.2.3 HVAC System Functions
19.2.4.2.4 ADA System Functions
19.2.4.2.5 Running Tests
19.2.4.2.5.1 Curve Clearance Verification Test
19.2.4.2.5.2 Brake Test
19.2.4.2.5.3 Riding Quality Test
19.2.4.2.5.4 Audible Noise Test
19.2.4.2.5.5 Cab Signal Qualification Test
19.2.4.2.5.6 PTC Qualification Test
19.2.4.2.5.7 TIMS Qualification Test

19.3 CONTRACT DELIVERABLES REQUIREMENTS LIST

CDRL	Title
C-19-01	Master Test Plan
C-19-02	Test Procedures
C-19-03	Electromagnetic Compatibility Control Plan

20 PRODUCT SUPPORT

All manuals, drawings, photographs, and training material ("Material") shall include an irrevocable license to reproduce such Material for Metra's internal purposes. Metra has rights to use above documentation in the bid package for overhaul, parts procurement without notifying OEM.
Manuals, Drawings, etc. shall be shipped to:

Metra
547 W. Jackson Boulevard
Chicago, Illinois 60661
Attention: Chief Mechanical Officer
Mechanical Department 16th floor

20.1 DRAWINGS AND REPRODUCTIONS

20.1.1 The Contractor shall furnish before the first car is delivered a complete and correct electronic (Original pdf) set of drawings, covering all assemblies, subassemblies, and all detail parts, manufacturing/shop/parts drawings prepared by the Contractor and Subcontractors that are necessary for the construction of equipment. The inspection (visual/dimensional) criteria, casting/forging material criteria shall be provided.

20.1.2 A formatted in Autodesk AutoCad (.dwg files) of the complete editable as-built version of the drawings above shall be provided thirty (30) days after the conditional acceptance of the last car. **[CDRL C-20-01]**

20.1.3 Metra shall have unlimited rights to use these drawings and documentation specifically issued to Metra for this project.

20.2 PHOTOGRAPHS

20.2.1 Electronic version (jpg) of the following color photographs shall be provided **[CDRL C-20-02]**:

20.2.1.1 Side elevation of the car;
20.2.1.2 Combination front and side (three-quarter) view of the car;
20.2.1.3 Head-on view of each end;
20.2.1.4 Car seating, both upper and lower (if applicable), taken from three (3) different angles;
20.2.1.5 Stairways
20.2.1.6 Both trucks in the ready to run condition, but not applied to car;
20.2.1.7 Mobility aid lift, completely lowered and completely raised;
20.2.1.8 Ten (10) miscellaneous photographs illustrating the construction of the cars;
20.2.1.9 Communication and door control station;
20.2.1.10 ADA positions;
20.2.1.11 Interior of all lockers and control panels;
20.2.1.12 Passenger boarding/alighting area;
20.2.1.13 Undercar equipment;
20.2.1.14 Major underframe connections (bolster at side and center sill, etc.);
20.2.1.15 Underframe, inverted, before addition of superstructure;
20.2.1.16 Roof, before addition to car;
20.2.1.17 Details of side panels;
20.2.1.18 Details of all communications equipment;
20.2.1.19 Details of door control stations and door operators.

20.3 DRAWING LISTS AND BILLS OF MATERIALS

20.3.1 Two (2) copies of a complete drawing list and bill of materials, which should include all Contractor's construction drawings and specialty manufacturers' drawings applicable to the cars shall be furnished. **[CDRL C-20-03]**

20.3.2 An electronic version, Microsoft Excel file, of each document shall be provided thirty (30) days after conditional acceptance of the last car.

20.4 SPARE PARTS CATALOGS AND MAINTENANCE MANUALS

20.4.1 There shall be two (2) comprehensive manuals: 1) Maintenance and 2) Parts. The Contractor shall deliver, in searchable, electronic form drafts of the Maintenance manual and of the Parts Manual to Metra prior to the shipment of the first production car. As-built updates, including car affectivity shall be provided through the life of the contract.

The Contractor shall deliver to Metra the final, editable electronic version of each manual within thirty (30) days after conditional acceptance of the last car. **[CDRL C-20-04] [CDRL C-20-05]**

All manuals shall be divided into fourteen (14) sections as follows:

20.4.1.1 Introduction (How to Use)
20.4.1.2 Car Body
20.4.1.3 Truck System
20.4.1.4 Electrical System
20.4.1.5 Braking System
20.4.1.6 Coupler System
20.4.1.7 Door System
20.4.1.8 Air Comfort System
20.4.1.9 :Lighting System
20.4.1.10 Communication System
20.4.1.11 Mobility Aid Lift
20.4.1.12 Seats
20.4.1.13 Cab Equipment
20.4.1.14 Miscellaneous Systems

Each section shall have a table of contents.

The contractor shall provide the manufacture name and part number for drop replacement parts.

In all both manuals, Contractor developed and Vendor supplied information shall be integrated into a unified presentation for each system addressed. For clarity of presentation the same data may be presented twice but shall use the same views and diagrams with the same reference numbers in each manual.

20.4.2 The Maintenance Manual shall address components to the lowest level identified in the parts catalog. The manuals shall contain a detailed analysis of each component so that maintenance personnel can effectively service, inspect, maintain, adjust, troubleshoot, repair, replace and overhaul the equipment. Where interfaces occur, a cross reference shall be made to the appropriate location.

The manuals shall be divided into the following sections and address the following topics:

20.4.2.1 **Introduction** - This shall include the purpose of the manual, special tools, technical guidance including torque requirement, sealing requirement etc., and equipment and safety precautions.

20.4.2.2 **Theory of Operation** - This shall include the general theory and the specifics of this system and the relationship of assemblies, subassemblies and components with an explanation and analysis of their functions to the smallest replaceable components.

20.4.2.3 **Operating Procedures** - This shall include the location and functional descriptions of all controls, monitors and indicators.

20.4.2.4 **Troubleshooting** - This shall include a list, in tabular format, of symptoms, causes of malfunction or improper operation, and probable remedies to the smallest line replaceable component or printed circuit board level. Logic/flow charts may be used to assist troubleshooting, but must reflect the most efficient and effective logic and not be simply tracing of schematics.

20.4.2.5 **Corrective Maintenance** - This shall include step-by-step removal, replacement, and adjustment procedures to the smallest line replaceable component or printed circuit board level. Detailed procedures shall be provided to adjust any unit that has been replaced.

20.4.2.6 **Preventive Maintenance** - This shall include a list, in tabular format, of all lubrication requirements, types of lubricants, frequency of application, inspection requirements and limits, component replacement and repair schedule, required adjustments, limits and tolerances, optimum test point readings, calibration charts and procedures in performing the preventive maintenance.

20.4.2.7 **Corrective Repair (Shop)** - This shall include detailed troubleshooting procedures for subassemblies as well as complete assemblies, step-by-step removal, overhaul, replacement and adjustment procedures to the smallest replaceable component. Detailed test and adjustment procedures shall be provided for all subassemblies and for the complete assemblies/units.

As part of the overhaul procedure, details for rebuilding, reclaiming or replacing all wearing or moving parts with comprehensive information on the limits and tolerances sufficient to determine the best approach to follow must be included.

20.4.2.8 **Appendix** - This shall include a list of reference drawings, interface drawings, circuit diagrams, symbols, cross references and revisions.

20.4.3 The parts manuals shall enumerate and describe every part to the lowest level of replaceable component. They shall include component name, symbol, function, rating, tolerance, manufacturer name and address, manufacturer's part number, commercial equivalents and quantity per assembly or sub-assembly. The manuals shall contain exploded-view diagrams illustrating and indexing every removable/replaceable part.

Each diagram shall be accompanied by a page listing every item indexed in the associated diagram and providing complete ordering data for every item. Diagrams and exploded views shall be provided to identify the appropriate location of parts within a sub-assembly and of the sub-assembly within the next larger assembly.

20.5 OPERATING INSTRUCTION BOOK

20.5.1 The Contractor shall furnish fifty (50) copies of instruction books, of a convenient size for handling and carrying, for train crew information on the operation of the cars. The book shall provide general information for the train crew duties, including troubleshooting information in case of breakdown or failure, and safety aspects related to train crew duties.

Diagrams and photographs shall be used where applicable.

20.5.2 All copies of the book covering the Metra cars shall be delivered sixty (60) calendar days before delivery of the first production car to Metra. The text of the operating instruction book shall be submitted to Metra for approval prior to printing. **[CDRL C-20-06]** In addition, an electronic version (format to be agreed upon) of this book shall be provided.

20.6 RECORD OF CONSTRUCTION/CAR HISTORY BOOKS

Car Contractor shall furnish in electronic form (Original pdf Files) to Metra a complete record of construction for each car consisting of the following information **[CDRL C-20-07]:**

20.6.1 All serial numbers on (and not limited to) trucks and related components (bolsters, equalizer beams etc.) and all heat numbers of truck forgings and castings; axles, wheels,

bearings, journal boxes, brake components, cab components and related components, HVAC systems and related components, Positive Train Control (PTC) equipment and related components, Cab signal and related components, display units, battery chargers and power supplies, Communications systems and related components, ADA systems and related components, pressurized components, toilet systems and related components yolk and coupler, and any other serialized parts, In addition, all software and firmware part numbers and revisions shall be provided.

20.6.2 Serial numbers, software and firmware part numbers and revisions shall be provided with each car history. In addition, an electronic version of a master list of serial numbers per vehicle shall be provide to Metra in Microsoft Excel format that can be uploaded into Metra's asset tracking database (Maximo).

20.6.3 Wheel and axle mounting reports;

20.6.4 Contractor's standard test sheets;

20.6.5 Two copies of "Certificate of Reservoir Construction" specifying minimum tensile strength of the material used, thickness of the shell and heads, outside dimensions and serial number;

20.6.6 Written reports, tests, and approved contract changes made by the Contractor during car construction;

20.6.7 Specification sheets as required by FRA shall be completed and delivered to Metra no later than delivery date of each car.

20.7 AS BUILT SPECIFICATION

Car Contractor shall furnish an electronic version of an as built specification showing all details of car, all components used and naming supplier and model of all equipment on cars. These books shall be furnished to Metra no later than 30 calendar days after delivery of final car. If any changes were made during construction, the as built specification shall detail the changes, and indicate to which cars changes were made or different equipment was applied during construction. **[CDRL C-20-08]**

20.8 FIELD SERVICE

The Contractor shall provide for field support facilities and personnel during the periods of performance testing, warranty, and retrofit programs (if any). The details and plans for field service shall be submitted to Metra for review and approval**. [CDRL C-20-09]** Where manufacturers' systems require specialist support, the Contractor shall arrange with the manufacturer for qualified personnel. Metra may require the Contractor to replace any field service personnel whom Metra deems in its discretion to be unsatisfactory.
Metra will accommodate field support personnel with a minimum of two parking spots at one of its main shops/yards, either Burlington Northern Santa Fe 14th St. Coach Yard or Rock Island Distrct 47th St. yard. The specific location for field personnel will be decided at a later date depending on Metra's needs and distribution of the newly purchased cars. The Contractor will be required to provide its own office space (trailer or other temporary office space, not to exceed 60 foot length by 12 foot wide by 12 foot height and office supplies (desks, chairs, computers, etc.). The field support office, including all furnishings, shall be covered under the Contractor's Risk Insurance. The Contractor shall be responsible for its own security of the office space and space provided for material storage. Material storage space will also be provided for the contractor. Metra will provide a minimum of one hundred and fifty (150) square feet of space for the Contractor to store material. Metra will provide utilities (electrical) for the office and material storage space.

20.9 TEST EQUIPMENT

The Contractor shall supply, sixty (60) calendar days prior to delivery of the first production car, four (4) sets of Specialty Tools, other than air brake test rack, where only one (1) would be required, and any test and diagnostic equipment necessary to support and maintain the cars and their sub-systems. The contractor shall propose the type and quantity of Test and Diagnostic Equipment the contractor deems necessary and most cost-effective for their proposal. A Specialty Tool shall be considered any tool, gage, die, etc. called out for inspection, repair, maintenance or overhaul of the vehicles that is not readily, commercially available. Special Tools shall not include fixed shop equipment. Fixed shop equipment shall be defined as cranes, drop tables, car jacks, and maintenance pits. Test equipment will troubleshoot down to electronic board level (qualify boards for functionality). **[CDRL C-20-10]**

20.10 TRAINING

20.10.1 General

The Builder must provide a modular training program using methodologies and formats which follow Instructional Systems Design (ISD) standards or equivalent Metra-approved formats recognized by American Society for Training and Development (ASTD). Training programs will be provided for the specified number of Metra's designated Instructors, Supervisors, Operating, Maintenance, and Engineering personnel, and be of a quality and depth sufficient to permit such personnel to train others in the operation and maintenance of the cars and to safely and satisfactorily operate, service, and maintain the cars and all their ancillary equipment. The training shall be based on Metra's "Train the Trainer" philosophy to allow future training programs to benefit fully from the training materials provided. Safety and FRA inspection compliance are of the utmost importance.

The Contractor must provide modular training materials using Metra's Word-based template and style (active voice, present tense). The Contractor must be familiar with Information Mapping methods and techniques. An additional requirement is that all written materials (course guides, tests, practical exercises) must allow for immediate and invisible integration into Metra Workforce Education and Training's (WFET) current training materials. This will allow for comprehensive training with respect to all aspects of operation and maintenance of the new equipment.

If the Builder intends to use a subcontractor for training, the Builder should identify the subcontractor. If a subcontractor is used, Metra's issuance of the Notice to Proceed is conditioned upon Metra's receipt of an executed copy of the Builder's contract with the trainer identified. The Builder should also specifically designate by name the project manager who will oversee the entire training process, oversee the training subcontractor, and who will interface directly with Metra's Director of Training & Development.

The ultimate objective of all training materials is that the trainees will be able to safely, accurately, completely, and successfully perform their assigned job tasks. Assigned job tasks include operations, maintenance, and repairs. Safety and FRA inspection compliance are critical to the success of the project. The training must include thorough explanations, operating, and maintenance instruction for any and all new technology. Metra requires that the training define with sufficient detail, accuracy, and completeness the operating and maintenance practices, procedures, and requirements associated with the supplied rolling stock.

Specifically, the Contractor must develop materials and deliver training that includes:

- Comprehensive conceptual information
- Functional descriptions
- System descriptions
- Component descriptions
- Installation and removal instructions

- Scheduled maintenance instructions
- Running maintenance instructions
- Comprehensive diagnostics and testing information
- Explicitly defined terminology for new technologies
- Comprehensive information for all new technologies, including system interfaces

Developing and delivering training requires that the Contractor:

- Obtain broad and deep knowledge of Metra equipment and supporting components
- Understand Metra's operations and operational goals
- Obtain a thorough understanding of all regulations that govern Metra operations

The training shall be conducted in ~~two~~ three phases. The first phase shall commence prior to the first production unit being available for revenue service. The second and third phases shall commence in sequential order directly following completion of the first phase ~~shall commence sixty (60) calendar days after the conditional acceptance of the last car of the initial order~~, in order to provide adequate training of Metra's designated personnel to allow them to become proficient with the equipment. Phase one consists of vehicle orientation, operation and running repair. Phase two consists of maintenance and troubleshooting. Phase three consists of vehicle heavy repair procedures and requirements. **(SCR-207)**

Training shall include instructor led classroom and hands-on instruction through the use of actual equipment, mock-ups, models, manuals, diagrams, and parts catalogs.

The Builder shall conduct a task analysis that is craft and location specific and includes an assessment of Metra's designated employees' baseline skills (knowledge, skills, abilities) to determine the appropriate level of content assumed in the training materials. The Builder shall assume the attendees have no knowledge of the features of the new cars, and using results of the assessment, shall design the training program to bring the level of student knowledge to one fully adequate for the stated objectives. The Builder's approach to this effort shall be based on the assumption that the builder's own interests, immediate and future, are best served by a high quality program.

All courses of instruction shall be presented in the English language.

Prior to the initiation of classroom instruction, all instructors to be utilized by the Builder shall attend an orientation at a Metra-designated location to become familiar with Metra's safety regulations and facilities, and to be advised of student qualifications and expectations.

A complete training plan including manuals and other training materials to be used by the Builder during training shall be delivered to Metra sixty (60) calendar days before initial training is conducted. The manuals shall be accurate, complete, of professional quality, and shall have been approved by Metra. Drawings shall be the most recent version reviewed and approved by Metra.

In addition to the above requirements, the Builder shall submit as part of the BAFO, in detail a projected training plan clearly linking each individual activity and deliverable to the car production schedule, providing clear project management documents (Gantt charts, etc.), which link the various time lines. Note: the clarity of the information and level of detail will be important factors in this evaluation.

The program shall be conducted in a Contractor provided facility, at or near Metra's facilities in the Chicago, Illinois metropolitan area and shall include classroom and hands-on instruction (including practical exercises on actual equipment). The Builder shall provide an adequate supply of high quality, professionally prepared material on paper and such other training aids as may be necessary to impart the essential information to the people involved and leave them with authoritative and up-to-date reference material. The program shall include pre and post tests and hands-on practical exercises to determine the proficiency of the students in meeting the course objectives.

The training shall provide in-depth instruction covering all subjects and systems and their location, removal, replacement, and interfaces with other systems and parts of the car. Special emphasis shall be placed on job aids and instruction that compare and contrast the differences

in new car systems with Metra's existing car systems. Metra will provide the Contractor with a set of maintenance manuals on typical existing equipment.

The Builder shall, within ninety (90) calendar days after the Notice to Proceed, submit an Overall Training Program Outline with clearly defined Terminal Learning Objectives and a schedule for Metra's approval that identifies milestones for submitting the course outlines, lesson plans, instructor and student guides, audiovisual and other training aids, simulators, written and practical skills evaluations, and conducting classes. The training outline shall identify each module of instruction and the general topics to be taught, and indicate the order in which modules will be presented. **[CDRL C-20-11]**

Training materials including manuals, audio/visual aids, reference documents, computer hardware and software, mock-ups, models, simulators, check lists, and related items shall be as described in Section 20.10.9.

Prior to training materials being developed for a given module, the Builder shall submit a set of clearly defined Module Enabling Learning Objectives being developed, and shall not proceed with development until the Module Enabling Learning Objectives are approved by Metra's Training and Development Division. As training materials are being developed, the builder shall work closely with Metra's staff to ensure Metra's standards with respect to the course organization, content, and overall quality of written documents and audio/visual aids are being met.

All training materials such as training aids and lesson plans shall become the property of Metra at the completion of the training program. The Builder shall be responsible for the condition of these materials for the duration of the training program and shall replace all damaged materials unless the damage results from Metra's negligence. Lesson plans shall be updated as required during the course of instruction. Metra shall be given full copyrights to reproduce and modify training materials for Metra's use.

20.10.2 Instructor Qualifications

Prior to the development of any training materials, all contracting instructors must attend an orientation at a Metra-designated location. The objective of the orientation is to familiarize the contracting instructors with Metra's safety regulations and facilities. At the orientation, Metra will also advise the instructors about student qualifications and expectations. The orientation will be a one-day session. In the event that more than one session is necessary, Metra will host multiple sessions in order to accommodate all instructors.

All of the instructors provided by the Builder shall be fully capable of delivering in-depth technical information that can be understood by participants. A detailed resume for each instructor shall be provided to Metra for approval sixty (60) calendar days prior to commencement of scheduled course instruction. **[CDRL C-20-12]** Metra reserves the right to disqualify any of the builder's instructors for reasonable cause at any time.

Metra will recognize the instructor as qualified when the individual:

- Can communicate, in English, in a manner that allows the participants to understand;
- Has been trained in adult teaching principles and methods and has had experience in conducting technical training courses;
- Has an in-depth knowledge of the system under discussion, how it interfaces with other systems or subsystems, the procedures for isolating faults, if applicable, and troubleshooting, and is able to communicate that information to students in an effective manner.
- Is able to design practical written tests, according to the approved course objectives, to determine the extent to which students understand and can apply the information that has been taught.

As part of the BAFO, the Builder should define and explain the specific person(s) for each subcontractor who will be designated as the contact to implement that portion of the training.

20.10.3 Training Schedules, Class Size, and Program Plan

The Contractor must, within ninety (90) calendar days of receiving the Notice to Proceed, submit an overall initial Training Program Plan that contains a detailed outline and a project schedule for Metra's approval. The program plan must contain:

- All assigned project team members including:
  - The tasks to which they are assigned
  - Company name
  - Location
  - Contact information
- Project Objectives.
- Detailed project phases, tasks, and deliverables (scope).
- A detailed schedule of delivery dates, specifying milestones such as draft delivery dates, edited materials delivery dates, and final delivery dates.
- The course modules and corresponding lessons.

The types of deliverables for each course module (CBT, hard copy materials, etc).

- Project team hierarchy, sign-off authority, and delivery process.
- Communication and reporting plan.
- Change management plan.

The training must provide in-depth instruction, covering all equipment and components and their relevancy to the operation, maintenance/troubleshooting, and repairs. Training requirements include familiarity with new equipment systems, location, removal, and replacement. It is critical that all materials and instruction focus on the new passenger car components.

Prior to submitting draft versions of training materials, the Contractor must submit detailed outlines and/or storyboards for approval. No development can commence without the approval of outlines and/or storyboards. Course and lesson objectives must be a part of the detailed outlines and/or storyboards.

The Contractor must submit all training materials for review to the Metra project team. The Metra project team requires fifteen (15) working Days (as defined in Exhibit 1-A) to review, edit, and return the training materials. The Contractor must have the ability to produce and submit materials according to a predetermined training plan and schedule.

Once the Contractor receives the edits from Metra, they must resubmit the edited version within ten (10) working days for approval. All materials must be finalized within a three-version cycle.

During materials development, the Contractor must work closely with Metra's project team to ensure the Contractor is meeting Metra's and project standards.

All final versions must be ready for delivery thirty (30) working days prior to the date scheduled training date.

All training materials will become the property of Metra at the completion of the development and training program validation. Metra will retain all materials utilized in the training program, and will use these for future internal training.

The Contractor must be responsible for the condition of all training materials and equipment for the duration of the training program, and must replace all damaged materials unless the damage results from Metra's negligence. The Contractor must update all materials, training aids, and mock-ups as necessary during development and course validation. Metra must have full copyrights to reproduce and modify training materials for future use at Metra.

Course duration (hours of instruction) and class size (number of trainees) will be clearly defined for each topic, depending upon the craft and topic involved. In addition, the proposal must clearly estimate the number of hours for development per hour of classroom instruction, for each module.

All ancillary equipment should be proposed to maximize the training objectives.

Operator field instruction of at least 4 hours is acceptable as an estimate; with more specific estimates of duration to be determined in the project plan.

The proposal must clarify whether proposed CBT modules are to support classroom modules or

if they are to act as a stand-alone modules.
Metra will determine the class size. In general, class sizes will be from five (5) to ten (10) people.
Metra acknowledges the variances (experience and technical skills) in the workforce. The Contractor must work with the Metra project team to determine the appropriate number of pilot and validation classes.
After Metra accepts the lessons, and objectives for each module, the Contractor must deliver a pilot class to verify content and presentation. After making additional necessary revisions, the Contractor must deliver a validation class to allow Metra to verify and approve content and delivery. In order to validate the class, the audience in validation class must be at least 50% of the pilot class audience. Changes to the validation course content must be included with the final deliverables.
Requests for revisions will be made by the Metra project team. The project team can determine the correctness and accuracy of the content. They can also judge the quality of the content based on their extensive design and development experience.
The Contractor must supervise all classes and must comply with all of Metra's labor agreements, safety rules, other work rules, and policies. The Contractor must conduct classes during Metra's normal daytime hours of operation, Monday through Friday. The classes cannot be more than 8 hours per day, with total course duration to be mutually agreed upon by the Contractor and Metra.
Metra is planning for a three-phase training approach. Phase I is described as the Introductory Phase, and will include:

- Overview and conceptual information about the equipment.
- Operation of the equipment.
- Daily inspections.

Phase II is described as the Qualification phase, and will include:

- Maintenance.
- Troubleshooting.
- Repair.

Phase III is described as the Heavy Maintenance phase, and will include:

- Equipment breakdown and rebuilding.
- Equipment overhaul.

As part of this contract, Metra requires that the Contractor provide training on specific topics for employee specializing in specific crafts. This table contains the topics, the craft, and the number of employees that must be trained in each topic.

Topic	**Craft and Number of Trainees**	**Totals**
ADA Equipment	• Carmen – 276 trainees (M) • Electricians – 234 trainees (M) • Managers – 87 trainees (M) • Instructors – 8 trainees (W)	605 Trainees
ADA Operations	• Instructors – 10 trainees (T) • Managers – 35 trainees (T) • Trainmen – 860 trainees (T)	905 Trainees
Air Brake System Equipment	• Carmen – 276 trainees (M) • Managers – 87 trainees (M) • Instructors – 8 trainees (W)	371 Trainees
Air Brake System Operations	• Instructors – 10 trainees (T) • Managers – 35 trainees (T) • Trainmen – 860 trainees (T)	905 Trainees
Automatic Train Control	• Electricians – 234 trainees (M)	329 Trainees

	• Managers – 87 trainees (M) • Instructors – 8 trainees (W)	
Low Voltage Power Supply / Battery Charger	• Electricians – 234 trainees (M) • Managers – 87 trainees (M) • Instructors – 8 trainees (W)	329 Trainees
Car Body Identification	• Instructors – 10 trainees (T) • Managers – 35 trainees (T) • Trainmen – 860 trainees (T)	905 Trainees
Communications System Equipment	• Electricians – 234 trainees (M) • Managers – 87 trainees (M)	321 Trainees
Communications System Operation	• Instructors – 10 trainees (T) • Managers – 35 trainees (T) • Engineers – 313 trainees (T) • Trainmen – 860 trainees (T)	1,218 Trainees
Door Systems Operation	• Instructors – 10 trainees (T) • Managers – 35 trainees (T) • Engineers – 313 trainees (T) • Trainmen – 860 trainees (T)	1,218 Trainees
Door Systems Equipment	• Carmen – 276 trainees (M) • Electricians – 234 trainees (M) • Managers – 87 trainees (M) • Instructors – 8 trainees (W)	605 Trainees
Electrical Cabinet Identification	• Instructors – 10 trainees (T) • Managers – 35 trainees (T) • Trainmen – 860 trainees (T)	905 Trainees
Electrical Systems	• Electricians – 234 trainees (M) • Managers – 87 trainees (M) • Instructors – 8 trainees (W)	329 Trainees
HVAC System Equipment	• Electricians – 234 trainees • Instructors – 8 trainees (W) • Managers – 87 trainees (M)	329 Trainees
HVAC System Operation	• Instructors – 10 trainees (T) • Managers – 35 trainees (T) • Engineers – 313 trainees (T) • Trainmen – 860 trainees (T)	1,218 Trainees
Lighting Systems Equipment	• Electricians – 234 trainees • Instructors – 8 trainees (W) • Managers – 87 trainees (M)	329 Trainees
Lighting Systems Operation	• Instructors – 10 trainees (T) • Managers – 35 trainees (T) • Engineers – 313 trainees (T) • Trainmen – 860 trainees (T)	1,218 Trainees
Truck and Coupler System	• Carmen – 276 trainees (M) • Managers – 87 trainees (M) • Instructors – 8 trainees (W)	371 Trainees
480 Volt Electrical System	• Instructors – 10 trainees (T) • Managers – 35 trainees (T) • Engineers – 313 trainees (T) • Trainmen – 860 trainees (T)	1,218 Trainees

(M) – Mechanical Department Employees
(T) – Transportation Department Employees
(W) - Workforce Education and Training

Note: This matrix contains a tentative list of topics and an approximate number of trainees. Actual topics and the number of employees requiring training in each topic will vary based on the equipment Metra ultimately purchases.

The training modules must be customized for the various technical, operational, and support staff impacted by the new equipment. The trainee groups include the following classifications and current number of existing employees:

- Workforce Education and Training (WFET) Instructors
- Mechanical
  - Apprentices
  - New Employees
  - Journeymen (Carmen, Electricians, Machinists, Sheet Metal Workers)
  - Foremen
  - Management Staff
  - Engine Watchmen
- Transportation
  - Engineers (Operators)
  - Trainmen
  - Instructors
  - Management Staff
  - Dispatchers

Note: The Contractor must provide training to the assigned Metra employee population on all components, systems, and subsystems that comprise the operation and maintenance of the new equipment. For example, all Metra electricians must attend those specific training classes for each topic related to electrician job tasks.

Training must include CBTs, instructor-led classroom, and hands-on instruction using actual equipment, mock-ups, models, manuals, diagrams, and parts catalogs. All equipment must be located and the training conducted at Metra's Rock Island District 47th Street yard. At the conclusion of the training as set forth herein, all actual equipment, mock-ups, models, and other training materials are to become Metra's property. The property is necessary for Metra to train new employees in the future.

As part of this contract, Metra requires that the Contractor provide training aids (mock-ups) for, but not limited to, the following equipment:

ADA Systems
HVAC Systems
Air Brake Systems
Door Systems
Communication Systems (PA and TIMS)
Low Voltage Power Supply / Battery Charger

All courses must include a combination of classroom and hands-on instruction. For most course topics, Metra expects 40%-60% of the classroom time to be allocated to hands-on activities. In-class exercises, written exams, and practical skills evaluations must be designed and developed for each course in order to determine the extent to which students have learned and can apply the information identified in the course. Metra requires the Contractor to make recommendations for test frequency and methods.

Classroom instruction for preventative maintenance courses must include not only the details and functioning of parts under discussion, but the essentials of their routine or periodic care, including lubrication schedules and materials. When methods of access, removal, dismantling, or application are not evident, the instruction must cover these matters.

The Builder shall make recommendations for test frequency, tolerance limits, and methods for

testing, including instruments required, when applicable. The Builder shall assist Metra personnel in developing suitable preventative maintenance, daily and periodic inspection forms, and shall instruct Metra employees how these inspections are performed.
The Contractor must give special attention in the instructions, to matters relating to current and proposed safety and FRA inspection requirements and must provide detailed checklists to assure compliance.
It is important that the Contractor recommend, develop, and provide the most appropriate training aids and equipment in response to the Metra workforce needs and the passenger equipment subsystems being proposed.
After Metra accepts the Terminal and Enabling Learning Objectives for each module, the builder shall deliver a Module Executive Overview to verify module concept. In addition, for each module, a presentation will be made to selected members of the Labor/Management Committee involving the pertinent labor and management representatives affected by the subject matter or topic. After making revisions, if necessary, the Builder shall deliver a Module Pilot Class to verify content and presentation. After making revisions, if necessary, the Builder shall deliver a Module Validity Class to verify and approve content and delivery. After approval, the module will be accepted for delivery to the general population.
The Builder shall supervise all classes and shall comply with all of Metra's labor agreements, safety rules and other work rules. Classes will generally be conducted during Metra's normal daytime hours of operation, Monday through Friday, and no more than 8 hours per day with total course duration to be mutually agreed upon by the Builder and Metra.
The Builder shall provide all necessary training equipment. ~~The~~ For VRE, the Builder will equip an approved classroom. ~~approved by Metra with~~ The Builder will utilize Metra's facility. The classroom will be equipped with the Builder's or Metra's standard audio-visual equipment (overhead projector, slide projector, DVD video player, projection screen, dry erase marker board) and furniture (desks, chairs, and tables) as needed. Instruction, practical exercises, multimedia presentations or computer based instruction requiring use of computers, large screen video projection (PowerPoint® for example), audio equipment, specialized tools, or test equipment are acceptable. All such hardware and software used will be provided by the Builder ~~and~~ but only intellectual property (manuals, tests, etc) will become the property of Metra upon completion of the training. **(SCR-146)**
Cost of any such hardware and software shall be borne by the Builder. Computer hardware and software compatibility shall be in accordance with the Training Materials Section.

20.10.4 Operator and Inspector Training

The operations training program shall include, but not be limited to, the following: specifications; controls and indicators; systems (brakes, train control, instrumentation, audible & visual signaling and communications); operations (i.e., actual operation of the car in maintenance yards and on the main tracks or operational simulator); troubleshooting procedures, and recovery operations (recovery from the situation, as in resolving the problem discovered when troubleshooting, i.e., fixing the problem).
Engineers must be trained in a fully operational cab simulator. Instruction will include comparisons to passenger cars currently in Metra service, with concentration on changes in operation, functions, features, locations and indication. A Metra supervisor or qualified instructor must accompany all Contractor instructors to ensure that the training complies with all Metra's safety and operational policies.
Operational instructions must follow a logical progression involving the details of the Cars, the manipulation of all controls, and actual operation of the Car components and systems. Actual operation must be conducted under Metra's operating rules and must be performed by Metra's qualified employees under the direction of the Contractor's representative. Operating instruction must include trouble indications, their proper reporting, and corrective measures available to the engineers and operators.
All bid respondents must take note of the provisions of 49 CFR § 238.109 in its entirety, and in

particular § 238.109(b)(12), 'Training, Qualification, and Designation Program.' As part of this program, the railroad should, at a minimum: "Add new equipment to the qualification and training program prior to its introduction into service."
If bid respondents propose an alternative to fully functional passenger equipment, given the training objectives and the federal requirements of CFR § 238.109; bid respondents should stipulate the alternative very clearly.
Phase I – Overview and Operations Training
Phase I training must address topics and content capable of being effectively delivered prior to the availability of the first production unit. Examples of Phase I topics might be, but are not limited to:

- New equipment orientation (similarities, differences, safety)
- New equipment operation training (normal and emergency operations)
- New equipment maintenance training (craft specific classes on items such as an introduction to Daily Inspections).

20.10.5 Maintenance Training

Metra's employees (a total of 597 employees, 4 crafts and their supervisors) shall be exposed to the depth of detail that is necessary for the performance of all preventive (scheduled) and corrective (unscheduled) maintenance operations for all aspects of the cars. Students shall be afforded the opportunity to perform the more complex maintenance functions on the car and in the shop, in addition to troubleshooting systems with faults artificially introduced in the equipment while using the appropriate subsystem test devices.
The program shall emphasize the details of performing heavy maintenance repair and rebuilding of major components. Metra performs complete car overhauls. Metra will accept and may approve modules pertaining to heavy maintenance within the acceptance parameters of this Contract.
Metra may, however, defer the classroom delivery of heavy maintenance training to a selected population on a date to be determined which is closer to Metra's performance of that work.
As part of the BAFO, the Builder should specifically define mock-ups or simulator equipment to be used in any training module to maximize the learner's "hands-on" operation and skills.
Required mock-ups must include but are not limited to the following systems:
A fully functional, ADA compliant lift, enabling both operational and maintenance training; and therefore, including related equipment, such as but not limited to exterior control panel, electrical pump enclosure, lift cassette and enclosure, manual pump operation apparatus.
A communications mock-up demonstrating TIMS (Train Information Management System) primarily for operating crew orientation and practical exercises. This mock-up should be designed to allow crew members to learn and practice proper modulation when making announcements. Ancillary equipment should allow evaluation of performance through audible output and may also include (for the purpose of practice) visual metering or other devices showing an acceptable range.
A cab mock-up with all controls with all dimensions and detail appropriate to train and orient operators and other trainees on newly located controls/devices.
An operational braking system mounted on a training rack must be provided for the related training exercises.
Builder must provide, for purposes of HVAC training, an air comfort system (a/c unit) which will include but is not limited to a maintenance rack, including a frame, unit and control panel. This mock-up should be developed to allow training on the new system, maintenance training, troubleshooting and any appropriate OSHA certification issues as they relate to the new system.
The Builder will provide the appropriate mock-ups required for training of the exterior passenger entrance doors and control system and the passenger compartment doors and control system.
The exterior passenger entrance door mock-up must be capable of simulation including, but not limited to, such items as: a single door panel; a door hanger; door operator assembly; power

supply; wire harnesses and piping; relay panel, emergency release handle(s); door open light; door closing light and audible alerters; etc. Likewise, the passenger compartment door mock-up must be capable of simulation including, but not limited to, such items as: door panels; door hanger; door operator assembly; sensitive door edges; kick plate; power supply; wire harnesses; etc.

The Builder must provide a functional mock-up of the toilet system. This mock-up must include but is not limited to the following sub-assemblies or items: actual toilet; air filter regulator; waste retention tank; freeze dump valve; etc. The mock-up must employ some type of water tank allowing sufficient water so that demonstrations can be conducted for the appropriate mechanical personnel.

Wherever possible, maintenance course modules and content shall be divided into two classifications: Electrical and Electronic Systems, and Mechanical Systems. To allow student participation during the demonstration and performance of maintenance functions, each course shall be separated into one of these classifications. It is understood that certain new systems may combine these disciplines, and there may be exceptions to this requirement.

Phase II - Maintenance Training

Training must be broad enough and deep enough to allow for the simulation of 'real life' activities that maintenance workers typically experience. This activity includes preventative, periodic (such as Air Brake System component rebuilds), and corrective maintenance operations for all new components on the passenger equipment. The procedures must also include the changes to existing systems as the result of changes in equipment and/or components. Students must have the opportunity to perform the more complex maintenance functions on the equipment and in the shop. The training must also include troubleshooting systems. Troubleshooting training must include artificially induced defects so the trainees will have the opportunity to repair them.

Metra requires that the bid respondents include actual component training aids as part of their training modules. When components are not possible, photograph and 'exploded' graphics are necessary to the program.

Phase III – Heavy Maintenance Training

Metra performs complete equipment overhauls and rehabs. The program must, therefore, provide the details of performing heavy maintenance, repair, and rebuilding of components. Metra further requires CBT modules pertaining to heavy maintenance within the parameters of this Contract.

20.10.6 Engineering and Supervisory

An overview course shall be provided familiarizing generalists (approximately eighty seven (87) participants total, from Mechanical, Operating, Engineering and Materials) with the new equipment. The course shall cover, in executive overview fashion, all subjects to be covered in all other training courses, and shall be provided prior to those courses being conducted. Class size will be between ten (10) to twelve (12) participants.

20.10.7 Parts Catalog Seminar

The Builder shall also include, as a part of its overall training program, a parts catalog seminar (or course of instruction) covering car and car component familiarization for material planners and operations support personnel (20 Materials Management personnel and from one hundred (100) to one hundred twenty (120) Mechanical personnel). This course of instruction shall be comprised of a number of classes with each class given to not more than ten (10) people per class. These classes shall be held during Metra's normal daytime hours of operation at a location in the Chicago, Illinois, metropolitan area designated by Metra. The course given to each class shall be of a total duration approved by Metra and shall include both classroom and field car and component familiarization. An outline of this course of instruction shall be included in the Training Program Outline.

20.10.8 Field Instruction and Warranty Field Instruction

In addition to the formal training described above, regularly scheduled field instruction must be provided by the builder during the warranty period for selected Metra personnel. This instruction must be hands-on instruction, using the standards described above, with the intent of producing Journeyman level mastery of the troubleshooting and repair tasks encountered. This activity shall be in addition to normal builder warranty efforts.

Field instruction involving use of the cars, including both maintenance and operation, shall be presented by qualified and approved instructors (in accordance with Section 20.10.2) having thorough experience in maintenance, service, or operation as the case may require.

Instructors must be capable of communicating their knowledge to others and must have their subjects properly organized prior to commencement of the class. Instruction in operation shall follow a logical progression involving the details of the cars, the manipulation of all controls, and actual operation. Actual operation shall be conducted under Metra's operating rules and shall be performed by Metra's qualified employees under the direction of the Builder's representative.

Operating instruction shall include trouble indications, their proper reporting, and corrective measures available to the operator.

If desired, the Builder may request to provide some of the field instruction in its own and its subcontractors' facilities. If the builder elects to provide this type of instruction as part of the formal instruction identified in Section 20.10.3, it must identify the number of hours and dates of the proposed training sixty (60) days prior to the date the training is to occur and obtain Metra's approval. Upon request of Metra, the Builder shall make these shops available for a limited number of Metra's supervisory and technical personnel to familiarize themselves with assembly methods. The Builder shall provide digital video and/or photograph portions of the car which would normally be inaccessible or concealed on the delivered units solely for use in Metra's internal training programs.

20.10.9 Training Material Standards

The following are standards for training materials that should be followed to assure compatibility with Metra's current methods of editing, production, duplication, storage, distribution, and delivery capabilities:

Minimum computer hardware configuration:

IBM compatible, Pentium III CPU, Intel Processor, 2 GHz processor or equivalent, 500 GB or greater hard drive

Software:

MS Windows 10 operating system

MS Office Suite (2019 or better)

MS Project

Graphics Format:

I GB video memory capacity, type DDR3

Digital Storage and Distribution:

USB 2.0 or better

Tools for developing written materials must be:

- Microsoft Windows Office-based products, including:
  - Word
  - PowerPoint
  - Excel
  - Visio
  - Publisher
- Picasa (for graphics)
- Adobe Acrobat

Tools for developing CBTs:

- Captivate

Tools for developing web-based materials:

- Captivate
- Dreamweaver

Any web-based applications proposed as CBT (Computer Based Training) should be clearly detailed including such items as: previous or current direct involvement with such applications; specific advantages this would provide in this training effort; updating capabilities including a definition of the webmaster; linkage, if any, to other interactive training products being proposed (e.g., the cd-rom program on x will later migrate to the web, since this will improve...); etc.

Video Format:
Digital
Computer Based Instruction/Training:
Metra standard not yet established for authoring software (submit recommendation)
Photographs:
35 mm color negatives (master)
35 mm slides, horizontal/landscape orientation only (master/copy)
8 X 10 print (copy)
Digital .bmp (master)
Digital .jpg (copy)
Overhead Projection Transparencies:
N/A. All presentations should be in digital format, MS Powerpoint or .pdf
Training Manuals:
Type set in 14 pt. san serif font (Arial True Type preferred)
High quality B&W printed (copied)
Masters shall be provided on USB drives in Microsoft Word or Original.pdf format
Blueprints (prints):
Readable paper copies
Reference Materials:
Copies of all reference materials will be provided by Contractor (i.e., FRA Regulations)
Tests:
4 answer, multiple-choice, with answer keys and references to student manual location with a minimum of three banks of equivalent questions
Job Aids/Check Lists:
Pocket-sized and plastic or heavy weight paper laminated in plastic

20.11 CYBERSECURITY

20.11.1 Summary

The contractor shall provide cybersecurity requirements for all hardware, software, and firmware (hereinafter referred to as the “products” for purposes of this section) under this Contract, whether resident within a microprocessor-controlled system, provided as part of test or interface equipment, provided for the purpose of post-download data analysis and processing, or incorporated within training technology and manuals, and Portable Test Equipment (PTE) as defined in the Technical Specification.

These requirements apply to all systems that include processors or other programmable components such as Programmable Logic Devices (PLDs) and Field-Programmable Gate Arrays (FPGA). Contractor is required to flow these requirements down to all subcontractors and require that these subcontractors flow these requirements down to all of their subcontractors and sub-suppliers, regardless of the tier. Thus, where the word “Contractor” is used, it includes all subcontractors and sub-suppliers, at every tier. If the Contractor fails to comply with any of the requirements set forth herein and fails to remedy such non-compliance upon notice from the Contracting Officer, the Authority may exercise all available legal, contractual and administrative remedies for such non- compliance, up to and including a

default termination in accordance with the Termination for Default article in the Contract. This applies not only to Contractors as defined in the above paragraph, but to manufacturers of all hardware, software, and firmware installed in the railcar or delivered as a part of the railcar procurement. Further, if the results of any penetration testing, vulnerability assessment or other examination or audit of the Contractor's cybersecurity protections yields any results that the Authority deems to require further examination and/or audit, the Authority may share the results of such testing with Federal, state or local authorities for the purpose of protecting national security interests, the safety and security of the riding public, or personal and real property. The Contractor shall support the Authority in all tasks necessary to implement best practices developed under section 2(c)(15) of the National Institute of Standards and Technology Act (15 U.S.C. 272(c)(15) as applicable to the current procurement. The Contractor shall also support the implementation of standards and best practices for rail fixed guideway public transportation systems developed under the authority of the Secretary of Homeland Security. This support shall include all necessary input, technology, and systems as identified by the latest NIST Framework for Improving Critical Infrastructure Cybersecurity to appropriately Identify, Protect, Detect, Respond, and Recover from cybersecurity threats related to Contractor supplied products. Additional specific requirements for this procurement are identified below.

20.11.2 Detailed Analysis

20.11.2.1 Cybersecurity Risk Assessment

The Contractor shall provide an analysis of the potential effects of various possible security attacks on network transmissions and the operation and effectiveness of the measures taken to ensure the security and safety of the networks. The security analysis shall be guided by the latest ~~NIST Framework~~ EBIOS Methodology for Improving Critical Infrastructure Cybersecurity. This document shall be submitted for Authority review and approval prior to the first design review and updated and submitted for review annually throughout the duration of the design, production, and warranty periods. **(SCR-206)**

20.11.2.2 Country of Origin

The Contractor shall identify the country (or countries) of origin of all products to be provided under this Contract, or any subcontracts, at any tier.

20.11.2.2.1 The Contractor shall identify the countries where the development, manufacturing, maintenance, and service for the product are provided or will be provided.

20.11.2.2.2 The Contractor must submit a list of the proposed products identifying the country of origin ("List" hereinafter) to the Authority for approval.

20.11.2.2.3 The Contractor shall notify the Authority of any changes to the List no less than 90 days prior to the date that the change will be implemented. The Contractor shall maintain the list throughout the effective term of the contract.

20.11.2.3 Cybersecurity Practices

The Contractor shall adhere to the specified cybersecurity practices detailed below. In the event that the Contractor knows that it cannot comply with a requirement at the time of its proposal, it shall specify in sufficient detail the justification for non-compliance and its proposed alternative method for meeting the requirement. The Contractor has the affirmative duty to seek and identify any and all information that would result in actual or potential non-compliance during the course of Contract performance. The Contractor shall immediately notify the Authority so that corrective action can be taken.

20.11.2.3.1 Software and Services

20.11.2.3.1.1 The Contractor shall remove and/or disable, through software, physical disconnection, or engineered barriers, all services and/or ports in the product not required for routine operations, emergency operations, maintenance, troubleshooting, or repair. This will include communication ports and physical input/output ports (e.g., USB ports, video ports, UART ports, serial ports, software terminal ports). The Contractor shall provide documentation of disabled ports, connectors, and interfaces for each device to the Authority.

20.11.2.3.1.2 The Contractor shall provide summary documentation of the product's security features and security-focused instructions on maintenance, support, and reconfiguration of the product's default settings.

20.11.2.3.1.3 The Contractor shall disclose the existence of all known methods for bypassing computer authentication contained in the product, often referred to as "backdoors," and provide written documentation that all such backdoors have been permanently deleted from the product.

20.11.2.3.2 Access Control

20.11.2.3.2.1 The Contractor shall restrict physical access to system components to all but authorized personnel.

20.11.2.3.2.2 The Contractor shall configure each component of the product to operate using the principle of "least privilege." This includes operating system permissions, file access, device access, device / user accounts, and communications / data transfer.

20.11.2.3.2.3 The Contractor shall provide user accounts with configurable access and permissions associated with one or more defined user role(s).

20.11.2.3.2.4 The Contractor shall utilize access control lists and provide a system administration mechanism for changing users' roles (e.g., group) or associations.

20.11.2.3.2.5 The Contractor shall configure the product such that when a session or inter-process communication is initiated from a less privileged application, access will be limited to and enforced at the more privileged side.

20.11.2.3.2.6 The Contractor shall provide a method for protecting against unauthorized privilege escalation.

20.11.2.3.2.7 The Contractor shall document options for defining access and security permissions, user accounts, and applications with associated roles. The Contractor shall configure these options, as specified by the Authority.

20.11.2.3.2.8 The Contractor shall recommend methods for the (Client) to prevent unauthorized changes to the Basic Input/Output System (BIOS) and other firmware. If it is not technically feasible to protect the BIOS to reduce the risk of unauthorized changes, the Contractor shall document this and provide mitigation recommendations.

20.11.2.3.2.9 The Contractor shall verify and provide documentation for the product, attesting that unauthorized logging devices are not installed (e.g., key loggers, cameras, and microphones).

20.11.2.3.2.10 The Contractor shall deliver a product that enables the Authority to configure its components to limit access to and from specific locations (e.g., security zones, business networks, and demilitarized zones) on the network to which the components are attached, where appropriate, and provide documentation of the product's configuration as delivered.

20.11.2.3.3 Authentication/Password Policy and Management

20.11.2.3.3.1 The Contractor shall document the levels, methods, and capabilities for authentication and authorization of passwords. The Contractor shall deliver a product that adheres to standard authentication protocols.

20.11.2.3.3.2 The Contractor shall protect all passwords, including, but not limited to the following methods: Contractor shall not store passwords in clear text and Contractor shall not hardcode passwords into software or scripts.

20.11.2.3.4 Logging and Auditing

20.11.2.3.4.1 The Contractor shall provide logging capabilities for all products. Logging capabilities provided by the Contractor shall be configurable by the Authority and support security auditing requirements. As specified by the Authority, the product shall cover the following events, at a minimum (as appropriate to their function):

20.11.2.3.4.2 Information requests and device responses;

20.11.2.3.4.3 Successful and unsuccessful authentication and access attempts;

20.11.2.3.4.4 Account changes;

20.11.2.3.4.5 Privileged uses.

20.11.2.3.4.6 The Contractor shall time-stamp audit trails and log files.

20.11.2.3.4.7 The Contractor shall provide security protection of log files with confidentiality and integrity.

20.11.2.3.4.8 The Contractor shall implement for Authority use an approach for automatic collection and storage of generated log files.

20.11.2.3.4.9 The Contractor shall provide a list of all log management activities that the product is capable of generating and the format of those logs. This list shall identify which of those logs are enabled by default.

20.11.2.3.5 Communication Restrictions

20.11.2.3.5.1 The Contractor shall provide detailed information on all communications (e.g., protocols and full interface control documents) required between the Authority's network security zones whether inbound or outbound and identify each.

20.11.2.3.5.2 The Contractor shall provide a method to restrict communications traffic between different network security zones. The Contractor shall provide documentation on any method or equipment used to restrict communications traffic.

20.11.2.3.5.3 The Contractor shall provide the Authority with access, including administrative access as needed, to the network components of the product.

20.11.2.3.5.4 The Contractor shall document all remote access entry pathways and ensure that they can be enabled or disabled by the Authority.

20.11.2.3.5.5 The Contractor shall submit the IP address and routing scheme for Authority review and approval for all products.

20.11.2.3.5.6 The Contractor shall provide a method for managing the network components of the product and changing configurations. (e.g., addressing schemes).

20.11.2.3.5.7 The Contractor shall certify that the network configuration management interface is secure.

20.11.2.3.5.8 The use of encryption, public/private keypairs, and hardware keys is encouraged as a mitigation. These technologies shall be implemented as required as a result of the comprehensive cybersecurity risk assessment.

20.11.2.3.5.9 The Contractor shall establish appropriate isolation of safety and security critical system functions from other functions.

20.11.3 Certification

20.11.3.1 Independent Assessment of Software and Firmware Quality

20.11.3.1.1 The Contractor shall procure an independent third-party assessment of all software and firmware used in safety-critical or related applications provided as part of this project. Software and firmware which are no safety-critical or related, but whose unmitigated risk identified as a part of the cybersecurity risk assessment retain unacceptable or undesirable residual risk shall also be put through an independent third-party assessment, procured by the Contractor, as an additional method of reducing the residual risk.

20.11.3.1.2 The assessment shall be performed by a qualified, independent organization approved by the Authority.

20.11.3.1.3 The Contractor shall ensure that the third-party software quality assurance provider shall check software and firmware to ensure that critical application security weaknesses (including OWASP's Top 10 and SANS' Top 25 Most Dangerous Software Errors) are addressed.

20.11.3.1.4 The Contractor shall ensure that the third-party quality assurance provider performs testing to identify potential cybersecurity weaknesses and vulnerabilities. This testing shall include, but is not limited to, fuzz testing, static testing, and dynamic testing.

20.11.3.1.5 The Contractor shall ensure that the results of any independent software and firmware quality assurance assessment are sent directly from the third-party provider to the Authority and the Contractor.

20.11.3.1.6 The Contractor shall provide a response to the third-party's assessment including plans to correct identified vulnerabilities. The Contractor's response and corrective action plan shall be sent to the Authority for approval.

20.11.3.1.7 This independent assessment of software and firmware quality (including the Contractor's response and Corrective Action Plan) is to be performed at any time of the Authority's choosing, as follows: one assessment after delivery of the pilot cars, but before their conditional acceptance; one assessment prior to completion of conditional acceptance of all base order cars; and one assessment at the conclusion of all software and field modifications that occur during the warranty period.

20.11.3.2 Independent Rail Car Penetration Test

To demonstrate compliance with specified functional and cybersecurity requirements relating to this Contract, the Contractor shall procure an independent third-party penetration test/vulnerability assessment.

20.11.3.2.1 This penetration test/vulnerability assessment shall be performed by a qualified, independent organization approved by the Authority.

20.11.3.2.2 The penetration test/vulnerability assessment shall cover all products included in or incidental to this procurement, as described in the other sections of the Technical Specifications.

20.11.3.2.3 The Contractor shall ensure that the results of any independent penetration test/vulnerability assessment are sent directly from the third-party provider to the Authority and the Contractor.

20.11.3.2.4 The Contractor shall provide the Authority with a response to the third-party assessment, including a Corrective Action Plan to correct identified vulnerabilities subject to the Authority's approval.

20.11.3.2.5 This independent penetration test/vulnerability assessment is to be performed at any time of the Authority's choosing as follows: one penetration test/vulnerability assessment after delivery of the pilot cars, but before their conditional acceptance; one penetration test/vulnerability assessment prior to completion of conditional acceptance of all base order cars; and one penetration test/vulnerability assessment at the conclusion of all software and field modifications that occur during the warranty period

20.12 CONTRACT DELIVERABLES REQUIREMENT LIST

CDRL	Title
C-20-01	As-Built Drawings
C-20-02	Photographs
C-20-03	Drawing Lists and Bills of Material
C-20-04	Maintenance Manuals
C-20-05	Parts Manuals
C-20-06	Operator Instruction Book
C-20-07	Car History Books
C-20-08	As-Built Specification
C-20-09	Field Service
C-20-10	Test Equipment
C-20-11	Training Program
C-20-12	Instructor Qualification Submittal

21 PROPOSAL DELIVERABLES REQUIREMENTS LIST

PDRL	Title
P-3-01	Car Height
P-3-02	Car Width
P-3-03	Seating Capacity
P-3-04	Passenger Flow
P-3-05	Car Weight
P-4-01	Exterior General Arrangement and Rendering
P-7-01	Door System
P-8-01	Carbody Interior
P-8-02	Accessibility (ADA) Provisions
P-9-01	HVAC System
P-10-01	Lighting Plan and Description
P-10-02	LLEPM
P-11-01	Electrical System and Load Study
P-11-02	Car Level Monitoring System
P-12-01	Functionality and the Onboard Equipment of Complete Communication System
P-12-02	Infotainment Proposal
P-13-01	Braking System
P-13-02	Braking Performance Calculation
P-14-01	Truck System
P-14-02	Ride Quality Simulation
P-17-01	Audible Noise Proposal

22 CONTRACT DELIVERABLES REQUIREMENTS LIST

CDRL	Title
C-1-01	Drawing Submittals
C-1-02	Car-Body Stress Analysis
C-1-03	Contractor's Quality Assurance Manual and Procedures
C-1-04	Contractor's Organizational Chart with Personnel Assigned to Metra's Contract
C-1-05	Contractor's Management's Declaration of their Commitment to Quality and the Implementation of the Contractually Required MQP and FTA QMS Guidelines
C-1-06	Contractor's Project Quality Plan and Procedures
C-1-07	Contractor's Ratio of Inspection to Production Personnel
C-1-08	Contractor's Software Quality Assurance Plan
C-1-09	Contractor's Supplier and Subcontractor Qualification, Quality Compliance, and Management Plan and Procedures
C-1-10	Contractor's List of all supplier and subcontractors, their qualifications, and quality certifications (ANSI-ASQ ISO)
C-1-11	Contractor's First Article Inspection (FAI) Plan and Procedures
C-1-12	Contractor's MRB Plan and Procedures
C-1-13	Corrective and Preventative Plan and Procedures
C-3-01	Clearance Diagram
C-4-01	Car-body Structural Diagram
C-4-02	Car-Body Strength Test Document
C-4-03	Emergency Roof Access
C-4-04	End Structure Design
C-4-05	Cross Bearer and Underframe Design
C-4-06	Jacking Pad Location
C-4-07	Insulation Samples.
C-4-08	Thermal Analysis
C-4-09	HVAC Duct and Piping Insulation Installation
C-4-10	Diaphragm Design and Installation
C-4-11	Ingress Emergency Window Layout
C-4-12	Egress Emergency Window Layout and Design
C-5-01	Exterior Safety Appliance and Handhold Design and Installation
C-5-02	Safety Gate Design
C-5-03	Interior Safety Appliance and Handhold Design and Installation
C-6-01	Coupler System Design
C-7-01	Side Loading Door Design and Configuration
C-7-02	Side Loading Timing and Announcement
C-7-03	External Door Release Design
C-7-04	Traction Interlock
C-7-05	No Motion/Zero Speed System
C-7-06	Passenger Compartment Door Panel Design (If Applicable)
C-7-07	Passenger Compartment Door Hold Open (If Applicable)
C-7-08	Electric/Crew Locker Door
C-7-09	Cab Door Panel Design
C-7-10	End Door Design and Configuration
C-7-11	Toilet Door Design and Configuration
C-8-01	Interior Material Samples
C-8-02	Wall Panels
C-8-03	Cab Locker Designs (Engineer and Fireman Side)

CDRL	Title
C-8-04	Floor Fire Test
C-8-05	Flooring System
C-8-06	Anti-Skid Design
C-8-07	Seat Ergonomic Assessment
C-8-08	Cushion Covering and Material
C-8-09	Seat Dynamic and Static Testing
C-8-10	Parcel Rack Design
C-8-11	Wheel Chair Lift System
C-8-12	Toilet Room/Equipment Arrangement
C-8-13	Retention Tank Level Indication
C-8-14	Toilet Shut-Off/ Drain Valve
C-8-15	Ticket Clip Installation and Design
C-8-16	Waste Receptacle
C-8-17	Automated External Defibrillator
C-8-18	Bicycle Racks
C-9-01	HVAC System – Design and Installation
C-9-02	Floor Surface Heating Solution (If Applicable)
C-9-03	Toilet Room Exhaust
C-9-04	HVAC Unit Lifting Provision
C-9-05	Temperature Control Arrangement
C-9-06	Retention Tank Heater
C-9-07	Water Freeze Dump Valve
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)
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
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

CDRL	Title
C-13-01	Brake System Description
C-13-02	Wheel Slide System Protection Design (If Applicable)
C-13-03	Tread Brake Unit Design and Installation
C-13-04	Reservoir Design and Installation
C-13-05	Handbrake Force Calculation
C-13-06	Disc Brake Design and Installation
C-14-01	Truck Design Review
C-14-02	Service History of Truck
C-14-03	Sensor Arrangement and Wiring (If Applicable)
C-14-04	Truck Ground Strap
C-15-01	Locomotive Control – Design and Arrangement of Cab Car
C-15-02	Cab Seating
C-15-03	Alerter Operation
C-15-04	Cab Signal System
C-15-05	PTC Installation
C-15-06	Cab Digital Video Recording System
C-15-07	Horn Heating System
C-15-08	Electric Bell
C-15-09	Windshield Wiper System
C-15-10	Pilot Design
C-16-01	Signage Plan
C-17-01	Noise Level Test Procedure
C-18-01	Material Certifications
C-18-02	Material Maintenance
C-18-03	Interior and Exterior Stainless Steel Samples
C-18-04	Stainless Steel Coil Test Reports
C-18-05	LAHT Tension and Bend Test Reports
C-18-06	Casting Qualification Report
C-18-07	Elastomer Certification
C-18-08	Visual Inspection Criteria for Glazing
C-18-09	Thermoplastic Sheet Color and Surface Finish Samples
C-18-10	Thermoplastic Test Certifications
C-18-11	Fiberglass Reinforced Plastic Test Certifications
C-18-12	Melamine Test Certifications
C-18-13	Leak Test for Air and Hydraulic Piping System
C-18-14	Piping, Tubing, and Pressure Vessel Specifications
C-18-15	Proposed Flushing and Cleaning Procedure for Pipe
C-18-16	Bearing Specification and Data
C-18-17	Paint Inspection and Acceptance Criteria
C-18-18	Adhesives Utilized
C-18-19	Insulation Application, Retention, and Data
C-18-20	Fire Safety Analysis
C-18-21	Threaded Fastener Data
C-18-22	Welding Documentation
C-18-23	Welding Inspection Plan
C-18-24	Brazing Documentation
C-18-25	Corrosion Control Plan
C-18-26	Wire and Cable Data and Specifications
C-18-27	Software Quality Assurance Plan
C-19-01	Master Test Plan

CDRL	Title
C-19-02	Test Procedures
C-19-03	Electromagnetic Compatibility Control Plan
C-20-01	As-Built Drawings
C-20-02	Photographs
C-20-03	Drawing Lists and Bills of Material
C-20-04	Maintenance Manuals
C-20-05	Parts Manuals
C-20-06	Operator Instruction Book
C-20-07	Car History Books
C-20-08	As-Built Specification
C-20-09	Field Service
C-20-10	Test Equipment
C-20-11	Training Program
C-20-12	Instructor Qualification Submittal

23 VIRGINIA RAILWAY EXPRESS (VRE) SPECIFICATION DEVIATIONS

VRESD	Title
V-1-01	Section 1.1.2 VRE Alternative Language
V-1-02	Section 1.1.3.2 VRE Alternative Language
V-1-03	Section 1.1.3.3 VRE Alternative Language
V-1-04	Section 1.1.11.3.2 VRE Alternative Language
V-3-01	Section 3.1.2 VRE Alternative Language
V-3-02	Section 3.1.3 VRE Alternative Language
V-3-03	Section 3.2.2 VRE Alternative Language
V-3-04	Section 3.2.2.7 VRE Alternative Language
v-3-05	Section 3.2.2.8 VRE Alternative Language
V-8-01	Section 8.3.1.5 VRE Alternative Language
V-8-02	Section 8.6.2.2 VRE Alternative Language
V-8-03	Section 8.6.2.4 VRE Alternative Language
V-8-04	Section 8.6.2.6 VRE Alternative Language
V-8-05	Section 8.6.2.13 VRE Alternative Language
V-8-06	Section 8.7.4 VRE Alternative Language
V-8-07	Section 8.7.6 VRE Alternative Language
V-8-08	Section 8.7.7 VRE Alternative Language
V-8-09	Section 8.7.8 VRE Alternative Language
V-9-01	Section 9.2.4 VRE Alternative Language
V-10-01	Section 10.4.7 VRE Alternative Language
V-11-01	Section 11.5 VRE Alternative Language
V-11-02	Section 11.6.4 VRE Alternative Language
V-12-01	Section 12.5 VRE Alternative Language
V-13-01	Section 13.2.2 VRE Alternative Language
V-13-02	Section 13.3.1 VRE Alternative Language
V-14-01	Section 14.12.3 VRE Alternative Language
V-15-01	Section 15.5.2 VRE Alternative Language
V-15-02	Section 15.7 VRE Alternative Language
V-15-03	Section 15.8 VRE Alternative Language
V-16-01	Section 16.1.2 VRE Alternative Language
V-16-02	Section 16.1.4 VRE Alternative Language
V-16-03	Section 16.1.14 VRE Alternative Language
V-16-04	Section 16.2.9 VRE Alternative Language