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1 GENERAL REQUIREMENTS

1.1 GENERAL REQUIREMENTS

1.1.1 This specification covers battery trainsets to be used in transporting passengers in the greater Chicago Metropolitan Area and its environs. The trainsets are designed to be operated in trains that can range in size from two cars minimum to four cars maximum in single traction. The design shall provide a safe, comfortable ride at all speeds up to Metra's maximum authorized operating speed (79 mph). The car shell and trucks shall be designed for speeds up to 100 miles per hour.

1.1.2 For the purposes of this specification, a trainset is defined as a collection of passenger cars which are permanently coupled to create a fixed consist to be used for a particular train application and a car is defined as that portion of the trainset which is located between coupling arrangements.

1.1.3 The trainset shall have cars in two configurations: Cab Cars and Intermediate Cars, single level seating configuration.

1.1.4 Trainset in its shortest form shall be two powered end cars. The trainset configuration as a two, three or four car consist shall be fixed and a reconfiguration is not needed.

1.1.5 The intention of a multiple unit trainset is in general to keep the consist length over the lifespan of the vehicle. But individual cars from a trainset may be separated and configurations of trainsets modified, but it is assumed that such operations will generally be performed as part of a major overhaul including major steps like for example Software Updates and Re-Commissioning of the trainset.

1.1.6 Individual cars from a trainset are not required to function as stand-alone cars when not assembled as trainset

1.1.7 Individual cars from a trainset are not required to be intermingled with Metra's existing cars. However, the trainsets shall be configured to allow interoperability with existing Metra fleet for emergency towing purposes.

1.1.8 The trainsets 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.

1.1.9 All documents, correspondence, meetings, and technical information shall be offered and conducted in the English Language. US customary system of weights and measures will be applied wherever possible in combination with metric if needed.

1.1.10 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 and EN standards (or conflict between regulations and standards) the following hierarchy shall apply: 1) FRA Regulations, 2) these Specifications, 3) APTA and EN Standards, and 4) AAR Standards. The Contractor and the Contracting Authority will jointly resolve any conflicts that exist.

1.1.11 As part of the design review the Contractor shall submit the drawings and documentation as required in sections 1.5 and elsewhere in this specification where terms "approved", "approved manner", "approved by the Contracting Authority", "subject to approval" and "The Contracting Authority approval" appear. The Contractor shall also provide additional non-proprietary 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:

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

1.1.11.2 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.

1.1.11.3 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.

1.1.11.4 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 drawing alterations (change requests) shall remain unincorporated on any drawing at any time, and no change request shall remain unincorporated into a drawing for a period greater than two months from the date of approval. 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.

1.1.12 The Contractor shall prepare and submit to each Contracting Authority for approval, prior to construction of the trainsets, copies (electronically in searchable original PDF format) 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 as long as the information is not proprietary: clearance drawing, arrangement 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.

1.1.13 The Contractor shall submit, prior to the car body testing, the current status of the stress analysis of the complete car body structure and supports for equipment weighing over two hundred (200) pounds in a comprehensive overview presentation. This analysis shall show the calculated stresses, allowable stresses and the margin of safety for the most critical 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 (Simulia Abaqus, Altair Hyperworks etc.). **[CDRL C-1-02]**

1.1.14 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:

1.1.14.1 Introduce Metra's key personnel to the Contractor
1.1.14.2 Confirm the Contractor's management team and key staff and the scope of supply of subcontractors, if already defined by the Subcontractor at this point.
1.1.14.3 Establish formal channels of, and procedures for, communication (e.g. letter and meeting numbering)
1.1.14.4 Establish an understanding of the Contractor's project control methodology and plans for initial activities before the start of formal progress reporting
1.1.14.5 Discussion to familiarize the Contractor with Metra's intended operations and maintenance environment
1.1.14.6 Identify the early information needs and decisions required by the Contractor from the Contracting Authority

1.1.15 The Contractor shall hold formal design review meetings with the Contracting Authority. The purpose of these meetings is to ensure 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, presentations, and other items required for the review. Four types of design reviews shall be held:

1.1.15.1 Preliminary design review (PDR): Preliminary design review of system components shall be made at the approximately 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 or pictures based on 3D CAD models of each component showing dimensions and structural elements in draft version. The Contracting Authority retains the right to redline, comment, and request changes to improve design and/or functionality.
1.1.15.2 Intermediate design review (IDR): An intermediate design review (IDR) shall be held when the design of the trainset is approximately 60% complete. This shall represent an advancement of design of the trainset 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 trainset to a level of detail sufficient that the Contractor shall be able to proceed with the development of the trainset design to the 95% draft final stage.
1.1.15.3 Mockup development and review: Upon completion of the IDR 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 trainsets. References, or already built projects can be used to present the systems instead of full size mockups. Additionally virtual reality can be used to support the design process; according the drawings as reviewed and approved at the IDR, for the Contracting Authority review and comment:

1.1.15.3.1 Passenger seats
The purpose of the mock-up is to approve colors, fabrics and confirm the seating comfort. Therefore, as part of the base order the Contractor shall present the passenger seats, with the METRA specific colors and fabrics on a simplified seat support structure.

1.1.15.3.2 Sidewall panels, passenger windows, and window gaskets
The purpose of the mock-up is to approve colors, surface structure and window-tinting. Therefore, as part of the base order the Contractor shall present a mood board with material samples for the wall panels, window glass and window gasket. If similar or identical components have been used in previous projects, the Contractor may present the systems or the components on an actual project.

1.1.15.3.3 ADA System (see also **Error! Reference source not found.**)
The purpose of the mock-up is to approve for conductors to see operating controls, functionality and the preventive maintenance accessibilities.

1.1.15.3.4 Toilet System (see also **Error! Reference source not found.**)
The purpose of the mock-up is to release the general design in terms of colors and surface structures including functionalities and preventive maintenance accessibilities. Therefore as part of the base order the Contractor shall present a mood board with material samples for the different visible surfaces. As reference, already built project with a similar or identical toilet design could be feasible for mock-up purposes to present the functionalities and preventive maintenance accessibilities.

1.1.15.3.5 Electrical Cabinet
The purpose of the mock-up is to mainly show the general design of the electrical cabinets, cable routing and preventive maintenance and troubleshooting accessibilities. A reference, already built project with similar or identical electrical cabinet designs could be feasible for mock-up purposes.

1.1.15.3.6 Door System (see also **Error! Reference source not found.**)
The purpose of the mock-up is to mainly show the general design and functionalities of the door system. A reference, already built project with a similar or identical door design could be feasible for mock-up purposes to present the functionalities and preventive maintenance accessibilities as well.

1.1.15.3.7 Driver Desk
The purpose of the mock-up is to mainly show the general design and functionalities of the driver desk. A reference, already built project with a similar or identical driver desk design could be feasible for mock-up purposes. The METRA specific adaptions of the driver desk can be covered with 3D-visualizations.

1.1.15.3.8 (deleted)

1.1.15.3.9 Propulsion system including battery system:
The purpose of the mock-up is to mainly show the general design and functionalities of the propulsion chain and to present the functionalities and preventive maintenance accessibilities. A reference, already built project with a similar or identical propulsion system design could be feasible for mock-up purposes. The zero emission propulsion chain consists of several new developments, therefore the overall mock-up concept could be a combination of already built projects, 3D visualization in CAD programs or components in the first article stage:
- Reference project: motor, converter, cable routing
- 3D visualization, first article stage: battery packs, connection box

1.1.15.4 Final design review (FDR): Final design review (FDR) of system components shall be held at approximately 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 of the pilot vehicle, if the design shows major issues in terms of manufacturability or maintainability.

1.1.16 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 or online via Teams as deemed necessary.

1.1.17 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 by providing the technical documentation of the product, 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

1.2.1 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 electronic formats, which shall conform to the requirements of this section.

1.2.2 Disposition for Problems, Questions, and Discrepancy

1.2.2.1 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.

1.2.3 Submittal Intervals

1.2.3.1 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.

1.2.4 Reviews and Approvals

1.2.4.1 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.

1.2.5 Electronic Delivery Media

1.2.5.1 Electronic delivery media shall be coordinated with the Contracting Authority's Project Manager to ensure compatibility with 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

1.2.6 Media Labeling

1.2.6.1 All media shall have a label containing under consideration of the maximum possible labeling length, but not limited to:

1.2.6.1.1 Preparation date of the media.

1.2.6.1.2 The project description.

1.2.6.1.3 Contractor name and contract reference.

1.2.6.1.4 Contract transmittal number.

1.2.6.1.5 (deleted)

1.2.6.1.6 (deleted)

1.2.6.1.7 (deleted)

1.2.7 Electronic File Preparation.

1.2.7.1 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:

1.2.7.1.1 Drawing files shall be in their native format, not DXF, or other neutral format. File format must be approved by the Contracting Authority.

1.2.7.1.2 (deleted)

1.2.7.1.3 (deleted)

1.2.7.1.4 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.

1.2.7.1.5 All deliverables shall be certified virus-free.

1.2.8 Documentation.

1.2.8.1 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:

1.2.8.1.1 A digital list of files included in the deliverable.

1.2.8.1.2 (deleted)

1.2.8.1.3 Person designated as point of contact.

1.2.8.1.4 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.

1.2.9 Quality

1.2.9.1 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.

1.2.10 Ownership

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

1.2.10.1.1 (deleted)

1.2.10.1.2 Metra shall have authorization to take pictures/videos of Metra's materials with Metra's electronic devices at the Contractor's facilities. In addition, Metra requests authorization to take pictures of Metra's materials at the subcontractor's facilities at FAI. Metra will ask the product / area of pictures before taking pictures/videos. Metra shall have the right to use such media at anytime and anywhere in accordance to the confidentiality rights of this contract..

1.3 QUALITY ASSURANCE

1.3.1 The Contractor shall have a quality assurance program conforming to the FTA Quality Management System Guidelines, FTA-PA-27-5194-12.1 latest issue 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 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 project specific 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 Submission of a proposal 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.

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

The audit will be styled after ISO 9001 and/or FTA Quality Management System Guidelines, FTA-PA-27-5194-12.1,

1.3.5 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 proposal.

1.3.6 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.

1.3.7 The Contractor shall submit the following with CDRLs after 60 days of NTP 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:

1.3.7.1 Contractor's Quality Assurance Program Plan and Procedures **[CDRL C-1-03]**
1.3.7.2 Contractor's organizational chart with personnel assigned to Metra's contract **[CDRL C-1-04]**
1.3.7.3 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]**
1.3.7.4 Contractor's Project Quality Plan and Procedures **[CDRL C-1-06]**
1.3.7.5 Contractor's ratio of Inspection to Production Personnel **[CDRL C-1-07]**
1.3.7.6 Contractor's Software Quality Assurance Plan **[CDRL C-1-08]**
1.3.7.7 Contractor's System Supplier Qualification, Quality Compliance, and Management Plan and Procedures according to ISO 9001-2015 **[CDRL C-1-09]**
1.3.7.8 Contractor's List of all System suppliers , their qualifications, and quality certifications according to ISO 9001-2015 **[CDRL C-1-10]**
1.3.7.9 Contractor's First Article Inspection (FAI) Plan and Procedures **[CDRL C-1-11]**
1.3.7.10 Contractor's MRB Plan and Procedures **[CDRL C-1-12]**
1.3.7.11 Corrective and Preventative Plan and Procedures **[CDRL C-1-13]**

1.3.8 The proposer 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.

1.3.9 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 trainset designs that minimize the type and impact of component failures, eliminate single point failures and identify critical components that affect system operation during the trainset 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 according to EN 50121
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 prior to Contract award. For new technologies (e.g. propulsion including battery system), which are not entirely service proven yet, the system reliability has to be checked by a theoretical analysis..

1.4.1.3 Reliability Requirements

The following specifies the revenue fleet reliability requirements:

	MDBF (miles)	MDBSI (miles)
After one month in service:	2,000	16,000
After 12 months in service:	4,000	32,000
At end of reliability demonstration period:	8,000	48,000

For the overall calculation only Chargeable failures will be considered.

Failure Classification:
MDBF - Mean Distance Between Failure (causing non service interruption).
MDBSI - Mean Distance Between Service Interruption (causing service interruption).

Non Service Interrupting Failures are defined as:
Failures that do not affect vehicle operation, or can be temporarily bypassed, reset or corrected by the train operator (following standard operational procedures) within 6 minutes, to allow continued service.

Service interrupting failures are defined as:

- An unscheduled maintenance action requiring the vehicle to be taken out of service.
- An unscheduled delay of six minutes or greater as a result of component failure.

The above failures exclude any failures due to third party influence or external factors.

Chargeable failure:
When assessing whether a chargeable failure has occurred, delays that are not a consequence of a defect in the vehicle (for example, delays caused by vehicle ahead or caused by vehicle operator/driver, or train master) should not be considered as a Chargeable Failure. The Authority and the operators are obliged to present information about the length of the delay related to a technical failure.

A chargeable failure of an item is a failure that results in a loss of function of that item, which requires maintenance, repair or replacement of a vehicle component, including:

a) A fault of an item while operating within its design and environmental specification limits.
b) Item degradation discovered during the recommended preventative maintenance interval or unscheduled maintenance repair activities.
c) Consumable items requiring replacement for abnormal service life depreciation, or which are not achieving its design life.
d) Loss of function resulting from the required resetting of circuit breakers, or similar re-initialization of systems, including the restarting of system software.
e) Failures caused by software.
f) A failure caused by human actions as a result of inadequate or improper Contractor documentation, training, or system indication.
g) Repeat failures, with the same root cause, on vehicles not removed from service or

returned to service without maintenance action shall be considered a single chargeable failure.

Non-chargeable failure:
A failure or condition of an item due to the following:

a) A failure caused by human error, except where due to inadequate or improper Contractor documentation or training.
b) A failure caused by Authority personnel not complying with the Contractors documentation, which has been approved and accepted by the Authority.
c) A failure caused by accidents not associated with the normal operation of the item, such as collision or strike.
d) A failure caused by operating the item outside of design or environmental specification limits.
e) Failure of consumable items requiring replacement during specified preventative maintenance, or which should have been replaced during previously scheduled preventative maintenance intervals and were not.

The following list contains examples of components that are excluded from Chargeable Failure.
The reason for excluding these components is that the replacement of these is a needs-based issue and that it is better to replace them, from a financial aspect, when they are defective or worn beyond a certain limit than to set a fixed preventive maintenance interval. This means the replacement/maintenance of these components is to be treated as remedial maintenance measures but not categorized as Faults. Before starting the validation, the Authority and the Contractor are to agree on a final version of this list:

- Windscreen wiper blades
- Interior lamps
- Lamps headlight
- Wheels
- Brake discs
- Brake pads
- All wear parts

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 Failures (MDBF) and Mean Time Between Failures (MTBF).

1.4.1.4 (deleted)

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 he 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 Fault Tree Analysis (FTA) Fault Tree Analysis (FTA) shall be kept current with design iterations.

1.4.1.5.6 A Failure Reporting and Corrective Action System (FRACAS), 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 the following systems, demonstrating that the specified reliability requirements at the end of the Reliability Demonstration Period listed in section 1.4.1.3 will be met or exceeded:
- Trucks and Suspension
- Propulsion System
- Control Systems
- Auxiliary operating equipment
- Monitoring and Diagnostic Equipment
- Lighting System
- HVAC System
- Passenger Door System
- Communication and Information System
- Air Supply System
- Friction Brake System
- Coupler & Draft Gear
- Toilet System

The theoretical calculation of the MDBSI value shall use the following formula for prediction purposes:

$$MDBSI_{(c_1;c_n)} = \left(\sum_{k-1}^{n} \frac{1}{MDBSI_{(c_k)}}\right)^{-1}$$

1.4.1.7 The analysis shall be performed in accordance with EN 50126 to the Line Replaceable Unit (LRU) level. Fault Tree Analysis, FMECA and RAM/LCC calculations shall be considered where applicable. Wherever possible, the reliability prediction shall be supplemented by actual field data for the system or subsystem.

1.4.1.8 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 trainset reliability.

1.4.1.9 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 train level The FMECA will be detailed to the LRU level for each subsystem and identify the failure effects at the LRU level, subsystem level and the train level.

1.4.1.10 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 for a period of two (2) years. The system reliability values shall be calculated for each failure type as the sum total of all mileage traveled by all vehicles during a given time period, divided by the total number of each type of failure that occurred during the twelve (12) month moving window period.. The demonstration results shall be documented in a Reliability Demonstration Report. **[CDRL C-1-17]** All system failures during vehicle burn-in shall be reported and recorded, but not counted in establishing Reliability values. Determination of pass or fail will be assessed only at the end of the reliability demonstration.
During the demonstration, the trains shall be maintained by qualified maintenance personnel according to the maintenance plan and maintenance manuals provided by the Contractor.
The Reliability data is calculated as the ratio of the total operating distance (d), accumulated by all vehicles during the Reliability Demonstration Test, to the total number of chargeable failures (F) occurring on all vehicles during the distance (d). The calculation shall be:
MDBF = d (miles) / F (number of failures causing non service interruption)
MDBSI = d (miles) / F (number of failures causing service interruption)
For the overall calculation only Chargeable failures considered.

1.4.1.11 A Failure Review Board (FRB) shall be established. The FRB shall consist of representatives from Metra and 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 meet the testability, reparability and ease of maintenance of equipment and components that affect system operation during the car useful life according to the requirements in this specification. These maintainability features include:

1.4.2.1.1 The use of modular design
1.4.2.1.2 (deleted)
1.4.2.1.3 Accessibility of components and fasteners that are relevant for preventive maintenance tasks
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 General trouble shooting on the train shall be possible with a commissioning laptop.
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, if it is necessary to open the covers or panels for regular preventive maintenance tasks and the quick-removal system can fulfill the structural requirements and improves the maintenance task time by more than 30%.

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) target are 5 hours. The required 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 30 days.

1.4.2.5 The Contractor shall submit to the Program Manager for review and approval a Maintainability Analysis report **[CDRL C-1-18]** 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. 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 to verify that the scheduled and preventive task durations fall within the times established by the Maintainability Analysis. A sample pool of maximum ten demonstration preventive maintenance 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 single point failures that affect system safety during the car useful life.

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 trainsets

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. Programmable safety controls shall be handled according to EN 50128 50129 (Hardware) and EN 50657 (Software). The railroad will provide the following items to the Contractor:
- Their own Part 270 approved SSP within ten (10) days after NTP for harmonization of the V-SSPP and associated safety documentation
- Lead on the Safety Committee and sufficient committee meetings to address all PHA topics in a timely manner prior all safety mile stones including PDR

1.4.3.4 The contractor must tabulate all known hazards from the Preliminary Hazard Analysis (PHA) on vehicle level into a Hazard Tracking Log **[CDRL C-1-22**], which shall be submitted to the Program Manager for review and approval. With PHA completion, the Hazard Log shall set up based on the PHA results and during design progress shall be refined via SSHA and SHA which per MIL STD are the applicable tools to analyze individual subsystems (SSHA) and their interaction in the integrated system (SHA). 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 according the categories in Metra's SSP 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
TOD	Train Operator Display
TFT	Thin-Film-Transistor
UP RR	Refers to the Union Pacific Railroad
US	United States of America

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 The total length of the vehicle measured over the coupler shall not exceed the following lengths:
- Two (2) car unit + PowerPack: 170'
- Three (3) car unit + PowerPack: 222'
- Four (4) car unit + PowerPack: 275'

3.1.2 Width of Car: The vehicles' width and attached equipment shall be built within the outline of the Equipment Diagram, Plate C as defined by Association of American Railroads (AAR).

3.1.3 Height of Car: The vehicles height and attached equipment shall be built within the outline of the Equipment Diagram, Plate C as defined by Association of American Railroads (AAR).

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]**

3.1.6.1 (deleted)

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

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

3.1.6.4 (deleted)

3.1.7 General Arrangement: Interior layout design of seating, aisle(s), and door(s) for the trainset 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 for trainset are listed below: **[PDRL P-3-04]**

3.1.7.1 60 passengers entraining/ 0 detraining
3.1.7.2 60 passengers detraining/ 0 entraining
3.1.7.3 (deleted)
3.1.7.4 40 passengers entraining/ 20 passengers detraining
3.1.7.5 (deleted)

3.1.8 (deleted)

3.1.9 Weight: Car total weight shall be minimized. Car weights shall be submitted at AW0, AW1, AW2 and AW3. The maximum axle load shall not exceed 22 tons (48,500 lbs) under AW3 loading conditions. All cars shall be weighed at Contractor's facility. Car estimated weight for

each car type shall be submitted during project execution at AW0, AW1, AW2, and AW3. **[CDRL C-3-02]**

3.1.9.1 The total weight difference between left and right vehicle side shall be less than 1,5% of total weight. The weight difference between on side of a truck to the other side of the same truck shall be less than 4%

3.1.9.2 All cars shall be within 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: 165 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 300' radius curve

3.2.1.2 (deleted)

3.2.1.3 (deleted)

3.2.2 The cars, and all appliances, shall conform to the clearance outlined in Equipment Diagram, Plate C as defined by Association of American Railroads (AAR).

3.2.2.1 (deleted)
3.2.2.2 (deleted)
3.2.2.3 (deleted)
3.2.2.4 (deleted)
3.2.2.5 (deleted)
3.2.2.6 (deleted)

The clearance diagram for the car shall be submitted to the Contracting Authority for review and approval. **[CDRL C-3-01]**

3.2.3 The clearance to top of rail shall be according to CFR49 229.71. No part, or appliance except the wheels, flexible nonmetallic sand pipe extension tips, and trip cock arms may be less than two and a half (2 1⁄2) inches above the top of rail.:

3.2.3.1 (deleted)

3.3 (deleted)

3.3.1 (deleted)

3.4 PROPOSAL DELIVERABLES REQUIREMENT LIST

PDRL	Title
P-3-01	Car Width
P-3-02	Car Height
P-3-03	Seating Capacity
P-3-04	Passenger Flow
P-3-05	(deleted)

3.5 CONTRACT DELIVERABLES REQUIREMENT LIST

CDRL	Title
C-3-01	Clearance Diagram
C-3-02	Car Weight

4 CAR BODY EXTERIOR

4.1 STRUCTURAL FRAMING

4.1.1 The car exterior shall be constructed of an 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 Customer's ZEMU vehicles will be used in unit consists of two cab cars coupled to middle cars inserted between the two cab cars in sufficient quantities to meet the Customer's passenger capacity requirements. The carbodies are an integral aluminum design optimized for light weight, stiffness and structural integrity. Carbody aluminum alloys are in accordance with EN 13981, EN 755-1 and -2+9, EN 1706, EN 586-1.

4.1.3 Features important to passenger safety and comfort and to operational requirements on the Customer's system must govern the carbody design. The Contractor shall submit a test procedure **[CDRL C-4-02]** and a stress analysis of the carbody structure prior to commencing manufacture of any carbody structural parts in accordance with APTA Standard SS-C&S-034-99, Rev. 2, Sections 7.1 to 7.3 or in accordance with 49 CFR Appendix G to Part 238 - Alternative Requirements for Evaluating the Crashworthiness and Occupant Protection Performance of Tier I Passenger Trainsets requirements. The stress analysis shall be used to design the car structure to obtain the lightest weight vehicle possible within the criteria set by these specifications.

4.1.4 Emergency roof access areas will be designed as per 49 CFR 238.123. In the vicinity of roof-mounted equipment and where maintenance personnel might stand, the roof shall support a concentrated load of 500 lbf (2,224 N) over an area of 0.75 ft2 (0.07 m2) without permanent deformation. Safety factors, such as overall carbody strength in conformance with the most recent CFR regulations, APTA standards, fatigue resistance, emergency egress openings, required by 49 CFR Part 238 Appendix B shall be considered. Design and layout of the emergency roof access shall be provided to Metra for review and approval. **[CDRL C-4-03]**

4.1.5 The car bodies shall be made out of aluminum extrusion profiles welded to an integral design..

4.1.6 The vehicle structure shall be designed to sustain collisions with other vehicles, including highway vehicles ranging from large automobiles to commercial tractor-trailer trucks without unnecessary risk of injury to passengers or Operators. The end structure shall be designed in accordance with 49 CFR 238. Operator and passenger protection shall also be designed into the carbody structure. The vehicle ends shall be designed to prevent overriding and telescoping of the vehicle into any passenger area in the event of a collision. The Contractor shall implement Crash Energy Management (CEM) designs in accordance with Appendix G of 49 CFR Part 238.

4.1.7 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 carbody structure 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 trainset shall have anti-climbing mechanism complying with FRA regulation 49 CFR Part 238. Appendix G and Section 5.5 of APTA Standard SSC& S-034-99, latest Revision. At a minimum, each end of each vehicle shall be fitted with an anti-climber having a minimum of three ribs. The height of the anti-climber shall be sufficient to ensure engagement with differences in floor height due to secondary suspension travel, track geometry, and wheel wear.

4.1.9 The vehicle shall be capable of being hoisted or jacked at designated carbody locations (including the weight of trucks) without permanent deformation, buckling, or loss of water tightness in carbody seams and joints, to facilitate routine maintenance operations, emergency lifting, or re-railing. Maximum stress level shall be fifty percent (50%) of the yield strength of the base material. Alternatively, EN 12663-1 may be applied. The location of the jacking pads will be submitted to Metra for approval. **[CDRL C-4-06]** Where practical, lifting points shall be masked or styled to match the vehicle aesthetics, but must be readily accessible with simple hand tools.

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 20.0 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. Corrosion exposed areas on 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 in accordance with manufacturers recommendations. 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 GANGWAY/BELLOW

4.3.1 A weather-tight, flexible diaphragm or bellow shall seal the passageway between two adjacent cars. The diaphragm or bellow shall be watertight as to prevent any water from entering the carbody using the existing Customer's car wash station, and shall comply with the fire safety requirements of Section 21.16, Flammability, Smoke Emission, and Toxicity.

4.3.2 The diaphragm or bellow shall be able to accommodate all curving and environmental conditions without interference, degrading, cracking, tearing, or separation from the vehicle. The diaphragm or bellow shall maintain a tight seal to the opposing car end diaphragm under all conditions of curvature, turnouts, and crossovers encountered in normal passenger operation. The diaphragm or bellow shall not lose its sealing ability under temperature conditions to be defined by Metra.

4.3.3 All necessary provisions shall be made to eliminate noise from the equipment. If needed, a full height vertical curtain of suitable vinyl plastic coated/impregnated material, equipped with safety release handles, or sliding doors shall be provided in between the coupled cars of a trainset. Engagement of curtains, or sliding doors 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. Pinch points, formation of large gaps during operation, sharp edges, openings, or trip hazards that could cause bodily harm to passengers are prohibited. Walkway plates, hinged to the carbody, shall be provided at each non-cab end of each car to provide a continuous walkway from car to car.

4.3.5 The entire diaphragm or bellow and walkway 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. The arrangement shall utilize abrasion resistant material, gray tinted, complying with Section 21.8.1 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 19.1.11) 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) pounds plus/minus three (3) pounds of force,but shall not be dislodged except through emergency procedure. 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). Instruct ion 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 PR-PS-S-002-98, latest revision, 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, laminated safety glass, 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 shall be replaceable from the outside of the vehicle.

4.4.7 On cab control cars, a horizontal pivot sash assembly shall be provided on each side of the control station. The sash assembly shall suit the minimum structural opening. Left and right hand versions shall be provided. 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 21.16 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	(deleted)
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/Gangway 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.
A waiver of the applicable CFR requirements may be applied, based on the alternative design of the trainset to negate this requirement.

5.1.3 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; A waiver of the applicable CFR requirements may be applied, based on the alternative design of the trainset to negate this requirement.
5.1.3.3 Two (2) horizontal handholds on each cab end at approximately 44" above top of rail on each side of coupler; A waiver of the applicable CFR requirements may be applied, based on the alternative design of the trainset to negate this requirement.
5.1.3.4 (delete)

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 PR-CS-S-006-98 latest revision

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.

5.2 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