NATIONAL TRANSPORTATION SAFETY BOARD
Office of Railroad, Pipeline, and Hazardous Materials Investigations
Washington, D.C. 20594

Survival Factors

Group Chairman's Factual Report of the Investigation[1]

– Railroad Equipment Crashworthiness[2] –

Report Date: October 04, 2022

A. Accident Information

NTSB Number:	HWY22MH009
Location (Jurisdiction):	Clarendon Hills, IL (DuPage County)
Date / Approx. Time of Accident:	May 11, 2022 / 08:16 (a.m.) CDT[3]
Brief Synopsis:	commuter train collision with highway vehicle (box truck) at a highway grade crossing
Train Equipment Owner / Operator:	Metra / Metra
Railroad (Property Owner):	BNSF
Accident Site (Location):	BNSF Chicago Subdivision - Main Line, Track #3, at (approximately) MP 18.32, which occurred at the Prospect Street grade crossing

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Note – most photographs and video images obtained by the Survival Factors investigation are not included in this report, due to the volume of materials, the diverse formats of the digital media, as well as confidentiality considerations.

[1] Generally described, NTSB investigations are conducted pursuant to the criteria cited under 49 CFR Part 831.

[2] This Survival Factors / Crashworthiness investigation report exclusively addresses the elements and factors of the railroad equipment crashworthiness (locomotive and passenger coach cars), including a brief injury summarization.

[3] Central Daylight Time

B. Synopsis of the Accident

See Synopsis narrative, as compiled by the Investigator-in-Charge, which is available in the NTSB public docket.

Table of Contents

Select abbreviations and acronym nomenclature used in this report

~	approximate, or approximately
BNSF	Burlington Northern Santa Fe Railway
CAD	Computer Aided Dispatch
CFR	Code of Federal Regulations (see https://www.ecfr.gov/)
ref	reference, or in reference to
FRA	Federal Railroad Administration (see https://railroads.dot.gov)

IL	Illinois
ROW	right-of-way [in the context of railroad trackage]
SF	Survival Factors [NTSB investigation Group]
US DOT	U.S. Department of Transportation
USGS	United States Geological Survey (see [Internet] https://www.usgs.gov/)
Volpe Center	Volpe National Transportation Systems Center (https://www.volpe.dot.gov)

C. **Technical Working Group Participants**[4]

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D. **Details of the Investigation**[5]

1.0 Relevant Background Factors / Information

1.1 Accident Scenario / Brief Summarized Characterization of the Event[6]

The accident involved the collision of an eastbound commuter train with a northbound 'box truck' [highway vehicle], which had stopped on a highway / railroad grade crossing, in the path

[4] Participants of the Technical Working Group typically include [1] the Group Chairperson (NTSB investigative staff), [2] participants as designated by the Party to the Investigation [organizations / entities], pursuant to the criteria of 49 CFR 831.11, and [3] potentially other individuals as designated by other organizations / entities that the Technical Working Group Chairperson deems necessary and appropriate to participate in the Group investigation.

[5] Data and documentation of the investigation, as accrued from, or as made available to the investigation by the individual participants of the Crashworthiness - Technical Working Group, and/or data / documentation as made available to the investigation by other contributors (as individually noted), is described in this report section.

[6] Narrative was compiled based upon information identified during the on-scene phase of the investigation, as supplied by witness(es) and/or supporting evidence at the accident scene, as identified by NTSB investigative staff.

of the oncoming train. The three occupants of the box truck departed the cab of the box truck shortly before the collision. The impact of the box truck cab [driver's door] with the front of the train resulted in the immediate clockwise rotation (as viewed from above) of the box truck. The rotation of the box truck resulted in the aft-end, left-side structure of the 'cargo box' to come into contact with the right side, sidewall structure of the lead passenger railcar of the train (a Cab Car), in an area immediately aft of the mid-car vestibule (right side entrance door) of that railcar. The box truck then separated contact with the Cab Car, to which momentum resulted in the movement of the box truck in an easterly direction, away from the train / grade crossing intersection. The box truck wreckage came to rest adjacent to the grade crossing intersection, in which a fire ignited and engulfed the box truck.

Upon the box truck separating contact with the Cab Car, momentum resulted in the continued movement of the train along the track, in which the train did not derail as a result of the collision. The train operator had applied the emergency brakes, in which the [lead end of the Cab Car of the] train came to rest about 963 feet to the east of the grade crossing.[7] There was no fire damage to the train.

The commuter train, which was in a 'push-pull' operation / configuration[8], was comprised of five passenger coach railcars, in which a 'Cab Car' (as occupied by the train operator / engineer, and passengers) was located at the lead-end of the train, with a locomotive (unoccupied) located at the aft-end of the train. The impact of the box truck resulted in an open breach of that Cab Car sidewall structure, aft of the vestibule door, which measured about 2 feet in width (top, to bottom), by about 9 feet in length (right side, to left side), which occurred immediately below the lower-level window line. The front bulkhead structure of the Cab Car sustained collision impact damage, but remained intact, in which none of the other passenger cars or the locomotive sustained damage.

A passenger of the Cab Car, who was seated immediately adjacent to the area of that Cab Car sidewall structure that was struck by the box truck, sustained fatal injury in the accident. That passenger [fatality] was subsequently ejected through a window [opening] located at the opposite side of the car to where that passenger was seated, in which that passenger came to rest on the ground [track ballast] on the left side of the train. Also, two passengers and two train crewmembers aboard the train reported injuries, which were subsequently determined to be minor in nature.

[7] Due to momentum, as a moving train cannot immediately stop upon an emergency braking application, the stopping distance was identified to be consistent with the stopping distance of a train of that weight and type of operation, and consistent with the observed prevailing weather condition (i.e., 'dry' track).

[8] A 'push-pull' operation is a train in which a 'cab car', containing a train operator's compartment, is located at the lead-end of the train, in which the motive power, consisting of a locomotive (which is usually unoccupied, when the train operator is operating the train from the cab car), is located at the aft-end of the train. See further "Report to the House and Senate Appropriations Committees: The Safety of Push-Pull and Multiple-Unit Locomotive Passenger Rail Operations, available at [Internet] https:// railroads.dot.gov/elibrary/report-house-and-senate-appropriations-committees-safety-push-pull-and-multiple-unit.

1.2 Topic-Points Reviewed by the Crashworthiness - Technical Working Group[9]

1.2.1 Metra – Passenger Railcar / Carbody Crashworthiness[10]

- Carbody Sidewall - Structural Integrity / Intrusion Resistance
- Sidewall Window Assembly[11] - Securement Integrity (Retention)
- Cab Car - Front Bulkhead – Structural Integrity
- Cab Car - Carbody Crashworthiness – Relative to Overhaul Activity[12]

1.2.2 Regulation

- Passenger Equipment Safety Standards (49 CFR Part 238) – Relative to Passenger Railcar / Carbody Crashworthiness, and associated / contributory regulations (as further described).

1.3 Locality of the Accident / Civil Jurisdiction, and Property Identification[13]

The accident occurred on the Burlington Northern Santa Fe Railway (BNSF) Main Line, Track #3, at (approximately) railroad milepost[14] (MP) 18.32, which occurred at the Prospect Street grade crossing, and was proximate to the Clarendon Hills [commuter train] passenger station. The accident site is within the emergency services / public safety and security jurisdictions of the municipal services agencies of the Village of Clarendon Hills, IL. The Village of Clarendon Hills is a civil municipality of DuPage County. The accident site is within the fire protection district of the Village of Clarendon Hills Fire Department (CHFD), and is within the law enforcement jurisdiction of the Village of Clarendon Hills Police Department (CHPD). The railroad track, as configured within the railroad right-of way (ROW) in this area, is property of, and is operated by the BNSF[15] (see further § 1.4.1 in this report).

1.4 Site Characterization – Pre-Accident

1.4.1 Overall Physical Configuration of the Accident Site[16]

[9] Topic-points as identified by NTSB investigative staff (SF / Crashworthiness Group Chairperson), as sourced to the evidence / facts obtained and identified during, and subsequent to, the on-scene phase of the investigation.

[10] i.e., features / structural elements of the subject [cab car] railcar, as visually examined, and/or as documented by the investigation.

[11] i.e., refers to a 'non-emergency use' passenger railcar service window.

[12] i.e., 49 CFR Part 238 Passenger Equipment Safety Standards, and other corresponding regulation, compliance requirements for the cab car, as a result of overhaul activity performed [completed] on the railcar in January 2014.

[13] ref, and for further information, see [Internet] https://www.clarendonhills.us, and as further described.

[14] A Milepost refers to point along the railroad line that identifies a dimensional distance, in miles, relative to the designated origin reference point.

[15] ref, and for further information, see [Internet] https://www.bnsf.com.

[16] Description based upon post-recovery examination of the accident site by the Crashworthiness Group (in which the overall characteristics of the site likely had not changed since prior to the accident), and imagery [recorded prior to the event] as shown in [Internet] https://www.google.com/maps/.

Generally described, the accident occurred on railroad trackage in which the property was owned / operated by BNSF, in which the collision occurred on Main Track number 3, which is the southern-most track of the triple-track BNSF mainline that is located in this area. The BNSF Main Track in this area is configured generally in an east/west orientation, in which the Main Track number 3, which closely parallels the adjacently located Main Track number 2 and Track 1, is tangent (straight) and has an approximately level grade. In the area proximate to the collision site, the distance between the centerline of BNSF Main Track 3 and the centerline of Track 2 measured about 14 feet. The Prospect Street[17] grade crossing [collision site] was located to the immediate west of the Clarendon Hills [commuter train] passenger station[18], in which a station platform[19] was observed to be located along the immediate southern edge of the Main Track number 3, proximate to the commuter train station location.[20]

See Railroad Operations and Human Performance Group - Factual Report, and Signals and Highway Factors - Group Factual Report, for additional information detail on the physical configuration of the accident site.

1.4.2 Map of Accident Site

A copy of an annotated segment of a USGS topographic (survey) map[21], describing the general area proximate to the accident site, is provided in Exhibit 1.

1.5 Highway Vehicle (Box Truck) – General Description[22]

The highway vehicle [struck by the train] was identified as a 2004 International, Model 4400, two-axle, commercial box truck, having a Gross Vehicular Weight Rating (GVWR) of 33,000 lbs., which consisted of a conventional chassis cab [vehicle platform], upon which an enclosed cargo box was installed.

See Vehicle Factors Group - Factual Report for additional information detail on the vehicle.

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[17] Review of local official maps (i.e., Village of Clarendon Hills property tax maps) identified that the roadway to the north of the grade crossing was labeled as North Prospect Street, and that the roadway to the south of the grade crossing was labeled as South Prospect Street, in which the investigation also observed that the roadway (in the area proximate to the grade crossing) was often locally referred to as Prospect Street.

[18] Review of accident site map data, identified that the distance from the approximate point of collision (at the grade crossing), to the western edge of the passenger station structure (i.e., the platform canopy), measured about 160 feet.

[19] Such a platform [surface] is typically provided at a passenger station, to afford train passengers a solid surface upon which to walk, when boarding and disembarking a train that is servicing that station.

[20] The station platform was situated between the edge of Track 3 and the passenger station structure, in which the platform extended (in an east / west direction) a distance of about 1,125 feet, between an area to the immediate east of the grade crossing, and to the eastern end of the station platform.

[21] Excerpt from United States Geological Survey (USGS) topographic survey map, [map ref] Hinsdale Quadrangle (Illinois), [dated] 2021 (7.5 Minute Series, original scale 1:24,000); ref, and for further information, see [Internet] https://ngmdb.usgs.gov.

[22] Source: documentation of the Vehicle Factors - Technical Working Group, and on-scene police report documents.

2.0 Accident Train – Owner / Operator / Technical Aspects of the Railroad Equipment

The accident involved a commuter train that was owned and operated by Metra, which was being operated [traveling] on property of the BNSF, which was involved in a collision with a highway vehicle (box truck) at a highway / railroad grade crossing.

2.1 Metra - Brief Summary – Operational Background[23]

Briefly described, "The Northeastern Illinois Regional Commuter Railroad Corporation (NIRCRC) is a public corporation of the State of Illinois that was authorized by [IL state] statute and created by Regional Transportation Authority (RTA) ordinance in 1980. The corporation, commonly known as Metra, is the primary operator of commuter passenger rail services in the six-county Chicago metropolitan area in Northeast Illinois.". Additionally, "Metra operates eleven main lines radiating from the Chicago Central Business District throughout Chicago and the six-county area. Diesel powered service operates on the BNSF Railway (BNSF), [and several other railroads located in the Chicago area]".[24]

Metra is a standard gauge[25], Tier I [commuter rail service] Provider[26], which operates local commuter railroad service in suburban Chicago, IL. Metra owns the motive power (locomotives) and rolling stock (passenger railcars) of the railroad operations, consisting of 173 [diesel-electric] locomotives and 861 [diesel-power drawn] passenger railcars, as distributed throughout the Metra system.[27]

The accident occurred on trackage of the BNSF Chicago Subdivision - Main Line, which is referred to as the Metra Aurora Line, which operates commuter trains between Chicago, IL at the eastern end of the Line, and Aurora, IL, at the western end of the Line. On-board train crews, for trains that operate on the Metra Aurora Line, are supplied by the BNSF, under a contractional arrangement with Metra.

See Railroad Operations and Human Performance Group - Factual Report for additional information detail on the railroad operations.

2.2 Accident Train – Consist and Technical Specifications[28]

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[23] ref, and for further information, see [Internet] https://metra.com/our-history, and as further described.

[24] Both narratives in this paragraph quoted from Metra 2018 State of the System; ref, and for further information see [Internet] https://metra.com/sites /default/files/assets/metra_state_of_the_system_2018_reduced.pdf.

[25] U.S. "standard gauge" track is 56.5 inches (143.5 cm) between the rails, as measured on straight track.

[26] ref, U.S.D.O.T, Federal Transit Administration, "Asset Type" Tier designation, and for further information, see [Internet] https://www.transit.dot.gov/sites/fta.dot.gov/files/transit_agency_profile_doc/2020/50118.pdf.

[27] quoted from Metra 2022 Proposed Operating & Capital Program & Budget; ref, and for further information see [Internet] https://metra.com/sites/default/files/inline-files/Brochure_8.5x11_ProposedBudgetBookElectronic_2022_VFINAL.pdf.

[28] Source: description of the accident train was sourced to observations by NTSB investigative staff (during, and subsequent to the on-scene phase of the investigation), and data as offered by Metra, and as further described.

The accident involved an eastbound, Metra commuter [passenger] train, having a Metra Timetable designation of Train Number 1242, which was comprised of five passenger coach railcars, in which a 'Cab Car' was positioned at the lead-end of the train, and one [diesel-electric] locomotive, which was positioned at the aft-end of the train. The train was being operated, at the time of the accident, by a train operator who was located in the operating cab of the Cab Car, at the lead-end of the train, in which the locomotive was unoccupied.

Generally described, the floorplan arrangement of the coach railcars consisted of a passenger compartment at both ends of the railcar, which was comprised of lower-level and upper-level seating (in which a stairway is provided to access the upper-level seating areas), and a vestibule area [compartment] in the center of the railcar, containing the access doors of the railcar (leading to/from the respective passenger compartments), and the main service doors as situated on both sides of the railcar.

Summarized technical specifications of the Metra commuter train equipment, as involved in the accident, is provided in Exhibit 2.

See Railroad Operations and Human Performance Group - Factual Report for additional information detail on the railroad equipment.

2.3 Cab Car of the Accident Train – Technical Specifications[29]

2.3.1 Engineering Drawings and Technical Specifications of Cab Car 8473

Engineering drawings and technical specifications of Cab Car [road number] 8473, and its components, were made available to the Crashworthiness investigation by Metra, the content list of which [of that documentation] is provided in Exhibit 3.

See Railroad Operations and Human Performance Group - Factual Report for additional information detail on the railroad equipment.

2.3.2 Cab Car Floorplan

An engineering drawing, describing the floorplan of a Metra 'Cab Car' [coach railcar], as involved in the accident, was made available to the investigation by Metra, a copy of which is provided in Exhibit 4.

3.0 Regulation of Railroad Passenger Coach Car and Cab Car Equipment[30]

3.1 Overall Provisions

[29] Source: engineering drawings and technical specifications [documentation] as made available by Metra.

[30] Ref, and for further information, see 49 CFR 238 Passenger Equipment Safety Standards; available at [Internet] https://www.https://www.ecfr.gov/current/title-49/subtitle-B/chapter-II/part-238, and as further described.

Generally described, relative to the topic-points reviewed [being addressed] by the Crashworthiness Group investigation, regulation of passenger railroad coach car and Cab Car equipment is addressed under regulation provisions of the U.S. Department of Transportation (US DOT), as promulgated by the Federal Railroad Administration (FRA), as follows.

- 49 CFR Part 229 Railroad Locomotive Safety Standards
- 49 CFR Part 223 Safety Glazing Standards - Locomotives, Passenger Cars and Cabooses
- 49 CFR Part 238 Passenger Equipment Safety Standards

3.2 Provisions of Tier I Operation

The passenger railroad equipment of the train involved in the accident operated under the Tier I operational definition criteria[31], referring to a maximum [permissible] train operation speed[32], as stipulated under the provisions of 49 CFR Part 238 Passenger Equipment Safety Standards.

Generally described, regulation of Tier I passenger railroad Cab Car equipment (i.e., of the train involved in the accident), relative to the topic-points of the investigation, are addressed under the provisions stipulated in the regulations, as follows.

- 49 CFR 223.3 Application [of safety glazing]
- Appendix A to Part 223 [Safety Glazing Standards]
- 49 CFR 238.209 Forward end structure of locomotives, including cab cars and MU locomotives.
- 49 CFR 238.217 Side structure
- 49 CFR 238.221 Glazing

3.3 Language of 49 CFR 238.221 Glazing - Tier I Operation

The language of the regulation under 49 CFR 238.221 Glazing, operating under the Tier I definition criteria, is as follows.

- 238.221 Glazing.
  (a) Passenger equipment shall comply with the applicable Safety Glazing Standards contained in part 223 of this chapter, if required by that part.
  (b) Each exterior window on a locomotive cab and a passenger car shall remain in place when subjected to:
  (1) The forces described in part 223 of this chapter; and

[31] Ref, and for further information, see 49 CFR 238.5 Definitions, then Tier I; available at [Internet] https://www.ecfr.gov/current/title-49/subtitle-B/chapter-II/part-238#238.5.

[32] i.e., under the 49 CFR 238.5 definition, “Tier I means operating at speeds not exceeding 125 mph.”.

(2) The forces due to air pressure differences caused when two trains pass at the minimum separation for two adjacent tracks, while traveling in opposite directions, each train traveling at the maximum authorized speed.

3.4 Language of 49 CFR 238 - Glazing Securement Provisions of Tier II and Tier III Operation

In addition to regulation of the passenger railroad equipment of the train involved in the accident (i.e., the Tier I definition, as described above), the investigation identified language of the regulation under 49 CFR Part 238, which addressed passenger railroad equipment that is operated under the Tier II[33] and Tier III[34] operational definition criteria[35], as follows (note - the prescriptive language of both regulation were identical).

3.4.1 Tier II

- 49 CFR 238.421 Glazing
  "Glazing securement. Each exterior window on a passenger car and a power car cab shall remain in place when subjected to:
  (1) The forces due to air pressure differences caused when two trains pass at the minimum separation for two adjacent tracks, while traveling in opposite directions, each train traveling at the maximum authorized speed; and
  (2) The impact forces that the glazed window is required to resist as specified in this section."

3.4.2 Tier III

- 49 CFR 238.721 Glazing
  "Glazing securement. Each exterior window on a passenger car and a power car cab shall remain in place when subjected to:
  (1) The forces due to air pressure differences caused when two trains pass at the minimum separation for two adjacent tracks, while traveling in opposite directions, each train traveling at the maximum authorized speed; and
  (2) The impact forces that the glazed window is required to resist as specified in this section."

3.5 49 CFR Part 238 / Applicability Date Provision

[33] i.e., under the 49 CFR 238.5 definition, "Tier II means operating at speeds exceeding 125 mph but not exceeding 160 mph.".

[34] i.e., under the 49 CFR 238.5 definition, "Tier III means operating in a shared right-of-way at speeds not exceeding 125 mph and in an exclusive right-of-way without grade crossings at speeds exceeding 125 mph but not exceeding 220 mph.".

[35] Ref, and for further information, see 49 CFR 238.5 Definitions, then Tier I; available at [Internet] https://www.ecfr.gov/current/title-49/subtitle-B/chapter-II/part-238#238.5.

Regulation under 49 CFR Part 238 Passenger Equipment Safety Standards, cites the following 'applicability date' provision.

- 49 CFR 238.3 Applicability. The regulation is applicable to passenger equipment ordered on or after September 8, 2000, or placed in service for the first time on or after September 9, 2002.

The investigation observed that because the Metra cab car (involved in the accident) was first placed in service [in 1997] prior to the applicability date of the described regulation [49 CFR 238.3 Applicability], this railcar was not subject to the noted regulation [49 CFR Part 238 Passenger Equipment Safety Standards]. In other words, the railcar was exempt under the "grandfather" provisions of the regulation. This would also apply to the other railcars of the train consist, as they also were first placed in service prior to the applicability date.

4.0 Accident Equipment Damage Characterization / Site Wreckage Distribution, and Relevant Factual Data

4.1 Time of the Event Occurrence[36]

The investigation identified the collision occurred at about 08:16:11 (a.m.) CDT[37], on May 11, 2022.

4.2 Train Speed at the Time of Collision[38]

The train was traveling at a reported speed of about 55 mph at the time of the accident (i.e., the moment of impact).

4.3 Approximate Point of Collision and Location Where Train Came to Rest

The point of collision was identified to be the northbound lane of the Prospect Street grade crossing, at the approximate point of intersection with the # 3 Main Track. The investigation identified that the right front bulkhead area of the Cab Car made the initial [collision] contact with the area proximate to the driver's [cab] door of the box truck, in which the 'cargo box' of the box truck was oriented to the south of the box truck cab. Measurement identified that the front of the Cab Car (at the lead end of the train) came to rest about 963 feet to the east of the Point of Collison at the grade crossing.[39]

See Technical Reconstruction Group - Factual Report for additional information detail on the accident site.

[36] Source: locomotive event recorder download data.

[37] Central Daylight Time

[38] Source: locomotive event recorder download data.

[39] Dimension based upon evidentiary artifact data identified during the on-scene phase of the Crashworthiness investigation (i.e., aerial [drone / UAV] imagery, as sourced to [developed by] the Technical Reconstruction Group).

4.4 Pre-recovery Examination / Damage Characterization – Railroad Equipment[40]

A pre-recovery examination of the railroad equipment, correspondingly involved [highway] vehicles, and the accident site, is conducted by the investigation prior to disturbance of the equipment, vehicles, and/or the site. This is performed to accurately identify and document the degree of damage as had been sustained by the evidentiary artifacts, as damage to the equipment / vehicles, and disturbance of the site, can readily occur during the equipment recovery process. Also, damage(s) as sustained by the environment [ground areas] proximate to the accident site, are also documented during the pre-recovery examination activity (e.g., skid marks on pavement, ground scars at the site, displaced / damaged railroad track, or other displaced fixed objects).

4.4.1 Cab Car 8473

The Crashworthiness Group conducted a pre-recovery equipment examination of Cab Car 8473 on May 12, 2022, while the railroad equipment remained at the accident scene (i.e., where the train came to rest), in which the observed conditions[41] of the railroad equipment are summarized as follows.

a. Exterior

- Front bulkhead - panel / structure:
  - right side collision post visually appears to exhibit gouges / striations / impact batter, etc. to the frontal surface areas (i.e., characteristics consistent with a collision impact), and appears to be without overall displacement or deformation (i.e., collision post appeared ‘intact’),
  - left side collision post visually appears not to exhibit any impact damage to the frontal surface areas, and appears to be without any displacement or deformation,
  - right side, front bulkhead panel surface - visually appears to exhibit gouges / striations / impact batter, etc. (i.e., characteristics consistent with a collision impact),
  - right side, front bulkhead panel surface - (visibly apparent, but not confirmed) slight amount of inward deformation to overall right-side area (i.e., unable to accurately measure in the field),
  - snowplow blade deformation, with right side hanging low,
  - buff plate observed to have been displaced aft, ~ 7½ inch on right side, ~ 5¾ inch on left side,
  - step plate observed to have been displaced upward by several inches,
  - uncoupling rod dent,

[40] Source: pre-recovery equipment / site examination was conducted [principally*] on 05/12/2022, by Party participants of the Crashworthiness Technical Working Group, with the data notations of that examination recorded by the Group Chairperson in the Field Notes Logbook, with technical and observational input of the Crashworthiness Group participants. *A ‘preliminary’ 'site inspection was conducted by the Group Chairperson on the evening of 05/11/2022, in which (due to darkness) minimal site examination and documentation occurred.

[41] Note – left and right locational reference indicators are relative to the forward direction of travel.

- 480 [volt / electrical] junction box (exterior shell) batter / deformation,
- sill step bent in aft direction,
- hand brake equipment damaged,
- right / front ‘grab iron’ - bent in aft direction deformation,
- end structure [horizontal] cross beam - deformation, with small shards of glass resting on top surface,
- cab signal receiver coil and attachment bracket deformation,
- right side [train operator’s] mirror damaged,
- right front ‘ditch light’ missing,

▫ Carbody right sidewall - panel / structure:

- train operator’s cab, right side sliding window - visible impact damage,
- lower level, 1st window [opening] aft of Operator’s Compartment - window panel components observed to be loose,
- upper level, 1st window [opening] aft of Operator’s Compartment - window panel components missing [except window grommet - observed hanging out window opening] (with remaining components found inside the car, at that window location),
- upper level, above 2nd window [opening] aft of Operator’s Compartment - minor [suspected] impact striation / gouging observed on the panel surface, with similar / minor, less prominent impact striation / gouging above that location,
- at the aft-side vestibule door panel; horizontal scoring of the door [metal] panel surface, door track assembly jammed, and rain gutter impact damage,
- door indicator light assembly missing,
- aft end of car - grab rail bent in aft direction,
- aft passenger compartment, upper level, 1st window [opening] - exit / access window was ‘pulled’,
- aft passenger compartment, upper level, window opening - side frame [element] pushed inward,
- lower level, 1st window [opening], aft of center vestibule doors - window panel [all components] missing (found inside the car, at that window location),
- above the lower level, 1st window [opening], aft of center vestibule doors – Metra signage [attached panel] gouged and pressed inward (in a manner consistent with having had contact with the box truck / cargo box),
- at a point commencing about 74 inches aft of the [aft-side of the] vestibule door frame, observed an open breach of the aft passenger compartment, carbody sidewall structure, which measured about 20 inches in width (i.e., top, to bottom), by about 111 inches in length (i.e., right side, to left side), which occurred immediately below the lower-level window line, in which debris [insulation, and sidewall materials] of the carbody sidewall structure was protruding from the aft-area of the breach.
- at a point commencing about 39 inches aft of the [aft-end of the] open breach (described above), observed a smaller puncture (breach), which measured about 6 inches in width (i.e., top, to bottom), by about 4 inches in length (i.e., right side, to left side).

- Carbody left sidewall - panel / structure:
  - lower level, 2nd window [opening], aft of center vestibule doors - window panel [all components] missing,
  - suspected accident debris [i.e., small shards of glass, soil grit, etc.] resting on top of # 4 axle journal box.
- Carbody rear bulkhead - panel / structure:
  - No damage or anomalous conditions / characteristics were observed / recorded.

b. Interior

- Train operator's compartment (upper level / lead end / right side of the car):
  - on the surface of operator's console - observed shards of glass,
  - on the surface of operator's seat and adjacent areas - observed shards of glass,
  - on headlight access panel - observed attachment screws sheared off,
  - right side, sliding window – damaged; 'binding' panel movement,
- Front passenger compartment:
  - Front end-door operable,
  - Right corner duct [containing airlines to cab] screws missing,
  - upper level, 1st window [opening] aft of Operator's Compartment - window panel components found inside the car, at that window location),
  - Otherwise no visibly apparent damage sustained to the any of the seat-sets in this passenger compartment.
- Vestibule compartment:
  - right side door, left door panel, horizontal scoring of the panel surface,
  - door track assembly jammed.
- Rear passenger compartment:
  - a preliminary / field-examination - damage inspection and initial documentation of the individual seat-set assemblies, identified damage / anomalous characteristics as follows, starting at the lead-end of the passenger compartment, proceeding in an aft direction, in which:

    LL and UL respectively, designates the Lower Level and Upper Level [of the compartment], respectively, and

    R, and L, respectively, designates the right side, and left side, respectively, of the railcar (relative to the forward direction of travel), and

    the number cited corresponds to the reference location, in sequence, described (e.g., LL R1, would be the Lower Level, right side, 1st seat-set location, relative to the lead end of that compartment):

    - stairway (to UL) frame distorted,
    - UL heater duct twisted,

- damage sustained to LL R1 seat-set,
- damage sustained to LL R2 seat-set,
- damage sustained to LL R3 seat-set,
- damage sustained to LL R4 seat-set,
- damage sustained to LL R5 seat-set,
- damage sustained to LL R6 seat-set,
- no visibly apparent damage sustained to the seat-sets aft of the LL R6 location,
- no visibly apparent damage sustained to the any of the seat-sets on the LL - L side of the railcar,
- no visibly apparent damage sustained to the any of the seat-sets on the UL of the railcar,
- examination of this passenger compartment, by the participants of the Crashworthiness Group, of the floor, walls and ceiling areas of this railcar, indicated that no evidentiary artifacts, which might be consistent with / suggestive of suspected human trauma, were observed (i.e., no blood, or tissue residue was observed).

c. Overall

- No fire damage was observed to have been sustained by this railcar.
- A number of emergency exit / responder access windows were observed to have been 'pulled' (i.e., manually removed), for reasons that were not identified.
- Fire extinguisher equipment, and associated hand tools (that are required [by regulation] to be present in the railcar), were observed to be present in this railcar.
- The railcar was not derailed, and remained coupled to the adjacent railroad equipment (i.e., coupled to the railcar located at the aft end of this railcar).

4.4.2 Remaining Equipment of the Train Consist[42]

- No physical or fire damage was observed in the remaining passenger coaches or locomotive equipment of the train consist.
- A number of emergency exit / responder access windows, in the remaining railcars of the train consist, were observed to have been 'pulled' (i.e., manually removed), for reasons that were not identified.
- Fire extinguisher equipment, and associated hand tools (that are required [by regulation] to be present in the railcar), were observed to be present in the railcars.

[42] Source: pre-recovery equipment / site examination was conducted [principally*] on 05/12/2022, by Party participants of the Crashworthiness Technical Working Group, with the data notations of that examination recorded by the Group Chairperson in the Field Notes Logbook, with technical and observational input of the Crashworthiness Group participants. *A 'preliminary' 'site inspection was conducted by the Group Chairperson on the evening of 05/11/2022, in which (due to darkness) minimal site examination and documentation occurred.

- The remaining passenger coaches and locomotive were not derailed, and all of the railcars, and locomotive, remained coupled to the adjacent railroad equipment.

4.5 Pre-recovery Examination / Brief Damage Characterization – Highway Vehicle[43]

The observed condition of the Highway Vehicle, as a result of the collision and subsequent fire, is briefly characterized as follows.

- The wreckage of this vehicle came to rest essentially in an inverted (overturned) orientation, in an open-area location [on the periphery of a parking lot pavement], about 75 feet to the approximate east of the grade crossing.
- The vehicle sustained severe impact damage and severe fire damage, resulting in [essentially of] only materials of the vehicle that were not consumed in the fire (i.e., only metal elements / components, except for some tires that had not ignited / fully burned, rear door panel, etc.).
- Apparent cargo of the vehicle was observed to be scattered about the area, proximate to where the vehicle [remains] came to rest, consisting of [what appeared to be] moving blankets / padding materials, which were not consumed in the fire.

See Vehicle Factors Group - Factual Report for additional information detail on the vehicle.

4.6 Pre-recovery – Characterization of the Site Condition

A Technical Reconstruction Group was established at the scene, to support the investigation in the documentation of the wreckage distribution, as identified in the wreckage debris field at the accident site.

An annotated aerial imagery [map][44], as sourced to [developed by] the imagery obtained [collected] by the Technical Reconstruction Group, describing the wreckage distribution in the wreckage debris field, was prepared by the investigation, which is provided in Exhibit 5.

4.7 Post- recovery Examination / Damage Characterization – Railroad Equipment[45]

[43] Source: pre-recovery equipment / site examination was conducted [principally*] on 05/12/2022, by Party participants of the Crashworthiness Technical Working Group, with the data notations of that examination recorded by the Group Chairperson in the Field Notes Logbook, with technical and observational input of the Crashworthiness Group participants. *A ‘preliminary’ 'site inspection was conducted by the Group Chairperson on the evening of 05/11/2022, in which (due to darkness) minimal site examination and documentation occurred.

[44] Source: aerial imagery, as made available to the investigation, from responded UAV [unmanned aerial vehicle] resources (also referred to as aerial ‘drones’), to which annotated data (describing select attributes / physical elements of the site) is correspondingly inserted in the image.

[45] Source: post-recovery equipment examination conducted on 05/12/2022, by participants of the Crashworthiness Group, at a secure site to which the railcar had been relocated (a Metra Railcar Maintenance facility), as an evidence preservation measure, with the data notations of that examination recorded in the Group Chairperson’s Field Notes Logbook.

A post-recovery examination of the railroad equipment is conducted by the investigation to appropriately / accurately document the accident-relevant information, upon relocation of the railroad equipment to a safe / secure site. During this activity, the time can be taken to more closely examine / document any additional damage details and artifact characteristics, beyond that as had been identified during the pre-recovery examination activity, as might be contained within the subject railroad equipment.

4.7.1 Cab Car 8473

The Crashworthiness Group conducted a post-recovery equipment examination of Cab Car 8473 on May 13, 2022, at the Metra West 14th Street maintenance shop (in Chicago, IL), in which the observed conditions / characteristics of the railroad equipment are summarized as follows.

a. Exterior

- Carbody front bulkhead - panel / structure:
  - No additional damage or anomalous conditions / characteristics were observed / recorded.
- Carbody right sidewall - panel / structure:
  - No additional damage or anomalous conditions / characteristics were observed / recorded.
- Carbody left sidewall - panel / structure:
  - No additional damage or anomalous conditions / characteristics were observed / recorded.
- Carbody rear bulkhead - panel / structure:
  - No additional damage or anomalous conditions / characteristics were observed / recorded.
- Carbody underside [46]:
  - No damage or anomalous conditions / characteristics were observed / recorded.

b. Interior

- Front passenger compartment:
  - No additional damage or anomalous conditions / characteristics were observed / recorded.
- Vestibule compartment:
  - No additional damage or anomalous conditions / characteristics were observed / recorded.
- Rear passenger compartment:
  - a damage inspection and documentation of the individual seat-set assemblies (either as a complete seat-set assembly, or as separated elements / components), identified damage / anomalous characteristics as follows, starting at the lead-end of the passenger compartment, proceeding in an aft direction, in which:

[46] The railcar was positioned atop an inspection pit, affording the opportunity to conduct a visual inspection of the railcar underside.

LL and UL respectively, designates the Lower Level and Upper Level [of the compartment], respectively, and

R, and L, respectively, designates the right side, and left side, respectively, of the railcar (relative to the forward direction of travel), and

the number cited corresponds to the reference location, in sequence, described (e.g., LL R1, would be the Lower Level, right side, 1st seat-set location, relative to the lead end of that compartment):

- LL R1 seat and seatback, the elements of which had separated (the damage apparently resulting from the accident); removed and photo-documented,
- LL R1 seat frame found bolted in place at side-frame attachment, with the pedestal observed to have been fractured; removed and photo-documented,
- LL A window gasket (with 'zip-strip' still intact), found on floor at R1 seat location; removed and photo-documented,
- LL R2 seatback and frame, the seatback remained attached with observed deformation at the attachment mounting holes; removed and photo-documented,
- LL R2 seat-bottom cushion; removed and photo-documented,
- LL R3 seat assembly (which had remained intact), 2-bolts on pedestal remained attached and 2-bolts on wall attachment bracket remained attached (both removed during this examination), right side of seatback observed to have been substantially 'twisted' / bent in an aft direction (which was determined, when removed from the railcar, to be in excess of 45 degree, relative to a 'flat plane' of the seatback), tearing of seat bottom and seatback cushions observed; all components removed and photo-documented,
- LL R4 seat assembly, needed to remove debris (in that area) to access the attachment bolts (which had remained intact), to dismount the seat assembly, which was removed as a complete unit (i.e., elements had not separated); all components removed and photo-documented,
- LL R5 seat assembly, needed to remove seatback to disassemble, needed to unbolt from pedestal, L side 'seat handle' elevated ~ 1 inch, pedestal bent [to the R] toward the aisle; all components removed and photo-documented,
- LL R6 seat assembly, no visibly apparent damage, except pedestal observed to be bent [necessitating a repair]; component not removed [from the railcar] but was photo-documented,
- no visibly apparent damage sustained to the seat-sets aft of the LL R6 location,
- 'light shade' [plastic light fixture cover], above missing window opening, broken,
- no visibly apparent damage sustained to the any of the seat-sets on the LL - L side of the railcar,
- UL R1 seat and seatback, the elements of which had separated; all components removed and photo-documented,
- no visibly apparent damage sustained to the any of the remaining seat-sets on the UL of the railcar.

- Examination of this passenger compartment, by the participants of the Crashworthiness Group, indicated a number of potential evidentiary artifacts on the floor of the railcar,

which were determined (at that time) to be irrelevant to the investigation (e.g., ticket stubs, which were dated prior to the accident date),

- A detailed examination of this passenger compartment, by the participants of the Crashworthiness Group, of the floor, walls, and ceiling areas of this railcar, indicated that no evidentiary artifacts, which could be suggestive of suspected human trauma, were observed (e.g., blood or tissue residue).

c. Exit / Rescue - Windows – 'Pull-Tests' Conducted

Generally described, regulation under 49 CFR 238.113 Emergency window exits[47], stipulate that passenger railcars be fitted with a certain number of windows that can be easily removed by person(s), without the use of tools, while inside the railcar, in case of a situation that requires immediate egress from the railcar, should egress through the [regular-use] service doors of that railcar be obstructed. Further, generally described, regulation under 49 CFR 238.114 Rescue access windows[48], stipulate that passenger railcars be fitted with a certain number of windows that can be removed, with the use of tools, from outside the railcar, in case of a situation that requires immediate access to the railcar interior, should access through the [regular-use] service doors of that railcar be obstructed.

Supportive to the above (i.e., as affirmation no issue was observed in this particular railcar), the Crashworthiness Group elected to pursue a 'pull-test', of one "emergency window" [for use in egress from the railcar] (i.e., 49 CFR 238.113), and one "rescue access window" (i.e., 49 CFR 238.114), as collectively installed in this railcar, to affirm that the respective windows performed pursuant to the respective regulations. The location of each respective window to be pulled was selected at random [by the Crashworthiness Group] for the respective 'pull-tests' conducted. The 'pull-test' consist essentially of the removal of the respective windows, such to replicate, for example, an emergency situation, to which a window removal would be required (i.e., the respective tests would be performed by an individual, simulating a passenger, or a 'rescuer' [e.g., an emergency responder], who would proceed to remove the respective window, pursuant the instructions provided at each window location).

Given the above, the 'pull-test' of one "emergency window" (located in the front passenger compartment, at the # 4 window location, on the left side of the railcar), and the 'pull-test' of one "rescue access window" (located at the rear passenger compartment, at the last window location, on the left side of the railcar), resulted in the removal of each respective window, without difficulty, which completed the respective tests (i.e., each window successfully 'passed' the respective 'pull-tests').

4.7.2 Remaining Equipment of the Train Consist

[47] ref, and for further information, see [Internet] https://www.ecfr.gov/current/title-49/subtitle-B/chapter-II/part-238/subpart-B/section-238.113.

[48] ref, and for further information, see [Internet] https://www.ecfr.gov/current/title-49/subtitle-B/chapter-II/part-238/subpart-B/section-238.114.

With no physical or fire damage, or other anomalous characteristics having been observed in the remaining passenger coaches or locomotive equipment of the train consist (see also § 4.4.2), no post-recovery damage inspection was conducted on this equipment.

4.7.3 Evidentiary Artifact Located in the Wreckage Debris Field - Window Assembly

The investigation identified that a window assembly, sourced to Cab Car 8473, had separated from that railcar during the accident sequence, in which the elements of the window assembly came to rest on the track-bed ballast, proximate to the grade crossing collision site (i.e., the area of which is collectively referred to as the wreckage debris field). Personnel of the BNSF [Claims Department] identified that this evidentiary artifact was sourced to the Cab Car, and recovered the artifact from the wreckage debris field.

Supportive to a documented 'chain-of-custody' protocol [evidentiary artifact preservation methodology], the elements of the artifact were 'tagged' (labeled with an attached identification tag), packaged, and securely transported to a BNSF [Claims Department] facility, in Chicago, for secure safekeeping (see further § 4.9.2).

The [recovered] window assembly was comprised of:

- two (2), rectangularly-shaped, with 'rounded' corners, window panel elements, each consisting of a ¼ inch thick polycarbonate sheet (sized for the window dimensions), and
- one (1) rubber window grommet element (which, when assembled, is positioned around the window panel perimeter).

During the post-recovery examination phase of the on-scene investigation, a visual examination of the [separated] window assembly (evidentiary artifact, as described above) was conducted by the Crashworthiness Group Chairperson, in which the observed conditions of the artifacts are summarized as follows.

- Window panel elements:
  - Impact batter damage (i.e., striations, gouges, etc.) was observed in the plane surfaces of both window panel elements, in which the individual window panel elements were correspondingly otherwise undamaged (i.e., not fractured).
- Window grommet element:
  - Impact batter damage (i.e., striations, gouges, etc.) was observed in the surfaces of the window grommet, in which the artifact was correspondingly otherwise undamaged.

4.8 Volpe Center Investigative Team - Post-Recovery Inspection of Cab Car

Supplemental to, and directly supportive of the FRA Party participation in the Crashworthiness Group investigation, a team of investigative staff of the Volpe Center conducted a post-recovery inspection of Cab Car 8473, the data of which was incorporated, by the Volpe Center

investigative team, in the Field Notes [notations] report of the post-recovery inspection activity. Additionally, the Volpe Center investigative staff conducted a technical review of the Overhaul activities as conducted on the Metra Cab Car, the data of which was incorporated in the Field Notes report of the post-recovery inspection activity. Correspondingly, the Volpe Center investigative team made a copy of the Volpe Center - Field Notations [documentation of the post-recovery inspection activity] available to the Crashworthiness investigation, a copy of which in provided in Exhibit 6.

4.9 Railroad Equipment / Evidentiary Artifact – Preservation / Securement

As described (see § 4.4.1), a pre-recovery examination of the railroad equipment (i.e., the accident train) was conducted by the Crashworthiness Group, at the location that the train came to rest (at the accident site), which identified that the only damage that occurred to the train, was the damage sustained by the Metra Cab Car [road number] 8473 (i.e., the lead railcar of the train). Correspondingly (upon conclusion of the pre-recovery railroad equipment examination), the balance of the train was released back to Metra, in which only Cab Car 8473, and a component that had separated from that railcar during the collision sequence (i.e., elements of a side window assembly; as further described in § 4.7.3), were secured by the investigation for further examination. Observations of those evidentiary artifact preservation activities are summarized as follows.

4.9.1 Metra Cab Car 8473

A pre-recovery railroad equipment examination was conducted by the Crashworthiness Group on May 12, 2022 (while the railroad equipment remained at the accident scene). At the conclusion of that examination, NTSB evidence preservation protocols prescribe that appropriate security / preservation measures be employed, to which an NTSB Evidence ‘Red Tag’ was attached to Cab Car 8473, by the Crashworthiness Group Chairperson, to temporarily secure the car as an evidentiary artifact, to help assure that it would be available to the NTSB [as follow-up support to the investigation]. Per the artifact preservation protocol (plan), the Red Tag was to remain attached to the car through the post-recovery equipment examination activity (as scheduled for May 13, 2022), so to have the railcar available for the subsequent examination / documentation processes by the NTSB Accident Reconstruction Group, which was scheduled for the following day.

The Crashworthiness Group conducted, and concluded, the post-recovery equipment examination of Cab Car 8473 on May 13, 2022, at the Metra W. 14th Street maintenance shop (in Chicago), with the observations of that examination recorded in the Crashworthiness Field Notes Logbook, by the Group Chairperson. The NTSB ‘Red Tag’ remained attached to Cab Car 8473.

The Accident Reconstruction Group conducted, and concluded, the laser-scanning documentation activities (i.e., laser-scanning of the railcar, using a UAV - aerial drone) on May 14, 2022, in which the NTSB Red Tag was removed from Cab Car 8473 on that day by the Accident Reconstruction - Group Chairperson, and was returned to the Crashworthiness Group Chairperson. This Red Tag removal formally ‘conveyed’ the Cab Car, and its ‘removed’

contents, back to Metra, which concluded the NTSB examination activities relative to Metra Cab Car 8473.[49]

4.9.2 Window Separated from Metra Cab Car 8473

A window assembly, sourced to the location [in the Cab Car] opposite to where the fatally injured passenger was seated[50], was found to have been separated from Cab Car 8473 during the accident sequence, in which the elements of the window assembly came to rest on the track-bed ballast, proximate to the grade crossing collision site. Personnel of the BNSF identified the elements of the [separated] window (where it came to rest on the track-bed ballast), and collected it, among the railroad 'debris' of Cab Car 8473 at the accident site. Supportive to a documented 'chain-of-custody' protocol [evidentiary artifact preservation methodology], the elements of the window assembly were 'tagged' (labeled with an attached identification tag) by BNSF personnel, packaged, and securely transported to a BNSF [Claims Department] facility, in Chicago, for secure safekeeping.

Given that the [separated] window of Cab Car 8473 might be of further interest, at a later date, to the NTSB Crashworthiness - Technical Working Group, in which NTSB evidentiary artifact preservation protocols prescribe that appropriate security / preservation measures be employed, the subject window assembly of Cab Car 8473 was further secured, on May 17, 2022, as an NTSB evidentiary artifact, by the Crashworthiness Group Chairperson. This securement was implemented by attachment of NTSB Evidence 'Red Tags' to the components of the window assembly, in which the components were placed in a locked storage locker at a BNSF [Claims Department] facility, in Chicago, IL, for secure safekeeping.[51]

5.0 Medical and/or Pathology Data - On-Board the Accident Train

5.1 Fatality Sustained[52, 53]

The DuPage County, Illinois, Office of the Coroner performed the fatally injured passenger's autopsy. According to the autopsy report, the cause of death was multiple traumatic injuries. Injuries described in the autopsy report included atlanto-occipital dissociation, punctate hemorrhages throughout the cerebral white matter of the brain, fractures of the sternum and multiple bilateral ribs, fractures of the left scapula and left clavicle, contusion of the heart, contusions of both lungs, lacerations of the left lung at the hilum, lacerations of the spleen, superficial lacerations of the right lobe of the liver, separation/fracture of the vertebral bodies of

[49] The evidentiary artifact securement protocol [described] was documented in an email to Metra [the designated participant of the Crashworthiness Group], dated May 19, 2022.

[50] i.e., the fatally injured passenger was seated directly on the opposite side of the railcar, relative to the location of the separated window.

[51] The evidentiary artifact securement protocol, as implemented, was documented in an email to Metra [the designated participant of the Crashworthiness Group], dated May 23, 2022.

[52] Source: pathology documentation as made available to the investigation by the DuPage County Coroner's Office.

[53] Source: report narrative [verbatim], as compiled by NTSB Medical Officer, addressing a medical evaluation of the pathology documentation (as made available by the DuPage County Coroner's Office).

the thoracic spine at T4 without apparent spinal cord laceration, separation of the spinal column at the level of the distal lumbar and proximal sacral vertebrae, separation of the pelvic girdle from the sacrum, multiple bilateral pelvic fractures, and multiple extremity fractures.

5.2 Other Injuries Sustained[54]

The investigation identified two passengers, and two train crewmembers, who were transported to a local medical facility, in which the degree of injury was characterized [to the investigation] as ‘non-life threatening‘.

6.0 Cab Car 8473 Maintenance History / Prior Damage / Review of FRA Regulations Applicable to the Overhaul

6.1 Heavy Maintenance / Overhaul History of Cab Car 8473

Cab Car 8473 was originally manufactured in 1997 by Amerail / Nippon Sharyo, as delivered to [the commuter rail operation that was to become] Metra. Maintenance history and damage that may have occurred to railcars in the Metra fleet, are documented by Metra in the Car History Book [for a given railcar]. Metra also documented, in a “8473 History” report to the investigation, that prior to the accident, during the service life of that car, there had been “No major accidents or major structural repair work in car 8473 prior history.”, as sourced to the Car History Book [for that railcar].

An overhaul (which is also referred to as a “rehabilitation” activity) of the 8473 railcar was completed in January of 2014, which was performed by personnel and resources of Metra. Metra made documentation of the Cab Car 8473 overhaul activity available to the investigation, as sourced to the Car History Book [for that railcar], and support documentation of the overhaul project. This documentation, supportive to the overhaul project, included [1] copies of various Car Inspection Reports for Cab Car 8473, and [2] a copy of the “Detailed Specification for General Repairs to Amerail Cab Cars 8400-8478, Specification M-08-007 Revision E, Revised April 15th, 2010”, as well as [3] the engineering drawings of the railcar (as applicable to the investigation; described in § 2.3.1).

Review of the overhaul activity documentation [in the received “8473 History” report] indicated that the project included “Install all new passenger windows”, among other steps of the project. The project entailed the requirement that all components / materials used in the overhaul comply with applicable FRA regulation (e.g., 49 CFR Part 229 Railroad Locomotive Safety Standards, Part 223 Safety Glazing Standards - Locomotives, Passenger Cars and Cabooses, and Part 238 Passenger Equipment Safety Standards, as described; see § 3.1 in this report).

6.2 Review of FRA Regulations Applicable to Cab Car 8473 Overhaul Activity

[54] Source: data as identified in the Survival Factors / Fire Department Response - Group Chairman’s Factual Report of the Investigation (see that report fur further information detail).

An opportunity was afforded the FRA [designated participant of the Crashworthiness Group], to identify specific regulation elements, as prescribed under 49 CFR Part 238 Passenger Equipment Safety Standards, or other applicable regulation, to which Cab Car # 8473 needed to be in compliance with, upon undergoing an overhaul activity, as might be relevant to the investigation.[55] Responsive to this, and directly supportive to the FRA [designated participant] participation in the Crashworthiness Group, as previously described (see § 4.8), the Volpe Center investigative staff, as an element of the post-recovery [Cab Car] inspection activity, conducted a technical review of the overhaul activities as conducted on the Metra Cab Car. This technical review effort was, among other activities as described, specific to identifying compliance with applicable FRA regulation [upon undergoing an overhaul activity], the data of which was incorporated in the Field Notes Report of the post-recovery inspection activity.[56]

Correspondingly to the above activity, the Volpe Center investigative team made a copy of the Volpe Center - Field Notes [documentation / report] available to the Crashworthiness investigation, as provided in Exhibit 6.

E. **Authorship**

Compiled by: // s // Date Oct. 04, 2022
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Crashworthiness – Technical Working Group Chairperson
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Supervisory review: // s // Date Sept. 28, 2022
Robert J. Beaton, Ph.D., CPE
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List of Exhibits

1. Annotated segment of a USGS topographic (survey) map

2. Summarized technical specifications of the Metra commuter train equipment

3. Content list of engineering drawings and technical specifications of Cab Car 8473, and its components

[55] Ref, emails of the Crashworthiness Group Chair, to the FRA Party participant, and FRA coordinating / technical support staff, dated 05/15/2022, to 09/19/2022, inclusive.

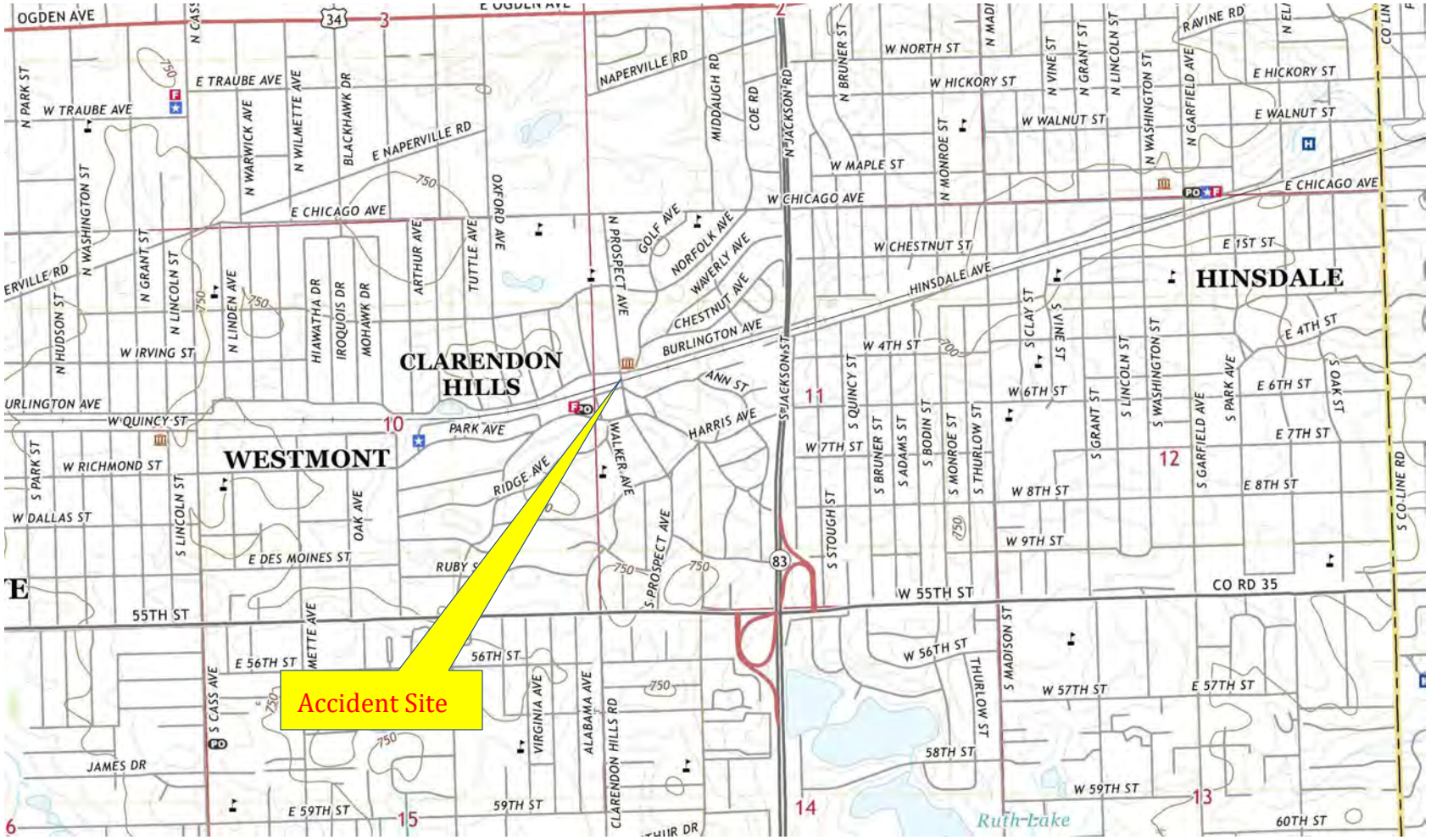
[56] Data that addresses the railcar overhaul activity is provided in pages 3 – 5, inclusive, of the Volpe Center investigative team - Field Notes Report.

4. Engineering drawing, describing the floorplan of a Metra ‘Cab Car’ [coach railcar], as involved in the accident

5. Annotated aerial imagery [map], describing the wreckage distribution in the wreckage debris field

– End of Exhibits List –

Exhibit 1. Annotated Segment of USGS Topographic (Survey) map, Proximate to Accident Site[1, 2]



[1] Excerpt from United States Geological Survey (USGS) topographic survey map, [map ref] Hinsdale Quadrangle (Illinois), [dated] 2021 (7.5 Minute Series, original scale 1:24,000); ref, and for further information, see [Internet] https://ngmdb.usgs.gov.

[2] Annotation by NTSB (SF Group Chairperson) to describe approximate accident site location.

Exhibit 2.

Summarized technical specifications of the Metra commuter train equipment

Contents

- Cab Car # 8473 specification summary and history sheet
- Specifications for the Construction of New Passenger Equipment Cars, Standard, S-034-69, (Adopted 1939; Advanced To Standard, 1945; Revised, 1967, 1969)
- Amerail As-Built Specification, Built for Metra, for Gallery Type Push-Pull, Commuter Cars, [dated] April 8, 1998

Car #: 8473

Builder: Amerail/Nippon Sharyo

Year Built: 1997

Built in compliance to latest revisions of applicable sections of Title 49 Code of Federal Regulations (49 CFR) Parts 38 and 200 to 236

The structural members of car framing are made of type 301L stainless steel (1/4 hard & ½ hard) & side sheathing is constructed of 301L stainless steel ½ hard.

All parts of the structure of the car in compliance with the requirements of the AAR specifications for the construction of new passenger cars. Buff loading of 800,000pounds was resisted without permanent deformity.

No major accidents or major structural repair work in car 8473 prior history.

Car Overhaul History: Performed January, 2014 at Metra Rock Island District 47th Car Shop

Metra's overhaul work scope includes the following:

- Overhaul of 26-C airbrake system
- Rebuild trucks
- Install new wheelchair lifts
- Replace interior flooring with new composite flooring
- Install all new passenger windows
- Install new seats that meet all the regulatory requirements of Title 49 CFR Part 238.223 and APTA standard SS-C&S-016-99, Rev. 2
- Upgrade interior lighting to comply with latest APTA standards
- Install sensitive edges on all side loading doors, replace existing door system in-kind
- Rebuild HVAC units
- Replace all decals/signage with new to include LLEPM
- Install Electrical outlets - Lower Level
- Install Passenger Emergency Intercom (PEI)
- Replace existing LED scrolling signs with new

Periodic Maintenance History

Cab car 8473 is subjected to the following inspections per FRA regulations:

- 229 & 238 Daily Inspections – Last performed on May 10, 2022
- Periodic Inspection
  - 229 – Last performed on April 12, 2022 (Previous was 10/14/2021) (OOS time from 1/13/2022 to 4/12/2022)
- 184-day Semi-Annual Inspection
  - 229 – Last performed on April 12, 2022
  - 238 – Last performed on April 12, 2022 (Previous was 7/15/2021) (OOS time from 1/13/2022 to 4/12/2022)
- Annual Inspection
  - 229 – Last performed on April 12, 2022 (Previous was 1/14/2021) (OOS time from 1/13/2022 to 4/12/2022)
  - 238 – Last performed on April 12, 2022
- Quadrennial (229) Cab Air Brake Inspection – Last performed on April 12, 2022 (Previous was 1/18/2018) (OOS time from 1/13/2022 to 4/12/2022)
- COT&S (238) Inspection -Last performed on April 12, 2022 (Previous was 1/18/2018) (OOS time from 1/13/2022 to 4/12/2022)

SPECIFICATIONS FOR THE CONSTRUCTION OF NEW PASSENGER EQUIPMENT CARS

Standard

S-034-69

Adopted 1939; Advanced to Standard, 1945; Revised, 1967, 1969.

PREFACE

The specifications have been prepared on the basis that they will be used for structural design of future new equipment and that the requirements laid down therein will not be retroactive into equipment now in service which has been built to former accepted specifications.

BASIC FUNDAMENTALS, NEW SPECIFICATIONS

The Railway Mail Service Specifications as revised July 20, 1938, were used as the basis for these specifications which provide for cars which my be used in trains of over 600,000 pounds light weight made up of cars of any type of construction now being operated.

The Committee's review of the latest Railway Mail Service Specifications resulted in the preparation of these specifications in such a way as to more definitely establish the strength values at various locations in the car, as follows:

(a) Trucks are required to be locked to the car body. This is for the purpose of obtaining the value of the weight of the truck plus the shear value of the truck attachments to the car body under abnormal accidental impacts.

(b) A car structure which resists minimum static end load of 800,000 lbs. applied on center line of draft without developing any permanent deformation in any member of the car structure. The minimum static end load of 800,000 lbs. was derived from a 400,000 lb. design load with an approximate factor of safety of 2. In meeting this requirement, it is important that vertical deflection be kept to a minimum.

Note:—As a guide in design, it is recommended that, for materials and forms of construction now used, the maximum vertical deflection measured at center of car and based on distance between truck centers should not exceed 1 inch. Normal vertical deflections for cars having approximately 60 ft. distance between truck centers range from ½ to ¾ in. for steels and different forms of steel constructions.

(c) Cars must be designed to resist a horizontal load of 500,000 lbs. applied on the buffer beam at a point 12 in. above the center line of draft. This static load was, derived from a 250,000 lb. design load employed in cars built to Railway Mail Service Specifications with an approximate factor of safety of 2.

(d) Vertical strength requirements have been assigned to the buffer beam construction, the anti-climbing arrangement, and the coupler carrier arrangement. All these parts are to be designed to resist vertical loads of 100,000 lbs. These requirements are to resist coupled car ends from moving vertically with respect to each other under abnormal accidental impacts.

(e) The two main vertical end members are required to have an ultimate shear value of not less than 300,000 lbs. each at a point even with the top of the underframe to which they are attached. This requirement was included to establish definite strength values at these points.

SECTION 1—SCOPE

Application

(a) These specifications have been prepared on the basis that they will produce passenger cars suitable for use with cars of all types of construction now in service and built in accordance with Railway Mail Service Specifications, with the result that new and existing cars will satisfactorily operate together with maximum protection under all conditions of service. These specifications provide that static end loading shall be applied through center line of draft but must not be construed as requiring the application of end loading on the center line of draft of existing cars constructed to Railway Mail Service Specifications.

(b) These specifications shall cover all new passenger equipment cars to operate in trains of over 600,000 pounds light weight.

SECTION 2—MATERIALS

(a) All strength members of cars shall be of all-metal construction.

(b) Where steel is specified, other approved materials producing equivalent strength of design may be used.

(c) Where “approved materials” are referred to in this specification, it shall be understood same refers to Association American Railroads’ standards or equivalent.

(d) Castings may be used as parts of the strength members. Such castings having a carbon content of .25% and over must be annealed.

(e) Where built-up welded metal parts are substituted in place of castings the unit is to be stress relieved before application.

(f) Any structural material in which the yield strength exceeds 80% of the tensile strength shall not be used except structural material not meeting this criterion and approved by the A.A.R. Committee on Freight and Passenger Car Construction may be used.

SECTION 3—WORKMANSHIP

All workmanship throughout the car shall conform to the best state of the art.

SECTION 4—LOADS

The car body shall be designed to carry its own dead weight in addition to the maximum specified live load under service conditions.

SECTION 5—TRUCKS

(a) Trucks may have either built-up metal or cast frames and may be either four or six-wheel type. All truck details and requirements shall be in accordance with the practice of the Association of American Railroads and the railroad for whose service the cars are built.

(b) The trucks shall be locked to car body. Strength of locking means shall be not less than the equivalent of an ultimate shear value of 250,000 lbs. and so arranged that the entire truck will lift with the car body without disengaging the center plates. The details of the attachments shall be such as to develop the full tensile strength of the connection.

SECTION 6—BUFFING

(a) The car structure shall resist a minimum static end load of 800,000 lbs. at the rear draft stops ahead of the bolster on the center line of draft, without developing any permanent deformation in any member of the car structure. In meeting this requirement, it is important that vertical deflection be kept to a minimum.

Note:—As a guide in design, it is recommended that, for materials and forms of construction now used, the maximum vertical deflection measured at center of car and based on distance between truck centers should not exceed 1 in.

Normal vertical deflections for cars having approximately 60 ft. distance between truck centers range from ½ to ¾ in. for steels and different forms of steel constructions.

(b) The resistance of the center sills shall be based on a design end load of 400,000 lbs. applied along the longitudinal center line of the car at a point midway between the center line of draft and the center line of buffer. This resistance shall be taken by the center sill construction only.

(c) The center sill construction may be considered as supported against deflection vertically and horizontally by the car body to the extent that the strength of the superstructure, cross-bearers and attachments are available for this purpose.

(d) The design stress in the center sill construction shall be determined by the following formula and shall not exceed that shown in Section 20 and modified by column and stability formulae in Section 20:

$$\text{Stress (Lbs. per sq. in.)} = \frac{\text{400,000 lbs.}}{\text{Area (sq. in.)}} \text{ + or - } \frac{\text{eccentricity (inches) x 400,000 lbs.}}{\text{Section modulus}}$$

(e) The stress due to eccentric moment from the above formula may be reduced to the extent that the car body is made available to resist this moment.

(f) Cars must be designed to resist a horizontal load of 500,000 lbs. applied along the longitudinal center line of car at a point on the buffer beam construction 12 inches above the center line of draft without developing any permanent deformation in any member of the car structure. The application of this load must not be distributed over an area greater than 6 inches x 24 inches.

(g) The buffer beam construction shall be designed to resist a vertical upward thrust from the coupler shank of 100,000 lbs. for any horizontal position of the coupler without exceeding the yield point of the construction or of its connections to the car structure.

(h) An anti-climbing arrangement shall be applied at each end, designed so that coupled cars under full compression shall mate in a manner which will resist one car from climbing the other. This arrangement shall resist a vertical load of 100,000 lbs. without exceeding the yield point of its various parts or its attachment to the car structure. Tight-lock couplers, if used, shall be considered as meeting this requirement.

(j) The coupler carrier and its connections to the car structure shall be designed to resist a vertical downward thrust from the coupler shank of 100,000 lbs. for any horizontal position of the coupler, without exceeding the yield points of the materials used. When a yielding type of coupler carrier is used an auxiliary arrangement shall be provided, designed in accordance with these requirements.

SECTION 7—DETAILS

(a) All connections, except those specified in Section 18 for end construction, shall be designed for the combined loads imposed upon them with stresses not to exceed those specified in Section 20.

(b) The distance between centers of rivet holes shall be not less than 3 diameters of the rivet and not more than twenty-four times the thickness of the thinnest outside member. In all cases, care should be exercised to provide sufficient shearing and bearing area for the stresses involved and to guard against local failure between rivets. The minimum distance between the center of the rivet role and a sheared edge shall be not less than one and one-half times the diameter of the rivet, or where the load acts against the edge of the sheet this edge distance shall be increased, if necessary, to develop the strength of the rivet.

(c) The use of fillers in the underframe and superstructure shall be avoided, whenever possible.

(d) All holes for rivets or bolts in the underframe, superstructure, or outside finish shall be drilled or punched and reamed to size and fairness. No drifting of holes will be allowed. In deducting rivet or bolt holes to obtain the net area of any section they shall he taken at 1/16 inch larger than the diameter of the rivet or bolt. The effective area of a rivet may be taken as its area after driving.

(e) All rivets when driven must completely fill the holes and have full concentric heads.

(f) Welding which develops the required strength of the member or connection may be used in place of riveting.

SECTION 8—CENTER SILLS

(a) Unit or built-up sills may be composed of rolled, extruded, or pressed shapes, either with or without cover plates.

(b) A center sill of unit construction is defined as a structural member formed of one piece or of two or more pieces joined by an approved method so as to produce the equivalent of a one-piece construction.

(c) Cast draft sills or end construction may be used with any of the above types, with adequate connections at splices. When flange angles are used, they shall be connected to the webs so as to transfer the total shear at any point in a distance equal to the effective depth of the sill at that point. When cover plates are used, they must extend at least two rows of rivets at each end beyond their theoretical length or equivalent when welded.

SECTION 9—BOLSTERS AND CROSS-BEARERS

The body bolsters and cross-bearers must be provided with ample connections at center and side sills to transmit the calculated vertical shear.

SECTION 10—FLOOR BEAMS

Transverse floor beams may be rolled, extruded, pressed, or built-up shapes, with suitable connections at center and side sills.

SECTION 11—FLOOR SUPPORTS

Longitudinal floor supports when used shall be supported at each transverse floor member.

SECTION 12—END SILLS

The end sills my be either of rolled, extruded, or pressed shapes, built-up or cast construction with ample connections at center and side sills. They must be designed for the maximum vertical loads to which they may be subject and also for the assumed horizontal loads transferred from vertical end members as specified in Section 18.

SECTION 13—COUPLERS AND DRAFT GEARS

Details of the coupler and draft gear must conform to the practice of the railroad company for which the cars are built.

SECTION 14—BUFFING MECHANISM

Details of the buffer and buffing mechanism when used stall be in accordance with the practice of the railroad company.

SECTION 15—LONGITUDINAL FRAME OR TRUSS FRAMING MEMBERS

In calculating the stresses in side frame, its effective depth when designed as a truss or girder may be taken either as the distance between centers of gravity of side plate and side sill or as the distance between centers of gravity of bottom and top chords of the girder. In the latter case the bottom member may be taken as the section comprising side sill, belt rail, and intervening side sheet; the top member may include side plate and letter board, provided corrections are such that all members will act together. Piers connecting the top and bottom chords above described must be of sufficient strength to withstand the shear loads imposed upon them, with stresses not to exceed those specified in Section 20. At side door openings the bending moment caused by the vertical shear at door posts shall be considered as being resisted by the section above and below door opening, and the sum of the direct stresses and those due to bending at such sections shall not exceed the stresses specified in Section 20. A sufficient proportion of all reinforcing members added to these sections shall be extended far enough beyond the door posts at each side to transmit their reactions to the side frame without exceeding the limit specified for stresses. The roof and underframe systems my be considered as load carrying members to the extent of their connection to the side frame.

SECTION 16—SIDE POSTS AND BRACING

(a) For girder construction or truss construction the sum of the section moduli about a longitudinal axis, taken at the weakest horizontal section between side sill and side plate, of all posts and braces on each side of the car located between the body corner posts shall be not less than 0.20 multiplied by the distance in feet between the centers of end panels.

(b) For girder construction only the sum of the section moduli, about transverse axis, taken at the weakest horizontal section between side sill and side plate, of all posts, braces and pier panels, to the extent available, on each side of car located between body corner posts shall be not less than 0.20 multiplied by the distance in feet between the centers of end panels.

(c) The center of the end panel is to be considered as the point midway between the center of the body corner post and the center of the adjacent side post.

(d) Side frame members shall also meet the stress requirements of Section 20.

SECTION 17—SHEATHING

(a) Outside sheathing of mild open-hearth steel when used flat without reinforcement (other than side posts) in a side frame of girder construction must be not less than 1/8 inch nominal thickness. Other metals may be used of a thickness in inverse proportion to their yield strengths.

(b) Outside metal sheathing of a lesser thickness may be used provided it is reinforced so as to produce at least an equivalent sectional area at right angle to reinforcements as flat sheathing specified above.

(c) For truss construction where sheathing serves no load carrying function, minimum thickness shall be not less than 40% of that specified above.

SECTION 18—VERTICAL END MEMBERS

(a) The sum of the section moduli of all vertical end members at each end of the car shall be not less than 65.

(b) The outside end of each car shall be provided with two main vertical members, one at each side of the diaphragm opening. Each of these members shall have a section modulis of not less than 24.375. Each main member shall also have an ultimate shear value of not less than 300,000 lbs. at a point even with the top of the underframe member to which it is attached. The attachments of these members at bottom shall be sufficient to develop their full shear value.

(c) This shear value shall he based on the area of the web, which is the depth of the member times the web thickness times the shear strength of the material used.

(d) If reinforcement is used to provide the shear value such reinforcement shall have full value for a distance of 18" up from the underframe connection, then taper to a point approximately 30" above the underframe connection.

(e) The attachment of the vertical members at the top shall be adequate to resist without failure the reactions of the members, without shear reinforcements, when assumed to be simple beams with free supports at their ends and loaded at a point 18" above the connection to the underframe member to which they are attached with a load sufficient to develop the yield point of the material.

(f) The remaining vertical end member requirements shall be distributed in the body end of the car. The attachments of these members at bottom shall be sufficient to develop their full shear value. The attachments at the top shall be determined in the same manner as proscribed above for the main end members.

(g) For cars having open end observation platform, the end construction of car body shall be as described above and in addition there shall be two stub end members, located similarly to main vertical members on end of platform extending to top of railing. These members shall have same shear strength value as the two main vertical members.

(h) Cars with large end doors to which the foregoing requirements of this section do not apply, shall be considered to meet these specifications if the doors and attachments are sufficient to develop a shear resistance equivalent to the main members described above.

(j) The top reaction of all vertical end members may be delivered to the roof of car or to a truss, girder or brace construction extending across the car. The structure employed must be adequate to transmit reactions from the posts to the side framing of the car.

SECTION 19—ROOF

(a) The projected area of the portion of the roof in square feet supported by carlines divided by the sum of the section moduli of the carlines at any section must not be more than 60.

(b) Flat roof sheets of mild open-hearth steel without reinforcements shall be of a minimum thickness of .05 inches, adequately attached to the roof framing.

(c) Metal roof sheets of a lesser thickness my be used provided they are reinforced so as to produce at least an equivalent sectional area at right angle to roof sheets specified above.

SECTION 20—STRESSES

(a) All structural members shall be so designed and proportioned that the sum of the direct stresses to which each is subject shall not exceed those stated in table below, except as modified by Section 18:

UNIT DESIGN STRESSES TO BE USED FOR ROLLED MILD OPEN-HEARTH STEEL

Center Sills	Unit Construction	Other than Unit Construction	Side Sills and Framing Members	Bolsters
Tension	19, 200	16, 000	16, 000	12, 500
Compression	19, 200	16, 000	16, 000	12, 500
Shear	12, 000	12, 000	10, 000	8, 000
Rivets Shear	12, 000	12, 000	10, 000	10, 000
Bearing	24, 000	24, 000	20, 000	20, 000

The total combined stress in any structural members, except center sills, may exceed the above figures by not more than 20%.

(b) Axial compression stresses in members, or elements of members, must not exceed those allowed by the following column and stability formulae:

For $\frac{L}{r} \leqq \pi\sqrt{\frac{2E'}{F}}$ then

$$\frac{P}{A} = F - \frac{F^2}{4\pi^2 E'} (L/r)^2 \text{ pounds per square inch}$$

For $\frac{L}{r} > \pi\sqrt{\frac{2E'}{F}}$ then

$$\frac{P}{A} \frac{\pi^2 E'}{(L/r)^2} \text{ pounds per square inch}$$

These formulae give a nominal safety factor of 2.0 for reasonably restrained end condition.

L = length of column center to center of connections, inches.
r = least radius of gyration of column cross section, inches.
E' = Secant modulus of elasticity as derived from the tensile stress-strain curve.
F = maximum allowable unit stress from table above.
P = axial load (concentric), pounds.
A = area of column cross section, square inches.
π = 3.1416, constant.

Stresses described above as maximum allowable are contingent upon the ability of webs and flanges to resist these stresses without buckling.

(c) For compression in the plane of any flat plate used as an element in the section the ability to resist buckling shall be checked and determined by substituting the following equivalent slenderness ratios in the formula applicable to the entire column:

For outstanding flanges: (Flat plates supported along one edge in the direction of stress) L/r = 5.0 b/t.

For other than outstanding flanges: (Flat plates supported along both edges in the direction of stress)

$$L/r = 1.8\ b/t.$$

b = flat width at right angle to direction of stress, inches.
t = thickness, inches.

The constants 5.0 and 1.8 in the above expression for the equivalent L/r give a nominal safety factor of 2.0 on reasonably restrained edge condition. Constants between these may be selected depending upon the shape of the member and connections used.

(d) Where metals other than mild rolled open-hearth steel are used, the car structure must be at least equal in strength to the stated specification requirements. The maximum allowable stresses shall bear the same relation to the stresses tabulated in this Section, as the yield strength of the metal used has to the yield strength of mild open-hearth steel, which for this comparison shall be taken as 32,000 pounds per square inch, but in no case, except bearing, shall the maximum allowable stress exceed 40% of the minimum tensile strength of such material. Cast metals shall be compared on same basis an structural metals; but the allowable tensile stress shall be limited to 80% of that allowable for rolled materials.

(e) Where minimum section moduli or thickness are specified they shall be adjusted in proportion to the ratio of the yield strength of the metal used, to that of mild open-hearth steel.

(f) Where yield and shear loads are specified the size of members shall be based on the yield or ultimate shear strength of the materials employed.

SECTION 21—SUBFLOOR

The entire car shall have metal subfloor, flat or corrugated.

SECTION 22—INSULATION

Insulation used must be such that it will not support combustion, will not absorb moisture beyond its own weight, and when wet will not cause corrosion.

SECTION 23—VESTIBULE DOORS

Vestibule doors, exterior and interior, must be of sliding or other types which do not open inwardly or outwardly and can be operated in emergency from inside the car.

SECTION 24—EMERGENCY SASH UNITS

Emergency escape sash, minimum of four per car and 18" x 24" minimum size, to be provided in each car at readily accessible locations, designed so that sash cannot be dislodged except by manual operation.

SECTION 25—WRECKING TOOLS

Wrecking tool cabinet, one per car, to be located in a conspicuous place in the main body of the car and to be easily accessible, avoiding location behind doors, etc. Cabinet to have 1/8" thick glass in door and to be equipped with one (1) six pound sledge and one (1) four and one quarter pound axe.

SECTION 26—EMERGENCY LIGHTING

Emergency lighting must be provided in vestibules and throughout aisles and passageways, of sufficient number and wattage to adequately illuminate car interior for safe exit. Emergency lighting to consist of an auxiliary light housed in standard lighting fixtures or in supplementary fixture and is to come on automatically if the main power fails. Power source for emergency lighting to be car or other batteries.

AMERAIL

AS-BUILT SPECIFICATION
BUILT FOR METRA

FOR

GALLERY TYPE PUSH-PULL

COMMUTER CARS

APRIL 8, 1998

COMMUTER CARS

TABLE OF CONTENTS

COMMUTER CARS

GENERAL

This specification covers a gallery type passenger car, with two levels, having seats on both levels, to be used in push-pull type passenger service transporting passengers in the greater Chicago Metropolitan Area and its environs. The cars are operated in the service of Metra, by, and over the property of the various railroads conducting train operations for Metra, in trains of from one to twelve cars.

Cars constructed are compatible in every respect with:

1) Metra's existing locomotives
2) Metra's existing gallery cars
   Series 7200-7300 trailer cars
   Series 8200 cab cars

The cars are built in accordance with the requirements described in this specification, and provide a safe, comfortable ride at all speeds up to and including 100 miles per hour, on trackage meeting appropriate standards of the United States Department of Transportation, Federal Railroad Administration.

The maximum operating speed of a locomotive hauled train is 79 MPH with the maximum number of cars in a train governed by the locomotives HEP system which can support 12 cars.

COMMUTER CARS

ABBREVIATIONS AND DEFINITIONS USED IN THE SPECIFICATION

A.A.R.	Refers to the Association of American Railroads
A.I.S.I.	Refers to the American Iron and Steel Institute
A.N.S.I.	Refers to the American National Standards Institute
A.S.T.M.	Refers to American Society for Testing Materials
B.N.R.R.	Refers to the Burlington Northern Railroad
C&N.W.T.C.	Refers to the Chicago and North Western Transportation Company
F.R.A.	Refers to the Federal Railroad Administration of the United States Department of Transportation
I.D.O.T.	Refers to the Illinois Department of Transportation
I.C.D.B.	Refers to the Illinois Capital Development Board
Metra or NIRC	Refers to the Commuter Rail Division of the Regional Transportation Authority.
N.T.S.B.	Refers to the National Transportation Safety Board.
R.T.A.	Refers to the Regional Transportation Authority.
Approved	Indicates that the builder must seek specific approval from purchaser before proceeding with the design, acquisition or installation in question.
Builder	Refers to American Passenger Rail Car Company (Amerail)
Manufacturer, or Vendor	Refers to the manufacturer of one or more components to be applied to the subject cars during the work performed under this specification.
Purchaser	Refers to Metra.
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 builder.

COMMUTER CARS

SECTION ONE: BASIC PARAMETERS

1.a General Requirements

The cars are built in accordance with the latest recommended practices of the A.A.R., I.D.O.T., and with the latest revisions of applicable sections of Title 49 Code of Federal Regulations (49 CFR) Parts 38 and 200 to 236. The cars also conform to the latest requirements of the United States Public Health Service, and to applicable regulations of the States of Illinois, Indiana and Wisconsin.

The cars can be, in emergency situations, coupled to other conventional passenger cars, except that provision of hotel power and locomotive control trainline, and car control trainline features shall not be required.

The exterior of the cars are of corrugated stainless steel (except in window areas), not painted.

The weight of the trailer car is 117,900 lbs.

1.b Car Quantities and Identities

Ninety-eight (98) commuter cars were provided to Metra, built to this specification.

1.c Seating Capacity

The subject cars carry 146 seated passengers with no wheelchairs or 139 passengers with 3 wheelchair positions occupied.

1.d Crush Passenger Loads

All cars have a capacity for 100 standing passengers, dispersed over both levels of the interior. The total Crush Passenger load is based on 100 standing passengers and a full seated load, at 155 pounds per passenger.

SECTION TWO: DIMENSIONS AND CLEARANCES

The principal dimensions and dimensional requirements are as follows:

Coupled Length:	85' - 0"
Width of Car:	
Inside Clear Width (Prior to application of moulding and carpet)	9' - 3"
Extreme Width (over side handholds)	10' - 4 3/32"
Extreme Width (over sill steps)	9' - 9"
Extreme Height above top of rail	15' - 11"
End Platform Height above top of rail	4' - 3"
Centerline of Coupler Height above top of rail	2' - 10 1/2"
Track Gauge	4' - 8 1/2"

The cars, when coupled, are able to negotiate a 250 foot radius curve, and a No. 8 crossover, having 12' - 2" track centers. The cars are constructed so that when fully loaded, the center of the car shall not deflect below zero camber, nor have more than 3/4" symmetrical camber between bolsters, when light.

The cars, and all appliances, conform to the clearance outlines of the following carriers, for service within Metra's jurisdictional area and other areas served by Metra:

- Amtrak
- Burlington Northern
- Chicago & North Western
- Chicago & Western Indiana
- Chicago South Shore & South Bend
- Consolidated Rail Corporation
- Illinois Central
- Metra
- Norfolk Southern

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

Bottom of vestibule threshold	1' - 2 5/16"
Truck parts	0' - 2 1/2"[1]

SECTION THREE: INSPECTIONS AND TESTS

3.a Inspection

Inspections of the first article produced, were conducted of the following components and assemblies: axles; wheels; truck frames; truck bolsters; couplers and coupler parts; coupler yokes; draft gear; air conditioning units; seats; control equipment, including door controls, climate controls, lighting; batteries; battery chargers; air brake equipment; toilets.

3.b Tests

Each car successfully passed the following tests conducted in accordance with standard test procedure:

a. **Car Water Tightness Test (shell and complete car)**

b. **Air Brake System Functional Test**

c. **Electrical and Car Wiring Test**

d. **Handbrake Test**

e. **Water System Test**

A running test was performed on each car, consisting of operation at varying speeds and under varying conditions. During this test all car subsystems were operated. These tests were conducted on Metra's property.

SECTION FOUR: STRUCTURAL FRAMING

4.a General

The cars are constructed of stainless steel, with integral longitudinally corrugated sides and roof. Flat sheets are used in the window areas with longitudinally corrugated sheets used in the other location. The entire structure, except for the end underframes, is stainless steel. The end underframes are of low alloy-high tensile steel.

The structural members of the car framing are made of the American Iron and Steel Institute Type 301L stainless steel with carbon content not exceeding 0.03% or equal. The roof, side frames, underframe and end frames consist of 301L -1/4 hard stainless steel with an ultimate tensile strength of 125,000 PSI and 301L - 1/2 hard stainless steel with an ultimate tensile strength of 150,000 PSI. Trhe side sheathing and roof sheathing is constructed of 301L stainless steel 1/2 hard (150,000 PS). All non structural stainless steel parts are composed of 304L annealed, or equal , with an ultimate tensile strength of 80,000 PSI.

All parts of the structure of the car equal or exceed the requirements of the A.A.R. Specification for New Passenger Equipment Cars and other applicable specifications. Buff loading of 800,000 pounds was resisted without permanent deformity.

4.b Roof

The main portion of the roof is covered by corrugated stainless steel sheets, secured by spot welding to the stainless steel carlines. All parts of the roof have sufficient strength to support concentrated loads of 250 lbs., applied 30 inches apart in a 12" x 4", area without permanent deformation.

4.c Sides

The corrugated and the flat window area stainless steel side sheets are secured to the side posts and other side structural members by spot welding. Any exterior exposed welds made by a spot-welding process are arranged in regularly spaced patterns and are minimally visible.

4.d Ends

The car end structure is 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. The end collision posts is made in accordance with A.A.R. standard S-580 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. The welding of collision posts to the buffer sill carries the end reaction developed by the collision post under the above loading. The torsional strains developed in the collision post are resisted by the buffer sill, and a transverse beam constructed into the end frame.

The exterior face of the car ends is constructed of stainless steel spot welded to the structural members. The end sheets are corrugated applied vertically. The sheets and supporting structural members combine to have an equivalent strength as 1/2 in steel plate at 25,000 psi yield strength per AAR standard S-580. The corner posts have an ultimate horizontal shear strength of 150,000 pounds.

4.e Vestibule

The walls and ceiling of the vestibule is constructed of unpainted stainless steel. The floor and steps are covered with stainless steel diamond pattern plates welded directly to the top of the floor structure.

4.f Underframe and End Underframe

The center sill and the underframe construction conforms to the latest recommended practices of the A.A.R. and the N.T.S.B. The draft sill arrangement and coupler permits satisfactory operation when cars are coupled to existing Metra cars.

Fusion welding of one sided joints in the fabrication of the end underframe incorporates the use of backup strips where 100% penetration of a single bevel weld is desired. The single bevel weld are also reinforced by the application of an additional fillet weld where joint strength requires it. All welds were inspected in accordance with the builder's quality control plan.

COMMUTER CARS

SECTION FIVE: SAFETY APPLIANCES AND INTERIOR HANDHOLDS

5.a General

All safety appliances and interior handholds comply with the requirements of the F.R.A., A.A.R., N.T.S.B., and with applicable state laws of Illinois, Indiana and Wisconsin.

5.b Side Sill Steps

Side sill steps are installed at each corner of each car, along with lower side sill. Side sill steps are of forged stainless steel with a satin finish, and are applied with stainless steel bolts. Stepping surfaces of sill steps have a mechanically applied anti-skid pattern.

5.c Handholds - Exterior

Handholds finished ground size are 5/8" minimum diameter, type 302 stainless steel rod, given polishing treatment after forging to remove burrs, surface defects and discoloration and applied with stainless steel bolts or cap screws. The following handholds are installed on the outside of car:

i) Two (2) vertical handholds at each center vestibule door opening;

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

iii) Two (2) horizontal handholds on each end of each car at approximately 44" above top of rail on each side of coupler;

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

5.d Stanchions and Safety Railing - Interior

The center vestibule area, immediately adjacent to side doors, is divided into two (2) bays by a "H" configuration assembly comprised of two vertical stanchions connected to each other with an appropriately angled handrail. The stanchions and handrails are tubular stainless steel 1 1/4" in diameter.

The upper galleries have an arrangement of continuous railing, supported, by vertical members of stanchions extending between carlines and gallery floor. The railings and stanchions material are aluminum.

COMMUTER CARS

These gallery railing assemblies have a decency panel to prevent spillage of items from edge of the gallery.

Additional rails are installed between the railing and the decency panel to prevent a small child from falling through to the lower level.

The gallery stairwells have a vertical full height continuous handrail. The side wall of each stairwell is equipped with an angled handrail.

SECTION SIX: FRAMING SPECIALTIES

6.a Draft Gear

Both ends of the car have one (1)twin cushion rubber draft gear, Hadady Part No. #655.

6.b Couplers and Yokes

Each end of each car is equipped with one (1) coupler and one (1) yoke.

The standard "H" tightlock coupler operating mechanism type No. 6, as per A.A.R. Manual of Standards and Recommended Practices, latest revision, for operation of the coupler from the left side of the car only, when viewing either end of the car from outside, is provided.

The coupler installed is Buckeye Steel Part No. C-13108. The yoke installed is Buckeye Steel Part No. C-8276.

c Coupler Carrier

Each end underframe is fitted with a coupler carrier, per Nippon Sharyo drawing B0331D54262, in accordance with A.A.R. Manual of Standards and Recommended Practices, latest revision.

6.d Buffing Device

The diaphragm face plate acts as a buffing device, and meets all horizontal loading requirements for a buffer beam contained in A.A.R. Specifications for New Passenger Equipment Cars. The car structure under the diaphragm is designed to resist the vertical coupler loads specified in the same A.A.R. Specifications.

6.e Jacking Pads

Eight (8) jacking pads are provided, one at both ends of each body bolster and one near each corner of the car body.

Reinforced lifting lugs are provided in the upper portion of each collision post in an approved manner, suitable for attaching gear for lifting with a wrecking derrick.

6.f Gutters

Rain gutters of stainless steel are provided over passenger side entrance doors. Baffles are placed at ends of the roof to

prevent flow of water from running off onto top of diaphragm.

6.g **Diaphragms**

A stainless steel face plate and an inner diaphragm is provided at both ends of the cars. The diaphragm is made of 2-ply, plastic coated fire and water resistant nylon belting, and is equipped with boots at the bottom to act as dust seals. The diaphragms are colored silver on the inside and outside. The complete buffer and diaphragm arrangement and suspension provide constant contact on coupled cars under all operating conditions encountered. The diaphragms are leaf sprung at the top, and the face plate dimensionally compatibility with Metra's existing cars. The diaphram assembly installed is Adams & Westlake Part No. DM-10029. The leaf spring is compatible with the spring rate of the existing diaphragm.

6.h **Vestibule Curtains**

A full height vertical curtain, Adams & Westlake Part No. 140293 is installed.

i **Tail Gates**

Hinged safety gate of stainless steel, Adams & Westlake Part No. P-314684 is provided at both ends of the cars.

6.j **Marker Lamp Brackets**

Requirement deleted.

6.k **Portable Rear Warning Light Brackets**

Portable rear warning light brackets are not provided.

6.l **Insulation - Body**

Thermal and acoustical insulation provided is in compliance with Sections 10, 11, and 12 of this specification. Insulation does not support combustion, does not absorb moisture beyond its own weight, and when wet, does not cause corrosion. Insulation is not subject to shaking down in long service. Insulation used is non-corrosive to aluminum and does not require special surface treatment of aluminum. Insulation provided is Fiberflex Duraflex Type 100 Thermal Insulation or Anco-Textrafine Type 100 Insulation.

All cars are 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 (except when fabricated from 1/8" thick diamond tread plate and/or when sound deadnener is exposed to exterior) is coated with Daubert Coating 368 or Nittoku Soundead, in accordance with manufacturers recommendations.

Insulation is applied per Nippon Sharyo drawing B0931B75490.

SECTION SEVEN: DOORS, SASH AND HARDWARE

7.a Exterior Passenger Entrance Doors

These are pneumatically operated bi-parting sliding type doors. Door panels are of stainless steel construction with aluminum Honeycomb core, one inch thick, internally reinforced and joined into an integral unit by resistance welding. The upper half has a window of clear 0.460" Lexan MR 5000 set in one piece, vulcanized, rubber glazing strips Clear light area in each door is 30 5/8" wide by 25 5/8" high. The doors slide in a straight line into door pockets placed on the inside of the side walls. Clear door openings are 6'-6 1/2" wide by 7'-6" high (from top of bottom step to bottom of door header). The door header provides 5'- 10" clearance over the wheelchair lift platform when in the raised position. Morton Part Nos. 105-326/327 are installed.

All exterior entrance doors and edges are thoroughy sealed against moisture ingress with Sika Flex sealant and door pulls are sealed with RTV #128. The threshold is designed with a raised diamond design to prevent passengers from slipping. The design of both threshold and door guides provide free drainage of moisture to the outside. Reference Nippon Sharyo drawings B0131B72944 and B0131B72945. Each door is equipped with a soft interlocking nosing rubber, Morton Part No. 628-151, mounted the full length of the leading edge. When the doors are closed the two nosing rubbers mate to form a weather-tight joint with a minimum width of four (4) inches. The rear weather-strip rubber, Morton Part No. 628-157, is used to seal the trailing edges of the doors when in a closed position.

The doors are supported from the top by means of a ball bearing type hanger/track assembly, Morton Manufacturing Part No. B106-185, and guided at the bottom in a manner providing freedom from rattles and squeaks.

Pneumatic door operating mechanisms are provided to operate the side doors. The force required to press the door back when the doors are closing is 25 lbs. The door operating mechanism are arranged to prevent scoring of the door leaf faces. Vapor door operating mechanisms are installed. Part Nos. are for the left door 59146581-10 and for the right door 59146580-10.

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

Adjustment is provided to enable these times to be maintained throughout the door operator life.

The door operator air reservoir is a standard 1,000 cubic inch, Wabco Part No. 520221, and is supplied from the main reservoir equalizing pipe through a charging check valve.

The passenger's emergency door opening device is located in a mount box on the vestibule wall to the right of both entrance doors. The door operating mechanism is enabled by releasing the air pressure at the emergency valve assembly, Vapor Part No. 59136582.

External employees access is by means of bleed valves, Vapor Part No. 58920665, which are adjacent to one door leaf on each side of the car. The bleed valves deplete the door operating mechanism air supply to permit manual opening, and when closed, allows the door operating air reservoir to recharge to reactivate the door air operating mechanisms. A recessed door pull is provided on each side of each door leaf.

The door closing warning system installed entails an advanced audio chime, Federal Signal Part No. 50GC-24VDC, and visual light assemblies, Vapor Part No. 59227617, located above the center of both door entrances. The warning system has a three (3) to four (4) second delay upon activation. Reference Nippon Sharyo Drawings C0431B76615 and C0431B76616.

7.b **Body End Doors**

Body end doors (lower level only) are manually opening and automatically closing sliding type, of stainless steel construction with aluminum Honeycomb core, and provided with a single glazed light of 0.460" Lexan MR 5000 or equal, into a door pocket, Morton Part Nos. 105-328 and 105-329. The light is set in one piece vulcanized rubber glazing strips. The light is clear on both the "A" and "B" end doors. Light opening is 19 5/16" wide and 28 3/8" high. The clear door openings are 28" wide by 6'-6" high. The dampened spring-return type door closing device, Vapor Part No. 56033792, is concealed but readily accessible for maintenance.

The doors are hung from the top by a ball bearing type hanger/track assembly, Morton Manufacturing Part No. B106-157, and guided in a threshold track of a self-clearing design,. Body end doors are lockable from either side only by Metra's standard coach key. Lock is Adams & Westlake Part Nos. P309173 and P309175.

COMMUTER CARS

A manually operated, rattle-free latching device, per Nippon Sharyo drawing C0331C75636 is provided such that when in use, the device holds the doors in an open position.

7.c **Toilet Room Doors**

The door from the passageway to the toilet room is sliding type, 1/2" thick and constructed of plymetal faced on both sides with stainless steel and suitably trimmed with a peripheral molding. The door is fitted with a grille to provide ventilation. The door is also be fitted with a locking passage set, J.L. Howard Part No. 2776. Door opens and closes manually. The door pull mechanism is in compliance with A.N.S.I. A117.1-1986. The clear door opening is 37" wide by 6'-4" high.

The passage set is lockable on the toilet side manually, and on the other side by Metra's standard coach key.

The locking passage set is the main door opening/closing device.

7.d **Electric Locker Doors**

The electric locker doors are hinged type, constructed of plymetal 1/2" thick, faced with stainless steel on both sides. Latches are pencil lock type, J.L. Howard Part No. 2069, except the A-1 locker which has a keyed lock, J.L. Part No. 2486, with a recessed door pull, J. L. Howard Part No. 2336, on the exterior face.

7.e **Vestibule/Carbody Doors**

Bi-parting, sliding type doors are located at each end of the center vestibule leading into the passenger compartments. When opened, each bi-parting door will slide into door pockets formed at each cross car partition. Clear door openings are 42" wide by 6'-9" high. Doors are sheathed on both sides with stainless steel. Left hand door is Morton 105-330 and right hand door is Morton 105-331.

Each door is single glazed with a fixed .25" thick clear Lexan MR 5000, or equal, set in a one piece vulcanized rubber or neoprene glazing strip, removable from the vestibule side of the door. Clear light area in each door is 12 5/16" wide by 28 5/16" high.

The doors are hung from the top by a ball bearing type hanger/track assembly, Morton Part No. C-106-184. The thresholds are of self-clearing design providing minimum obstruction for the movement of wheelchairs.

COMMUTER CARS

Door pulls, J.L. Howard Part No. 2942, are on both sides of each door and the meeting edges of the doors are provided with rubber nosing, Vapor Part No. 59020253.

The operator, Vapor Part No. 59146590, is air to open and spring to close. The door operating mechanism is locally controlled by push buttons, Vapor Part No. 57336697, located on both the compartment side and vestibule side of the doors. The control panels are located such that they may be operated by both ambulatory and wheelchair confined patrons. A sensitive edge mechanism, Vapor Part No. 59310401 is is provided in the door nosing to immediately reactivate the opening cycle upon striking any object.

7.f Control Station Doors

This section not used

7.g Side Windows - Coach Section

Windows are capable of withstanding external and internal pressure differentials caused by head-on pressures, and passing trains, while the cars are at maximum operating speed.

Each coach section has six (6) rectangular windows per level,per side, except for the B-end of the car which has four (4) rectangular windows on the toilet room side.

These windows are double glazed, set in one piece, continuous, rubber glazing strips and are removable from inside the car. The arrangement, J. T. Nelson Part No. R01A00135, utilizes 1/4" thick Lexan MR 5000, and is uniformly green tinted for approximately 22-25% light transmission outboard, clear inboard.

7.h Side Windows - Toilet Room

This section not used.

7.i Windshields - Control Station

This section not used.

7.j Sliding Side Sash - Control Station

This section not used

7.k **Weatherstripping**

Adequate weatherstripping is provided is provided to provice satisfactory seals at door openings, windows, etc., and at any other locations where airtight weatherproof conditions are required.

7.l **Mirror**

One (1) mirror of 1/4" coated polycarbonate, per Todco Drawing A-TS-131-007, is provided in each toilet room.

7.m **Hardware Fixtures**

Rubber bumpers are used as appropriate on all hinged doors to prevent rattling. All exterior and interior hardware is of unpainted white bronze or stainless steel . Hardware includes cases, handles, lock sets escutcheons and hinges.

7.n **Gallery Section Parcel Rack**

A continuous parcel rack constructed of plymetal 3/8" thick faced on both sides with stainless steel and with aluminum longitudinal retention type edging is located above the center aisle beneath the air distribution duct. The rack is supported on the gallery railing stanchions and is open between high galleries. The lower edge is covered by the communications speaker trough described in Section 8.c.

7.o **Lower Level Parcel Rack**

A continuous open type luggage rack, per Nippon Sharyo Drawing C2131B72578,is provided in each of the lower level coach sections and is located along the right side Gallery railing on the B-end and the left side on the A-end.

7.p **Escape Sash**

Eight (8) hinged escape sash are installed in each car, one on each side of each end, on both the upper and lower levels. The sash opens in an emergency with fifteen (15) pounds plus/minus three (3) pounds of force, but does not dislodge except through emergency procedure.

The escape sash is J.T. Nelson Part No. R01F0013.

Instruction on the procedures to open the escape sash are posted on each escape sash.

7.q Waste Receptacle

Two waste receptacles, one in each lower level passenger compartment is installed in each car. The stainless steel mounting brackets are installed on the A-1 locker door and the B-2 passenger side locker wall.

SECTION EIGHT: INTERIOR FINISH

8.a Interior Finish - General

The interior linings are attached to the structure by means of screwed molding of aluminum with a screw covering material insert.

The carbody floor is constructed of 3/4" thick plymetal, faced on both sides with stainless steel. The floor is adequately protected on the bottom by stainless steel floor pans.

8.b Side and End Finish

A formed panel made of fiberglass material meeting specified flammability and smoke emission standards. The panel is held in place by rubber glazing strips and separated from the melamine side lining surface by suitable tape or similar material. The panels abut at the center of the windows, and the joint are covered by a fiberglass batten.

The frieze panels are constructed of 1/8" unbalanced melamine.

The wainscot panels are 14 gauge aluminum.

The end bulkheads are aluminum faced plymetal.

Wainscot and end bulkhead walls are covered by carpeting. The carpet is tufted level loop Mohawk commercial carpet performers 28, with pattern "PFR281103" Carnival Red constructed of 100% solution dyed nylon equivalent to DuPont Antron-3, minimum of eight stitches per inch, 1/8 inch gauge with woven polypropylene or thermoplastic vinyl backing.

The end and side walls of the toilet room are lined with stainless steel.

The interior surface of all toilet room walls are lined with stainless steel.

Any area not conducive to melamine application is painted. Walls are Westinghouse Micarta with "string" color # 91M12.

Color strips are "Wilson Art" hollyberry D 307-6.

8.c **Headlining**

The headlining in the passenger occupancy sections is lined with molded faced melamine.

A hinged access panel is provided in the passageway ceiling under each plenum chamber for servicing of air filters.

The flat ceilings over the toilet room are formed of melamine plastic faced plymetal, and a hinged access door is provided in the toilet room ceiling for servicing or removal of the water tank.

The flat ceiling over the lower section seats and forming the bottom of the gallery floor is aluminum faced plymetal covered with melamine plastic. The floor side is covered with stainless steel.

The bottom section of the upper level air distribution ducts are aluminum faced 3/8" plymetal covered with melamine plastic, arranged with alternate fixed and removable panels for access for cleaning.

Hinged access doors and hinged access panels are provided with limit chains, safety catches and quarter turn locks. Two "T" type handles are provided per car.

The public address speaker trough is comprised of sides of aluminum extrusions and on the bottom of the aluminum faced plymetal, covered with the melamine plastic.

8.d **Partitions, Lockers, Etc.**

The partitions around the toilet room are constructed with melamine plastic faced plymetal.

The partition at the face of the lockers are constructed of melamine plastic faced plymetal.

The air duct at the stairways in the vicinity of the overhead heaters is constructed of stainless steel.

Stainless steel flashing is provided on the stair risers, the face of the gallery railing toward the seats and the panel under the gallery seat platform. The face of the gallery railing base on the center aisle side shall be melamine covered.

The gallery stairway side linings are stainless steel faced on the lower portion and melamine faced on the upper portion. The

gallery stairwell width is 23 inches.

The return air grilles are located on the face of the bulkhead at the upper level.

Two exhaust grilles are mounted in the side of the car near each end and one in the toilet room ceiling.

Electric locker doors are equipped with a perforated aluminum grille at the top and bottom to allow circulation of air.

Window sills are not provided.

A small underseat storage locker is installed under the seat against the stairway bulkhead in the "A" end of the lower level passenger compartment of all cars, on the left facing "B" end from the center of the car. The locker housing is constructed of stainless steel with a stainless steel hasp and keeper to accomodate a trainman's padlock. The latches are Southco Part No. 44-1-1-1. The locker storage space is suitably sized to house flagging equipment and a trainman's case.

Two underseat lockers are installed at the end of the "B" end lower level passenger compartment under both end wall seats. Both lockers are constructed of stainless steel with hinged access panels fastened with 1/4" turn Dzus fasteners.

SECTION NINE: FURNISHINGS AND EQUIPMENT

9.b Floor Covering

Smooth sheet rubber floor covering, 1/8" thick, R.C.A. Rubber Company Transit-Floor is provided in the lower passenger section, on the upper gallery floor and on the floor of the toilet room.

Ribbed sheet rubber floor covering, 3/16" thick, R.C.A. Rubber Company Transit-Floor is provided in the upper and lower levels.

Ribbed floor covering is RCA Rubber Company #766 darker grey utilized in aisles and #711 lighter grey smooth floor covering is utilized under seats.

Steps and landings of the stairways to the upper level, including the lower level landing and floor between the vestibule partition and the first seats are constructed of an anti-slip surface of stainless steel. All stair risers in vestibule and interior shall have the upper 4" covered by Yellow 3m Scotchlite reflective warning material, applied so to resist peeling. All vestibule and gallery step treads have a full length, 3 inch wide application of anti-skid material, Belzona Molecular Grip Co., on the outer edge.

9.c Decorations

All exterior exposed metal surfaces on the roof, sides and ends of the car, not of stainless steel, or other non-corrosive bright metal, are painted aluminum color.

Underframe equipment and underframe assemblies and trucks, except for wheel treads, axles, rubber parts, friction materials and wear liners, are painted aluminum color.

9.d Seating

Five types of seats are utilized in passenger compartments.

The first type, the two seat walkover (Coach & Car Part No. 3373200) is installed in the lower level compartments.

The second type, the two seat bulkhead (Coach & Car Part No. 3373230) is installed in the lower level compartments and the "A" and "B" ends of the upper level compartment, located at each of the end walls. These seats are in a fixed position and do not require inertial locks. Bulkhead seats are similar in appearance to the walkover seats, but have no arms.

The third type, the one seat low back bulkhead (Coach & Car Part No. 3373295) is installed on the upper level against stairway walls.

The fourth type, the flip seat is a spring-operated retractable seat installed on the upper levl compartments and wheelchair position area. The seat configuration varies in number of leg supports and mounting locations. The two passenger flip seats used on the upper level are Coach & Car Part Nos. 3373260 and 3373263. The three passenger flip seats used on the upper level are Coach & Car Part No.s 3373250 and 3373251.

The fifth type seat, the one passenger walkover (Coach & Car part no. 3389000), is similar to the two passenger walkover seat. It allows for either tandem in-line seating or for facing seat arrangements. It is also fitted with a stainless teel grab handle for passenger safety and ease of use. The seat is different in that it does not have armrests on the aisle side.

The wheelchair position has two passenger and three passenger flip seats built in accordance with Nippon Sharyo drawings C1131B78538, 539 and 540. Coach & Car Part Nos. are not applicable.

9.e Gallery Edge Protection

The aisle lower corner of the gallery shall be padded with a protective strip. This strip is fastened in such a way as to be easily replaceable, but shall not be unintentionally dislodged or removable by tampering. It is comprised of a core of an approved Neoprene/Neoprene based foam. The outer covering is blue Uniroyal Naugahyde upholstery material.

The step indentation below the gallery nearest the center bulkhead walls, receives a similar application.

9.f Fire Extinguisher

Each car is equipped with two (2) Ansul Model 11734 fire extinguisher, each mounted in a case with a clear polycarbondate front. Fire extinguishers are mounted one each in the B1 and A2 stairwells.

9.g Keys

Three hundred (300) Metra Standard Coach keys were provided. Two (2) appropriate keys were provided per car for any other locking devices used other than pencil locks.

9.h **Toilet Room**

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

1) One (1) retention type toilet, Monogram #25751-001.

2) One (1) soap dispenser made of standard white polyethylene soap globe(container),per Todco Drawing A-TS131-006.

3) One (1) roll type toilet paper holder, per Todco Drawing A-TS131-005;

4) One (1) towel dispenser,per Todco Drawing A-TS131-003;

5) One (1) soiled towel receptacle, stainless steel, per Todco Drawing A-TS131-004;

6) One (1),white bronze folding coat hook per "Adams and Westlake" drawing # BML4906.

7) One (1) mirror, per Todco Drawing A-TS131-07;

8) Two (2) handholds, chrome plated or stainless steel, per Todco Drawings A-TS131-001 and A-TS131-002;

9) One (1) stainless steel wash basin, with one spring loaded to "off" position type water tap and integrated drain plug, per Todco Drawing A-TS131-010.

10) One ionization sensor type smoke alarm. Fyrenetrics Part No. 1275.

9.i **Coat Hooks**

Folding coat hooks per Adams & Westlake Drawing BML-4906, mounted in pairs on each pier panel are provided at the lower level only.

9.j **Ticket Holders**

Stainless steel ticket clips without seat number, per Adams & Westlake Drawing BM-4087-2, are provided and mounted on the aisle side of the gallery decency panels and on top of lower level seatbacks.

9.k **Exterior Painting**

The roof, sides, ends and floor are constructed of unpainted stainless steel, except for the end underframe assemblies.

COMMUTER CARS

Parts under the floor or attached to the car which are constructed of metal other than stainless steel, such as underfloor equipment and designated truck parts, received one (1) color coat of Williams Hayward 9230, light bodied silver paint. The end underframe assemblies received one (1) coat of Williams Hayward 9230, light bodied silver paint on both the inside and outside surfaces.

9.l Exterior Signs

Metra's standard 12' x 2' stainless steel letter boards are applied over the upper corrugations. The background color is #108-17 3M Scotchlite blue.

The car number is applied to the lower level flat deadlight panel to the left of the side entrance doors, facing car from the exterior, using black Scotchlite reflective material. All numbers are ten (10) inches high, per Nippon Sharyo drawing H0131C76585.

An International Symbol of Accessibility complying with A.N.S.I. 117.1-1986, per Nippon Sharyo Drawing No. H0131C77790, is applied to the lower deadlight to the right of the side entrance door.

A stainless steel sign with the car number, 2" high, sand etched and painted black, per Nippon Sharyo Drawing Nos. H0131C76586 and H0131C76587, is provided on each body end door on both inside and outside, located immediately below the window.

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

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

9.m Interior Painting

Lockers A-1, A-2, B-1, and B-2 are finished inside with a top coat of white insulating paint, GEEP-1A primer and GEEP-2A white top coat or Pruett Schaeffer 27-2 red oxide fire resistant WB primer, 27-3 white semi-gloss fire resistant WB paint and 27-4 black semi-gloss fires resistant WB paint. The edges of grille cutouts and hardware located on the inside surfaces of the locker doors painted with aluminum colored synthetic enamel.

9.n Interior Signs

Two (2) builder's nameplates are provided and located in the vestibule above the passenger side entrance openings.

The car numbers are applied using two (2) inch high numbers near the car builder's plate, over each set of side entrance doors, inside the center vestibule.

Black plastic plates with engraved white lettering are provided at the switchboard and panels to designate the switches, circuit breakers, fuses, relays, resistors, etc.

Interior of door to Locker B-2 contains stainless steel plate with car number, identity class TA-2G, date built and location of manufacture, etched and painted black. Inside of locker door is furnished with record and log book holders.

The cover of the fire extinguisher cases are labelled with appropriate access instructions.

The following items are labelled.

Overhead Heater;
Air Filters;
Emergency Brake Valve (red lettering);
Signal Button (labelled "Signal");
Danger Do Not Touch (red lettering);
Heat Thermostat (labelled "H");
Cooling Thermostat (labelled "C");
Three (3) Electric Locker Doors (labelled "Danger 480-Volts" in 3" red lettering), excludes Locker A-1;
Lockers A-1, A-2, B-1 and B-2 (labelled with designation only).

A stainless steel plate with the wording "Lavatory" sand etched and painted black is provided on the toilet room door.

A "Watch Your Step" sign is provided on the top riser of each set of passenger entrance steps on both sides of the car. Letters are sand etched and painted black.

"Watch Your Step" signs, per Nippon Sharyo Drawing No. H0131C78234, are applied to the gallery stairway walls.

Two stainless steel signs, each with the words "No Smoking, Please"and no smoking symbol, per Nippon Sharyo Drawing No. H0131C78228, are provided in each end of the car. Letters are sand etched and painted black.

COMMUTER CARS

9.o First Aid Kit

One (1) Eatern Safety Equipment Co., Inc. Unit #325 First Aid Kit is mounted on the interior of the door to Locker A-1.

SECTION TEN: AIR CONDITIONING SYSTEM

10.a General Requirements

All Cars are equipped with air conditioning equipment comprising two self contained compact units, Thermo King Part No. 096013, mounted over the ceiling of the vestibule at the center of the cars.

Each unit consists of an evaporator, evaporator blower, condenser coil, condenser fan, liquid receiver and a semi-hermetically sealed compact compressor, and a control panel. Each air conditioning unit provides separate air conditioning for one section of the car. The controls for each unit are separate and independent, as specified in Section 12.d.

Each of the two units have a minimum gross capacity of ten tons of refrigeration, rated at 120,000 B.T.U. per hour with total air supply of 2400-2600 c.f.m., 25% fresh air with the dampers fully open, based on an outside air temperature of 100 F dry bulb (80 F wet bulb), and inside temperature of 78 F dry bulb (68 F wet bulb), 60% relative humidity.

Refrigerant for these units is Freon R-22.

10.b Construction and Suspension

The units are constructed using stainless steel. The mounting bolts, are secured with safety wire to prevent loosening and are high strength Grade 8. The mounting of the air conditioning units incorporate damping to cushion and limit longitudinal movement. The units are equipped with vibration isolators sized to eliminate transmission of vibration of the units to the car body. The refrigerant compressors are cushioned to prevent transmission of vibration to the air conditioning unit frame and suspension.

Each package air conditioning unit is individually removable by lifting apparatus through a hatch in the car roof. The structure of the units permits the entire unit to be lifted, without damage.

10.c Control and Power Source

The power for the air conditioning system is 480 volt, 3 phase, 60 Hertz alternating current. Power for the control of the air conditioning system is 120 volt single phase alternating current. All motors, for the evaporator, condenser and compressor 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.

10.d **Condensate Drains**

Two 1 1/4 inch minimum, inside diameter copper pipes are provided on each unit, each pipe routed to the nearest side of the car. The drain lines are routed to the underside of the car, each terminating in a "kazoo"-type trap. The drain piping is insulated to preclude condensation. A flexible hose transition is provided between the drain pan outlet and the carbody drain line, using hose clamps and hose fittings, to avoid any leakage.

10.e **Evaporator and Condenser Coils and Refrigerant Piping**

Coils are constructed of seamless copper tubing with copper fins. The minimum fin thickness is 0.008" (0.2 mm). There are no greater than 10 fins per inch on the condenser, and no greater than 8 fins per inch on the evaporator. The fins are mechanically bonded to the tubes. The condenser inlet is screened to preclude entry of debris. The screened cover is hinged to provide access for inspection, cleaning, and replacement of fan blades.

All refrigeration piping is type K quarter-hard temper copper tubing.

10.f **Air Filters**

Disposable filter elements are provided in the air intake of each unit, and are accessible through hinged ceiling panels. The size of these filter elements are 2" x 16" x 20". These filters are located just ahead of the evaporator blower unit so that recirculated air and fresh air will be filtered before being passed through the blowers.

10.g **Air Conditioning Accessories**

The units also have within the self-contained assembly at least the following accessories:

- filter drier with replaceable core;
- moisture indicator;
- inlet and outlet shutoff valves (liquid line);
- refrigeration charging valves;

COMMUTER CARS

- all standard high-low safety pressure switches, a test switch, modulation pressure switch and including test gauges to be suitable for vibration and shock of the railroad environment.

- a strainer upstream of the evaporator expansion valve equipped with a replaceable screen.

- Direct (not belt driven) driven condenser fan and evaporator blower.

SECTION ELEVEN: VENTILATION SYSTEM

11.a General

The ventilation system is designed to maintain a uniform temperature through the car. Under normal conditions the air from the passenger section at one end of the car is not permitted to mix with that from the other end.

11.b Fresh Air

Fresh air enters through screened openings in the side of the roof above the entrance doors, two on each side of the car passing into a plenum chamber. Automated dampers are provided to control the amount of fresh air.

11.c Recirculated Air

Return air passes through grilles located in the face of the bulkhead at the upper level, into the plenum chamber where it mixes with the fresh air.

.d Exhaust Air

Air is discharged from the car through static-type ventilators mounted in the side of the car near each end.

A fan-driven exhaust outlet above the toilet is provided. The fan is grounded, and mounted resiliently to minimize noise and vibration. The exhaust air passes through a grille in the toilet room ceiling and is ducted to the atmosphere.

11.e Plenum Chamber, Ducts and Diffusers

A plenum chamber is built into the car structure for each of the self contained air conditioning units of sufficient size to handle the requirements of the ventilation system.

Flexible transition ducts connect the passenger supply distribution ducts to each overhead evaporator. Flexible transition ducts also connect the side roof mounted fresh air intakes to each overhead air conditioning unit.

Air ducting is insulated and constructed of stainless steel. Ducts are designed to provide specified air volume without exceeding 1,000 feet (304.8 m) per minute air velocities within the ducts.

Air is forced through the main ducts from the evaporator blowers

over the center vestibule toward the end of each passenger compartment. Air is distributed from the main duct to the upper level of the car through diffusers located above sides of the upper level parcel rack. Air is forced from the main duct to lower level distributing ducts via branch ducts. The lower level ducts run directly into passenger compartment through regularly spaced holes in the bottom of this duct. All air diffusers are designed for the minimization and ease of required cleaning, and so as not to accumulate dust, soot, and debris. The air diffusers are integrated with the cove light fixture.

11.f **Pressurization**

Ventilation system is balanced so as to provide pressurization for the car body (body doors closed) of 0.125" of water at 0 mph and positive pressure at any speed, with the evaporator blowers for both ends of the car operating.

11.g **Back-Up Ventilation**

A supplemental ventilation system, to be utilized in the event of an A/C unit cooling failure, is provided for each passenger compartment and activated manually by a circuit breaker. A secondary blower rated at 400 cfm will operate in conjunction with the A/C unit evaporator blower and induce additional outside air directly into the passenger compartment. The total volume of fresh air introduced in this operating mode will then exceed the 600 cfm of fresh air normally provided by the evaporator blower. The secondary, supplemental blower is powered by 120 volt single phase AC.

SECTION TWELVE: HEATING SYSTEM

12.a General

The cars are electrically heated using 480 volt, 3-phase, 60 cycle A.C. supplied from a source outside of the car.

The system is thermostatically controlled, having electric heaters set in stainless steel guards along the floor at the side walls of the lower level, operating in conjunction with an electric heater mounted near each air conditioning evaporator unit.

Two zones of heating are provided, one in each end of the car.

Automatic damper controls are furnished as part of the heating system.

No surface which a passenger may contact, including floor heaters and vestibule step and door track over antifreeze heaters exceeds 140 degrees F except for the door track heaters.

12.b Electric Heaters - Coach Sections

The electric heaters have a capacity of 12 KW for the overhead heating and a capacity of 12 KW for the floor heat in each end of the car. The overhead heaters are separate units installed in the car duct work down stream from the evaporator coils. The system is arranged for two stages of heat. In cool weather, with automatic fresh air dampers open, the system provides 12 KW overhead heat and 4 KW floor heat for each end of the car. In cold weather, with automatic fresh air damper closed, the system provides 4 KW overhead heat and 12 KW floor heat for each end of the car. The total heating load is 32 KW with either stage.

12.c Electric Heaters - Control Station

This section not used.

12.d Controls - Heating and Cooling

The heating and cooling controls consist of two heating and cooling control panels, each to control one end of the car. The control panels are arranged for automatic changeover from heating to cooling.

Each control panel is equipped with a selector switch for summer

or winter positions and provides the following heating and cooling settings:

SUMMER

Heating	Modulated Cooling	Cooling
69 degrees F.	72 degrees F.	74 degrees F.

WINTER

Heating	Modulated Cooling	Cooling
72 degrees F.	75 degrees F.	77 degrees F.

The controls are positive, non-hunting type to ensure proper operation of the air comfort sub-systems. The thermostat assembly is located behind the return air screen in the return air duct.

12.e **Layover Heat**

The controls are arranged that layover heat will automatically be provided when the car is parked, as long as the car is connected to a source of head end power.

Layover heat control is part of the HVAC automatic controls. A toggle switch, which can be operated from the face of each heating and cooling control panel, permits selection of 45 degrees F. or 60 degrees F. layover heat for that end of the car which the panel controls.

12.f **Anti-Freeze Protection**

Anti-freeze protection is provided under the bottom step, at the entrance doors and is of sufficient capacity to prevent the formation of ice at these locations. Anti-Freeze protection is in the form of element strip heaters, two strip for each door opening. The total wattage per door opening is 1200 watts at 120 VAC.

Anti-freeze protection is be provided for the water tank, piping from the tank to the basin and the drain from the wash basins in the toilet room.

12.g Heater Guards

Floor heat is provided on the lower floor only by electric heaters mounted behind stainless steel heater guards. The heater guards is designed to prevent the surfaces coming in contact with passengers from exceeding 140 degrees F.

12.h Indicator and Monitor Panel

An indicator and monitor panel is furnished, to convey the functioning of the heating and cooling equipment. The panels are located in the same lockers as the climate control panels.

The panels indicate which stages of heating or cooling have been called for by the settings of the climate control panels, and the thermostats, and indicate whether the heating or cooling being called for is functioning.

SECTION THIRTEEN: WATER SUPPLY

13.a General

The supply side of the water system is designed for potable water. Cold water only is provided at the wash basins.

13.b Water Tank

A single gravity feed stainless steel water tank is furnished, located above the ceiling in the toilet room. Service water capacity is fifty (50) gallons. The tank is suitably insulated to prevent the formation of condensate on its exterior.

The tank is vented to the roof, permitting the fill pipes to drain. Access to the tank is provided by a removable panel in the toilet ceiling.

A grille, located in the ceiling of the toilet room, permits circulation of heated or cooled air around the water tank.

The water tank is designed to withstand a hydrostatic test of fifty (50) pounds per square inch.

13.c Water Fill Nozzles

Two (2) water filling nozzles are provided, located at the toilet end of the car, one on each side, and just below the bottom of the side sill. One nozzle is used as a fill and the other to act as an overflow drain. These are enclosed in a self-draining stainless steel box, covered by a spring-loaded hinged stainless steel door for sanitary protection.

The water fill nozzle is of a concentric ring conical design over which a rubber hose is applied, Adams & Westlake Part No. P-510244.

13.d Pipe and Fittings

A suitably-sized interconnecting network of insulated copper piping is furnished, using sweat type fittings except where removal of components dictates the use of compression fittings. Piping is joined, using silver solder and is clamped to prevent rattles.

Shut-off valves with metal identification tags are provided at major equipment locations. A main drain valve, accessible from outside the car is installed under the washroom.

COMMUTER CARS

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

13.e **Water Coolers**

This section not used.

SECTION FOURTEEN: ELECTRICAL SYSTEM

14.a General

The electrical power, except for the 32 volt D.C. battery circuits, is supplied from a locomotive.

14.b Voltage

The A.C. trainline voltage is 480 volts, 3-phase, 60 cycle A.C.

120 volts A.C. is provided for lighting, air conditioning controls, door operating controls and utility circuits

32 volts D.C. is provided from a power supply or the battery for emergency lights.

64 volts D.C. trainline from locomotive battery in the 27 conductor traction control trainline is used for the electric signal buzzer circuit and traction controls.

64 volts D.C. trainlined from the locomotive battery through the Train Communications Trainline is used for the Train Communications System. Although this power comes from the same source (locomotive battery) it is trainlined separately through different connectors to be consistent with existing cars, some of which had the communications added after the cars were built.

14.c Batteries

Each car is provided with a 32 volt, nickel cadmium battery to provide 80 amp. hours at eight hour rate of discharge, SAFT-NIFE Part No. 80-94166-01.

14.d Battery Box

The batteries are mounted in a battery box, per Nippon Sharyo drawing no. J2331B71346, located under the car.

14.e Battery Charging Equipment

One static battery charger, SAFT-NIFE Part No. 80-02324-01 is provided. It converts 480 volt, 3-phase A.C. to 38 volt D.C. battery voltage. The D.C. voltage is self regulating. The battery charger is circuit breaker protected. It is capable of constant current charging the batteries supplied at a nominal 38VDC.

14.f **Switchboard and Control Features**

Switchboards and equipment for the control of the various electrical circuits, such as circuit breakers, etc., is provided in the Main Circuit Breaker Locker and the Electric Lockers on the "A" end and the "B" end.

A 120 volts A.C. receptacle is provided in the stairway on each end of each car.

14.g **Buzzer System**

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

1) One (1) pushbutton, located in the vestibule of all cars;

2) One (1) pushbutton, located in the body end door opening at the "B" end of all cars;

3) One (1) pushbutton, located in the body end door opening at the "A" end of all cars.

14.h **A.C. Power Supply**

Three 5.0 KVA single-phase, 480/120 volt A.C. transformers are provided to supply 120 volt, single-phase A.C. for lighting.

14.i **Cable and Wire**

All wire is copper unless otherwise approved and complies with A.A.R. Standard S-501. See Appendix D for approved deviations.

The cars are wired using a minimum No. 14, or larger, wire for all circuits unless otherwise noted.

The car wiring is properly tagged for identification.

The wire packs in the electrical locker and control locker are corded to a point where the wires are required to fan out and fastened to the electric and control locker side walls by the use of harness clamps.

14.j **Conduit**

The car is provided with rigid threaded iron pipe conduit underfloor except for trainline cables which is cleated to the underfloor structure, in such manner as to prevent wire chafing. The car is provided with thin wall conduit within the car body.

COMMUTER CARS

Conduit runs with drop boxes at each seat location for future equipment installation are provided.

14.k **Circuits**

Locker B-1/Main Power, Main Lighting and Door Control Locker

1) One (1) 3-pole Main Circuit Breaker;

2) One (1) 3-pole Main Lighting Circuit Breaker;

3) One (1) Door Control A.C. Trainline and Convenience Outlet Switch Breaker protected;

4) Two (2) Door Control Zone Switches;

5) One (1) Marker Bracket Receptacle and Portable Rear Warning Light Receptacle Switch Breaker Protected;

6) One (1)Battery Isolation Breaker;

7) One (1) Locker Lights and Doors Open Indication Light Circuit and One (1) Locker Light Switch Breaker protected;

8) One (1) Battery Charger Breaker Protected;

9) One (1) Emergency Light Relay;

10) One (1) Door Track and Drain Anti-Freeze Contactor;

11) One (1) Door Operator Relay Panel;

Locker A-2/Climate Control Circuit Breaker and Panel Locker

1) Two (2) 3-pole Air Conditioning Evaporator Blower Circuit Breakers;

2) Two (2) 3-pole Air Conditioning Condenser and Compressor Circuit Breakers;

3) Two (2) 3-pole Overhead Heat Circuit Breakers;

4) Two (2) 3-pole Floor Heat Circuit Breakers;

5) One (1) Locker Light Door Switch;

6) One (1) Heat Contactor Panel - "A" End;

COMMUTER CARS

7) One (1) Air Conditioning Control Panel - "A" End;

8) One (1) Temperature Control - "A" End.

9) One (1) 2-pole Back-up Ventilation Circuit Breaker;

Locker B-2/Climate Control Panel and Lighting Circuit Breaker Locker:

1) Two (2) 3-pole Fluorescent Lighting Circuit Breakers;

2) One (1) 2-pole Vestibule, Stair and Toilet Light Circuit Breaker;

3) One (1) Public Address System Breaker;

4) One (1) 2-pole Emergency Light Circuit Breaker;

5) One (1) 2-pole Toilet Exhaust Fan Circuit Breaker;

6) One (1) Locker Light Door Switch;

7) One (1) Heat Contactor Panel - "B" End;

8) One (1) Air Conditioning Control Panel - "B" End;

9) One (1) Temperature Control Panel - "B" End;

10) One (1) 2-pole Spare Circuit Breaker, rated at 120VAC, 15AMP

14.1 480 Volt Trainline and Connectors

A 480 volt nominal, 3-phase, 60 cycle A.C. power trainline consisting of six conductors 500 MCM cables arranged as two parallel 3-phase circuits is provided per car. A power control trainline consisting of two 6-conductor No. 12 cables is also provided on each car.

Two 3/3 pole receptacles, Clements National Part No. MRA-1-0036A,are provided at both ends of the cars. The receptacles are mounted on the car ends, one on each side of the car and the jumper assemblies adjacent to each receptacle. The receptacle is painted red.

Two 3/3 pole hard wired jumper assemblies, Clements National Part No. MPA-1SR-0072, are provided at both ends of the car. The jumper plugs are yellow.

COMMUTER CARS

14.m **Door Control Trainline**

The cars are provided with an eight conductor trainline for door control to accomplish proper door operation.

A fixed eight point jumper, Clements National Part No. DPX-8, is provided on the end sill at the "B" or trailing end of all cars. The color of the jumper is black.

An eight point dummy receptacle assembly, Clements National Part No. DRX-DA, is provided on the end sill at the "B" or trailing end of all cars for use with the fixed jumper when the car is at the end of the train.

An eight point receptacle assembly, Clements National Part No. DRX-8A, is be provided on the end sill at the "A" or front end of all cars for use with the fixed jumper. The receptacle color is red.

The door control trainline is located on the right hand side of the car when looking at the "B" end from outside the car.

4.n **27 Wire Locomotive Control Trainline**

The locomotive control current is trainlined between cars, and between cars and locomotives, by means of a jumper cable, Clements National Part No. CRA-2780-MU-V01, on the left side of the longitudinal center line of car, when facing car exterior on "B" end. The jumper is hard-wired to the "B" end of each car. A dummy receptacle, Clements National Part No. CRA-2700-MU-W, is provided adjacent to the hard-wired jumper on the "B" end, and a live receptacle provided on the "A" end. The jumper and live receptacle are integrally colored orange. The dummy receptacle are integrally colored white.

14.o **Fans and Blowers**

An exhaust fan operating on 120 volt A.C. single phase shall be provided in the ceiling of the toilet room, exhausting air through an opening in the side of the car. Thermo King Part No. 814172 is installed.

14.p **Marker Light and Portable Rear Warning Light Receptacles**

The requirements for this section were deleted.

COMMUTER CARS

14.q **Headlight**

This section not used.

14.r **Rear Warning Lights**

This section not used.

14.s **Ditch Lights**

This section not used.

14.t **Water Cooler Receptacles**

None to be provided in either passenger compartment.

14.u **Electrical Grounds**

This section has been deleted.

14.v **Lighting Fixtures**

Continuous fluorescent fixtures located on the sides of the ceiling provide general compartment lighting. The fixtures have an aluminum frame and UV stabilized polycarbonate lenses with self hinging lip. The fixtures are mounted with non-exposed hardware and resist undesired opening. Re-lamping and/or ballast replacement is accomplished from the exposed fixture face, with tamper resistant closing devices used. Lamps are supported by mechanical restraints to relieve mechanical loading on the power pins. Emergency lighting integral with the fluorescent fixtures and is incandescent.

Individual reading lights are provided for each seating position. They are located above the centerline of each seat. Reading light fixtures are locally controlled, recess mounted and passenger adjustable a minimum of 25 degrees from normal throughout 360 degrees. Fixtures utilize incandescent lamps with a bayonet base.

A double fourty eight (48)inch fluorescent fixture is located in the vestibule over each stairway and over the center of the vestibule platform. One (1) twenty four (24) inch fluorescent fixture is located immediately inside the bi-parting vestibule doors and one (1) twenty-four (24) inch fluorescent fixture is located over each gallery stairway. Emergency lights are located in the vestibule, toilet room, all gallery stairways and near all escape sash locations.

COMMUTER CARS

End passageways outside body end doors are lighted incandescent fixtures.

One (1) twenty-four (24) inch fluorescent fixture is located in the toilet room ceiling.

Electrical lockers are provided with exposed incandescent bulbs operated by door switches.

Escape sash signs are incorporated into the fluorescent fixture lenses at each sash location.

All fluorescent, reading and incandescent light fixtures operate on 120 volt, 60hz, A.C. Emergency lights operate on 32 volt D.C. All fluorescent lamps are cool white.

Door open red lensed pilot lights, are installed on the exterior adjacent to each set of side entrance doors on the upper portion of the upper window deadlight. These lights are operated on battery voltage.

The fixtures are Vapor 5703-0175, with two red lenses in each showing to the front and to the rear. The lights are breaker protected.

14.w **Train Communications**

A complete train communications system is installed and provides passenger cars with the following functions:

1) One-way communication from the train crew or engine control station to the passengers (Public Address System, Paging Function);

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

3) One-way communication from a wayside point to the passengers and crew (Public Address System through Train Radio Function);

4) One-way communication from a wayside point to the train crew (Intercommunication System through Train Radio Function).

The complete system is be Midwest Electronics Industries with the following components installed on each car:

COMMUTER CARS

Description	MEI P/N	Trailer Car
Conductor Control Unit	971-7284	1
PA Amplifier	971-7285	1
AAR Base	971-7745	1
Spkr/Grill/Encl	971-7746	7
Nine Cond. Cable	443-1649	100 Ft

The communication jumper, Clements National Part No. CX-316-4M00-A7-V01, does not have a color associated with it. The receptacle cover is brown.

The cable to connect each car is Clements National Part No. CRA-2780-MU-V01. The "A" end of the car has a jumper assembly, Clements National Part No. MPA-1SR-0072. The "B" end of the car has a male receptacle, Clements National Part No. CX-316-1POC-V01. Interconnection cable for cab and conductor control equipment within each car is Midwest Electronics Industries Model #443-1649 (9 conductor, 10 AWG, 2 shielded pairs). There is a hook on each end of car,so that the interconnection cable between cars may be protected from damage when not interconnected.

14.x **Cab Signal, Train Stop, Train Control and Speed ControlSystems**

This section not used.

14.y **Beacon Light**

This section not used.

14.z **Oscillating Headlight**

This section not used.

SECTION FIFTEEN: BRAKE SYSTEM

15.a General

Air brake equipment with 26-C brake schedule, arranged for unit tread brakes with composition shoes for operation in trains with head end diesel-electric locomotive and with rear end cab control cars,per WABCO drawing 674095,1010,OE.

The brake system permits operation of the train from a cab control station located in a cab control car at the opposite end of the train from the locomotive.

15.b Handbrake

All cars are provided with one (1) handbrake, lever type, Peacock No. 800-LG, with twenty-four (24) inch handle, located on the collision post at the "B" end.

15.c Braking Power and Pressure

All cars are provided with unit tread brakes Westinghouse Air Brake Co. Part Nos. 6766235321 (with handbrake), 6766226412 (without handbrake) and 6766225321 (without handbrake).

The following are the nominal working pressures of the air brake system, in pounds per square inch:

- Brake Pipe 90-110 P.S.I.
- Main Reservoir 130-140 P.S.I.
- Brake Cylinder (Full Serv.) 60 P.S.I.
- Brake Cylinder (Emergency)) 90 P.S.I.
- Minimum Brake Pipe to obtain an emergency brake application 50 P.S.I.

15.d Piping and Fittings

Brake pipe is 1 1/4" A.A.R. standard pipe, or equivalent.

The main reservoir equalizing pipe is one (1) inch A.A.R. standard pipe.

All branch air piping is A.A.R. standard pipe below floor level. Type "K" copper tubing is used above the floor level.

COMMUTER CARS

All fittings are of A.A.R. type malleable iron or copper to suit the particular pipe application requirements and are socket weld type.

Gauge fittings are applied to the brake cylinder pipe.

15.e **End Connections**

All cars are provided with a 1¼ inch self locking ball style brake pipe end cock (R. H.), on the air brake trainline; WABCO Part No. 581828.

An A.A.R. standard type rubber hose with couplers for the brake trainline are provided at both ends of all cars; WABCO Part No. 146260.

All cars are provided with the following equipment in order to reservoir on the last car of the train (cab control car) based on a train consisting of up to twelve (12) cars:

1) Two (2) 1" self-vented cut-out cocks with locking handle (MRE pipe), with cock open handle perpendicular to the pipe; WABCO Part No. 576601.

2) Two (2) 1 1/8", by 33" hoses (MRE pipe to coupler); WABCO Part No. 520102.

3) Two (2) 1 1/8", by 22" hoses with LS-4 coupling (MRE pipe); WABCO Part No. 146262.

4) E and L dummy couplings, vented type. WABCO Part No. 145065.

15.f **Conductor's Valve**

The car is provided with two conductor's valves, Wabco B-3-B, located in the diagonally opposite corners of center vestibule. The valves, marked "Emergency Brake", when actuated, shall cause an emergency brake application to all cars in the train.

15.g **Back-Up Features**

This section not used

15.h **Air Supply for Pneumatic Door Operators**

The door operator reservoir is supplied from the auxiliary air reservoir and shall be provided with a suitable governor. The door reservoir is a standard 1,000 cubic inch air reservoir.

SECTION SIXTEEN: TRUCKS

16.a General Design

The trucks are cast steel Commonwealth inside swing hanger type, four wheel single equalized coil spring trucks, using steel coil springs for both bolster and equalizer springs. Longitudinal bolster anchors and vertical shock absorbers are provided. Pedestals are cast integral with the truck frames. Solid spring planks are used. The trucks are equipped for truck frame mounted unit tread brakes and roller bearings of a rotating end cap design. Capital Engineering Trucks 7100C (A-end) and 7100B (B-end).

16.b Dimensions

The following are the truck dimensions:

Wheel Base:	8' 6"
Journal Bearing Size:	61/2" x 12"
Pedestal Opening:	13 3/8"
Wheel Size:	33"
Center Bearing Diameter:	16"
Minimum Clearance of Truck Parts above top of rail:	2 1/2"

16.c Truck Frame

Truck frames are stress relieved, per Atchison Casting drawing D-920017, cast alloy steel, ACC grade C4 normalized and tempered.

All truck frames are stencil marked "No Field Lubrication" in black one inch letters.

Truck pedestals 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, have hardened steel bushings.

16.d Truck Bolster

The truck bolsters are an alloy/steel casting, ACC grade C4 stress relieved, normalized and tempered, per Atchison Casting Drawing #920020. A longitudinal bolster anchor on each side stabilizes the bolster with respect to horizontal movement,

utilizing rubber cushioned truck frame and bolster attachments.

The bolster includes an integral center plate. A three piece locking center pin is accommodated.

16.e **Swing Hangers and Swing Hanger Bars**

Swing hangers are forged carbon steel to A.A.R.Specification M-126, latest revision, Grade F, per Kropp Forge Drawing K-19814-F. Swing hanger cross bars are forged alloy steel, per Kropp Drawing K-19813-F.

16.f **Spring Planks**

Spring planks are one piece, cast alloy steel normalized and tempered, ACC grade C4 (see 20.e), per Atchison Casting Drawing D 920019.

Spring plank safety straps, bolted to the swing hanger supporting brackets, are provided two per truck.

16.g **Shock Absorbers**

Each truck is provided with two Monroe 80080 shock absorbers to control the vertical motion of the truck bolster.

16.h **Side Bearings**

The truck is provided with two friction type side bearings per truck, having a cast base and rubber insert supporting a cast manganese steel bearing surface.

16.i **Equalizer Bars**

Equalizer bars are "I" beam type, Canton Drop Forge, 99-50325. The equalizer is drop forged, alloy steel and conforms to A.A.R. Specification M-127, Grade A, latest revision.

16.j **Spring Seats - Equalizer**

Equalizer spring seats are made from low carbon cast steel conforming to A.A.R. Specification M-201, latest revision, Grade B, per Atchison Casting Drawing C-920010.

16.k **Springs**

The trucks are provided with steel coil type equalizer, Atchison Casting 920022 and bolster springs, Atchison Casting Drawing C-920021.

COMMUTER CARS

16.l **Pins and Bushings**

Pins and bushings are of case hardened carbon steel. The center pin assembly is of three piece locking design, with minimum 250,000 pounds ultimate lifting strength in locked configuration, for locking bolster to car body.

16.m **Sound Deadening and Wear Cushioning**

Fabreeka sound deadening pads are provided between equalizer feet and journal bearing mounting seats. Fabreeka sound deadening pads 1/4" thick are provided at the top and bottom of all coil springs. Rubber bumpers cushion lateral motion of the truck bolster.

16.n **Journal Number Plates**

The trucks of all cars are provided with cast number plates applied at the center of the pedestal opening on truck frames above the journal boxes.

16.o **Axles**

The axles are Class F, per Nippon Sharyo Drawing T1136B14575.

16.p **Journal Bearings**

The cars received Timken AP-Class F journal bearings, Part No. HM13344490525.

16.q **Wheels**

Wheels are 33" diameter, wrought or cast steel, multiple wear, heat-treated, conforming to A.A.R. Specification M-107, for wrought wheels or specification M208 for cast wheels, latest revision, with 2 1/2" minimum rim thickness, in accordance with the A.A.R. P-33 or CP-33 wheel, as specified in the Manual of Standards and Recommended Practices.

16.r **Truck Grounds**

A flexible ground strap system is provided between the car body and each truck's frame.

16.s **Truck Brakes**

This section is deleted

COMMUTER CARS

16.t **Painting**

The trucks of all cars have the entire truck except the wheels, axles, rubber parts, friction materials and wear liners painted as per Section 9.k.

16.u **Centerplate Liners**

Truck centerplates are equipped with a horizontal or vertical wear liners.

SECTION EIGHTEEN: ENVIRONMENTAL EFFECTS

This section is deleted.

COMMUTER CARS

SECTION NINETEEN: PROVISIONS FOR THE MOBILITY LIMITED

19.a General Requirements

This section is deleted.

19.b Clearance and Physical Requirements

This section is deleted.

19.c Vestibule Steps and Wheelchair Lift Platform

This section is deleted.

19.d Seating and Tiedown Positions

This section is not applicable. See Section 9.d for description of seats.

19.e Wheelchair Lifts

A wheelchair lift, Ricon Model F9000SW-T, is provided on each side of the vestibule of each accessible cab-control car, to permit the raising and lowering of passengers in wheelchairs, or between station platform level and car lower level floor height.

19.f Wheelchair Lift Controls

The wheelchair lifts operate on 12 volts, single phase A.C. The wheelchair lifts are circuit breaker protected. Control of the lifts is local and side-specific. The lift control is trainlined and interlocked with the train propulsion. The lift controls are interlocked with the car's air brake system.

The control, via keyed switches, will apply power to the lifts for operation, activate the indicator lights on both sides of the car, prevent the release of the brakes on that car, and send a 74 volt DC trainline signal to the "lift deployed relay" that prevents the operation until the lift is completely stowed.

In the event of a lift failure, or a power failure, it is possible to operate the lift to and from any position in the raise/lower cycle, whether loaded or unloaded, and to deploy and stow the lift platform by hand.

19.g Wheelchair Lift Indicator

A pilot light is installed on each side of the car directly below

door open indicator. The light fixture is identical to the door open indicator except that they provide an amber aspect.

These illuminate on both sides of the car when the door on either side is in fully open position and its corresponding wheel-chair lift is energized, regardless of the actual position of the lift.

	Deviation Description	Vendor/Sub-system (If Applicable)
12.a	Metra granted a deviation to allow step heaters to generate a temperature greater than 140^0 F.	
14.w, 20.i,	9-Conductor train communications interconnection cable	MEI
14.i; 20.i	Flexible cable is 3 conductor #18 AWG with type SJO synthetic rubber insulation.	Vapor Vest Door
20.g	Metra allowed E.P.D.M to be used for truck radial pads	
20.g	Door nosing rubber in vestibule door has a durometer of 60 ± 5.	Vapor Vest Door
14.i; 20.i	The following carbody wiring will be #16 AWG:	
	From: To: Location: Remote box PA/IC control box Remote box Term. block for radio Cab Remote box Handset Cab Remote box Term. block cab inter-cab connetion PA/IC/Radio control box Term. block for radio Cab PA/IC/Radio control box Speaker box Cab Radio Circuit breaker Cab	Midwest/ Communication-tion System

COMMUTER CARS

	Deviation Description	Vendor/Sub-system (If Applicable)
	From: To: Location: Cab signal indicator — Cab signal rack — Cab signal locker Test panel — Cab signal rack — Cab signal locker	GRS/Cab Signa
	From: To: Location: Master controller — Plug assembly — Cab Mating connector — Terminal block cab interconnections — Cab	Master Controller
14.i; 20.i	The following carbody wiring will be #18 AWG with sunlight resistant polyvinyl chloride (PVC) insulation/jacket: From: To: Location: Term. block — Control module — (MK to define) Control module — Speed indicator — (ditto) Power supply — Term. block — (ditto) TMACS unit — Term. block — (ditto) TMACS unit — Air manifold — (ditto) TMACS unit — Crew alert panel — (ditto) TMACS unit — LIM & term. blk. — (ditto) TMACS unit — Cab sig. term. blk. — (ditto) TMACS unit — Ditch light panel — (ditto)	Bach-Simpson/ Alertness Control
14.i; 20.i	Exhaust fan wiring is 8" length of 3 conductor #18 AWG with SJO synthetic rubber insulation.	Thermo King Exhaust Fan
15.d	250# fittings for the 3/4" malleable tees with female on the run for the truck piping shown as item #9 on dwgs. T1936B14505 and T1936B14742.	Capital/ Truck Ass'y
14.i; 20.i	Wires will be identified with pre-printed vinyl tube markers in the wiring harnesses that are shipped with the carshells.	Nippon Sharyo/ Elec. wiring
20.i	#18 AWG polyvinyl chloride (PVC) insulated wires for the standard flourescent light ballasts is acceptable to use.	Luminator

COMMUTER CARS

	Deviation Description	Vendor/Sub-system (If Applicable)
20.l	Metra allowed the use of untreated plywood for use in interior door panels	UPC
20.m	Metra approves the use of window masks with a minimum tensile strength of 12,000 lbs. per square inch.	**Metal Cladding**
20.n	Metra waived the smoke requirements for the toilet seat.	**Monogram 4806--1**
20.n	Metra waived the smoke, flame and toxicity requirements for the diaphragm	Adams & Westlake
20.n	Metra waived the smoke, flame and toxicity requirements for Diabond Products.	
20.n	Metra waived the smoke, flame and toxicity requirements for sensitive edge cable jacket	Vapor
20.n	Metra waived the smoke requirement (ASTM E-662) for Norcast 2316 floor leveling compound.	
20.n	Metra waived the smoke, flame and toxicity requirements for three light lenses - "Door Closing" "Occupied"	Luminator

Exhibit 3.

Content list of engineering drawings and technical specifications of Cab Car 8473, and its components, as made available to the Crashworthiness investigation by Metra

Railcar history:

- 8473 History

Railcar Carbody [equipment specifications]:

- AAR C-034-69 Construction_specsfornewcarconst1967
- Amerail A01 [general carbody arrangement drawings]
- Amerail As-Built Specification
- Amerail B01 [engineering drawing package]
- Amerail B02 [engineering drawing package]
- Amerail B03 [engineering drawing package]
- Amerail B06 [engineering drawing package]
- Amerail B08 [engineering drawing package]
- Amerail B09 [engineering drawing package]
- Side Frame drawings [engineering drawing package]

Car overhaul:

- Car 8473 Overhaul Car History Book [activities in 2014]
- M-08-007_Amerail Cab Rehab_Rev_E

Carbody Sidewall Window [specifications]:

- 38 AM-I-W02 - Install Passenger Windows Combined
- FRA Type II AR TG 250 clear dual glazed 11-04
- FRA Type II AR TG 250 tint dual glazed 11-04

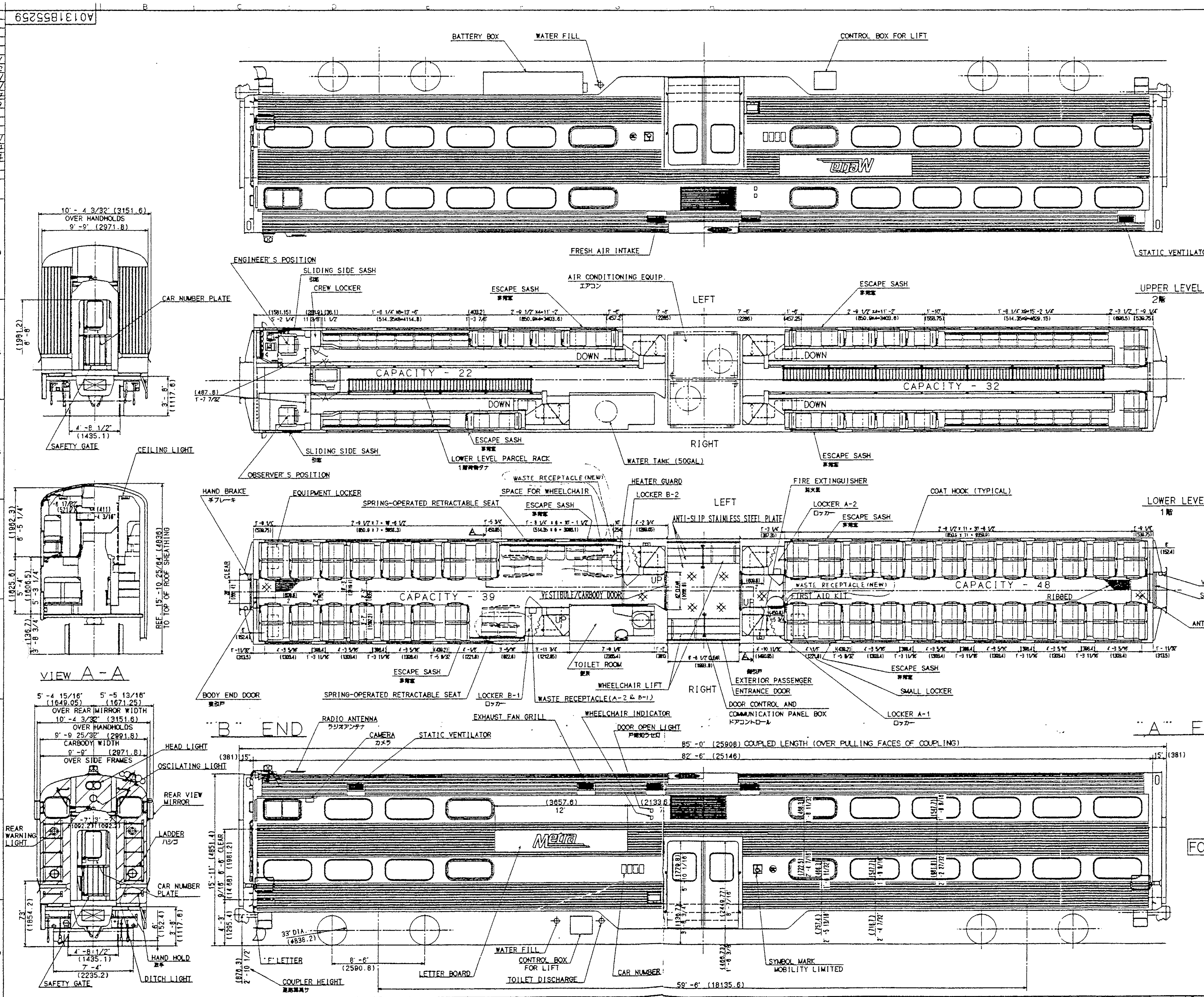
Coach Seat Assembly [specifications]:

- 70 AM-I-S02 - Install Seats Combined
- KSU-ASY-006695B
- KSU-ASY-006696b
- Seat Testing Documentation

– End of Exhibit –

Exhibit 4.

Engineering drawing, describing the floorplan of a Metra ‘cab car’ [coach railcar], as involved in the accident



REV.C 1992-6-18

1. ALTERED LENGTH OF TOILET ROOM TO SATISFY ADA REQUIREMENT.
2. ELIMINATED ONE RETRACTABLE SEAT AT UPPER LEVEL ON TOILET SIDE AND ADD ONE RETRACTABLE SEAT AT LOWER LEVEL ON OPPOSIT TOILET SIDE.
3. ELIMINATED CAB SIGNAL LOCKER AND ADDED 2PASSENGER SEAT. ACCORDINGLY ALTERED TOTAL SEATING CAPACITY TO 140 FROM 138.
4. ALTERD SIZE OF SIDE WINDOW.
5. ALTERED FLOOR HEIGHT TO 44 3/4" FROM 44" .AND HEIGHT OF SIDE ENTRANCE ACCORDINGLY.
6. ADDED DITCH LIGHT.
7. ALTERED LOCATION OF LETTER BOARD.
8. ALTERD DIRECTION OF END STRIPE.
8. ADDED LATERAL OUTRIGGER ARM FOR COLLISION POSTS.

REV.D 1992-9-19

1. ALTERED LOCATION OF ESCAPE SASH ACCORDING TO MET-NKC-0003-DG.
2. ADDED BEACON LIGHT.
3. ALTERED CLEAR OPENING OF END DOOR.

REV.E 1993-1-18

1. ALTERED DIMENSION OF TOILET ROOM
2. ALTERED LOCATION OF DOOR OPEN LIGHT AND WHEELCHAIR INDICATOR.
3. ALTERED SLOPE AT END DOOR TO STEP.
4. ADDED EXTERIOR VIEW OF "A" END.
5. MOVED EXHAUST FAN LOCATION.
6. ALTERED DIAPHRAGM.
7. ALTERED SAFETY BAR TO SAFETY GATE.

REV.F 1993-4-9

1. ALTERED RIBBED FLOOR COVERING AT END DOOR STEP TO ANTI-SLIP STAINLESS STEEL PLATE.
2. EXTENDED LUGGAGE RACK.
3. ADDED CONTROL BOX FOR LIFT.
4. RELOCATED LETTER BOARD.
5. RELOCATED CAMERA.
6. RELOCATED WINDSHIELD.
7. ADDED SIDE VIEW OF SNOW PLOW.
8. ALTERED CREW LOCKER WIDTH.
9. INCREASED PASSENGER-CAPACITY 140 TO 141.

REV.G 1993-10-13

1. ALTERED WINDOW WIDTH.
2. ALTERED SOME HAND HOLDS.
3. ALTERED SOME EXTERIOR MARKINGS & LETTRINGS.
4. ALTERED RETURN AIR GRILL.
5. ADDED CONTROLL BOX (FOR LIFT).

REV.H 1994-2-23

1. DELETED OWNER PLATE.
2. ALTERED SNOW PLOW.

REV.I 1994-3-28

1. ADDED HEATER GUARD.

REV.J 1994-5-23

1. ADDED WASTE RECEPTACLE.(NEW)

REV.K 1994-9-2

1. DELETED WASTE RECEPTACLE.(NEW)

REV.L 1995-1-14

1. FLIP UP SEATS WERE ALTERED.
2. ADDED WASTE RECEPTACLE (NEW) AGAIN. H.H.

ESTIMATED	119.541 LB.
CARBODY	86.064 LB.
TRUCK	33.477 LB.

FOR PROTOTYPE ONLY

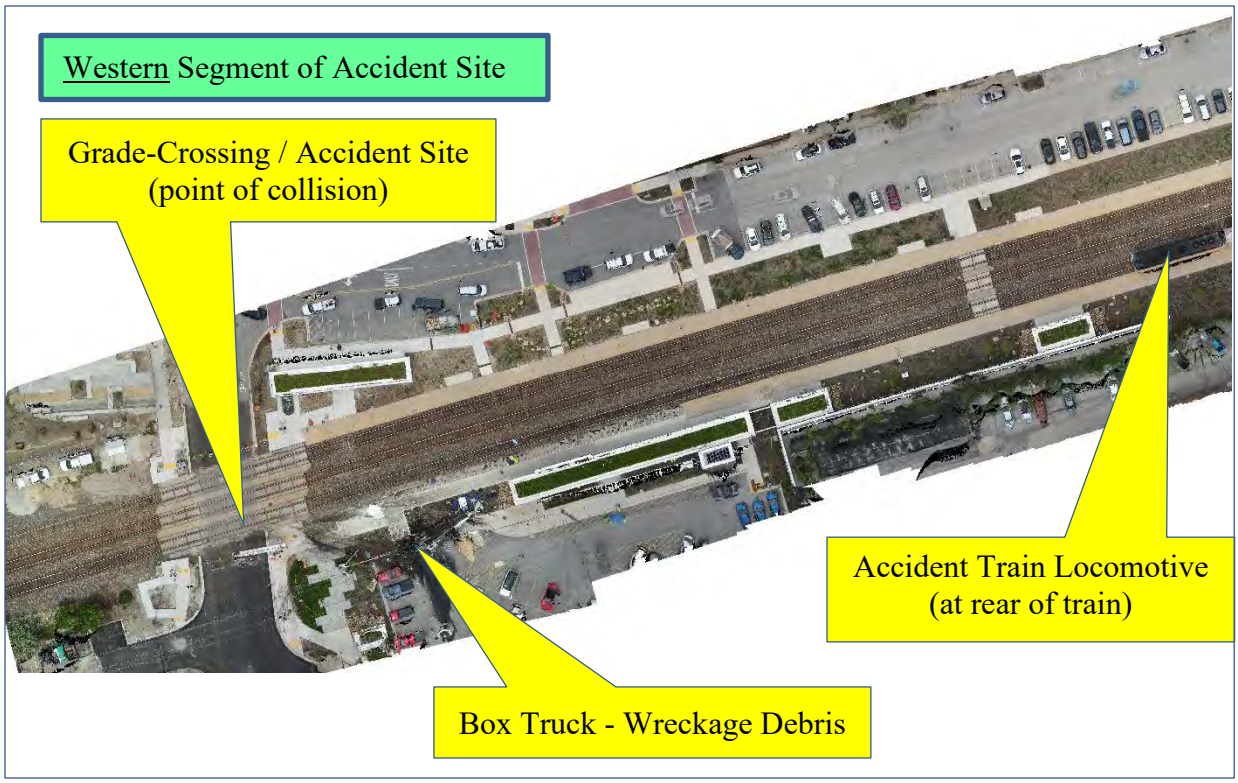
A-1

APPROVED: T. Kawashima, T. Mizuguchi, H. Hirano	日本車輌 NIPPON SHARYO, LTD.
TITLE	GENERAL ARRANGEMENT (CAB CAR) (C車 形式図)
ORG. NO. / DATE 91.5.23	SCALE 1/50
DRG. NO.	A0131B55259
REV.	L

変 現・材 '94.6.2 '95.2.16 出図 A01-1

Exhibit 5.

Annotated aerial imagery [Site Map], describing the wreckage distribution in the wreckage debris field


Western Segment of Accident Site
Grade-Crossing / Accident Site (point of collision)
Accident Train Locomotive (at rear of train)
Box Truck - Wreckage Debris


Eastern Segment of Accident Site
Accident Train Cab Car (at front of train)
Locomotive to the left of this Coach Car (at rear of train)

Exhibit 6.

Volpe Center investigative team - Field Notations of post-recovery cab car inspection

Draft Field Notes: Clarendon Hills Grade Crossing Accident, Metra vs. Box Truck

Date of Accident: May 11, 2022

FRA IIC: Leon Ferguson
Volpe Staff: Karina Jacobsen & Tatiana Mowry
Date of FRA/Volpe Inspection: June 1, 2022

Equipment:

Cab Car Leading Eastbound Metra Train

Cab car, five coaches, 1 locomotive

Cab car #8473

- Railroad: Metra
- Cab Car Manufacturer: AMERAIL, American Passenger Rail Car Company in 1996
- Walkover style seats rebuilt and tested by Kustom in 2014
- Windows replaced in 2014
    - Two panes installed into rubber gasket; no vacuum between panes
    - Green outer pane and clear inner pane

Box Truck

- 2004(?) 40' Marion dry freight box truck, being utilized as a moving truck
- Reported as having full tank of gas; approx. 100 gallons

Collision Events:

A cab car leading Metra Eastbound Train #1242, traveling at 60.9 mph impacted a box truck obstructing the track at a grade crossing in Clarendon Hills

The rear of the box truck swung around the right side of the cab car and impacted the side just behind the side door.

The side wall punctured.

One passenger fatality; seated near the impacted section of the cab car.

Damage:

Cab car

- Front End
    - Superficial scratches along front end at the corner post
    - Plough missing

    - long thin dent just behind operator right side window approximately 143” above top of rail
    - side mirror deformed, pushed back and mirror missing
- Right side:
    - Dent on left sliding door
    - Puncture located behind right side door and between the side sill and lower window frame
        - 136” in length
        - 14-24” in height
        - Vertical channels (about 19” apart) between side sill and belt rail detached and bent into the car, along with interior wall, insulation, etc.
    - Smaller puncture located further back
        - 7-10” in length
        - 4-6” in height
- Seats
    - 1 row on the upper level damaged; removed from car during NTSB investigation
    - 5 rows on the lower level behind the right-side door damaged, R1-R5; removed from car during NTSB investigation
        - Seat attachments at floor and side sill show signs of inward deflection
        - Appear to have failed due to lateral intrusion of side wall pushing against them.
    - No damage to seats on left side of car but broken light cover above left side Row 4
- Glazing
    - 1 window by left side Row 4 missing with no signs of carbody damage, interior or exterior
    - Broken light cover above Row 4; no visible signs of bodily fluids, hair, etc.

Fatality:

Informed by Metra, not observed by Volpe

Body located on the left side of the train approximately 502 feet away from end of car.

Equipment information

Cab Car No. 8473 is part of a series of cars that Metra refers to as Amerail cars. The Amerail car series consists of 176 cars total (79 cab cars and 97 trailer cars) built by Morrison-Knudsen (Amerail) between 1994 and 1998.

Cab Car No. 8473
Model: CA-2G, Gallery bi-level
Built: 1996
Manufacturer: American Passenger Rail Car Company, AMERAIL,
Standard: A.A.R. Standard SO-34-1969

Overhaul: No. 8473 received mid-life overhaul maintenance in January 2014 at Metra's Rock Island District 49th Car Shop. This overhaul work did not affect the structure of the car and the car does not employ any alternative compliance design / performance specifications. However, Metra did perform refurbishment work on the car which required certification / verification of compliance with 49CFR.

Metra's mid-life overhaul work scope includes the following tasks:

- Overhaul of 26-C airbrake system
- Rebuild trucks
- Install new wheelchair lifts
- Install rebuilt HVAC units
- Install Electrical outlets - Lower Level
- Install Passenger Emergency Intercom (PEI)
- Replace existing LED scrolling signs with new scrolling signs

These additional mid-life overhaul tasks require certification / verification of compliance:

- Replace interior ply-metal flooring with new composite flooring.

  49 CFR 238.103(a)(2) requires that materials introduced in a passenger car or a locomotive cab, as part of any kind of rebuild, refurbishment, or overhaul of the car or cab, shall meet the test performance criteria for flammability and smoke emission characteristics as specified in Appendix B to this part, or alternative standards issued or recognized by an expert consensus organization after special approval of FRA under § 238.21.

  Metra provided certification showing that a representative sample of combustible materials used, has been tested by a recognized independent testing laboratory and that the results show the representative sample complies with the requirements of paragraph (a) of this section at the time it was tested.

- Install all new passenger windows.

  49 CFR 223.9(c) Passenger cars, including self-propelled passenger cars, built, or rebuilt after June 30, 1980, must be equipped with certified glazing as specified in Appendix A to Part 223. Metra provided the manufacturer's test verification data for each type of glazing material supplied for this purpose and it has been successfully tested in accordance with Appendix A to 49 CFR 223.

- Install new seats that meet all the regulatory requirements of Title 49 CFR Part 238.233 and APTA standard SS-C&S-016-99, Rev. 2

  The replacement of seats required compliance with 49 CFR 238.103(a)(2) that materials introduced in a passenger car or a locomotive cab, as part of any kind of rebuild, refurbishment, or overhaul of the car or cab, shall meet the test performance criteria for flammability and smoke emission characteristics as specified in Appendix B. Metra provided certification that a representative sample of combustible materials used, has been tested by a recognized independent testing laboratory and that the results show the representative sample complies with the requirements of paragraph (a) of this section at the time it was tested. The seat replacement also required compliance with 238.233 interior fittings and attachments, which requires the seats be fastened to the carbody to withstand specific forces. Metra provided a report of testing performed by Kustom Seating Unlimited (KSU). For purposes of showing compliance with the requirements of this section, the strength of a seat attachment was demonstrated through sled testing.

- Upgrade interior lighting to comply with latest APTA standards

  49 CFR 238.115(b)(1) requires emergency lighting shall be provided in each passenger car in accordance with the minimum requirements specified in APTA PR-E-S-013-99, Rev. 1, "Standard for Emergency Lighting System Design for Passenger Cars," Authorized October 7, 2007, or an alternative standard providing at least an equivalent level of safety if approved by FRA pursuant to § 238.21. Metra provided test results showing the lighting design complied with APTA standard PR-E-S-013-99.

- Install sensitive edges on all side loading doors and replace existing door system in-kind.

  The replacement of the sensitive edges on all side loading doors requires compliance with 49 CFR 238.103(a)(2) which requires that materials introduced in a passenger car or a locomotive cab, as part of any kind of rebuild, refurbishment, or overhaul of the car or cab, shall meet the test performance criteria for flammability and smoke emission characteristics as specified in Appendix B. Metra provided certification that a representative sample of combustible materials used in the refurbishment, has been tested by a recognized independent testing laboratory and that the results show the representative sample complies with the requirements of paragraph (a) of this section at the time it was tested.

- Replace all decals/signage/LLEPM

  Prior to January 28, 2015, federal regulations required emergency exits to be conspicuously and legibly marked with luminescent material on the inside of each car to facilitate egress. Legible and understandable operating instructions, including instructions for removing emergency windows, shall be posted at or near each such window exit. Manufacturer / supplier-provided independent laboratory certified test reports shall show that all tested samples of passive HPPL material, as used in the finished component configurations (including any cover or protective coating if used, but not including text or graphics) comply with the minimum luminance criterion.

  Metra provided certification that emergency signage and markings met the minimum requirements specified in 238.125 and APTA PR-PS-S-002-98, Rev. 3, "Standard for Emergency Signage for Egress/Access of Passenger Rail Equipment," Authorized October 7, 2007, or an alternative standard providing at least an equivalent level of safety, if approved by FRA pursuant to § 238.21.

Attachments:

1. § 238.103 Fire safety.

- ASTM E 119 Test Reports
- Cab Seat
-Passenger Seat
- Composite Flooring material
- Passenger Window Glazing & gasket
- Sensitive edging material
- Window Mask

2. Emergency lighting Verification Test
3. Manufacturer / supplier-provided independent laboratory certified test result report of Photoluminescent (Phosphorescent) Markings
4. APTA Testing for Passenger Seats testing performed by KSU, for purposes of showing compliance with the requirements with 49CFR238.233(g)