



Chicago Transit Authority

Maintenance Manual

01 Introduction

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## 5000 Series Rapid Transit Cars

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## 5000 Series Rapid Transit Cars

# 01 INTRODUCTION

## 1.1 FRONT MATTER

### 1.1.1 Introduction

The procedures detailed in the Maintenance Manual (MM) provide guidance for performing maintenance on the 5000 Series rapid transit cars of the Chicago Transit Authority (CTA). These procedures integrate vendor recommendations, carbuilder information, and CTA standard practices. The MM also includes removal and installation instructions for operations that are performed at the terminal or in the shop.

System 01 contains no maintenance procedures and serves as an introduction to the MM.

System 01 is separated in four sections. First, it provides an explanation of the how and why behind the lay-out of the manual. Second, it contains a list of warnings and cautions found throughout the entire set of manuals for the 5000 Series rapid transit cars. Third, System 01 presents the physical characteristics of the A-car and B-car (otherwise known as the Married Pair). Finally, this manual provides a description of how all the systems operate and interact with one another.

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### LIST OF ABBREVIATIONS AND ACRONYMS

Abbreviation	Definition
ac / AC	Alternating Current
Amp*H	Ampere Hour
APS	Auxiliary Power Supply
APTA	American Public Transportation Association
ATC	Automatic Train Control
ATO	Automatic Train Operation
AW	Car Weight Designation ranging from AW0 to AW3 (AW0 = Weight of Empty Car in Ready to Run Condition and AW3 = Weight of Fully Loaded Car)
CTA	Chicago Transit Authority
dc / DC	Direct Current
ft	foot / feet
GPS	Global Positioning System
IGBT	Insulated Gate Bipolar Transistor
in	inch / inches
IP	Internet Protocol
kVA	kilovolt Ampere
kW	kilowatt
lb	Pound
LED	Light-emitting Diode
MM	Maintenance Manual
Ni-Cd	Nickel Cadmium
PPE	Personal Protective Equipment
PTU	Portable Test Unit
REF	Reference
TCMS	Train Control and Management System
TOTS	Train Operator's Touch Screen
V	Volt
Vac / VAC	Volt, Alternating Current
Vdc / VDC	Volt, Direct Current
VIAT	Vehicle Identification and Annunciation Transponder
WDS	Wayside Diagnostic System

## 5000 Series Rapid Transit Cars

# 1.2 STRUCTURE OF THE MAINTENANCE MANUALS

## 1.2.1 Manual Organization

The entire set of books known as the Maintenance Manuals of the 5000 Series rapid transit cars is divided into twenty divisions. These divisions correspond mostly with the car systems, as follows:

- 01 Introduction
- 02 Carbody
- 03 Truck System
- 04 Propulsion System
- 05 Electrical System
- 05A Electrical System - TCMS
- 05B Electrical System - Cab Control and Operating Equipment
- 05C Electrical System - APS (includes Batteries)
- 05D Electrical System - Undercar
- 06 Braking System
- 07 Coupler System
- 08 Side Door System
- 09 Air Comfort System
- 10 Lighting System
- 11 Communications/Signs System
- 12 Video Surveillance System
- 13 Event Recorder System
- 14 ATC/ATO System
- 15 Hydraulic System
- 16 Reference Documents/Special Gauges and Tools.

### 1.2.1.1 Paragraph Numbering

Paragraph numbers group instructions on each topic.

- The first number field of a paragraph number corresponds to the system number. For example, all paragraphs related to the Lighting System begin with the number 10. The system number is also the prefix for each page, figure, and table, which are numbered sequentially.
- The second field of a paragraph number indicates a major topic heading. For example, 10.1 in the Lighting System is the paragraph number for the major topic "Introduction."
- Three or more number fields indicate a paragraph containing secondary information. For example, paragraph 10.3.1 further details the topic in paragraph 10.3, "Theory of Operation."

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### 1.2.1.2 Manual Format

Each manual division begins with a List of Abbreviations, a Table of Contents, a List of Figures, and a List of Tables and is divided into major sections shown on Table 1-1 "Manual Sections".

**Table 1-1 Manual Sections**

<b>Sections</b>	<b>Description</b>
<b>Introduction</b>	The standard Introduction section provides an overview of safety requirements and lists the warnings, cautions, and notes that apply for the system. Refer to the <i>Working Environment and Conditions - Safety First</i> section.
<b>General</b>	The General section gives a brief overview of the system, including location of major components.
<b>Theory of Operation</b>	The Theory of Operation section gives a brief overview of general system operation and explains the functions and relationships of assemblies, subassemblies, and major components of the system.
<b>Component Description</b>	The Component Description section includes a detailed description of each major component within the system.
<b>Operating Procedures</b>	The Operating Procedures section includes diagrams of the major sequential events of system operation.
<b>Equipment and Material Requirements</b>	The Equipment and Material Requirements section lists all special tools and equipment, consumables, and supplies referenced in the maintenance procedures. Procedures are listed in paragraph number order along with the applicable tools and equipment and corresponding part numbers.
	<b>List of Tools, Test Equipment, and Special Equipment</b> The List of Tools, Test Equipment, and Special Equipment specifies tools not commonly available and any equipment (such as portable test units or PTUs) required to perform a maintenance procedure.
	<b>List of Consumables</b> The List of Consumables specifies items (such as sealants and lubricants) required to perform a maintenance procedure.
	<b>List of Supplies</b> The List of Supplies specifies the replacement parts used in the maintenance procedure and which are found in the Illustrated Parts Catalog.
<b>Preventive Maintenance and Corrective Maintenance</b>	The Preventive Maintenance section provides the procedures to be followed in performing scheduled preventive maintenance. These are preceded by a table showing the service interval for each procedure.  The Corrective Maintenance section provides the complete procedures to be followed in performing component replacement. Information on the use of any applicable special tools or instruments is also included. The structure or lay-out of these procedures is identical to the Preventive Maintenance Procedures.
	<b>Table of Service Intervals</b> The table of Service Intervals lists scheduled procedures along with the corresponding paragraph number, title, service interval (in days), and applicable cars.
	<b>Preventive Maintenance Procedures</b> The preventive maintenance procedures provide instructions for performing inspections, servicing, adjustment, and testing. Information on the use of any applicable special tools or instruments is also included.
	<b>Applicable Car</b> The Applicable Car section indicates the car(s) to which the maintenance procedure applies.

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**Table 1-1 Manual Sections**

Sections	Description
	<p><b>Equipment Conditions</b></p> <p>Equipment Conditions section describes the state or condition of the equipment that must exist before each maintenance procedure can be performed.</p>
	<p><b>Special Tools</b></p> <p>Special Tools section specifies tools that are not commonly available.</p>
	<p><b>Supplies</b></p> <p>The Supplies section specifies the replacement parts used in the maintenance procedure and which are found in the Illustrated Parts Catalog.</p>
	<p><b>Test Equipment</b></p> <p>Test Equipment section identifies any equipment (such as portable test units) required to perform the test procedure.</p>
	<p><b>Consumables</b></p> <p>The Consumables section specifies items such as sealants and lubricants used in the maintenance procedure.</p>
	<p><b>Activity</b></p> <p>The title of an activity describes a major maintenance action that is performed during a maintenance procedure, such as removal or installation. There can more than one activity per procedure.</p>
	<p><b>Figure</b></p> <p>Figures are included in maintenance procedures to clarify the procedure and identify parts. The parts are identified by numerical callouts that are referenced in the instruction steps of the procedure. Any dimensions provided on the figure are indicated in U.S. units of measure. The indication "REF" shown on an illustration means that the item indicated is shown for reference only.</p>

## 5000 Series Rapid Transit Cars

**Table 1-1 Manual Sections**

Sections	Description
	<p><b>Step</b></p> <p>Steps are procedural instructions, generally written in telegraph style, and made up of simple commands. When steps must be performed in a certain order or sequence, they are numbered or lettered in the required sequence. If steps do not need to be performed in any order or sequence, the steps are bulleted.</p>
	<p><b>Follow-on Tasks</b></p> <p>The Follow-on Tasks section lists the other procedures that must be performed to ensure that the current procedure has been successfully completed.</p>
<p><b>Troubleshooting</b></p>	<p>The Troubleshooting section is a table of high-level trouble symptoms, their possible causes, and how to correct them.</p> <p>There are four levels of diagnosis for troubleshooting using the Train Control and Management System (TCMS).</p> <ul style="list-style-type: none"> <li>• Viewing real-time fault information on the Train Operator's Touch Screen (TOTS) Operation screen. A component fault is indicated by illumination of a system button in an amber color for a minor fault or in red for a major fault.</li> <li>• Logging in to TOTS Maintenance screens to view system status and detailed fault code information. Use the Event View screen to see Help Text on individual fault conditions. Press anywhere on the fault description line to view detailed Help Text about a specific fault.</li> <li>• Using a PTU diagnostic system to connect to the train network on the A-car or B-car. The PTU enables system troubleshooting, data retrieval and viewing, configuration parameter modification, and software upgrading.</li> <li>• In addition, the Wayside Diagnostic System (WDS) can communicate system status information from the car to a remote maintenance site.</li> </ul> <p>If TCMS fault code Help Text lacks sufficient detail, physical examination of the component may indicate the cause of the fault.</p> <p>NOTE: Information presented in the Troubleshooting sections in each of the system manuals is subject to continuous updating by the TCMS through the wireless Wayside Diagnostic System (WDS). Fault and event code data displayed on the TOTS may be revised at any time based on CTA experience, and help text entries can be changed to reflect new maintenance information. The troubleshooting information printed in this manual corresponds to the carbuilder's initial baseline information only. If TOTS help text information differs from text printed in this manual, the TOTS screen version shall prevail.</p>

## 5000 Series Rapid Transit Cars

### 1.3 WORKING ENVIRONMENT AND CONDITIONS

#### 1.3.1 Working Environment and Conditions - Safety First

Always consider “Safety First” in everything that you do.

While preparing for, or during performance of, any work related activity, safety must always be of primary concern. CTA insists that its employees consider “Safety First” in everything they do. Knowledge of and adherence to CTA safety and regulatory guidelines is essential. Rules and regulations must be known and thoroughly understood in order to be practiced safely. Fellow employees should be assisted to promote and ensure a safe working environment. Anyone found working in an unsafe manner should be told so. Assist them. Educate them. If they do not respond, advise the supervisor. It is everyone’s duty (not only to themselves but to fellow employees as well) to ensure safe working conditions. Remember, commitment to safety may save a life.

During maintenance activities that will take place within the CTA work environment, you and your fellow employees may be exposed to hazards that could jeopardize your safety. Before proceeding further, it is important to understand how Warnings, Cautions, and Notes are used in the maintenance manuals of the 5000 Series rapid transit cars.

Warnings, cautions, and notes are identified by symbols and are defined as follows:



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#### WARNING

**Identifies an instruction which, if not followed, could cause serious personal injuries including the possibility of death.**

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#### CAUTION

**Denotes an instruction, which, if not followed, could severely damage vehicle components.**

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#### NOTE

**Indicates supplementary information needed to fully complete an instruction.**

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NOTE: Steps within a procedure may be preceded by a warning, caution, or note. Some warnings and cautions are in a shortened form. In such cases, there is a reference to a more detailed version, which is listed in the Introduction section of the manual.

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The following is a complete list of the warnings and cautions that appear in the Introduction section of each system manual:

### General Rules

To prevent physical injury or damage to equipment, all personnel directly or indirectly involved in the maintenance of the 5000 Series rapid transit cars must observe the following:

- (1) Observe all CTA safety rules and regulations.
- (2) Follow all WARNINGS, CAUTIONS, and NOTES found throughout this manual (see below). If you must use a work procedure or tool that is not covered in this manual, you must select a method that is safe and will not damage equipment.
- (3) Follow the recommended preventive maintenance schedule and procedures provided in this manual. Failure to perform maintenance tasks in accordance with the recommended maintenance schedule may result in equipment failure.
- (4) Ensure that maintenance tasks are performed by qualified personnel with the appropriate job skill levels and training. Improper performance of maintenance tasks may result in equipment failure or personal injury.
- (5) When performing maintenance tasks, use the appropriate personal protective equipment (PPE) in accordance with CTA regulations.
- (6) Where conventional tools are not adequate for a particular task, use the special tools or test equipment identified in this manual.
- (7) Use replacement parts that are identical to the original equipment. Refer to the List of Supplies provided in the maintenance manuals. The use of non-approved substitute parts may result in equipment damage or malfunction or personal injury.
- (8) Where fasteners removed from car equipment are not satisfactory for reuse, be sure to select replacements that match the originals. Mismatched or incorrect fasteners can result in equipment damage or malfunction or personal injury.
- (9) The information in this section is provided by the carbuilder for technical information purposes only. If this information conflicts with established CTA procedures, CTA procedures shall govern.





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**WARNING**

**When making up consists, make sure all personnel are clear of cars prior to movement. Follow all safety instructions. Failure to do so may result in damage to property, serious injury, or loss of life.**

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**WARNING**

**For the protection of personnel around or under the consist, ensure that the wheels are chocked. For made-up trains, ensure that the car crew is aware of personnel movement. Failure to do so may result in damage to property, serious injury, or loss of life.**

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**WARNING**

**Dangerous voltages are present throughout the consist. Exercise extreme care when working on or near electrically charged equipment. Observe all CTA safety rules and procedures. Failure to do so may result in damage to property, serious injury, or loss of life.**

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**WARNING**

**Before making any power jumper connection, verify that power has been cut off in the cars or at the shop/wayside supply. Handle all jumpers with care and in accordance with CTA operating rules and instructions. Failure to do so may result in damage to property, injury, or loss of life.**

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## 5000 Series Rapid Transit Cars



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### WARNING

When checking continuity or when handling equipment connections, shut off car power. Failure to do so may result in damage to property, injury, or loss of life.

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### WARNING

Isolating a single car from others in the train does not ensure that equipment is safe. Instead, make sure the entire train is isolated from the supply and batteries are disconnected.

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### WARNING

Before disassembling any electrical unit, removing any electric board, or unplugging any connectors, ensure that the unit is isolated from its electrical power source. Failure to do so may result in damage to equipment, serious personal injury, or loss of life.

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### WARNING

When working on equipment containing capacitors, be aware that these devices can retain lethal voltages even after being isolated from the high voltage supply. Check capacitors with a voltage multimeter to ensure they have discharged to a safe level (less than 10V).

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### WARNING

Make sure that equipment cannot be started automatically or accidentally. If valves are closed or circuits interrupted during service procedures, control switches must be suitably tagged. Failure to do so may result in damage to property, serious injury, or loss of life.

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## 5000 Series Rapid Transit Cars



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### WARNING

Unless absolutely necessary, do not perform maintenance under a car while the hydraulic suspension system is active. Instead, secure the carbody using standard CTA procedures then de-energize and depressurize the hydraulic suspension system (dead mode). Failure to do so may result in damage to equipment, serious injury, or loss of life.

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### WARNING

If you must perform work on the car while the hydraulic suspension system is active, be aware that the carbody may rise or lower unexpectedly. Keep clear of pinch points under the vehicle. Failure to do so may result in serious injury or loss of life.

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### WARNING

Equipment requiring removal must be isolated from the pressurized hydraulic system. Ensure that pressure is released before working with any hydraulic fitting, hose, or component. Failure to do so may result in serious injury or loss of life.

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### WARNING

Hydraulic fluid under high pressure and temperature and can penetrate or burn skin. Follow approved maintenance procedures when replacing hydraulic components. Failure to do so may result in serious injury or loss of life.

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**WARNING**

When working with dangerous materials, make sure the area is well-ventilated and avoid prolonged breathing of vapors. Avoid contact with skin. Keep materials away from flame. Consult the appropriate material safety data sheet or contact your supervisor for safe handling procedures. Wear the appropriate PPE and clothing. Failure to do so may result in damage to property, serious injury, or loss of life.

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**WARNING**

Following operation, some equipment surfaces may be hot enough to burn skin. Allow sufficient time for surfaces to cool before working on or around equipment. Failure to do so may result in injury.

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**WARNING**

When removing or installing heavy components, use the appropriate lifting equipment and techniques. Be aware that the center of gravity of the component may be offset. If necessary, enlist the help of additional personnel. Failure to do so may result in damage to equipment, serious injury, or loss of life.

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**WARNING**

Oily or greasy surfaces may make components difficult to handle. Exercise caution during component disassembly or removal. Failure to do so may result in damage to equipment or personal injury.

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## 5000 Series Rapid Transit Cars



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### CAUTION

**When replacing electrical equipment, make sure all electrical connections are securely attached. Loose or damaged electrical connections may result in intermittent equipment operation or potential equipment damage (arcing).**

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### CAUTION

**Semiconductor devices used in electronics are sensitive to static electricity. Use a grounded wrist strap to avoid electrostatic discharge. Avoid touching the surface of any Printed Circuit Board (PCB). Failure to do so may result in damage to equipment.**

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### CAUTION

**Ensure that all hydraulic connections are properly secured after maintenance. Leakage of hydraulic fluid on hot parts creates a possible source of ignition. Loose or damaged hydraulic connections may result in impaired system performance, contamination, or failure.**

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### CAUTION

**Ensure that software versions installed on replacement equipment are consistent with the operational configuration of the car. Failure to do so may result in equipment malfunction.**

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Be mindful of all WARNINGS, CAUTIONS, and NOTES presented throughout the Maintenance Manuals and remember: "Safety First". Before beginning any type of work, ensure that your safety as well as that of your co-workers has been considered.

## 5000 Series Rapid Transit Cars

### 1.4 CAR TECHNICAL DATA

#### 1.4.1 General Data and Technical Characteristics

The 5000 Series rapid transit cars, built for the Chicago Transit Authority by Bombardier, are lightweight rapid transit passenger cars. These cars are manually operated, with Automatic Train Control (ATC) provided to enforce speed restrictions.

The 5000 Series consists of two car types, A-car and B-car, operated in married pair units of two cars composed by coupling an A-car to a B-car with a semi-permanent drawbar. Married pair units can also be coupled mechanically and electrically to form trains of four to twelve cars. See sub-section Car Interoperability.

**Table 1-2 Car Technical Characteristics**

Item Description
Nominal line voltage: 600 Vdc, full performance from 400 to 800 Vdc
Propulsion:• Single VVVF-IGBT inverter and line reactor with forced air-cooling• Two IGBT choppers for dynamic brakes• Spin-slide control (including in emergency)• Four AC traction motors, four pole, force cooled, squirrel cage induction
Auxiliaries, natural air-cooled heatsinks (for each car) include:• Battery charger 3.75 kW• Low voltage power supply: 37.5 Vdc - 9 kW (7.5 kW continuous)• Inverter (230 Vac): 45 kVA continuous (120 kVA transient capacity)• Inverter (120 Vac): 5 kVA single phase 60 Hz
Battery (for each car): 195 Amp*H Nickel-Cadmium
Stainless steel carbody
Inboard bearing, welded-steel frame truck
Hydraulic leveling suspension
Dynamic braking with regeneration and hydraulic friction brake system
Electromagnetic track brake
Forced-air wall and floor heaters
Air-conditioning capacity of 11 tons
Manual coupling system at No. 1 end of A-car and B-car
Four double-sliding side doors (two per side)
Serial trainline and data communications• Ethernet over IP trainline network
Communication• LED message and destination signs• Illustrated rail system map• GPS and automatic public announcements
Digital video recording system
On-board microprocessor-controlled diagnostic system
Event recorder IEEE 1482.1-1999 compliant

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**Table 1-3 Dimensions and Weights**

Item Description	Value
Car length (over couplers)	48 ft
Maximum exterior width	9 ft 4 in
Exterior width at floor	8 ft 8 in
Interior width	9 ft 2-5/8 in
Doors Side door height Side door width End door height End door width	Clearance 6 ft 4 in 50 in 6 ft 4 in 24 in
Floor to ceiling height	6 ft 7 in
Head room in aisle	6 ft 9 in
Aisle width between convertible seats	26-3/8 in
Aisle width between longitudinal seats	42-5/8 in
Track gauge	4 ft 8-1/2 in
Distance between truck centers	33 ft 8 in
Truck wheelbase	6 ft 6 in
Wheel diameter	28 in
Minimum radius of horizontal curve	85 ft
Minimum radius of vertical curve	2000 ft
Car weight - Empty	57,000 lb
Car weight - Full Capacity (Seated only)	64,200 lb
Car weight - Full Capacity (Seated and Standing)	80,100 lb
Design buff strength	200,000 lb

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**Table 1-4 Performance and Capacity**

Item Description	Value
Maximum design speed at AW1	70 mph
• Initial acceleration rate	2.8 mphps
• Full service braking	2.8 mphps
• Emergency braking rate	5.1 mphps
Passengers (seated and standing)	123
Number of regular seats per car	34
Number of folding seats (wheelchair access) per car	4

### 1.4.1.1 Car Numbering Scheme

The two 5000 Series vehicle types are similar but differ as follows:

- A-car

The A-car is equipped with a roof-mounted communications antenna, ladder, gang plank, and with the no motion speed sensor on the No. 1 axle.

- B-car

The B-car is equipped with the Automatic Train Control (ATC) speed sensor on the No. 1 axle.

The cars are numbered sequentially. A-cars are odd numbered and start at 5001 while B-cars are even numbered and start at 5002.

The 5000 Series car numbering equipment is illustrated in the Figure 1-1 "Car Number Location on the 5000 Series Car".

### 1.4.1.2 Car Orientation

The operating cab is at the No. 1 end of each car.

A semi-permanent drawbar is located at the No. 2 end of the A-car and B-car and is used to couple a married pair.

Doors No. 1 and 3 are located on the right side of the car while doors No. 2 and 4 are located on the left side. To identify the doors correctly you must be facing the operator's cab while standing inside the car.

### 1.4.1.3 Car Equipment

#### 1.4.1.3.1 Exterior Carbody Equipment

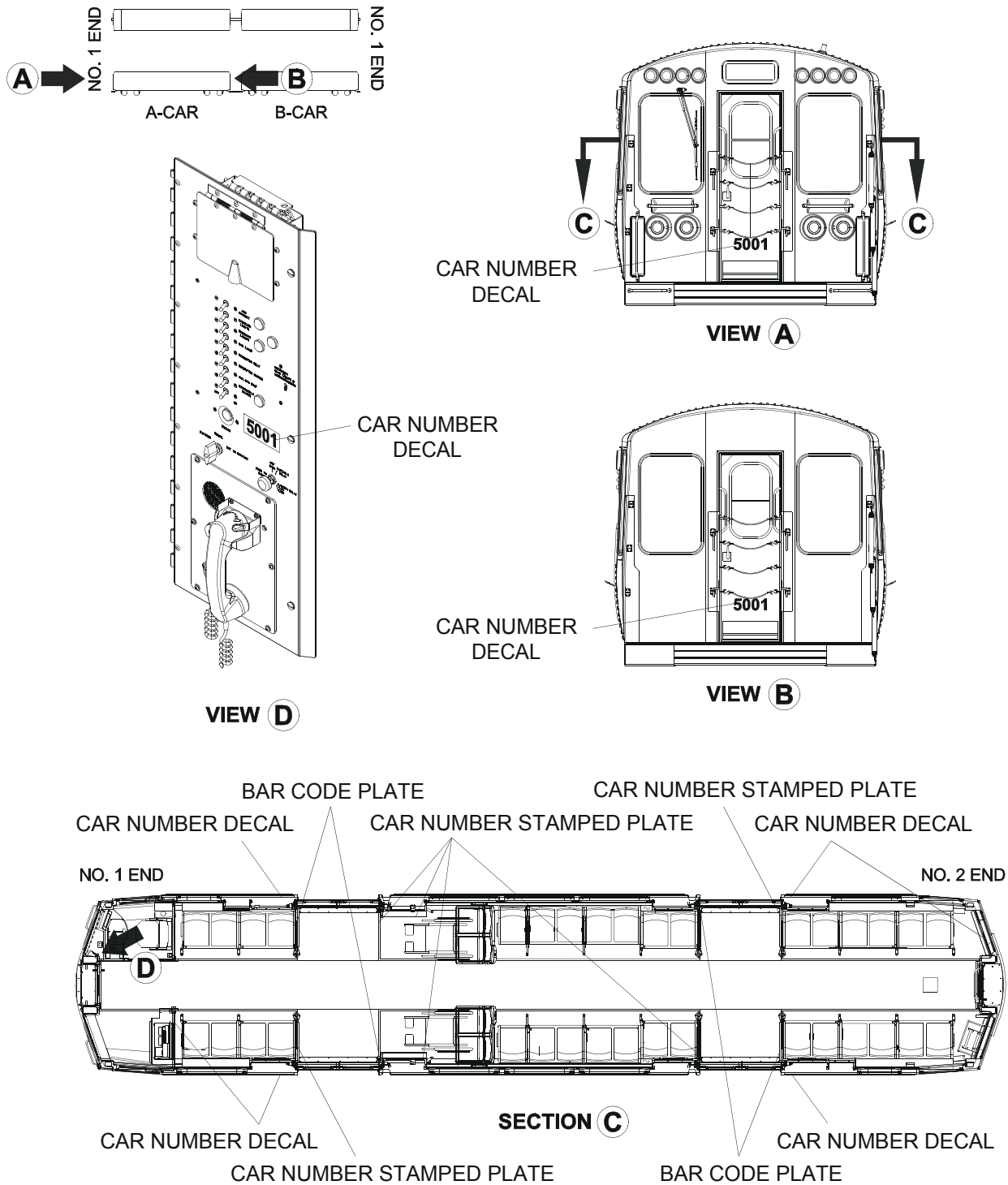
The 5000 Series car exterior equipment is illustrated and described in the Figure 1-2 "Exterior Carbody Equipment".

#### 1.4.1.3.2 Undercar Equipment

The 5000 Series car undercar equipment is illustrated and described in Figure 1-3 "Undercar Equipment (Sheet 1 of 2)", and Figure 1-4 "Undercar Equipment (Sheet 2 of 2)".



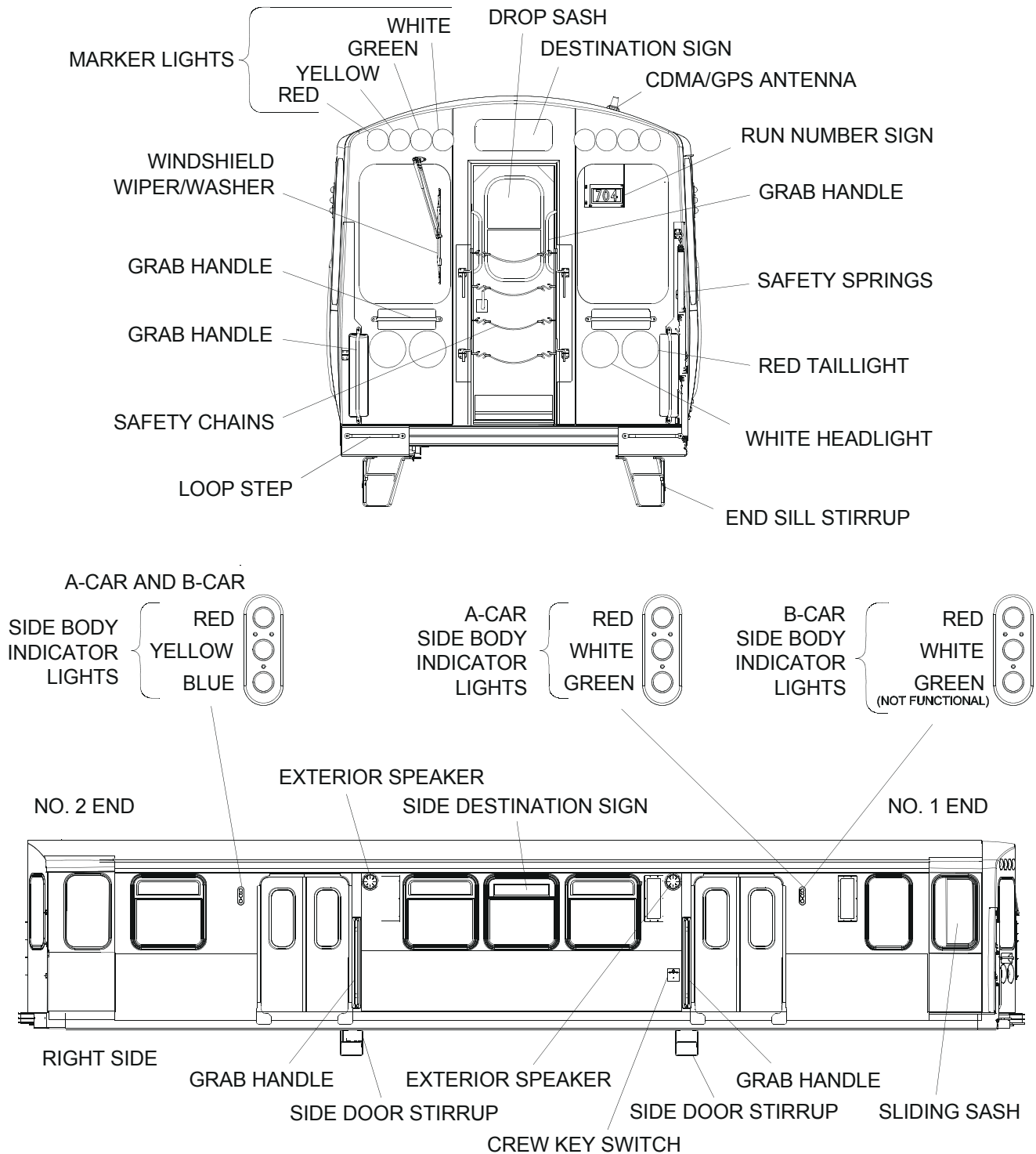
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Figure 1-1 Car Number Location on the 5000 Series Car

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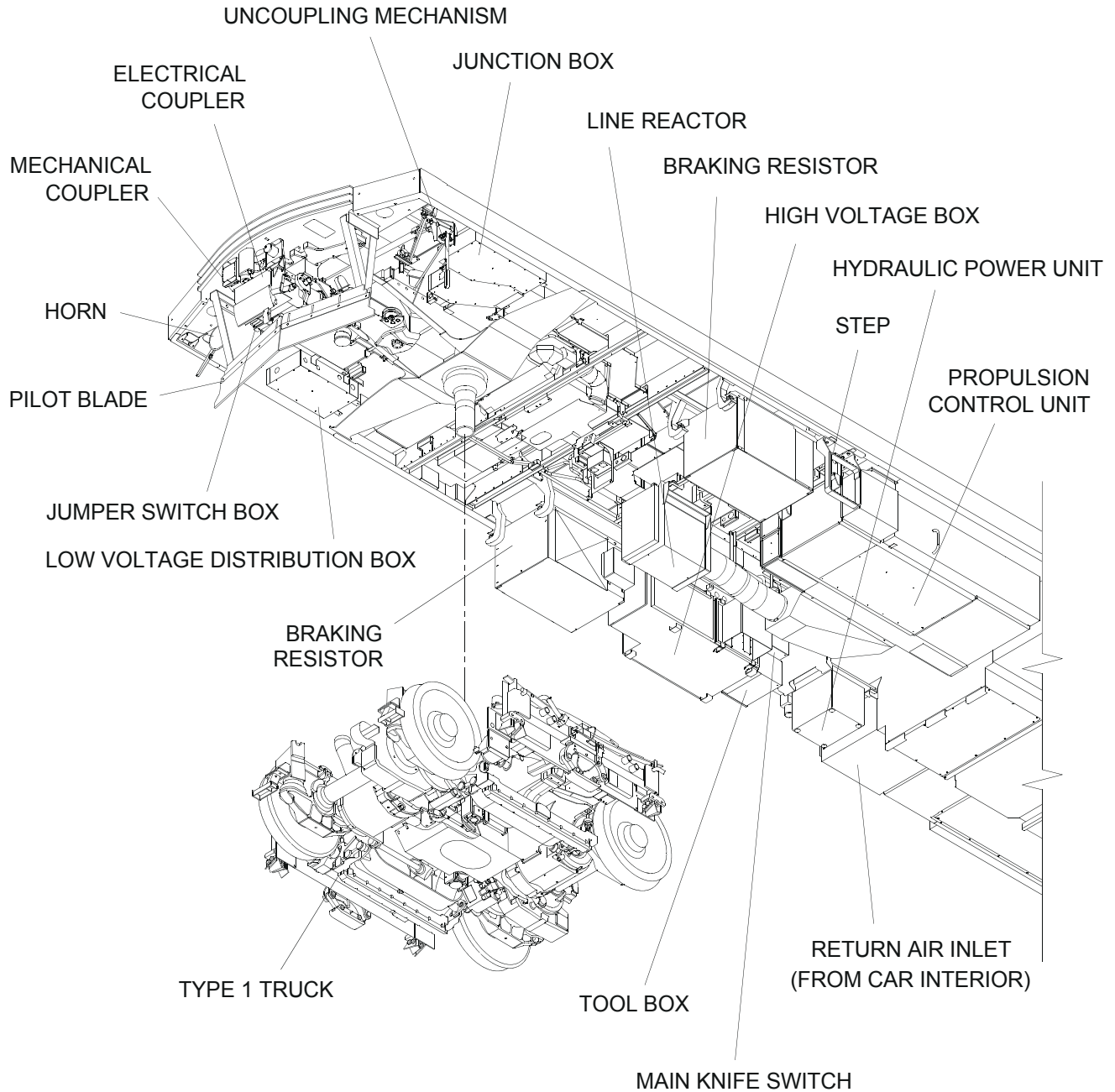


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Figure 1-2 Exterior Carbody Equipment

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NO. 1 END

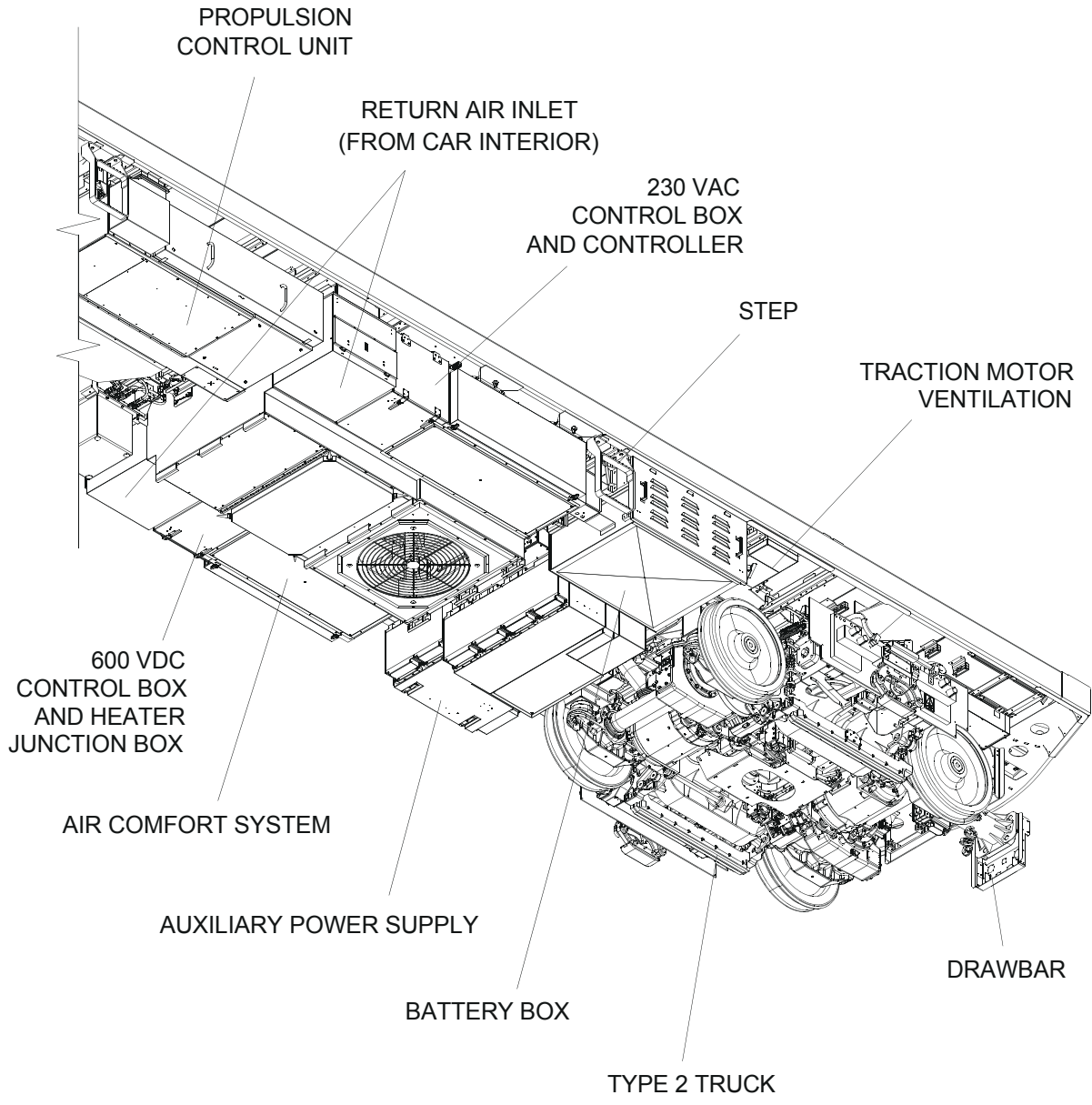


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Figure 1-3 Undercar Equipment (Sheet 1 of 2)

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NO. 2 END

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Figure 1-4 Undercar Equipment (Sheet 2 of 2)

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### 1.4.1.4 Emergency Equipment

The 5000 Series cars are equipped with five components under this category (refer to Figure 1-5 "Emergency Equipment"). The emergency equipment components are as follows:

- Pump-type Fire Extinguisher

The extinguisher is a water-type, 1.5 gallon capacity fire extinguisher. This type of fire extinguisher is used to extinguish fires in solid combustibles, such as wood, paper, or seating upholstery.

- Dry Chemical-type Fire Extinguisher

This type of fire extinguisher is used to extinguish electrical and flammable liquid (oil or grease) fires. It can also be used to extinguish fires on surfaces of solid combustibles, such as paper and wood.

- Sleet Scraper Stick

The sleet scraper stick is a pipe-shape tool used to raise and lower the sleet scraper blades and to operate the manual brake cutout mechanism. The sleet scraper stick is also used to raise and lower the sleet scrapers and generally as a tool providing limited electrical isolation.

- Gang Plank

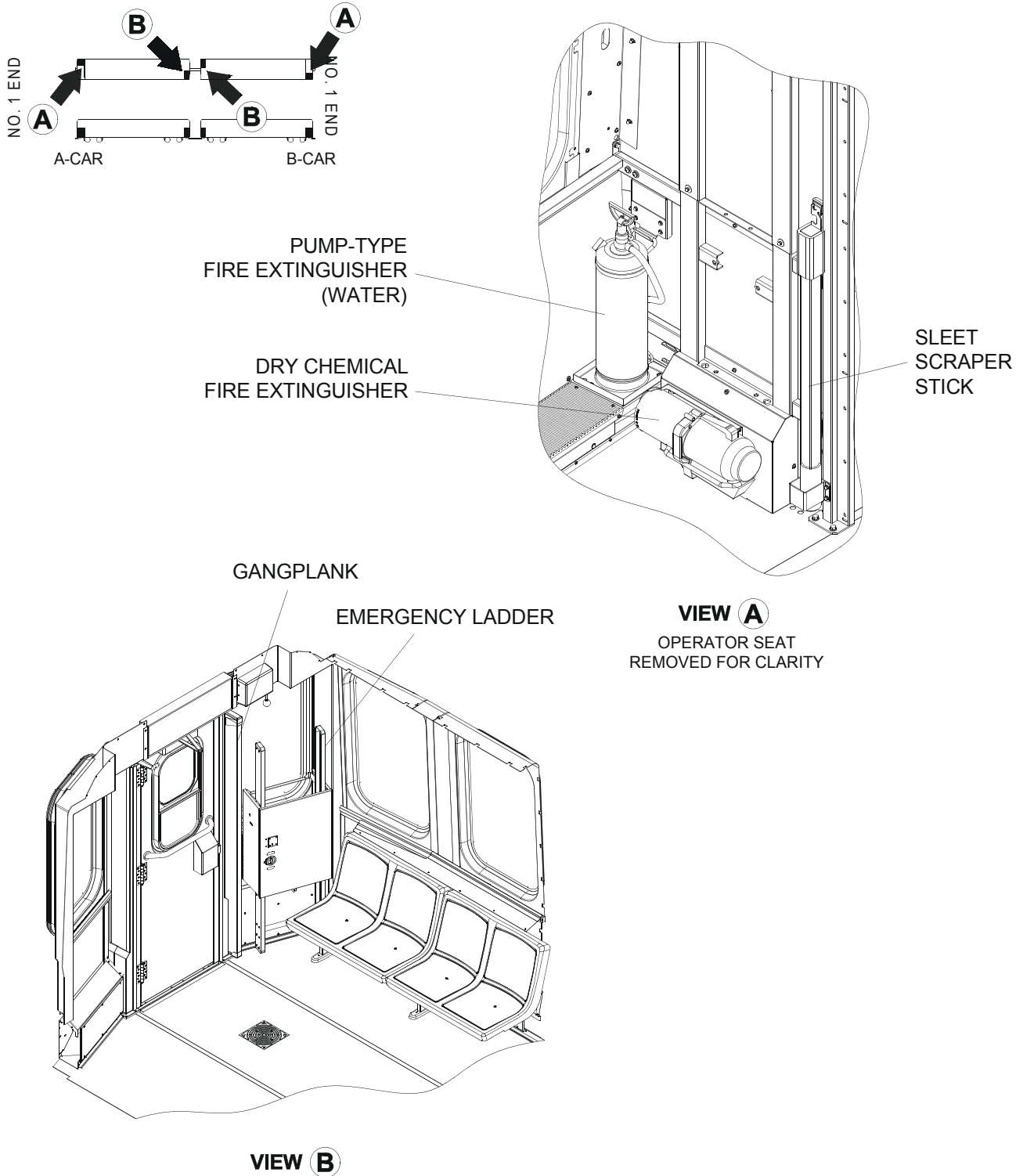
The gang plank is a six foot long wooden board attached to brackets next to the No. 2 end door. Gang planks are used in emergencies to bridge gaps when passengers have to cross to a car on an adjacent train.

- Emergency Ladder

A sixty-two inch ladder with fiberglass side rails and non-skid aluminum rungs is stored in the cabinet next to the A-car No. 2 end door. The cabinet is latched and locked using the CTA standard door key.

In emergencies, this ladder is clipped to a side door threshold, steadied by a roller wedging on the underside of the carbody.

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Figure 1-5 Emergency Equipment