Test Project

Module A – Maintenance and Control of Pantograph

Rail Vehicle Technology

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WSC2026_TP61_en

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Pantograph electric circuit wiring table. (For Car A1 and Car B1) 1

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Introduction

A pantograph is an electrical device of a rail vehicle that collects electricity from an overhead contact system and is a core component that provides the vehicle with power source. Therefore, the maintenance of pantograph is an essential routine task for vehicle technicians, mainly covering the maintenance of pantograph mechanical parts, electric circuits, pneumatic circuits, etc.

The workstation has a pantograph with a complete mechanical structure as well as its electrical control system. The equipment, however, may have various issues, the vehicle technicians should thus conduct the inspection, repair, and commissioning of the pantograph and its control systems according to the process standards to make the equipment meets the requirements for normal use.

Meanwhile, with the development of rail transit intelligence, intelligent technologies have been applied increasingly, and intelligent operation and maintenance technologies have also been introduced into rail vehicle maintenance. This Test Project requires the Competitor to install intelligent detection modules to monitor the operating parameters of the pantograph in real time, thereby enabling an innovative approach to intelligent vehicle maintenance.

Description of project and tasks

The time allocated to the Maintenance and Control of Pantograph Test Project is 360 minutes.

The Competitor should complete all tasks within the time allocated to the Module.

First, make preparations according to requirements.

Second, complete the five (5) tasks listed below:

- A1 Pantograph mechanical parts maintenance
- A2 Pantograph pneumatic circuit maintenance
- A3 Pantograph motion parameters adjustment and setting
- A4 Pantograph electric circuit wiring and test
- A5 Pantograph intelligent detection function extension

Note: During operations, strictly adhere to the operation safety rules and carry out the tasks in order of A1, A2, A3, A4, and A5.

Lastly, after all tasks listed in this Test Project are completed, the Competitor should clean and organize the site and submit the relevant materials and Record Sheets to the Experts.

Preparations

Before starting the operation tasks, the Competitor needs to analyze all tasks and count and check equipment, tools and materials in the workstation according to the standards and requirements set out in the WSC2026_WM61_A Maintenance and Control of Pantograph Work Manual. In the case of any problem, the Competitor need to solve it immediately.

1. Read carefully this Test Project to understand the operation tasks;
2. Count and check all equipment, tools and materials in the workstation and fill the problems uncovered in the Maintenance and Control of Pantograph Pre-operation Inspection Record Sheet (fill all problems at once). If any equipment, tools or material is found missing or unqualified, submit the Record Sheet to the Experts to apply for replacement or supplementation.

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3. Submit the Record Sheet (with name and country of the Competitor filled at the corresponding blanks) to the Experts.

Note: Some valves may have been installed on the pneumatic circuit installation panel of the control cabinet.

*Note: The **WSC2026_TP61_A_R03_Pantograph** Fault Example Description Table clarifies the types of defects, and any defects not described in the Table are considered normal.*

A1 Pantograph mechanical parts maintenance

Task A1 requires the Competitor to inspect and maintain pantograph mechanical parts according to the standards and requirements of the WSC2026_WM61_A Maintenance and Control of Pantograph Work Manual. Main work items include:

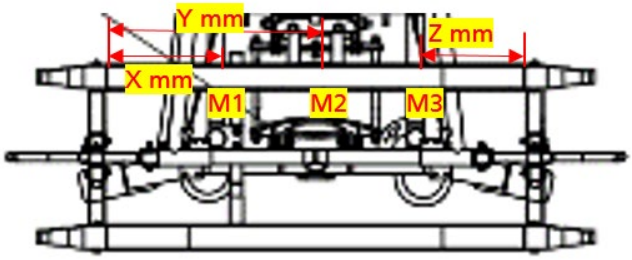
Pantograph mechanical parts appearance inspection and maintenance

1. Conduct an all-round appearance inspection of the pantograph body according to operation standards;
2. Fix defects concerning fasteners, stains, and foreign objects found during the inspection (Note: For the repair of anti-loose mark defects, it is not required to reapply torque.);
3. Fill the defect inspection results and their fixing status in the A1-1 Pantograph mechanical parts appearance inspection and maintenance Record Sheet.

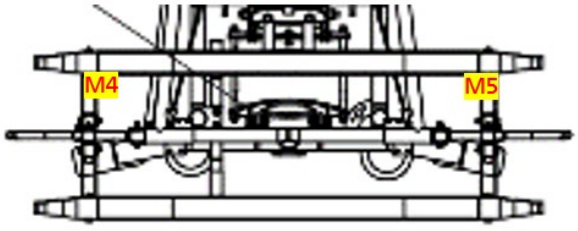
*Note: The **WSC2026_TP61_A_R03_Pantograph** Fault Example Description Table clarifies the types of defects, and any defects not described in the Table are considered normal.*

Pantograph mechanical parts parameters measurement

1. As shown below, measure the thickness of M1, M2 and M3 of the carbon contact strip near the airbag according to operation standards (Note: Clear marks of the measurement points are indicated on the carbon contact strip);



2. As shown below, measure the width of the gap (M4 and M5) between the pantograph horns and the carbon contact strip near the airbag according to operation standards;

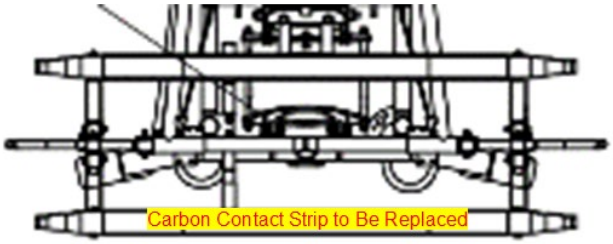


3. Measure the gap (M6) between the panto down position sensor and the aluminum induction plate according to operation standards;
4. Fill the measurement results in the A1-2 Pantograph mechanical parts parameters measurement Record Sheet.

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Pantograph mechanical parts replacement

1. As shown below, replace the carbon contact strip further from the airbag according to operation standards;



2. Replace the conducting wire with obvious loose strands according to operation standards;
3. Record the replacement status in the A1-3 Pantograph mechanical parts replacement Record Sheet.

Work report

After completing all items involved in task A1, the Competitor needs to report the operation status to the Experts and submit the Record Sheets (A1-1, A1-2, A1-3). Only with the Experts' approval can the Competitor proceed to the next task.

A2 Pantograph pneumatic circuit maintenance

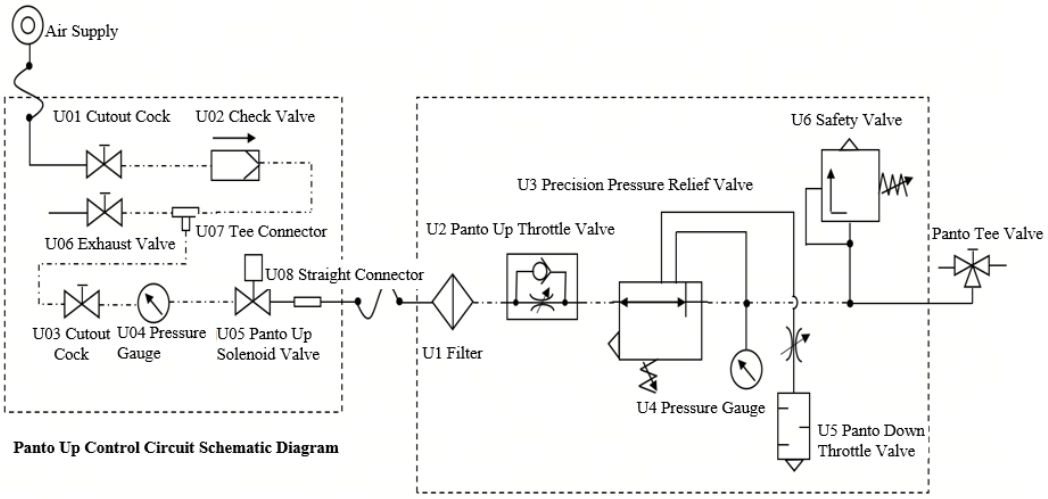
Task A2 requires the Competitor to maintain the pneumatic circuit of the pantograph according to the requirements of the WSC2026_WM61_A Maintenance and Control of Pantograph Work Manual. Main work items include:

1. According to the pneumatic circuit schematic diagram indicated below, select proper pneumatic components and hoses and complete the installation of the pipes of the panto up control box and air valve box on the pneumatic circuit installation panel.

Note: Some valves and pipelines have been installed in advance, and the Competitor only need to install the missing parts. The pipes indicated as dotted lines in the diagram need to be connected by the Competitor.

Note: When installing components, the layout should be as level and aligned as possible (the Competitor may select push-in pneumatic fittings at their discretion), with adequate spacing reserved between components to avoid any operational interference.

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Panto Up Control Circuit Schematic Diagram

Air Valve Box Circuit Schematic Diagram

2. After the pneumatic hoses are installed, carry out the pressure maintaining test according to operation standards. If the test fails, locate and fix the hose fault until the test succeeds.
3. Fill the test and maintenance results (including faults and their fixing status) in the A2 Pantograph pneumatic circuit maintenance Record Sheet.
4. After completing all items involved in task A2, the Competitor needs to report the operation status to the Experts and submit the Record Sheets (A2). Only with the Experts' approval can the Competitor proceed to the next task.

A3 Pantograph motion parameters adjustment and setting

Task A3 requires the Competitor to complete the installation of the intelligent detection devices according to the requirements of the WSC2026_WM61_A Maintenance and Control of Pantograph Work Manual. Main work items include:

1. Adjust the static contact force of the pantograph to the standard range;
2. Adjust the pantograph lifting duration to the standard range;
3. Adjust the pantograph lowering duration to the standard range;
4. Fill the adjustment and setting results in the A3 Pantograph motion parameters adjustment and setting Record Sheet.
5. After completing all items involved in task A3, the Competitor needs to report the operation status to the Experts and submit the Record Sheets (A3). Only with the Experts' approval can the Competitor proceed to the next task.

A4 Pantograph electric circuit wiring and test

Task A4 requires the Competitor to complete the installation, wiring and test of electric circuits as per the electric circuit schematic diagrams and electric circuit wiring table provided in the workstation according to the requirements of the WSC2026_WM61_A Maintenance and Control of Pantograph Work Manual. Main work items include:

1. Complete the wiring of the Train Activation, Cab Occupation and Pantograph Control and Monitoring loops of Car A1 and Car B1 according to operation standards and process requirements. The Competitor need to complete the wiring within the relay cabinets only, as the wires in the ground test bench and between equipment have been connected in advance. See the Wiring Table in the Attachment)

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2. After the wiring is completed, conduct electrical wiring inspection and fill the results in the A4-1 Pantograph electrical circuit wiring and inspection Record Sheet.

Note: The Competitor must not dismantle or modify the wires already connected in the electrical cabinets; complete the connection of missing wires only according to the Pantograph Electric Circuit Wiring Table.

Note: Carry out this task based on the contents of the Record Sheet, without the need to refer to the Work Manual.

3. Conduct electrical function tests according to operation standards, and record the results in the A4-2 Pantograph electrical function test Record Sheet;
4. During electrical commissioning, it's allowed to use an electrical auxiliary test box;
5. After completing all items involved in task A4, the Competitor needs to report the operation status to the Experts and submit the Record Sheets (A4-1, A4-2). Only with the Experts' approval can the Competitor proceed to the next task.

A5 Pantograph intelligent detection function extension

Task A5 requires the Competitor to complete the installation and connection of intelligent detection devices using the provided tools and materials according to the requirements of the WSC2026_WM61_A Maintenance and Control of Pantograph Work Manual. Main work items include:

1. Install the ultrasonic reflector onto the pantograph head;
2. Install the ultrasonic sensor into its base, and adjust the distance between the sensor and the reflector to 120mm;
3. Connect the wires of the ultrasonic sensor to the corresponding connector according to the wire markers requirements shown as below:

NO.	SENSOR WIRE COLOR	WIRING POINT
1	Brown	1
2	Blue	2
3	Black	3
4	White	4

4. Install a pressure sensor between the U04 Pressure Gauge and the U05 Panto Up Solenoid Valve on the pneumatic control installation panel.
5. Connect the electrical wires of the pressure sensor to the designated terminal strip of the control cabinet pneumatic control installation panel according to the wire markers requirements shown as below:

NO.	SENSOR WIRE COLOR	TERMINAL MARKER
1	Red	03
2	Black	04

6. After the ultrasonic height detection sensor and pressure detection sensor are installed and connected, power on the pantograph system and perform Panto up & down for 3 times. Compare the manually measured values with the values displayed on the Pantograph Commissioning Software to ensure the intelligent detection data is normal and accurate. Record the results on the provided A5 Pantograph intelligent detection function commissioning Record Sheet.

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After completing all items involved in task A5, the Competitor needs to report the operation status to the Experts and submit the Record Sheets (A5). Only with the Experts' approval can the Competitor proceed to the next task.

Post-operation site cleaning

After all tasks are completed, the Competitor should clean the site and return the tools.

1. Turn off the power supplies;
2. Arrange the equipment neatly and clean the site;
3. Return tools and remaining materials. Check the tools and remaining materials again to ensure that they have all been returned.

Instructions to the Competitor

Instructions

1. The Competitor should not bring any device irrelevant to the Competition to the workstation.
2. Tools, electrical components and materials for the skill competition are all provided at the workstation for the Competitor's free access.
3. During the Competition, for matters irrelevant to the Competition contents, such as use of the washroom, or report of equipment, facilities, tooling, or tool faults, the Competitor can seek help from the Experts.
4. The Competitor may refer to the reference documents for the skill competition provided.

Operation safety rules

1. Put on proper personal protective equipment according to operation requirements;
2. Take site safety protection measures and confirm that no safety hazards exist;
3. Before performing operations with power off, confirm that the power supplies are turned off and hang the No Switching On plate;
4. Before performing operations with power on, turn on the power supplies after confirming that no safety hazards exists;
5. Do not operate in a violent or an unsafe manner, including but not limited to forcibly pulling, dragging, smashing, throwing, and other violent behaviors, as well as behaviors that may cause personnel injuries or damage to equipment;
6. When using a torque spanner, do confirm the correctness of the torque; set the torque to 0 when returning the spanner;
7. All the tools or materials used during operations should be placed in the tool trolley or on the rubber tool mat only.

Note: If a Competitor fails to comply with the operation safety rules and is considered to be have operated in a dangerous manner or have caused a safety hazard in the workplace, or equipment damage or personal injuries, marks will be deducted. In serious cases, the Competitor may be disqualified from the Competition.

Record sheets and attachment

The Record Sheets to be filled out during completion of this Test Project are:

1. Maintenance and control of Pantograph pre-operation inspection Record Sheet

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2. A1-1 Pantograph mechanical parts appearance inspection and maintenance Record Sheet
3. A1-2 Pantograph mechanical parts parameters measurement Record Sheet
4. A1-3 Pantograph mechanical parts replacement Record Sheet
5. A2 Pantograph pneumatic circuit maintenance Record Sheet
6. A3 Pantograph motion parameters adjustment and setting Record Sheet
7. A4-1 Pantograph electric circuit wiring and inspection Record Sheet
8. A4-2 Pantograph electrical function test Record Sheet
9. A5 Pantograph intelligent detection function commissioning Record Sheet

Note: Record Sheets will be provided separately. **The attachments for this Test Project include:**

1. Pantograph electric circuit wiring table. (For Car A1 and Car B1)

Note: The wiring table will be provided separately.

References

1. WSC2026_WM61_A Maintenance and Control of Pantograph Work Manual
2. WSC2026_TP61_A_R03_Pantograph Fault Example Description Table

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Maintenance and control of pantograph pre-operation inspection Record Sheet

Country/Region:_____ Competitor:_____

Instructions:

1. Record abnormal equipment/tools/materials only and mark the corresponding options with "☒". After inspection of all equipment/tools/materials, sign at the bottom of the Record Sheet;
2. If an item needs to be replaced or claimed, submit this Record Sheet to an Expert (or designated person). For replacement of an item, the original one needs to be provided as well. The Expert have the right to reject requests for items that are not abnormal;
3. The Review Result column will be filled in by the Expert (or designated person) who should sign at the bottom of the Record Sheet after requests have been reviewed and handled.

No.	Equipment/Tool/Material Name and Specification	Problem Description	Request	Review Result
1			Replacement□ Claim for new item□	Approved□ Rejected□
2			Replacement□ Claim for new item□	Approved□ Rejected□
3			Replacement□ Claim for new item□	Approved□ Rejected□
4			Replacement□ Claim for new item□	Approved□ Rejected□
5			Replacement□ Claim for new item□	Approved□ Rejected□
6			Replacement□ Claim for new item□	Approved□ Rejected☐

Expert (or designated person):

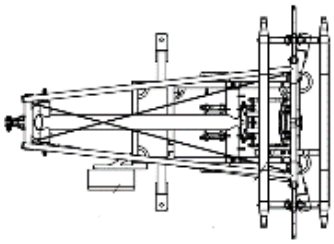
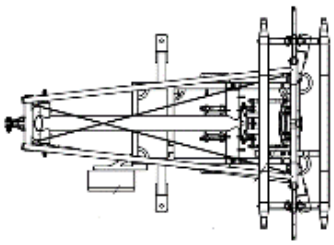
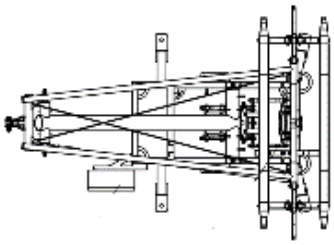
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A1-1 Pantograph mechanical parts appearance inspection and maintenance Record Sheet

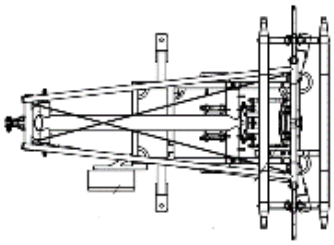
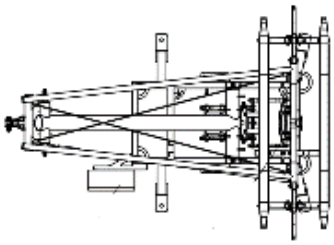
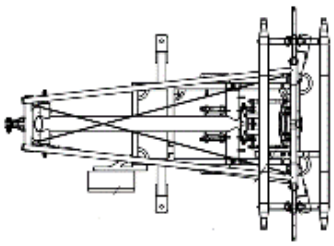
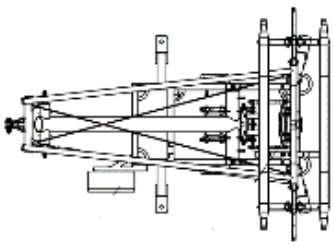
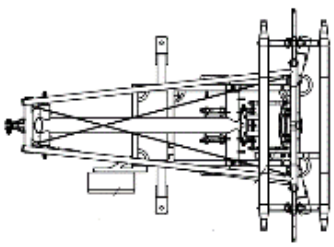
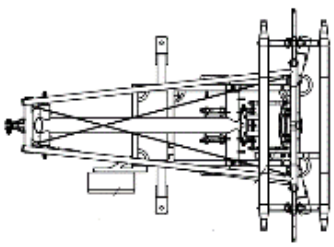
Country/Region:_____Competitor:_____

Instructions:

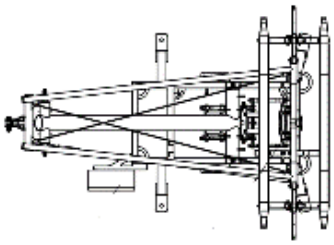
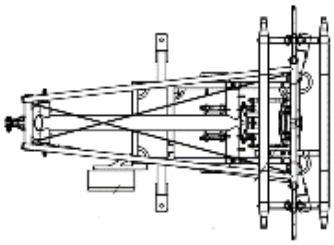
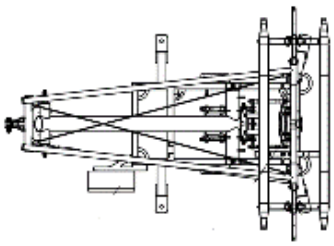
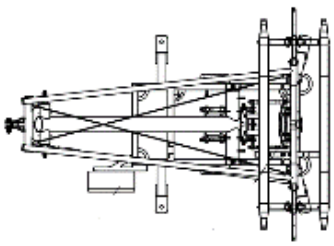
1. For the record of a single faulty part, fill in one row of the table, where the Competitor should circle the faulty position in the Fault Position Illustration column. If a part has multiple faults, additional annotations can be added as needed. (Note: The fault point should be at the center of the circle, and the diameter of the circle shall not exceed 10 mm.)
2. In the Fault Description column, describe fault type only, such as loose fastener, stains, and foreign objects;
3. Fill in the Maintenance Status according to actual operation status and mark the corresponding option with "☒".

No.	Faulty Part	Fault Position Illustration	Fault Description	Maintenance Status
1				Repaired☐ Not repaired☐
2				Repaired☐ Not repaired☐
3				Repaired☐ Not repaired☐

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4				Repaired☐ Not repaired☐
5				Repaired☐ Not repaired☐
6				Repaired☐ Not repaired☐
7				Repaired☐ Not repaired☐
8				Repaired☐ Not repaired☐
9				Repaired☐ Not repaired☐

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10				Repaired☐ Not repaired☐
11				Repaired☐ Not repaired☐
12				Repaired☐ Not repaired☐
13				Repaired☐ Not repaired☐

Supplemental description (if necessary):

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A1-2 Pantograph mechanical parts parameters measurement Record Sheet

Country/Region:_____ Competitor:_____

Instructions:

1. Fill in the values measured according to operation requirements;
2. Fill in the Result Judgement column according to actual status by marking the corresponding option with "☒".

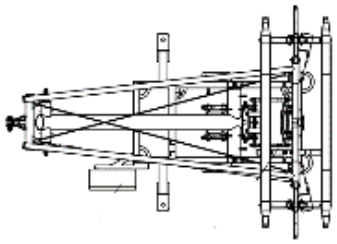
No.	Parameter	Measurement Result	Result Judgement	Remark
1	Carbon contact strip thickness	M1= mm M2= mm M3= mm	/	
2	Gap between pantograph horn and carbon contact strip	M4= mm M5= mm	M4: normal□ too large□ too small☐ M5: normal□ too large□ too small☐	
3	Gap between the panto down position sensor and the aluminum induction plate	M6= mm	M6: normal□ too large□ too small☐	

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A1-3 Pantograph mechanical parts replacement Record Sheet

Country/Region:_____ Competitor:_____

Instructions: Fill in the values measured according to operation requirements.

No.	Part to be replaced	Replacement Result	Remark
1	Carbon contact strip	**Measure and record the gap between pantograph horns and the new carbon contact strip** Gap 1：　　mm Gap 2：　　mm	
2	Conducting wire	**Circle the position of the new conducting wire:** 	

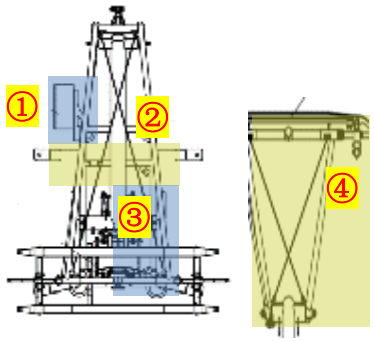
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A2 Pantograph pneumatic circuit maintenance Record Sheet

Country/Region:_____ Competitor:_____

Instructions:

1. If the test result is a value by measurement, fill in the exact figure and the figure should be rounded up to two decimal places;
2. Fill in the Defect Description, Maintenance Status and Result Judgement columns according to actual conditions and mark the corresponding options with "☒";
3. The Competitor may give up this item and apply to the Experts that the equipment be restored by the Experts or designated technicians, in which case no marks will be awarded for this item. (The Competitor must leave the workstation and is not allowed to enter it within 10 minutes).

No.	Operation Item	Operation Sub-item	Result Judgement	Defect Description	Maintenance Status
1	Pantograph pneumatic circuit maintenance	*Position no.*	 Base Upper Frame	/	/
		Pressure maintaining test (fill in the value measured at the last time, and incorrect values can be crossed out). If the panto fails to be raised or lowered, the Competitor may check and adjust the panto up and down throttle valves.	Pressure before the pantograph is raised: _____ MPa Pressure at the start of the pressure maintaining test (after the reading is stable): _____ MPa Pressure at the end of the pressure maintaining test: _____ MPa Leak value: _____ MPa Test result judgement: Normal☐ Abnormal☐	Type: joint leaks□ hose leaks□ Position: ①☐ ②☐ ③☐ ④☐	Repaired□ Not repaired☐

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A3 Pantograph motion parameters adjustment and setting Record Sheet

Country/Region:_____ Competitor:_____

Instructions: If the test result is a value by measurement, fill in the exact figure.

No.	Operation Item	Test Result
1	Measurement and setting of pantograph static contact force (values to be recorded to one decimal place)	Standard range of tensile force: _____N
		Adjusted tensile force: Measurement at 1st position: _____N Measurement at 2nd position: _____N
2	Adjustment of pantograph lifting duration (values to be recorded to two decimal places)	Adjusted pantograph lifting duration:_____s
3	Adjustment of pantograph lowering duration (values to be recorded to two decimal places)	Adjusted pantograph lowering duration:_____s

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A4-1 Pantograph electric circuit wiring and inspection Record Sheet

Country/Region:_____ Competitor:_____

Instructions:

1. Record faults as per the requirements of the Record Sheet. Where status selection is involved, mark the correct option with "☒";
2. Fill in the Test Result column according to actual values or phenomena. When recording the voltage value, fill in the power type (AC or DC) and specific value.

1. Train activation and cab occupation loops inspection – No. 1 end

No.	Test Procedures	Test Result
1	1. Confirm that the U03 cutout cock in the panto up control box is switched on and turn on the power supplies in the power distribution box and cabinet relays. 2. Turn on all relevant circuit breakers in Car A2.	/
2	1. Measure the Battery Power Supply circuit breaker 32-F02 of Car A1. 2. Turn on the circuit breaker 32-F02 of Car A1 after the measurement result is correct.	Before circuit breaker 32-F02 is turned on, the input side voltage is _____V and there (is□/is no□) interphase short-circuit at the output side.
3	Measure the voltages of terminals A1 X2-01, B1 X2-01, and B1 X2-20.	The voltages are _____V relative to the negative pole of the power supply.
4	Measure the voltages of terminals A1 X2-03, B1 X2-03, and B1 X2-18.	The voltages are _____V relative to the negative pole of the power supply.
5	1. Measure the Train Activation circuit breaker 32-F01 of Car A1. 2. Turn on the circuit breaker 32-F01 of Car A1 after the measurement result is correct.	Before the circuit breaker 32-F01 is turned on, the input side voltage is _____V and the output side (is□/is not□) connected to the ground (cabinet body).
6	Turn the Train Activation knob 32-S01 of Car A1 to the On position. After hearing the action of relays, release the knob to the "0" position.	The relay _____ and relay _____ of Car A1 and of Car A2 are closed upon energization.
7	Measure the voltages of terminals A1 X2-02, B1 X2-02, and B1 X2-19.	The voltages are _____V relative to the negative pole of the power supply.
8	1. Measure the connection between terminal A1 X1-03 and terminal A1 X1-04.	The terminals (are□/are not□) connected when the Master Key 24-A01 is at the On position and

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	2. Turn the Master Key 24-A01 of Car A1 to the Off positions.	(are□/are not□) connected when the Master Key 24-A01 is at the Off position.
9	1. Measure the Cab Activation circuit breaker 21-F01 of Car A1. 2. Turn on the circuit breaker 21-F01 of Car A1 after the measurement result is correct.	Before the circuit breaker 21-F01 is turned on, the input side voltage is _____V and the output side (is ☐/is not☐) connected to the ground (cabinet body).
10	Turn the Master Key 24-A01 of Car A1 to the On position.	The relays _____, _____ and _____ of Car A1 are closed upon energization; and the relay _____ of Car A2 is closed upon energization.
11	1. Turn the Master Key 24-A01 of Car A2 to the On position. 2. Turn the Master Key 24-A01 of Car A2 to the Off position after confirming the status of relays.	The status of the relay of Car A1 and of Car A2 remains unchanged.
12	1. Turn the Train Activation knob 32-S01 of Car A1 to the Off position. After confirming the status of relays, release the knob to the "0" position. 2. Turn the Master Key 24-A01 of Car A1 to the Off position.	The relay _____ and _____ of Car A1 and of Car A2 are open upon de-energization. The relay _____, _____ and _____ of Car A1 is open upon de-energization, the relay _____ of Car A2 is open upon de-energization.

2. Inspection of pantograph control and monitoring loop – pantograph lowering control part at No. 1 end

No.	Test Procedures	Test Result
1	1. Measure the connection between terminal +111 X2-13 and terminal B1 X1-02. 2. Measure the connection between terminal +111 X2-12 and terminal B1 X1-03.	Normal connection (Yes☐\No☐)
2	Measure the connection between terminal A1 X1-11 and terminal +111 X2-11.	Normal connection (Yes☐\No☐)
3	1. Turn the Train Activation knob 32-S01 of Car A1 to the On position. After hearing the action of relays, release the knob to the "0" position. 2. Turn the Master Key 24-A01 of Car A1 to the On position.	/
4	1. Measure the Panto Control circuit breaker 22-F01 of Car A1. 2. Turn on the circuit breaker 22-F01 of Car A1 after the measurement is correct.	Before 22-F01 is turned on, the input side voltage is _____V and the output side (is ☐ /is not ☐) connected to the ground (cabinet body).
5	1. Measure the Panto Control circuit breaker 22-F01 of Car B1. 2. Turn on the circuit breaker 22-F01 of Car B1 after the measurement is correct.	Before 22-F01 is turned on, the input side voltage is _____V and the output side (is ☐ /is not ☐) connected to the ground (cabinet body).

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6	1. Press the Emergency button 26-S02 of Car A1. 2. Turn the Emergency button 26-S02 of Car A1 to get the button popped up.	When the button is pressed down, relay _____ of Car B1 is closed upon energization. When the button pops up, relay _____ of Car B1 is open upon de-energization.
7	1. Press the Panto Down button 22-S01 of Car A1. 2. Press the Panto Down button 22-S01 of Car A1 again to get the button popped up.	When the button is pressed down, relay _____ of Car B1 is closed upon energization. When the button pops up, relay _____ of Car B1 is open upon de-energization.

3. Inspection of pantograph control and monitoring loop – pantograph lifting control part at No. 1 end

No.	Test Procedures	Test Result
1	1. Turn the Panto Up Selection knob 22-S05 of Car A1 to the Panto 1 position. 2. Press the Panto Up button 22-S02 of Car A1.	When the button is pressed down, relays _____ and _____ of Car B1 are closed upon energization; and the panto up solenoid valve B1 U05 is (switched on upon energization☐/switched off upon de-energization☐). When the button pops up, the relay _____ of Car B1 is open upon de-energization.
2	Press the Panto Down button 22-S01 of Car A1.	Relays _____ and _____ of Car B1 are open upon de-energization; and the panto up solenoid valve B1 U05 is (switched on upon energization☐ /switched off upon de-energization☐).
3	1. Turn the Panto Up Selection knob 22-S05 of Car A1 to the Panto 2 position. 2. Press the Panto Up button 22-S02 of Car A1, and measure the voltage of terminal B2 X1-04.	The terminal voltage is _____V relative to the negative pole of the power supply.
4	Press the Panto Down button 22-S01 of Car A1, and measure the voltage of terminal B2 X1-04.	The terminal voltage is _____V relative to the negative pole of the power supply.
5	1. Turn the Panto Up Selection knob 22-S05 of Car A1 to the Panto 1 & 2 position. 2. Press the Panto Up button 22-S02 of Car A1, and measure the voltage of terminal B2 X1-04.	Relays _____ , _____ of Car B1 are closed upon energization; and the panto up solenoid valve B1 U05 is (switched on upon energization ☐ /switched off upon de-energization☐). When the button pops up, the relay _____ of Car B1 is open upon de-energization. The terminal voltage is _____V relative to the negative pole of the power supply.

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6	Press the Panto Down button 22-S01 of Car A1, and measure the voltage of terminal B1 X2-12.	The relay _____ of Car B1 is open upon de-energization; and the panto up solenoid valve B1 U05 is (switched on upon energization☐/switched off upon de-energization☐). The terminal voltage is _____V relative to the negative pole of the power supply.
7	1. Turn the Panto Up Selection knob 22-S05 of Car A1 to the Panto 1 position. 2. Turn the Train Activation knob 32-S01 of Car A1 to the Off position. After hearing the action of relays, release the knob to the "0" position. 3. Turn the Master Key 24-A01 of Car A1 to the Off position.	/

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A4-2 Pantograph electrical function test Record Sheet

Country/Region:_____Competitor:_____

Instructions:

1. Conduct the tests in accordance with the standards set out in the Work Manual and fill out the Record Sheet as per the Instructions. For Fault Type, mark the correct option with "☒";
2. If any faults are found during testing, troubleshoot and resolve them based on the electric circuit schematic diagrams before proceeding with the subsequent test steps.

No.	Test Item	Test Result
1.	Car A1 Activation and Occupation	Function (is☐/is not☐) normal
2.	Panto 1 Lifting and Lowering Tests from Car A1	Function (is☐/is not☐) normal
3.	Panto 2 Lifting and Lowering Tests from Car A1	Function (is☐/is not☐) normal
4.	Panto 1 & 2 Lifting Test from Car A1	Function (is☐/is not☐) normal
5.	Emergency Panto Lowering Test from Car A1	Function (is☐/is not☐) normal
6.	Car A2 Activation and Occupation	Function (is☐/is not☐) normal
7.	Panto 1 Lifting and Lowering Tests from Car A2	Function (is☐/is not☐) normal
8.	Panto 2 Lifting and Lowering Tests from Car A2	Function (is☐/is not☐) normal
9.	Panto 1 & 2 Lifting Test from Car A2	Function (is☐/is not☐) normal
10.	Emergency Panto Lowering Test from Car A2	Function (is☐/is not☐) normal
11.	Turning off Train Activation and Getting the Cab Unoccupied from Car A2	Function (is☐/is not☐) normal

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Country/Region:_____Competitor:_____

Instructions:

1. Conduct the tests in accordance with the standards set out in the Work Manual and fill out the Record Sheet as per the Instructions.
2. The pantograph lifting duration starts when the pantograph head acts, and ends when the carbon contact strip touches the overhead contact system.
3. The pantograph lowering duration starts when the carbon contact strip leaves the overhead contact line, and ends when the strip reaches the down position.

No.	Test Item	Test Result
1	Panto up and panto down for the 1st time	Initial panto up pressure:_____Mpa Panto up duration (Manual Measurement):_____S Panto up duration (Automatic Detection):_____S Panto down duration (Manual Measurement):_____S Panto down duration (Automatic Detection):_____S The detection result (is□/is not□) normal. (Tolerance ±1 s)
2	Panto up and panto down for the 2nd time	Initial panto up pressure:_____Mpa Panto up duration (Manual Measurement):_____S Panto up duration (Automatic Detection):_____S Panto down duration (Manual Measurement):_____S Panto down duration (Automatic Detection):_____S The detection result (is□/is not□) normal. (Tolerance ±1 s)
3	Panto up and panto down for the 3rd time	Initial panto up pressure:_____Mpa Panto up duration (Manual Measurement):_____S Panto up duration (Automatic Detection):_____S Panto down duration (Manual Measurement):_____S Panto down duration (Automatic Detection):_____S The detection result (is□/is not□) normal. (Tolerance ±1 s)

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A5 Pantograph intelligent detection function commissioning Record Sheet

Pantograph electric circuit wiring table. (For Car A1 and Car B1)

WIRE NO.	POSITION	START POSITION	END POSITION
32101	A1	21-F01:1	22-F01:1
21103	A1	21-K01:13	21-K11:21
21103	A1	21-K01:13	21-K01:A1
21104	A1	21-K01:33	21-V01:+
32100	A1	21-K01:A2	21-K02:A2
22101	A1	21-K02:14	22-F01:2
21103	A1	21-K02:A1	21-K11:21
32100	A1	21-K02:A2	21-K11:A2
21105	A1	21-K11:A1	21-V01:-
32103	A1	32-K01:14	32-K01:44
32206	A1	32-K01:A1	32-K02:43
32100	A1	32-K01:A2	32-K03:A2
32201	A1	32-K02:14	21-K01:44
32201	A1	32-K02:44	21-K01:44
32203	A1	32-K02:A1	32-K03:21
32100	A1	32-K02:A2	32-K03:A2
32121	A1	X1:1	32-F02:1
32120	A1	X1:2	32-F02:3
21101	A1	X1:3	21-F01:2
21101	A1	X1:3	21-K01:34
21102	A1	X1:4	21-K01:14
21102	A1	X1:4	21-K11:22
22102	A1	X1:5	21-K02:13
22106	A1	X1:6	21-V02:+
22107	A1	X1:7	21-V03:+
22104	A1	X1:8	X2:9
22113	A1	X1:9	X2:10

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22112	A1	X1:10	X2:11
32100	A1	X1:11	21-K11:A2
32201	A1	X1:12	32-F01:2
32201	A1	X1:12	32-K02:14
32201	A1	X1:12	32-S01:5
32202	A1	X1:13	32-S01:6
32202	A1	X1:13	32-K02:13
32202	A1	X1:13	32-K03:22
32204	A1	X1:14	21-K01:43
32204	A1	X1:14	32-S01:1
32205	A1	X1:15	32-S01:2
32205	A1	X1:15	32-K03:A1
32205	A1	X1:15	X2:4
32102	A1	X2:1	32-F02:2
32102	A1	X2:1	32-F01:1
32102	A1	X2:1	32-K01:13
32101	A1	X2:2	32-K01:43
32101	A1	X2:2	21-F01:1
32100	A1	X2:3	32-K01:A2
32100	A1	X2:3	21-K01:A2
32100	A1	X2:3	32-F02:4
32203	A1	X2:5	32-K03:21
21105	A1	X2:6	21-V01:-
22108	A1	X2:7	21-V02:-
22109	A1	X2:8	21-V03:-
22114	B1	22-K01:21	22-K02:14
22111	B1	22-K01:22	22-K01:32
22116	B1	22-K01:31	22-K03:44
32100	B1	22-K01:A2	22-K02:A2
22115	B1	22-K02:13	22-K03:13
22114	B1	22-K02:14	22-K03:14
32100	B1	22-K02:A2	22-K03:A2

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22115	B1	22-K03:13	22-K03:A1
22111	B1	X1:1	22-K01:22
22111	B1	X1:1	22-F01:2
22112	B1	X1:2	X2:11
22113	B1	X1:3	X2:10
22117	B1	X1:4	22-K03:43
32100	B1	X1:5	22-K03:A2
32102	B1	X2:1	X2:20
32101	B1	X2:2	X2:19
32101	B1	X2:2	22-F01:1
32100	B1	X2:3	X2:18
32100	B1	X2:3	22-K01:A2
32205	B1	X2:4	X2:17
32203	B1	X2:5	X2:16
21105	B1	X2:6	X2:15
22108	B1	X2:7	22-K02:A1
22108	B1	X2:7	X2:13
22109	B1	X2:8	X2:14
22104	B1	X2:9	22-K01:A1
22104	B1	X2:9	X2:12

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