6500

SMOKE OPACITY METER

OPERATION MANUAL

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Revision History

Revision	Date	Description
0.1	December 2025	Initial comprehensive revision for the WAGER Model 6500 Smoke Meter, replacing the previous manual. This version features an updated and reorganized structure for clarity, covering all operational and maintenance aspects, including Safety and Compliance, System Overview, Initial Setup, Daily and Neutral Density Filter Calibration/Verification, both SAE J1667 Snap-Test and Follow Mode operations, Data Management & Printing, Configuration, Maintenance, Troubleshooting, and detailed Appendices.

Table of Contents

1. Safety & Compliance

Before operating this equipment, read and understand all safety warnings. Failure to observe these warnings may result in personal injury or equipment damage.

WARNING

- Hot Exhaust Hazard: The vehicle's exhaust stack is hot. Use extreme caution when working around a hot stack. Protective gloves are required.
- Fall Hazard: Manual installation of the sensor head, which may require using a ladder or climbing on the equipment, is not recommended. Use the provided extension pole to attach the sensor head from the ground.

NOTICE

- Compliance: The WAGER Model 6500 Smoke Meter is in full compliance with the requirements of the SAE J1667 test criteria.
- Robert H. Wager Co., Inc. is not liable for personal injury sustained by operators not in compliance with this instruction manual.

2. Introduction

Thank you for purchasing the WAGER Model 6500 Smoke Meter. This device provides an accurate (±1%) and portable means of detecting and measuring the opacity of smoke emitted by a diesel engine.

Using the Model 6500 promotes combustion efficiency, leading to greater fuel economy and ensuring compliance with diesel emission standards.

3. System Overview

3.1 What's in the Box

Your complete system includes the following components:

a. Control Unit
b. Sensor Head Assembly (Full Flow or Partial Flow)
c. 25' Connecting Cable
d. AC Adapter / Charger (Power Supply Transformer)
e. Neutral Density Calibration Filter
f. Extension Pole
g. Carrying Case
h. Thermal Printer Assembly
i. PC Interface with USB Adapter

3.2 Component Identification

Control Unit

- **Keypad:** An 8-button membrane keypad with tactile feedback.
- **Display:** A 2-row, 16-character alphanumeric LCD , which is backlit for low-light situations.
- **Memory:** Stores up to 100 tests.
- **Ports (Side):**
  - **RS232:** Connects to a printer or PC.
  - **Banana Jacks (0-1V):** Outputs a 0-1 VDC signal for a chart recorder or a data logger.
  - **Power:** Connects to the AC Adapter/Charger.

Sensor Head

- Consists of a light source (transmitter) and a light detector (receiver).
- The transmitter emits a pulsed green LED light beam. The receiver measures the amount of light that passes through the smoke plume. The difference is calculated as opacity.

Power

- The unit is powered by an internal 12 V sealed lead-acid battery and is charged using an 18 V power adapter.
- A full charge provides up to 40 hours of continuous operation (reduced to 20 hours with backlight on.)
- The unit will automatically power off after 20 minutes of inactivity to save power (this feature can be disabled.)

4. Initial Setup

To prepare the smoke meter for first use:

1. **Unpack:** Remove the control unit and sensor head from the case.
2. **Charge Battery:** Connect the AC Adapter/Charger (110 V) to the control unit and a wall outlet until fully charged.
3. **Connect Cable:** Connect the 25' cable to the control unit's mating receptacle, locking it clockwise. Connect the other end to the sensor head.
4. **Power On:** Press **ON/OFF**. Ensure the unit is in **FOLLOW** mode; if in **TEST SERIES** mode, press **ZERO**. The unit will self-calibrate.
5. **Perform 0%/100% Check:**
    - When calibration finishes, press **SAVE** when the screen displays **STACK SIZE 5 IN** and **SELECT or SAVE**.
    - On the next screen, press **SAVE** when **HP RATE HIGHER THAN 300** scrolls and **SELECT or SAVE** displays.
    - On the final screen, if **MAX** is not **0.0**, press **ZERO** to clear any residual value.

a. Ensure the sensor head is clear of all obstructions. The display should read "0" (zero). If it does not, press the **ZERO** button.	
b. Pass your hand through the light path. The unit should display 100%.	
c. Remove your hand. The unit should return to 0%.	

5. Calibration & Verification

To ensure continued accuracy, you must perform two types of calibration checks.

5.1 Daily 0%/100% Check

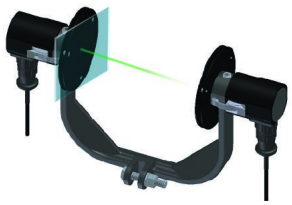
Before starting a test, ensure the unit is properly zeroed. (Refer to Section 4.)

1. Turn the unit on and let it self-calibrate.
2. With the sensor path clear, check that the display reads 0.0%. If not, press the **ZERO** button.
3. Block the light path completely with your hand. The display must read 100%.

5.2 Neutral Density Filter Verification

This procedure verifies the meter's accuracy (± 1%) using the supplied Neutral Density (ND) Filter. This should be done daily before testing.

1. **Power on** the meter. Check the meter is in TEST SERIES mode. If the unit is in FOLLOW mode, press **ZERO** to switch into TEST SERIES mode and allow the unit to self-calibrate.
2. Accept the default stack size and horsepower rate (5”; > 300 HP) by pressing the **SAVE** button twice.
3. The meter should display on Line 1 "0.0 OPACITY" and on Line 2 “PRESS START TEST. If the meter is not reading 0.0 opacity value, press the **ZERO** button. **Do not press START TEST**.
4. **Insert the ND filter** into the sensor head path as described for your filter type.

Full Flow: Place the 2" square filter flush against the metal baffle plate, centered over the green light.	
Partial Flow: Insert the aluminum bar (glass end first) into the filter slot.	

5. Press **START TEST**. The meter will read the filter opacity.
6. Press **SAVE**.
7. **Repeat steps 5 and 6** two more times, for a total of three readings.
8. Press the **COMPUTE AVERAGE** button.
9. **Compare** this average to the stated value on the document that came with your filter. The average must be within the specified range (max and min values) on that document.
10. **If the average is out of range:**
    - Clean the sensor lenses (Section 10.1) and the filter glass with a clean, dry cloth.
    - Re-run the verification.
    - If it still fails, do not perform tests and contact WAGER Technical Support.

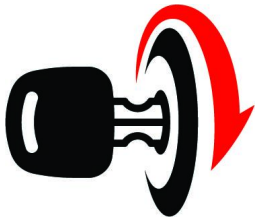
Filter Care: Always store the filter in its protective sleeve. Extended exposure to sunlight (UV light) can deteriorate the tint and cause it to read lower than its stated value. Filters will have to be replaced periodically.

6. Operation: SAE J1667 Snap-Test

This is the primary test mode for the Model 6500 , which guides the operator through the required three-test sequence.

6.1 Phase 1: Setup

1. **Warm Engine:** Bring the vehicle's engine to its normal operating temperature, then turn it off.	
2. **Purge Exhaust:** With the engine in Neutral or Park, rapidly accelerate the engine 3-4 times to clear residual particles from the exhaust.	 ***Neutral or Park***
3. **Power On Meter:** Press **ON/OFF**. Make sure the unit is in TEST SERIES mode. If the unit is in FOLLOW mode. Press **ZERO** to switch into TEST SERIES mode. The unit will then self-calibrate.	
4. **Set Stack Size:** Press the **SELECT** button until the correct exhaust stack size (e.g., 2" to 6") is displayed. Press **SAVE**. *Note:* If using a partial flow sensor, you must always select the 5" stack size.	

5. **Set Horsepower:** The default HP for that stack size will display. If this does not match the engine's specifications , press **SELECT** until the correct HP range is shown. Press **SAVE**.	
6. **Zero/Span Check:** The screen will momentarily display a test record number. Then the screen will display "0.0 OPACITY" on line 1 and "PRESS START TEST" on line 2. Perform the 0%/100% check as described in Section 5.1. Press **ZERO** if the display does not read "0.0".	(See graphic in Section 4)
7. **Attach Sensor Head to Stack:** ○ **WARNING:** The stack is hot. Use protective gloves. ○ Use the extension pole to position the sensor head over the top of the exhaust stack. Ensure it is attached as described in the SAE J1667 booklet.	WARNING HOT STACK 
8. **Start Engine:** Start the vehicle engine.	

6.2 Phase 2: Conduct Test Series

1. **Test 1:** Start the test by pressing **START TEST**. Line 1 of the display will initially show the current opacity reading on the left and the peak opacity reading (labeled "T1 = ") on the right. Line 2 will present the options: "SAVE, START TEST, or ZERO." To initiate the acceleration phase, press **START TEST** a second time. While the vehicle's transmission is in *neutral* or *park*, rapidly accelerate the engine for 4 to 5 seconds, then allow it to return to idle. The display will then show the maximum opacity value reached during this phase. After this, press **SAVE**. At this point, Line 1 will show the peak value recorded for test 1, and the values for tests 2 and 3 will be zero. To restart an improperly performed test, press the **ZERO** button.	
2. **Test 2:** Perform Test 2 by repeating step 1. Be sure to press **SAVE** to record the test results. Once saved, Line 1 will display the peak values for Test 1 and Test 2, while the value for Test 3 will be zero. To restart an improperly performed test, press the **ZERO** button.	

3. **Test 3:** Repeat step 1 to perform **Test 3**, and be sure to press **SAVE** to record the results.

   After saving, the meter displays the peak values for Test 1, Test 2, and Test 3 on Line 1. Line 2 shows the **SPREAD** value and the options **START TEST** or **COMPUTE AVERAGE**. The **SPREAD** value represents the difference between the maximum and minimum of the three test results.

   If a test was performed incorrectly, press the **START TEST** button to restart the testing sequence.

"START TEST" Button

6.3 Phase 3: Compute & Save Results

1. **Compute Average:** To view the average of the three tests, press **COMPUTE AVERAGE**. The resulting screen will display the average value and provide the options to either PRINT or SAVE the test results.

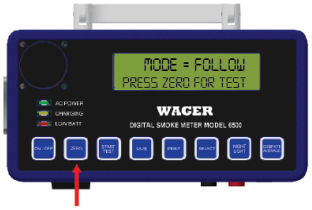
   Press **PRINT** to print test results. (See Section 8 for printer setup.)

   Press **SAVE** to save test results into memory.

2. **Check Spread:** The test is only valid if the three peak readings are within 5% of each other. This is shown as "Spread" on the test result.	
3. **Remove Head:** Carefully remove the sensor head from the hot stack.	
4. **Power Off:** Press **ON/OFF** to turn the unit off.	 **"ON/OFF" Button**

7. Operation: Follow Mode (Rolling Test)

"Follow" mode provides a continuous, real-time opacity reading , which is useful for tests under load on a dynamometer or on the road.

1. **Switch to Follow Mode:** Press the **ON/OFF** button to power on the unit. Check to see if the unit is in FOLLOW mode. If the unit is TEST SERIES mode, immediately press the **ZERO** button to switch the unit into FOLLOW mode.	
2. **Setup:** Attach the sensor head to the stack. If performing a road test, secure the sensor head firmly.	
3. **Set Parameters:** Press **SELECT** to set the stack size and press **SAVE**. Press **SELECT** again to set the horsepower and press **SAVE**.	
4. **Begin Test:** The display will continuously show the opacity reading in the left numeric field, with the peak opacity value ("MAX=") captured in the right numeric field. To reset the test results, press either the **START TEST** or **ZERO** button.	

Note: Follow mode tests **cannot** be printed on the impact printer nor be saved into memory. Data can only be captured via the 0-1V chart recorder jacks.

8. Data & Printing

The Model 6500 can store up to 100 tests.

8.1 Printing a Test

You can print a test *immediately* after the test, either before or after you save the record.

1. Connect the impact printer to the RS232 port.	
2. Turn on the printer by switching the ON/OFF toggle switch on the back of the printer to the ON position.	
3. On the control unit, press the **PRINT** button.	

4. The printed strip will include the record number, date/time, stack/HP ratings, peak values, average, spread, and a Pass/Fail line .	WAGER MODEL 6500 RECORD NUMBER #1096 TIME 01:45 pm DATE 06-16-24 VID _____ STACK SIZE 5.0 HP RATE HIGHER THAN 300 TEST1 7.4 TEST2 7.3 TEST3 7.3 AVERAGE 7.3 SPREAD 0.1 PASS / FAIL TESTER _____

8.2 Printing from Memory

To print previously saved tests:

1. With the control unit **OFF**, connect the printer. Then turn on both the control unit and the printer.
2. On the control unit, **press and hold the PRINT button**, then press the **ON/OFF** button.
3. The display will show the last test number performed.
4. Press **SELECT** to scroll through the saved records.
5. When the desired record number is displayed, press **PRINT**.

8.3 Deleting Tests

You can only delete tests from the "Printing from Memory" mode.

1. Enter the memory/print mode as described in 8.2.
2. Scroll to the test you wish to delete.
3. Press the ZERO button to delete that test. **Note:** If memory is full (100 tests) , the unit will automatically enter this mode and force you to delete tests before you can perform a new one.

8.4 PC Interface Software

The optional "6500 PC Interface" software (V5.1 or higher) enables the download of test data to a connected PC.

To download data to your PC:

1. **Install the Software:** Click the setup file to install the software on your PC (compatible with up to Windows 11).

2. **Configure Settings:**
    - Run the software.
    - Navigate to **Print to PC > Configuration**.
    - Enter your company information.
    - Select the correct COM port (for your computer or USB-to-serial adapter).
    - Click **Save**.
3. **Connect Devices:** Use the interface cable to connect the 6500 control unit to your PC.
4. **Initiate Download on the Unit:**
    - Turn on the control unit.
    - *Immediately* press the **PRINT** button.
5. **Select Record:**
    - The unit will display the first recorded test.
    - Use the **SELECT** button to find the specific record you wish to download.
6. **Manage Data on PC:** Within the PC software, you can now enter vehicle information, print a comprehensive report, or save the test file.

9. Configuration (Settings Menu)

You can change the unit's internal settings by entering Configuration Mode.

1. Turn the unit on.
2. Within 2 seconds, press the **ZERO** and **START TEST** buttons at the same time.
3. The display will show the Configuration menu. Use the following keys :
    - **SELECT:** Move to the next menu item.
    - **ZERO:** Change the setting.
    - **SAVE:** Store the change.
    - **START TEST:** Exit Configuration Mode.

Menu Options:

- **Set Time:** Press **SELECT** once. Press **ZERO** to enter setting mode. Allows you to set the hour , minutes , and format (12-hr or 24-hr).
- **Set Date:** Press **SELECT** twice. Press **ZERO** to enter setting mode. Allows you to set the month , day , year , and format (American mm/dd or European dd/mm).
- **Time-Out:** Press **SELECT** three times. Press **ZERO** to toggle the 20-minute auto-off feature "enabled" or "disabled".
- **Reset Factory Default:** Press **SELECT** four times. Press **ZERO** to reset the unit to factory settings.
- **Print Configuration:** Press **SELECT** five times. Press **PRINT** to print all current settings.

10. Maintenance

10.1 Cleaning the Lenses

Soot and dirt on the lenses will cause inaccurate readings. Regular cleaning is the most important maintenance task.

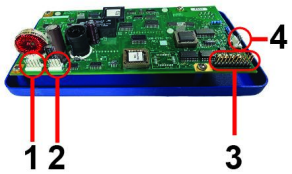
1. Open the snap closures on the sensor head to access the lenses.
2. Wipe the lenses with a soft, clean cloth.
3. For stubborn soot, dip the cloth in denatured rubbing alcohol, rub gently, and allow to dry completely before use. During heavy use, clean the lenses frequently throughout the day.

Full Flow Sensor Head

Partial Flow Sensor Head

10.2 Battery Replacement

The rechargeable battery will gradually lose its ability to hold a charge and must be replaced.

1. Remove the two screws on the front panel and carefully lift it off.	
2. Disconnect the four connectors from the front panel and set it aside.	

3. Turn the unit over and remove the four screws holding the battery bracket.	
4. Disconnect the two connectors from the battery terminals.	
5. Install the new battery and reassemble in reverse order.	

10.3 Cable Care

Cables are subject to wear and tear from hot stacks and improper handling.

- **DO NOT** carry or dangle the sensor head assembly by the cable. This causes extreme stress and leads to failure. Always carry it by the metal "yoke".
- Inspect cables regularly and replace them if their condition affects operation.

11. Troubleshooting

Problem	Solution
How do I switch between 'follow mode' and 'test series (snap test) mode' after initial power-on?	*Immediately after powering up the unit, use the ZERO button on the controller to toggle between these modes.*
What should I do if I get a 'Cable Failure Error' or 'Sensor Failure Error'?	*Ensure all cables and sensors are securely connected and locked before applying power to the unit.*
I cannot scroll through test records on my unit. How can I fix this?	*Put the unit in configuration mode (normally used to set date and time) and select the option to restore the unit to factory default.* ***Warning:*** *This will delete all the records previously stored in the unit.*

12. Appendices

Appendix A: Technical Specifications

- **Light Source:** Green Gallium Phosphide LED (570 nm)
- **Accuracy:** ±1.0%
- **Range:** 0.0% - 100.0% opacity
- **Response Time:** 0.45 seconds (0-90% opacity)
- **Operating Temp:** 32°F to 120°F (0°C to 50°C)
- **Battery:** 12V, 2.2 amp hour, sealed lead-acid
- **Battery Life:** 40 hours (20 hours with backlight). 8 hours to full charge.

Appendix B: Definitions

- **Opacity:** The percentage of light from a source that is prevented from reaching a detector.
- **Snap Acceleration Test:** An SAE J1667 test where the engine is rapidly accelerated from idle for 4-5 seconds.
- **Follow Mode:** A mode that provides a continuous, real-time opacity reading.
- **Test Series Mode:** The default mode that guides an operator through a 3-test Snap Acceleration series.

Appendix C: Parts & Accessories List

Model 6500 Smoke Opacity Meter System Components

Description	Part Number
Control Unit	194-0003
Sensor Head Assembly (complete)	147-0166
Transmitting Unit	147-0164
Receiving Unit	147-0165
5” Mounting Clamp Assembly	194-0005
Sensor Head Assembly Partial Flow	194-0016-F
Curved Nozzle	194-0018-C
Straight Nozzle	194-0018-S
Clamping Style Nozzle	194-0018-SC
5” Mounting Clamp Assembly	194-0005
Power Supply Transformer	194-0004
25” Connecting Cable	192-0003A
Carrying Case	147-0150-2
Extension Pole for Full Flow Head	147-C0092
Extension Pole for Partial Flow Head	147-0092-PF
Neutral Density Full Flow Filter	544-0006
Partial Flow Filter Assembly	194-0029-2
Thermal Printer Assembly	195-0008
CPU Interface Cable with Software CD	194-0009
Instruction Manual	6500 Manual

Optional Items and Consumables

Description	Part Number
12 V Sealed Lead-Acid Battery	800016
25” Extension Cable	191-0011
Power Supply Transformer (220 V)	194-0006
Fuse	820015
Printer Ribbon	555-0008
Printer Paper	566-0004

Appendix D: Warranty Information

Limited Warranty

1. Warranty Coverage and Duration

The Seller warrants that the **equipment will match its description** and that all **Seller-manufactured parts** will be **free from defects** in materials and workmanship under normal use. This warranty is valid for **one (1) year from the date of shipment**.

2. Warranty Remedy

If a failure occurs within the warranty period and the Buyer provides prompt written notice, the Seller will, at its sole discretion, **repair or replace the defective parts** free of charge. Repairs/replacements are made F.O.B. Seller's facility and do not include costs for dismantling or reinstallation. Defective parts must be returned freight prepaid upon Seller's request.

3. Exclusions and Third-Party Items

This warranty is void if the equipment is subjected to **improper storage, handling, installation, operation, maintenance, or unauthorized alteration/repair**. Components or accessories made by other manufacturers are covered only by the **original manufacturer's warranty**, if any.

4. Limitations of Liability

The remedies listed above are the **Buyer's sole and exclusive remedy**, and the Seller's entire liability. **NO OTHER WARRANTIES** are provided, express, implied, or statutory, including warranties of **merchantability or fitness for a particular purpose**, except for title. The Seller is **not liable for special, indirect, incidental, or consequential damages**, including lost profits.