

# 6500

RAILROAD SYSTEM OPERATION MANUAL



**WAGER**  
C O M P A N Y

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## WARRANTY

Seller expressly warrants to Buyer (a) that the equipment will comply with the description set forth herein; (b) that the components and parts fabricated by Seller will be free from detrimental defects in workmanship and materials.

If it appears within one year from date of shipment by Seller that the equipment does not meet these express warranties and Buyer gives Seller prompt and reasonable notice, Seller shall, at its option, either repair or replace at its expense, F.O.B. Seller's works, but not dismantle or reinstall, the defective parts provided, upon request such parts are shipped freight prepaid to Seller's works.

These warranties shall not apply if equipment is subjected to other than normal and proper storage, handling, installation, operation and maintenance or to unauthorized repairs or alterations. Equipment, components and accessories made by other manufacturers are warranted only to the extent of the original manufacturer's warranties to Seller.

The foregoing warranty obligation of the seller shall constitute the sole and exclusive remedy of the buyer and the sole liability of the seller, except as set forth herein and except as to the title it is expressly agreed (a) that there is no warranty of merchantability of any other warranty, express, implied or statutory, nor any affirmation of fact or promises by Seller with respect to the equipment or parts or otherwise which extend beyond the specifications mutually agreed upon in writing by Seller and Buyer, and (b) that the Buyer acknowledges that it is purchasing the equipment solely on the basis of the commitments of Seller expressly set forth herein, in no event shall Seller be liable for special, indirect, or consequential damages including, without limitation, anticipate profits.



## General

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The WAGER Model 6500 Smoke Meter is in full compliance with the requirements of the SAE J1667 test criteria—the current U.S. standard.

The meter's simple design and portability makes it easy to obtain accurate measurements. It provides an accurate means ( $\pm 1\%$ ) of detecting and measuring the opacity of smoke emitted by a locomotive engine.

The use of the Model 6500 Smoke Meter promotes combustion efficiency for fuel economy and ensures compliance with diesel emission standards set by environmental air quality codes.

The program document for SAE J1667 is *Surface Vehicle Recommended Practice*. It can be obtained from:

SAE International  
400 Commonwealth Drive  
Warrendale, PA 15096-0001 Telephone: 724/776-4970

Or electronically at: <http://www.arb.ca.gov/msprog/hdvp/saej1667.pdf>

It is also part of the *Heavy-Duty Vehicle Inspection Program Periodic Smoke Inspection Program* issued by the Mobile Source Operation Division, California Environmental Protection Agency, Air Resources Board. One copy can be downloaded free of charge from:  
[www.arb.ca.gov/msprog/hdvp/saej1667.pdf](http://www.arb.ca.gov/msprog/hdvp/saej1667.pdf)



## System Description

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### Model 6500 Railroad (Opacity) Meter System Components

Description	Part Number
Control Unit	194-0003
Power Supply	194-0004
Frame, Smoke Meter Extended	247-D0180
Light Unit Assembly	192-D0006
Receiving Unit Assembly	192-D0007
Heavy Duty Cable Assembly (100ft)	192-0009
Verification Filter Assembly (.2 ND)	194-0034
Verification Filter Set (.04, .1, and .2ND)	194-0036

### Optional Items, Consumables

Battery, Control Unit	800016
Fuse Holder	627-0123
Fuse	4143551
4" Locking Nut	45
Pipe Plug 3/8"	SB-8

### System

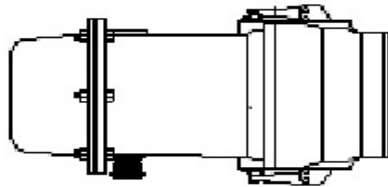
The complete system consists of a Control Unit, Power Supply, Sensors (Receiving and Light Unit), Connecting Cable, Frame, and Verification Filter Assembly Set.





## Control Unit

The control unit is operated by a membrane keypad, which consists of eight tactile feedback push buttons. The display is an alphanumeric LCD, containing 16 characters by two rows. In low light situations, the display can be backlit. The display shows the prompts the operator follows throughout the test sequence(s). The banana jacks (red and black) allow a 0 –1 VDC output for a chart recorder. There are two modes the unit can operate in. In railroad applications, the user should have the control unit in the follow mode. During boot up, the meter will display the mode it is in and give the operator about 2 seconds to change the mode. Press “zero” to toggle which mode you wish the meter to operate in.



## Sensor Assemblies

The optics set consists of the Light and Receiver Units. The light unit has 7 pins and emits a green light and the receiver has 5 pins. Note, the green light is only on in certain modes so if you do not see green light, do not assume the system is not functioning properly. These sensors have a threaded socket for mounting to the frame. Once the sensors are mounted to the frame, there are quick release latches for easy access to perform periodic cleaning of the sealing glass. Note, once the initial setup of the system has been performed, ensure the optics are always re-mounted to the side that they were initially installed on. Otherwise you may have to perform the beam alignment again. These assemblies also contain ports for application of purge air. The purge air creates a bubble of clean air over the sealing glass to keep the glass cleaner longer.

## Cable

The connecting cable is 100 feet heavy duty (standard). Optional cable lengths are available. The cable ends for the optics are keyed, and can only be connected to their proper location.





## Power Pack

The meter is shipped with an AC Adapter/Charger which operates in 100-240vac at 50-60hz power.

The control unit has a power input jack that will mate to the connector on the power charger. AC power light and the charging light indicate that the power is applied and charging the battery. The control unit also has a time-out feature that will turn the control unit off automatically if none of the front panel buttons are pressed for 20 minutes. This feature can be disabled using the configuration menu.



## Frame

The frame is made out of light-weight aluminum beams with detachable legs. Threaded 4" pipe nipples are attached on both of the short sides of the frame. The optics mount on these threaded pipe nipples.





## Verification Filter Assembly

The verification filter set consists of three filters. .01, .1, and .2 neutral density filters and are used to verify the meter is functioning properly. On a periodic basis, run a test on the glass and compare the readings to the document that was provided with the filter. If the reading is within plus or minus 1 percent of the stated value on the document, the meter is working properly and it is ok to perform a test. If the filter is reading outside of the plus or minus 1 percent range of the stated value, then system is not operating properly and do not perform any testing.

## Filter Slot

(SEE PHOTO ON PAGE 15)

There is only one filter slot where the verification filter can be inserted. This is on the light unit. Ensure you keep the filter slot attached to the light unit and not to the receiving unit. To use the filter, power on the meter normally, then select the default stack size and horse power (do not change these values and just hit save and save). Once the meter say “press start to begin test”, do not press start. This is when you insert the filter assembly fully in, glass end in first, and then presses “start”. Compare the displayed filter reading to the stated value on the document.





## Technical Specifications

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### Design Criteria

#### Accuracy

The unit's accuracy is  $\pm 1.0\%$  nominal  $\pm$  one digit. The control unit is initially calibrated under clear stack conditions with checks at 0% and 100% opacity.

#### Ambient Conditions

The unit operates in 32° to 120° F (0° to 50° C).

#### Reliability

Zero stability at less than 1% drift per use.  
The pulsed green LED has infinite life expectancy.  
Check filter provided for easy calibration  
All solid state electronics.

#### Applications

The Model 6500 Smoke Meter can be used on any diesel engine, with primary application in testing trucks, busses, and locomotives.

### Functional Description

When the unit is activated, it performs a self-calibration and then the transmitter emits a light beam at a known intensity. As the light passes through the smoke plume, some or all the light is diverted.

The sensor head consists of two components, a light source (transmitter) and a light detector (receiver).

The light detector measures the amount of light received, and compares this with the amount of light being emitted. The difference between the two values is opacity.



## Installation

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### Installation of Sensors

#### Installation of Optics

Attach the four legs to the frame at whatever length is required. Screw the optics on to the threaded pipe nipples. It doesn't matter which side you mount the optics but once you have aligned the beam, never swap sides. Use the 4" locking nut to secure the optics into place.

#### Attachment of Cable

The transmitter and receiver connectors different in the number of pins each has. The cable connections are keyed, so the cable cannot be connected incorrectly. Please match up the 5 pin cable end to the receiver and the 7 pin cable end to the transmitter.

#### Connection of Purge Air

Compressed, regulated air (Not supplied) may be applied to the optics set, using the 3/8 NPT connection. Remove the pipe plug and attach your air fittings..

#### Analog Retransmission Output

The WAGER Model 6500 Smoke Meter outputs a 0 – 1 V signal through the red and black banana jacks (located next to the AC power input plug). The output voltage reflects the opacity output where 0 V is 0 % opacity and 1 V = 100% opacity. If the display is showing 55% opacity, then the output will be .55vdc.



## Operation - Testing

### Testing Process

Following installation of sensors, frame, cabling and control unit, the following listing provides a step by step listing of the correct usage of the Model 6500 for railroad usage.

1. With a clear sensor light path (no smoke), turn the Control unit on, by pressing the ON/Off button. The system will display the time and date.
2. Next, the system will display the Test selection screen (Briefly). The top line of the display should show MODE = FOLLOW, if not, press the ZERO button to change the selection.

NOTE: The system automatically starts in the last testing mode used – this selection is not required to be changed for subsequent testing.

3. The system will perform an Auto-Calibration (for zero and span), followed by a prompt to select the Stack Size. Railroad testing conventionally uses the system default setting of 5” stack size. Press “SELECT” to change the stack size selection, press SAVE to store the current selection.

**NOTE: Exhaust sizes exceeding 6” in diameter do not require the stack size selection to be changed. The user should press SAVE while viewing the system default setting of 5: stack size.**

4. The system will display a Horsepower selection, Inline testing conventionally uses the system default setting of Above 300 HP. Press “SELECT” to change the horsepower setting, press SAVE to store the current selection.

**NOTE: Exhaust sizes exceeding 6” in diameter do not require the HP selection to be changed. The user should press SAVE while viewing the system default setting of above 300 HP.**

5. The system will display 0.0 % opacity, and prompts the user to press Start Test to begin. Press START TEST, the system will display the real-time opacity (at the top left), and the Maximum opacity (at the top right).
6. Start the test engine. The system will continuously monitor the opacity until the ON/OFF button is pressed. (Or the 20 minute timeout is reached if enabled in the system configuration)

NOTE: Stack Size selection and Horsepower settings are normally set to the system defaults of 5” and Above 300 HP, which prevents the system from applying the Beer-



Lambert Correction formula. Please feel free to contact Wager Technical Support to determine if your application requires a different configuration.

## Appendix A Configuring Control Unit

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### Configuration Mode

In the configuration mode, the user can change the following items in the control unit:

- Time including hour, minutes, and format (12 hour or 24 hour clock)
- Date including month, day, year, and format (American or European)
- Time-out battery saving feature
- Reset to factory defaults
- Print current configuration

To access the “Configuration Mode” turn on the unit and press ZERO and START TEST at the same time. Press these two buttons within 2 seconds.

The “Configuration” display will give you the following selections:

START TEST =exit  
SELECT=next,  
ZERO=change  
SAVE=store.

Set Time:

Press the SELECT button. The LED displays the following:  
ZERO= set time      XXXXX (your current time setting)

Press the ZERO for ”setting mode.”

Press ZERO to change time format (toggles between 12 and 24 hour clock).

Press the SELECT for “hour” mode.  
Press ZERO to scroll to your correct hour.

Press the SELECT for “minute 10’s digit mode. (12:00 a.m.)  
Press the ZERO to scroll to the correct minute 10’s digit.



Press the SELECT for “minute 1’s digit mode. (12:00 a.m.)  
Press the ZERO to scroll to the correct minute 1’s digit.

## Set Date

Press SELECT twice.

Press ZERO for “set date” mode.

Press ZERO to change date format (toggles between the formats dd/mm and mm/dd).

Press SELECT to set month 10’s digit. (06-12-98)  
Press ZERO to scroll to your correct month 10’s digit.

Press SELECT to set month 1’s digit. (06-12-98)  
Press ZERO to scroll to your correct month 1’s digit.

Press SELECT to set day 10’s digit. (06-12-98)  
Press ZERO to scroll to your correct day 10’s digit.

Press SELECT to set day 1’s digit. (06-12-98)  
Press ZERO to scroll to your correct day 1’s digit.

Press SELECT to set year 10’s digit. (06-12-98)  
Press ZERO to scroll to your correct year 10’s digit.

Press SELECT to set year 1’s digit. (06-12-98)  
Press ZERO to scroll to your correct year 1’s digit.

## Time-Out/Battery Saving Feature

Press SELECT three times for “Time Out” mode.

Press ZERO to change time out feature (toggles between enabled and disabled).

## Reset Factory Default

Press SELECT four times for “reset” mode.

Press ZERO to reset factory defaults (as you received the unit from WAGER).

Press COMPUTE AVERAGE to confirm reset to factory default.

## Print Configuration

Connect printer cable to control unit. Press “1” (figure one) on your printer to turn the unit on.



Press SELECT five times for “Print Configuration” mode.

Press PRINT for configuration print out.

#### Exit Configuration Mode

Press START TEST to exit the configuration mode at any time. Any changes you have made up to that point will be saved (become the default setting).



## Appendix B

### Adjusting the Optics

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#### Diagnostic Mode.

Start with the control unit off. Ensure the filter is not inserted and there is no smoke present. Hold the ZERO and START TEST buttons down while powering on. The control unit should display CONFIGURATION MODE. If not, turn the unit off and try again. Once you see CONFIGURATION MODE, release all buttons. Then press SELECT three times. Next press COMPUTE AVERAGE once. Finally, depress ZERO and then SELECT in a quick manner. This pressing of the SELECT button freezes the automatic gain control and is required to stabilize the digital values. Upon completion of this button series, the LCD will show three values. If you do not have 3 values, turn the meter off and start again. The top left value is the LED DRIVE value and should not be changing and should be steady stable. Block the beam of light and ensure the top left value does not change. The value is not important just as long as it is between 1500 and 3500 as is stable. The bottom left number is the TRANSMITTER value and the top right number is the RECEIVER value.

**The goal of the optic alignment is to have the TX and RC values to be equal and around 2800.**

#### ADJUSTMENT (located on optic units)

Remove the cap cover to expose the adjustment screws. Start on the transmitter. This is the one emitting green light. Inspect the value displayed and adjust the brass flat-head screw of the potentiometer on the circuit board. The potentiometer is a 20 turn device and has a self-protect mechanism. If you hear it click, you are at the limit and further turns will not affect the value. Clockwise (CW) increases the value and counter-clockwise (CCW) decreases the value. Adjust the transmitter potentiometer for a value of 2800. Once the TX value is 2800, no further adjustment of this potentiometer is required.

Now inspect the digital value of the receiver. This is displaying the amount of light the receiver is viewing. While still on the transmitter side, adjust the 3 beam alignment screws for a maximum value on the receiver. Note: the digital values have a peg maximum of 4096. So if at any time the receiver is pegged high, turn the receiver potentiometer CCW to 2800. Continue adjusting the transmitter beam alignment screws for a maximum value on the receiver. Lastly, loosen the 3 focal length screws and slide the shield in or out for a maximum value on the receiver. Once you have the maximum, tighten the focal length screws gently to secure the shield in place.

Now proceed to the receiver. If at any time the RC value goes about 4000, turn the RC potentiometer CCW to 2800. Adjust the receiver potentiometer beam alignment screws for a maximum value on the receiver. Now loosen the 3 focal length screws on the receiver and slide the shield in or out for the maximum value. Tighten the 3 focal length screws to gently to secure the shield in place. Lastly, adjust the receiver potentiometer for a value of 2800.



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Turn the meter off and go into the diagnostic mode again and verify the values of the TX and RC are approximately equal.

Example

2145 28xx

28xx

x=changing number

A – Purge Air Port

B – Verification Filter Slot

C – Cable Connector

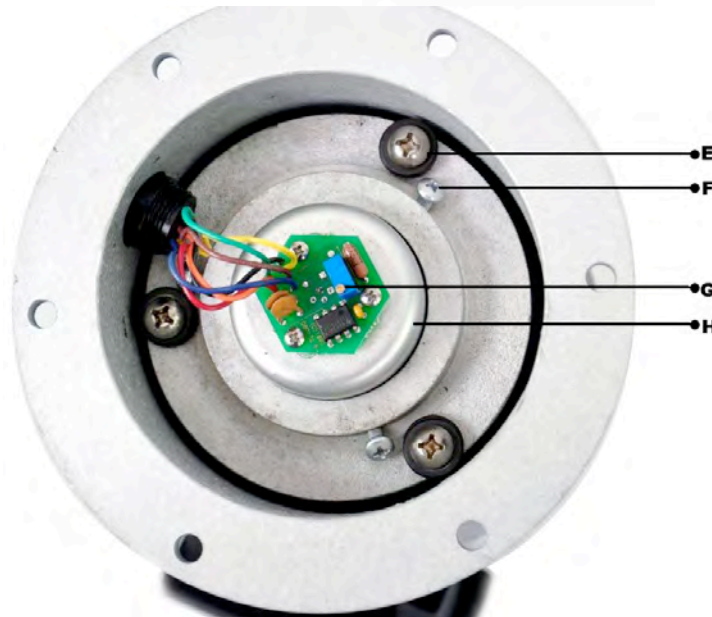
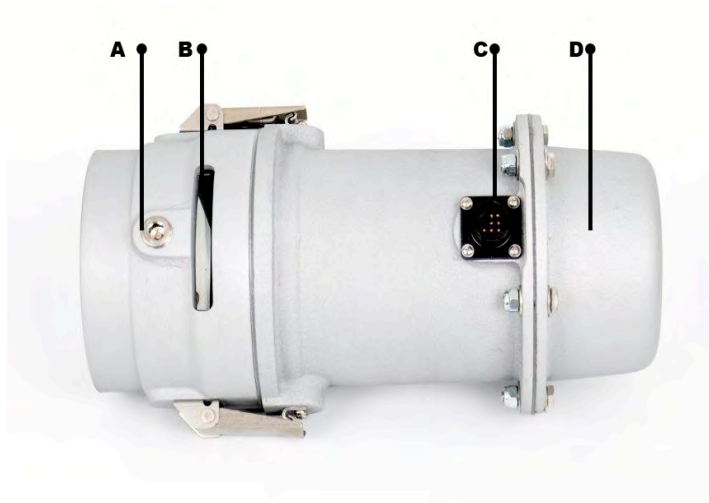
D – Cap Cover

E – Beam Alignment Screws

F – Focal Length Screws

G – Potentiometer Screw

H – Shield



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