Literature Number: LG-7040
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Operating Manual

MTG

Multi-Test Gravelometer Impact Tester

Applicable for Serial Number: XXXX

H.J.Unkel(Shanghai) International Trading Co., Ltd.
Unit 2201 Block 2, Xi'an Zone, 20 Middle Xuhong Road, Shanghai 200235 China
Tel: +86 (21) 5169 1088
Fax: +86 (21) 5282 9830
E-mail: marketing@hjunkel.net.cn
Web site: http://www.hjunkel.com.cn

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1. Warranty

The Multi-Test Gravelometer is guaranteed against defects in workmanship or materials for one year. Liability is limited to replacing or repairing any part or parts, which are defective in materials or workmanship and are returned to our factory, shipping costs prepaid. Liability in all events is limited to the purchase price paid. Damage due to accident or abuse is not covered. Labor cost is not covered.
H.J.Unkel Limited makes no other warranties, including implied warranties of merchantability or fitness for a particular purpose, except as may be expressly provided by H.J.Unkel Limited in writing. H.J.Unkel Limited shall not be liable for any incidental, consequential, special, or contingent damages arising out of the sale or use of any product.

2. Safety Guidelines

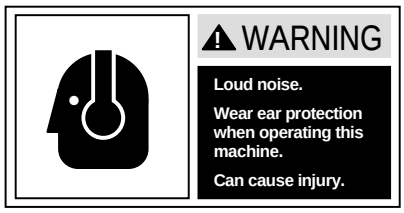
- Read this operation manual before operating your Multi-Test Gravelometer (Adhesion) Tester. Any questions regarding safety should be answered before handling specimens or operating any part of this machine.
- Ear and eye protection must be worn during operation of the Multi-Test Gravelometer unit. The Multi-Test Gravelometer operates at a noise level of 100 dBA. It projects media at high speeds at test specimens and produces a very high noise level.
- The nozzle air pressure line must remain connected whenever a test cycle is ON. The flexible line will whip if it is disconnected.
- Never loosen or remove the gun air supply line's connection when the test cycle switch is ON.
- Do not override the safety interlock switches. The interlock switches are supplied for your safety. The interlock switches are adjusted at the factory. If they do not operate correctly, call H.J.Unkel Limited Customer Service for repair information.
- When the Multi-Test Gravelometer is moved, the 3D Specimen Chamber and gravel box must be removed; the base unit, gun, and target chamber may remain attached.
- When the Multi-Test Gravelometer is moved, use the 90° elbow on the control cabinet's side as a handle. Lift the unit until the weight is over the wheels. The unit can now be rolled.
- Depressurize the Air Receiver Tank whenever the Multi-Test Gravelometer is going into storage, will not be in use for a long time, or is being moved.
- There are two acceptable methods for removing the Air Receiver Tank:

    1) Leave the complete Multi-Test Gravelometer with gun, target chamber, and gravel box together. Turn the main power air supply off. Turn the manual cycle control ON until all air is depleted.

    -OR-

    2) Open the condensation drain valve. Remove loose dirt and objects from the air path. Leave the condensation valve open until all air is depleted.

The following safety warning labels appear on the gravelometer. Their locations and meanings are given in the table.

Label, Warning, or Symbol	Location on the Gravelometer	Meaning
	Appears on the control cabinet side, above the air regulation knob.	The gravelometer will produce a lot of noise during operation. The operator should wear ear protection for noise. Ear protection should reduce the noise level to less than 85 dBa (or lower, if national or local worker safety regulations so require).
	Appears on the control overlay.	The operator should consult the operating manual for proper instructions and hazard warnings.

Hazards of waste product disposal:

Gravelometer testing will produce dust. Dust masks should be used during cleanup after running tests.

The Test Cycle Meter and the Elapsed Time Indicator use lithium batteries. These batteries are rated to last for five years. When necessary to replace the batteries, be sure to dispose of them properly.

3. General Description

The Organic Coatings Committee of the Society of Automotive Engineers originally developed the Gravelometer in 1968. It was designed to test and rate the resistance of automotive materials to chipping caused by flying gravel.

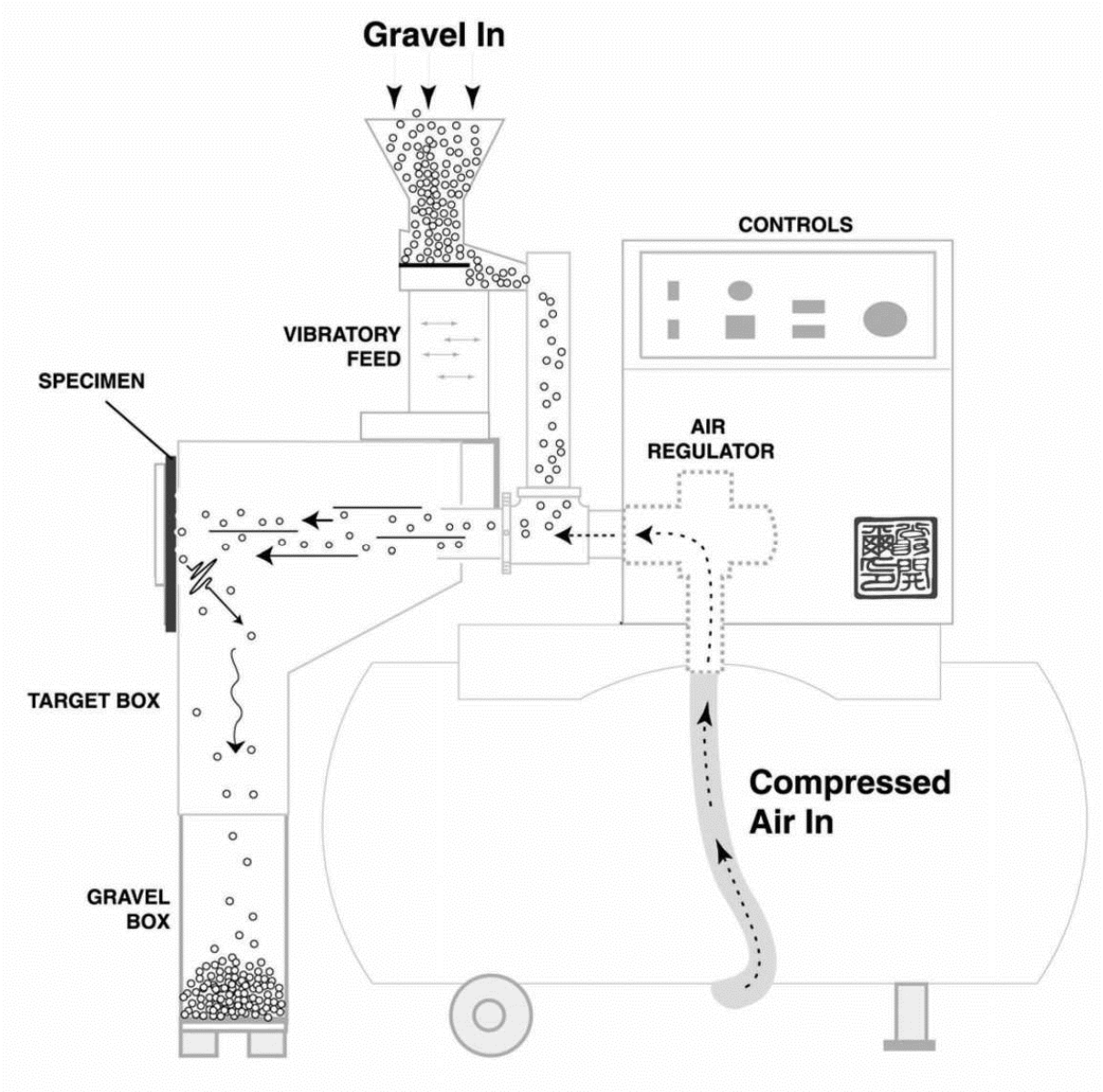
In summary, the Gravelometer test consists of using compressed air to project or shoot gravel, or some other media, onto a test specimen to simulate the effect of highway gravel on a coating or other automotive product. The Gravelometer is used to test the following: cohesional failure of topcoats, adhesion failures of different layers of a coating, system brittleness of hard glassy materials, optimum film thickness for chip resistance, chipping and abrasion resistance of plastics and glass.

The Multi-Test Gravelometer is based on a unique modular design that consists of a Base Assembly and a choice of various modular components. The Base Assembly is common to all test methods. It consists of an Air Receiver Tank, Vibratory Feed, Hopper, Gun Mount and Control Cabinet. Depending on which test procedure is to be run, the user chooses the modules which are most appropriate and attaches them to the Base Assembly. The system can be varied by the choice of the following modules:

SAE Gun Assembly
VDA Gun Assembly
SAE 90° Target Chamber
SAE 45° Target Chamber
VDA 90° Target Chamber
VDA 54° Target Chamber
Flat Specimen Holder Assembly
3D Specimen Chamber

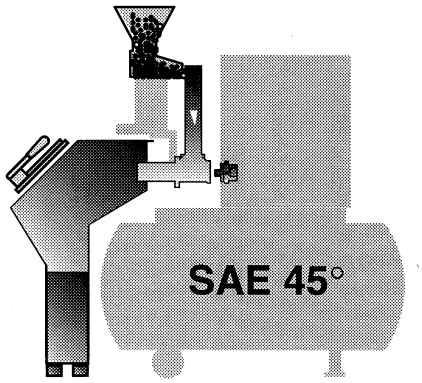
The most common test standards that the Multi-Test Gravelometer accommodates are the Society of Automotive Engineers (SAE) J400 test, and the German Automotive Industry Association (VDA) test. For the exact procedures of each of these tests, refer to SAE J400 and VDA Test Sheet 621427.

3.1 How the Multi-Test Gravelometer Operates

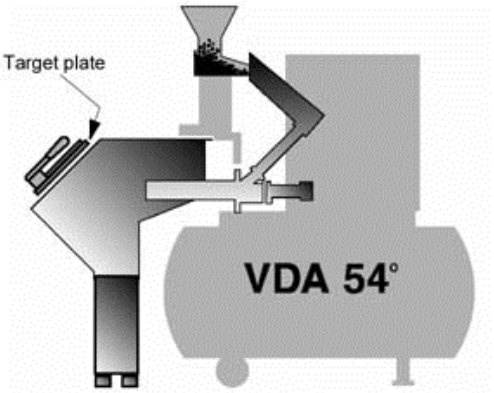


Gravel or other media is placed into a hopper where a vibratory feed moves it into a feed chute. The media falls down into the feed chute, where a vacuum exists due to the high velocity air below. The media is sucked down into the gun and is fired at the test specimen by means of an air blast. After the media hits the target, it falls into the Gravel Box below.

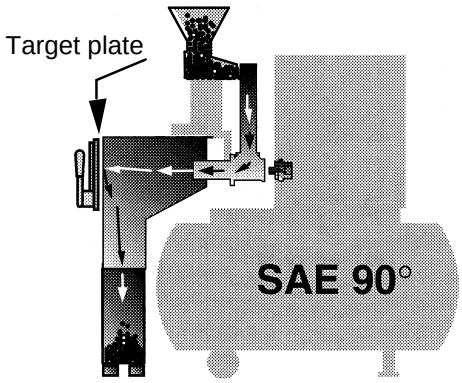
Various Configurations of the Multi-Test Gravelometer



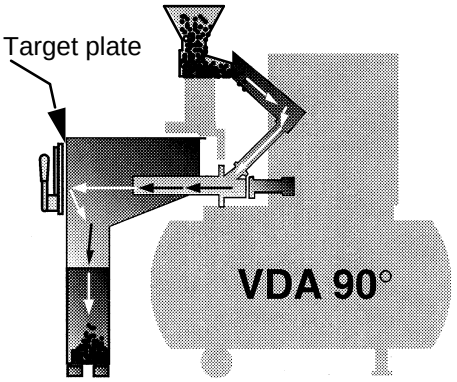
SAE Configuration With 45° Angle Target Plate And Gravel Path Shown



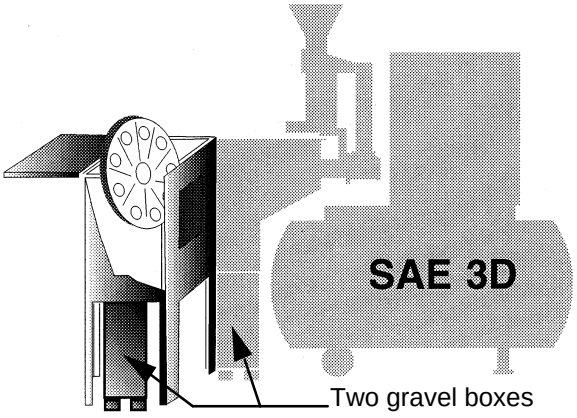
VDA Configuration With 54° Angle Target Plate And Gravel Path Shown



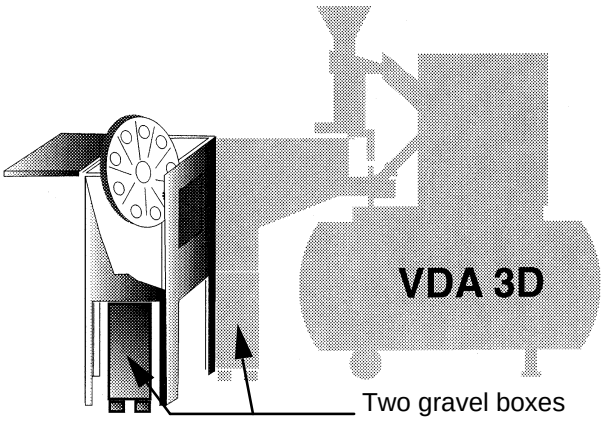
SAE Configuration With 90° Angle Target Plate And Gravel Path Shown



VDA Configuration With 90° Angle Target Plate And Gravel Path Shown



SAE 3D Configuration With Two Required Gravel Boxes



VDA 3D Configuration Showing Two Required Gravel Boxes

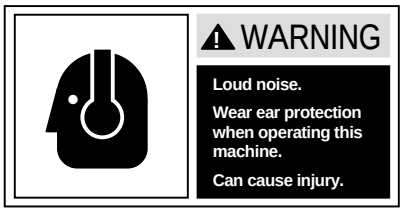
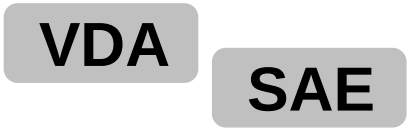
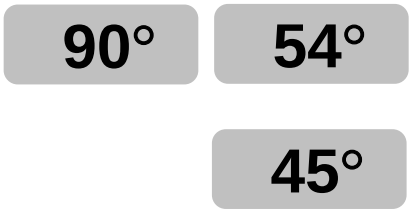
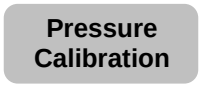
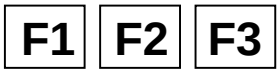
3.2 Specifications

Indoor Use:	This equipment is for indoor use only.
Electrical:	
Voltage:	120 V ± 10 V, or 240 V ± 10 V.
Frequency:	50 to 60 Hz.
Current:	2 amp at 120 V, 1 amp at 240 V.
Wattage (max):	240 W.
Installation:	Rated as Installation (Overvoltage) Category II for transient overvoltages.
Grounding:	This machine is rated as Class I equipment. This machine requires a properly grounded electrical supply (mains receptacle) for safety.
EMC Immunity:	EN 50082-2 (1995).
EMC Emissions:	Class A per EN 55011 (1997).
Air:	
Air Consumption Rate:	The gravelometer will require up to 80 psi at 100 CFM for 5-10 seconds (550 kilopascals at 47.2 L/sec). (VDA requirements are lower.)
Compressed Air Requirement:	The gravelometer will require up to 80 psi at 100 CFM (550 kilopascals at 47.2 L/sec). Compressed air supply should be 3/4 inch (19 mm) inside diameter, or higher for SAE testing, or ½ inch inside diameter or more for VDA testing. (VDA requirements are lower.)
Reservoir Capacity:	30 gallon tank.
Operating Temperature:	-30°C (-22°F) to 40°C (104°F).
Relative Humidity Maximums:	80% for temperatures up to 31°C (88°F) decreasing linearly to 50% relative humidity at 40°C (104°F).
Pollution Control:	Pollution Degree 2 for protection against ambient pollution.
Sound Pressure Level:	Sound pressure level emitted by equipment exceeds 100 dBA. Ear protection equipment is required to be supplied by user.
Altitude:	2000 m (6560 feet).
Continuous Operation:	The gravelometer is suitable for continuous operation.
Gun Barrel Interior Dimensions:	SAE J400: 2.07 inch (52.6 mm) VDA: 1.18 inch (30 mm)
Distance From Gun to Test Specimen:	SAE J400: 13.75 inch (349.25 mm) VDA: 11.42 inch (290 mm)
Flat Test Specimens - Overall Size:	4 x 6 inch (101.6 x 152.4 mm) 4 x 8 inch (101.6 x 203.2 mm) 4 x 12 inch (101.6 x 304.8 mm) Thickness up to 1-3/8 inch (34.9 mm)
Flat Specimen Holder Assembly - Test Specimen Exposure Area:	(area of test specimen exposed to media impact) 3.625 x 5.625 inch (92.08 mm x 142.88 mm)

3D Specimen Chamber Capacity Specifications:	Length: 17 1/8 inch (435.10 mm) Width: 10 1/8 inch (257.3 mm) Depth: 16 1/2 inch (419.1 mm)
3D Specimen Chamber Test Specimen Exposure Area:	(area of test specimen exposed to media impact) 8 x 8 inches (203.2 mm x 203.2 mm)
Test Specimen Mounting Angles:	90, 54 and 45 degrees (The 45 and 54 degree mounting angle is only applicable for flat panels.)
Hopper Feed Rate Capability:	Gravel: 5.8 sec to over 5 min Buck shot: 12.7 sec to over 5 min Split shot (Chilled grit iron): 6.2 sec to over 5 min
Spatial Considerations:	Note: Dimensions are given for the largest possible configurations.
Multi-Test Gravelometer Base Unit Size:	Width = 22 inch (55.9 cm) Length = 44 inch (111.8 cm) Height = 48 inch (121.9 cm)
Multi-Test Gravelometer Base Unit with VDA Chamber & Flat Specimen Holder:	Width = 22 inch (55.9 cm) Length = 66 inch (167.6 cm) Height = 48 inch (121.9 cm)
Multi-Test Gravelometer Base Unit with VDA Chamber & 3D Specimen Chamber:	Width = 22 inch (55.9 cm) Length = 70.5 inch (179.1 cm) Height = 48 inch (121.9 cm)

3.3 Labels, Warning Statements, and Symbols Explained

The following labels, warnings, and symbols are found on the gravelometer. The location and meaning of each is identified in the table.

Label, Warning, or Symbol	Location on the Gravelometer	Meaning
	This label appears on the control cabinet side, above the air regulation knob.	The gravelometer will produce a lot of noise during operation. The operator should wear ear protection for noise. Ear protection should reduce the noise level to less than 85 dBa (or lower, if national or local worker safety regulations so require).
	These labels appear on the operator's side of all target chambers and gravelometer guns.	These labels identify the proper target chamber and gun to be used for either the VDA test or the SAE test.
	These labels appear on the operator's side of all target chambers below the VDA or SAE label.	These labels identify the proper target chamber and gun to be used for a particular VDA or SAE test.
	This label is located above the quick-connect bulkhead air fitting on the control cabinet's side.	This label identifies the location where the calibrated air pressure gauge will be placed during pressure calibration.
	This label appears just above the air regulator knob on the control cabinet's side.	This label shows the location of the air regulator control.
	This appears on the inside of the control cabinet on the front face of each electrical relay.	These labels identify the different relays. The operator should refer to these when using the electrical diagram.
	These appear on the inside of the control cabinet on the electrical fuse blocks.	These labels identify the different fuse blocks. The operator should refer to these when using the electrical diagram.
	This appears on the control overlay.	The operator should consult the operating manual for proper instructions and hazard warnings.

4. New Multi-test Gravelometer vs. Old QGR Gravelometer

Previous models of the Gravelometer were designed to run only a small number of tests at a time. They could not easily accommodate a large number of successive tests. The Multi-Test Gravelometer is modular and more user-friendly. It can accommodate a large number of successive chipping tests without the hassle of opening and closing compartment lids before and after every test. The Gravelometer can be equipped to run either an SAE J400 or VDA standard test, as well as tests that require media such as sand, MDOT 25A, split shot, and buckshot. The Gun Assembly, Target Chamber, and Flat Specimen Holder Assembly can be changed to accommodate different standards and different angles of impact. The J400 Target Chambers come in 90 and 45 degree angles from the horizontal. The VDA Target Chambers are available in 90 and 54 degrees. There is also a 3-Dimensional (3D) Specimen Chamber designed to accommodate large or unusually shaped specimens. In addition to being versatile, the new Multi-Test Gravelometer is designed to be more precise. The new features are designed for precision to reduce testing error.

5. Functions, Capabilities, and Features

The following features and capabilities are designed into the Multi-Test Gravelometer to enhance ease of use and precision:

5.1 Flexibility

Accommodates SAE J400, VDA, or other standard tests
The versatility of the Multi-Test Gravelometer allows it to accommodate many different configurations. Different Gun Assemblies and Target Chambers attach to the Base Assembly of the machine to perform different tests. Target Chambers position specimens at either 90°, 54°, or 45° from the horizontal. Different test standards require test specimens to be positioned differently. The Target Chambers automatically position the specimens at the correct angle in order to reduce test result variability.

Accommodates different widths of test panels
The test specimen holder accommodates specimens with a width of 4 inches (101.6 mm) to 4 1/8 inches (104.9 mm). The spring-loaded specimen holders hold panels that may be slightly wider than the standard 4 inches (101.6 mm).

3D Specimen Chamber holds specimens unusual in size
Many test specimens are not flat test panels, or are too large or unusually shaped to fit in the Flat Specimen Holder Assembly. The 3-Dimensional (3D) Specimen Chamber allows testing of many differently shaped specimens.

Manual/automatic timer option
These timers offer the option of presetting the length of a test, or manually controlling the test.

5.2 Precision

Electrically controlled vibratory feeder & adjustable feed rate
The adjustable vibratory feed rate allows the media to empty the hopper at different rates in order to accommodate different tests.

Air pressure and airflow are constant during tests
Constant airflow and air pressure reduce variability in tests.

Machined nozzles fit together precisely
This ensures that no air escapes from the nozzles and the air flows through the correct diameter of tubing in order to eliminate error.

Adjustable air nozzle pressure
The air pressure can be adjusted in order to change the speed of airflow through the gun, or the speed of the media hitting the test specimen. These may need to be adjusted to accommodate different tests.

Test Timer
The Test Timer on the control panel displays time up to a tenth of a second. These enable the operator to time precisely the duration of each test.

Test Counter
The test counter enables the operator to keep track of how many tests have been run.

More Precise air flow volume
After many tests in the Gravelometer, the high velocity air flowing through the tubing begins to widen the inside diameter of the nozzle. The go/ no-go gauge in the calibration kit allows the operator to check the diameter and replace the nozzle as necessary.

Adjustable feet aid in leveling the machine
If the Gravelometer is level while tests are running, there will be a lower variability in the test results. Two of the feet on the Gravelometer adjust to raise or lower the machine in order to make it level.

5.3 Calibration

Air Flow
The go/no-go gauge allows the operator to determine when the diameter of the nozzle has become too large or too small and needs to be replaced.

Pressure Gauge
The pressure gauge indicates the pressure as the air flows through the gun assembly. A built-in calibration port allows you to use a Reference Pressure Gauge to calibrate the Air Nozzle Pressure Gauge to ensure correct air pressure.

5.4 Ease of Use

Receiver Tank Stores Air From In-Plant Compressor
Stored air minimizes the drop of air pressure during a test.

Gravel Box Collects Media After Use
The Gravel Box only needs to be emptied after 10 to 15 tests. The media collected in the Gravel Box can be refiltered and used again for subsequent tests.

Air Filter Controls Dust
As the media hits the test specimen, some pieces fracture upon impact. These project small pieces of rock and dust into the air. The air filter stops the dust and particles from being released into the surrounding air. The Air Filter should be cleaned after every 500 to 700 tests.

5.5 Safety

Safety features shut machine off if Flat Specimen Holder or Target Chamber is removed
Because the media is projected at the test specimens at high velocities, there is a chance of injury if the machine is in operation while the Flat Specimen Holder Assembly is open or Target Chamber is not attached.

Air Receiver Tank has safety relief valve
The Air Receiver Tank should maintain an air pressure below 150 psi (1034 kPa). If the pressure inside the tank exceeds 150 psi, the air relief valve automatically opens and air escapes in order to lower the pressure inside the tank.

Air filter controls dust
As the media hits the test specimen, some pieces fracture upon impact. These project small pieces of rock and dust into the air. The air filter stops the dust and particles

Tubular Bubble Level
The Tubular Bubble Level is a quick indicator of whether or not the machine is level.

6. Utilities and Installation

Several factors need to be considered when deciding where to set up your Multi-Test Gravelometer. Find a location that has a level floor, the correct electrical outlet and an air supply. Because the Multi-Test Gravelometer generates a noise level of 100 dBA, locate the Gravelometer in a place where a high noise level can be tolerated. Depending on the media used, the Gravelometer can generate large amounts of dust. Locate the Gravelometer in an area with adequate ventilation.

6.1 Utilities

Air Compressor supply: Up to 100 CFM at 80 psi (550 kilopascals at 47.2 L/sec) for 5-10 seconds per test. A 100 CFM compressor is not necessarily required because the Gravelometer only operates for 10 seconds at a time. For instance, a 25 CFM compressor with an 80 gallon receiver tank may be adequate, depending on distance from the Gravelometer, other air demands, and system pressure.

Electrical Power Supply: 120V AC or 240V AC single phase depending on model.

Ventilation: The site location should have good ventilation.

Temperature: Usually, the Gravelometer is operated at room temperature; however, many tests require freezing the specimens. Extreme differences in room temperature may affect chipping test results. Operating the Gravelometer inside a freezer room requires the G-9620-X, “In Freezer Capability Kit.”

6.2 Installation

6.2.A Leveling

Note: Two people are needed to perform the following procedures.

1. Position the Gravelometer where you want to operate it. The floor beneath it should be flat and level.

2. One person can lift the Gravelometer several inches off the ground on the side with the adjustable leveling feet.

3. While one person is holding the end of the Gravelometer several inches off the ground, the other should adjust the leveling feet by turning the nut on the lower part of the foot.

4. To raise, turn in a counterclockwise direction. To lower, turn in a clockwise direction.

5. Use the bubble level on the top of the machine to the left of the control panel to determine if the machine is level. Adjust the two adjustable feet until the machine is level. The machine is level when the bubble in the Tubular Bubble Level is positioned between the two centerlines.

6. The Multi-Test Gravelometer is now level.

6.2.B Noise Level

The Gravelometer operates at a noise level of 100 dBA. Because of the loud noise generated from running the Gravelometer, set up the machine in an area where the noise can be tolerated. Anyone near the Gravelometer during its operation should wear ear protection.

6.2.C Compressed Air Supply

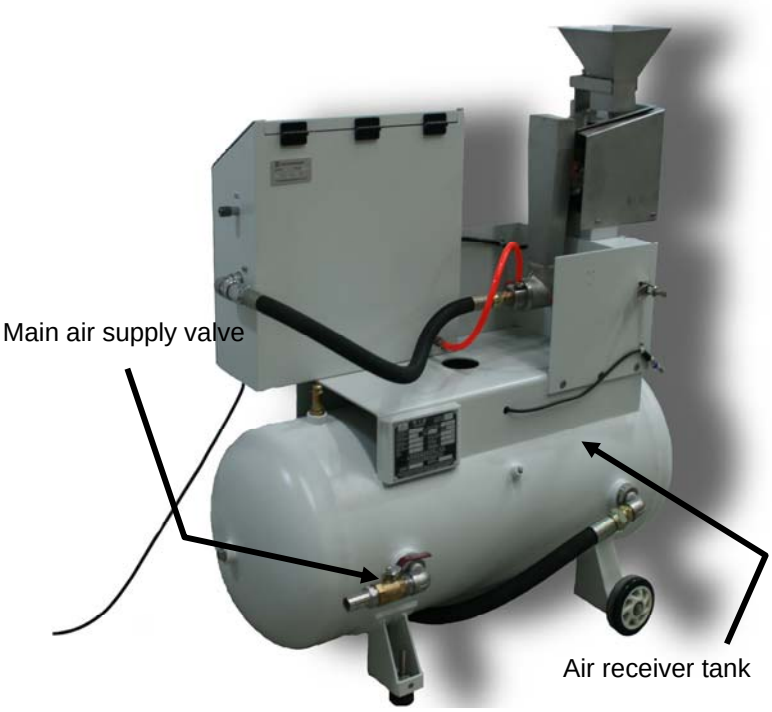
In order to conduct SAE tests, the Multi-Test Gravelometer requires an air compressor capable of producing a high volume of compressed air, approximately 80 psi at 100 CFM (550 kilopascals at 47.2 L/sec) for 5-10 seconds for each test. The compressed air supply must be ¾ inch (19 mm) or higher in tubing diameter for SAE testing or ½ inch (12.7 mm) for VDA testing. Usually, a five horsepower compressor, operating at 100 psi (690 kPa) or greater, is sufficient depending on the distance from the compressor and other demands on it. VDA air pressure requirements are much lower than SAE air pressure requirements; therefore, if the air pressure demands can be made for SAE testing, the VDA air pressure requirements can also be met.

The most common problem in SAE Gravelometer testing is insufficient air pressure caused by either a supply pipe that is too small (<19mm), or by air flow restrictions caused by quick connect fittings, pressure regulators, or filters.

6.2.D Air hook up

After the Gravelometer is level and in place, the air compressor should be connected to the Air Receiver Tank. The Air Receiver Tank stores air and keeps the air pressure constant throughout each test. Inconsistent air pressure and airflow can cause variability in test results. The Air Receiver Tank should be full before the first test is run.

Connect the plant air supply hose to the main air supply valve. This valve is located on the back left side of the Air Receiver Tank. Make sure that the tubing from the air compressor is securely fastened to the Air Receiver Tank. If it is not fastened tightly, there is a chance that the tubing can come undone and dangerously whip through the air due to the high velocity airflow inside.



Main Air Supply Valve on the Air Receiver Tank

6.2.E Electrical

Important: Do not switch the Main Power to ON until the other services have been connected.

The Multi-Test Gravelometer is available in either a 120V or 240V version. It is important that the Gravelometer is connected to the correct voltage so the warranty is not made void.

6.2.F Operation in a Walk-in Freezer Room

If the Gravelometer is to be operated in a freezer room where the temperature is below 0°C (32°F), the Gravelometer must be equipped with the optional G-9620-X, “In-Freezer Capability Kit.” This modification consists of thermostatically controlled heaters that prevent freezing of the timers and solenoid valve.

Turn the main power switch to the ON position. Turn the manual/time switch to the OFF position. This preheats the solenoid valve and liquid crystal displays. If the machine is at 0°C it needs to be preheated for at least four hours before pressurizing the air receiver tank; otherwise, the solenoid diaphragm may crack.

If the Gravelometer has been kept in the freezer room overnight, condensation may freeze in the air nozzle. In order to insure proper airflow through the nozzle, the nozzle should be thawed. This can be accomplished easily through the use of a typical hand-held hair dryer.

If the freezer room has an automatic defrost cycle, care must be taken to make the defrost cycle a minimum of 12 hours. Shorter defrost cycles cause the nozzle and vibratory feed to accumulate condensation. When the room freezes, frozen condensation will prevent the vibratory feed from functioning properly.

During defrost cycles, it is important to check for condensation in the air receiver tank. To check for and purge condensation from the air receiver, open the drain valve at the bottom of the tank while it is under pressure. This will blow out water that may have condensed in the tank.

7. Major Components

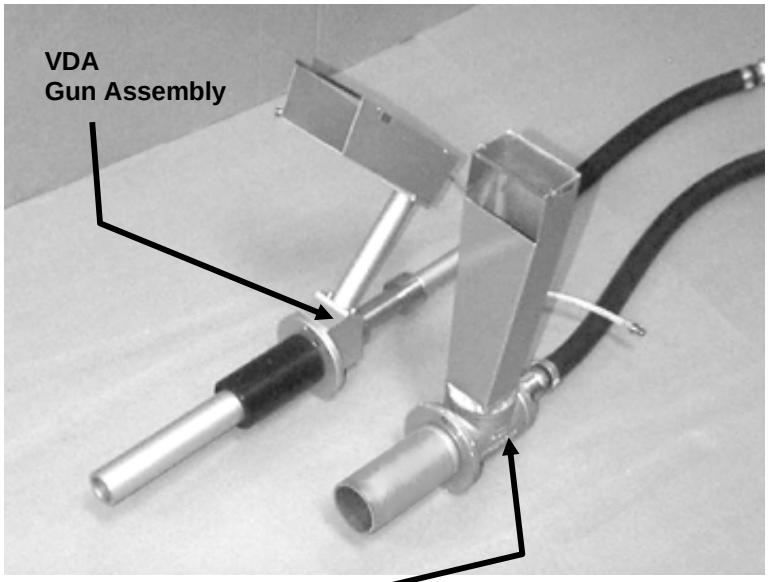
7.1 Air Receiver Tank

The Air Receiver Tank has a volume of 30 gallons (120 L). The Air Receiver Tank stores air between tests and ensures that pressure is constant for the duration of each test. Pressure inside the Air Receiver Tank should not exceed 150 psi (1034 kPa). If the pressure becomes greater than 150 psi (1034 kPa), the air relief valve will automatically open and let air escape from the tank. This pressure is unrelated to the pressure reading indicated on the Air Nozzle Pressure Gauge on the Control Panel.

Gravelometer and Air Receiver Tank

7.2 Gun Assemblies

Two gun assemblies are designed to operate different tests in the Multi-Test Gravelometer. The SAE Gun Assembly is designed to run tests with gravel. The VDA Gun Assembly is designed to run tests with split shot (chilled grit iron). Because the two assemblies accommodate different media, they are shaped differently. The VDA gun barrel is longer than the SAE barrel.

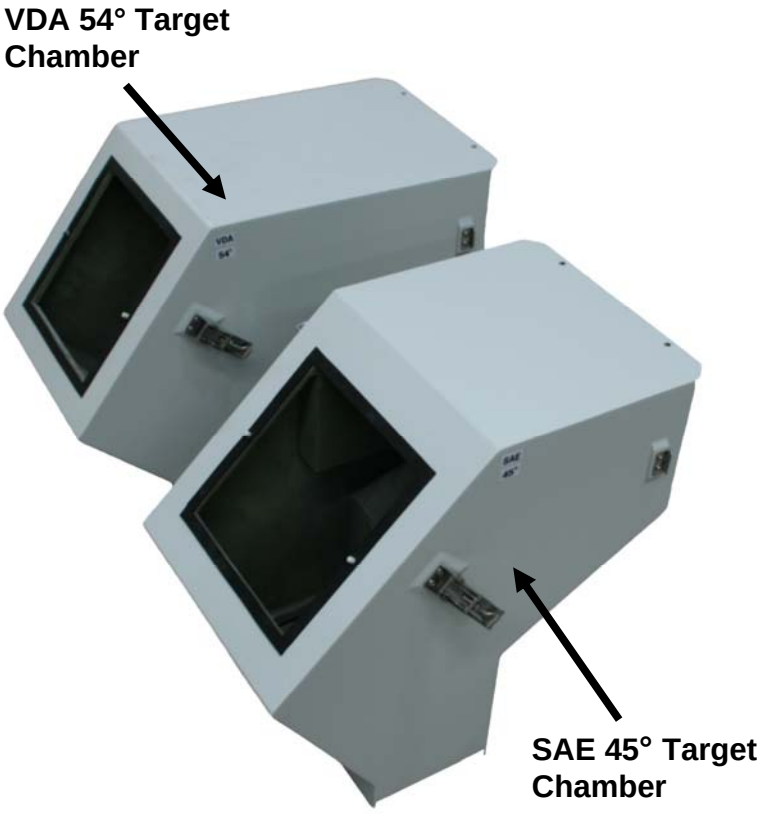


SAE and VDA Gun Assemblies

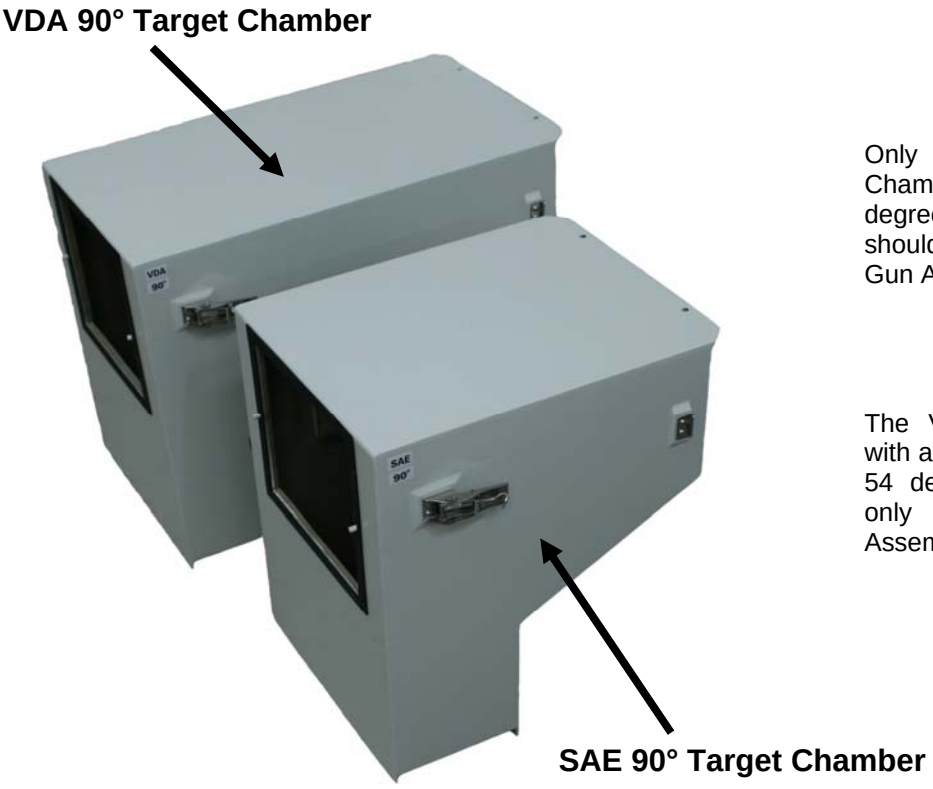
7.3 Target Chambers

Target Chambers hold the test specimen at a set distance from the gun and at a precise angle relative to the gun. The type of Target Chamber used varies depending on the type of test you wish to run. There are four types of Target Chambers available for use with the Multi-Test Gravelometer:

SAE 90° Target Chamber
SAE 45° Target Chamber
VDA 90° Target Chamber
VDA 54° Target Chamber



SAE 45°and VDA 54° Target Chambers

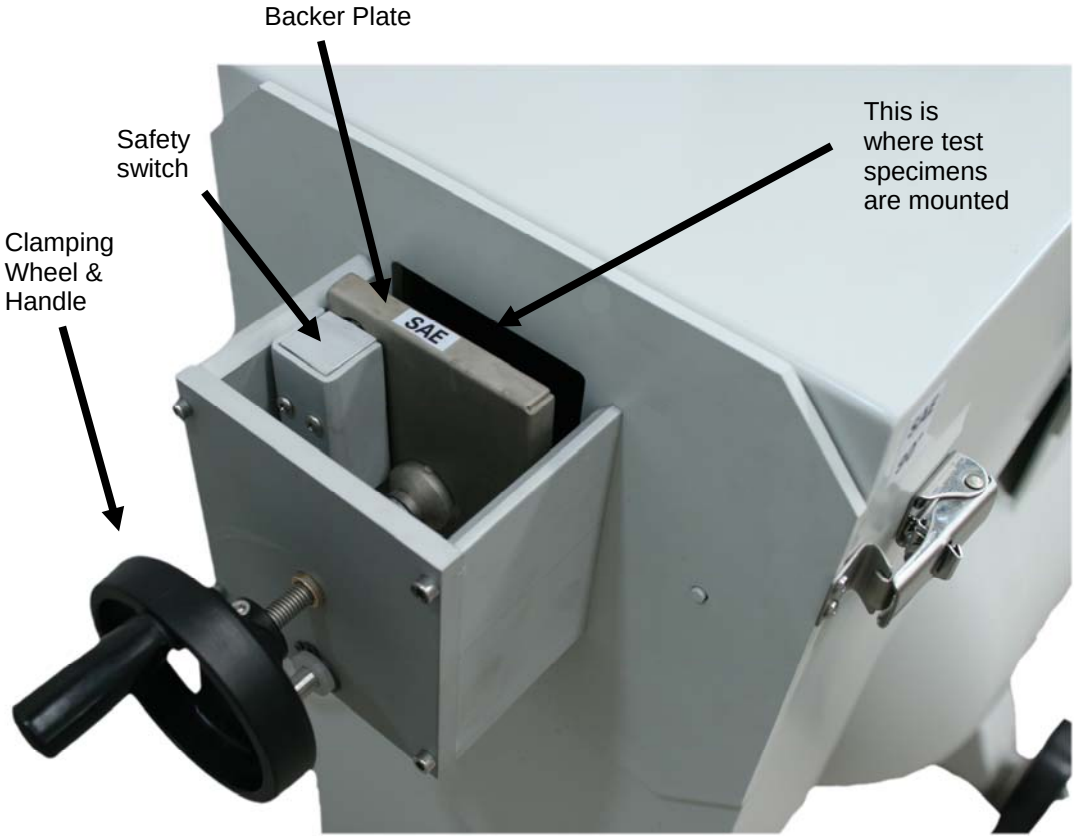


SAE and VDA 90° Target Chambers

Only the SAE Target Chambers with angles of 90 degrees and 45 degrees should be used with the SAE Gun Assembly.

The VDA Target Chambers with angles of 90 degrees and 54 degrees should be used only with the VDA Gun Assembly.

7.4 Flat Specimen Holder Assembly



The Flat Specimen Holder Assembly allows quick and easy presentation of test panels to the Target Chamber. The Flat Specimen Holder Assembly attaches to any of the Target Chambers.

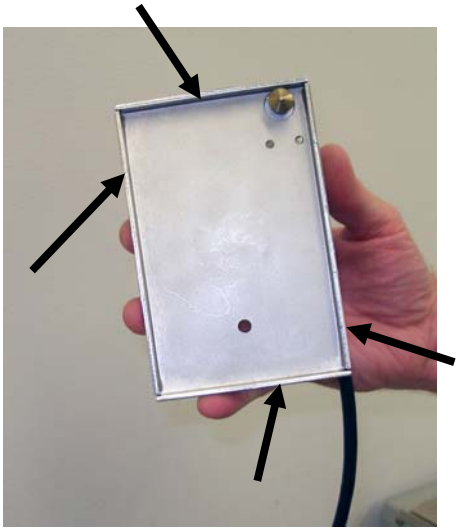
Sample size (flat panels):

4 x 6 inch (101.6 x 152.4 mm)
4 x 8 inch (101.6 x 203.2 mm)
4 x 12 inch (101.6 x 304.8 mm)
Thickness up to 1-3/8 inch (34.9 mm)

7.5 SAE and VDA Backer Plate

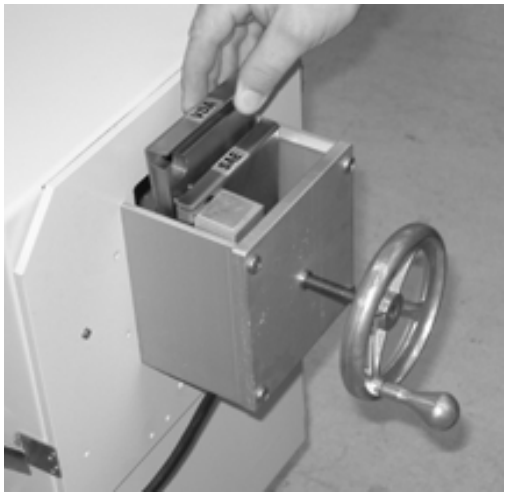
Flat specimens are held in place by pressing against the back surface using a backer plate. There are two different types of backer plates, an SAE and VDA. The SAE backer plate is hollowed out so that only the perimeter of the specimen is supported. This allows the specimen to flex when the media hits it. The VDA backer plate is not hollowed out and does not allow the specimen to flex.

All MTG's come with the SAE backer plate. The VDA backer plate is optional and inserts inside the SAE backer plate.



SAE backer plate
Contacts specimen only around the edges

VDA backer plate
Contacts specimen on entire surface



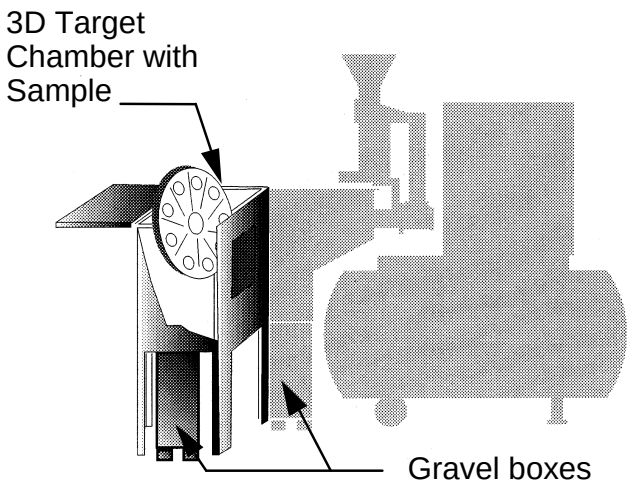
VDA backer plate being installed
Fits inside SAE backer plate and held in place with a magnet

7.6 3D Specimen Chamber

The 3-Dimensional (3D) Specimen Chamber takes the place of the Flat Specimen Holder and allows testing of bulky objects without compromising standardized gun- to-specimen distance. It is used only with either the VDA 90 degree Target Chamber or with the SAE 90 degree Target Chamber. This chamber allows tests of springs, shocks and other objects with a diameter less than 16 inches.

3D Specimen Chamber Capacity:

Length: 17 1/8 inch (435.1 mm)
Width: 10 1/8 inch (257.3 mm)
Depth: 16 1/2 inch (419.1 mm)



3D Target Chamber Used With Two Gravel Boxes

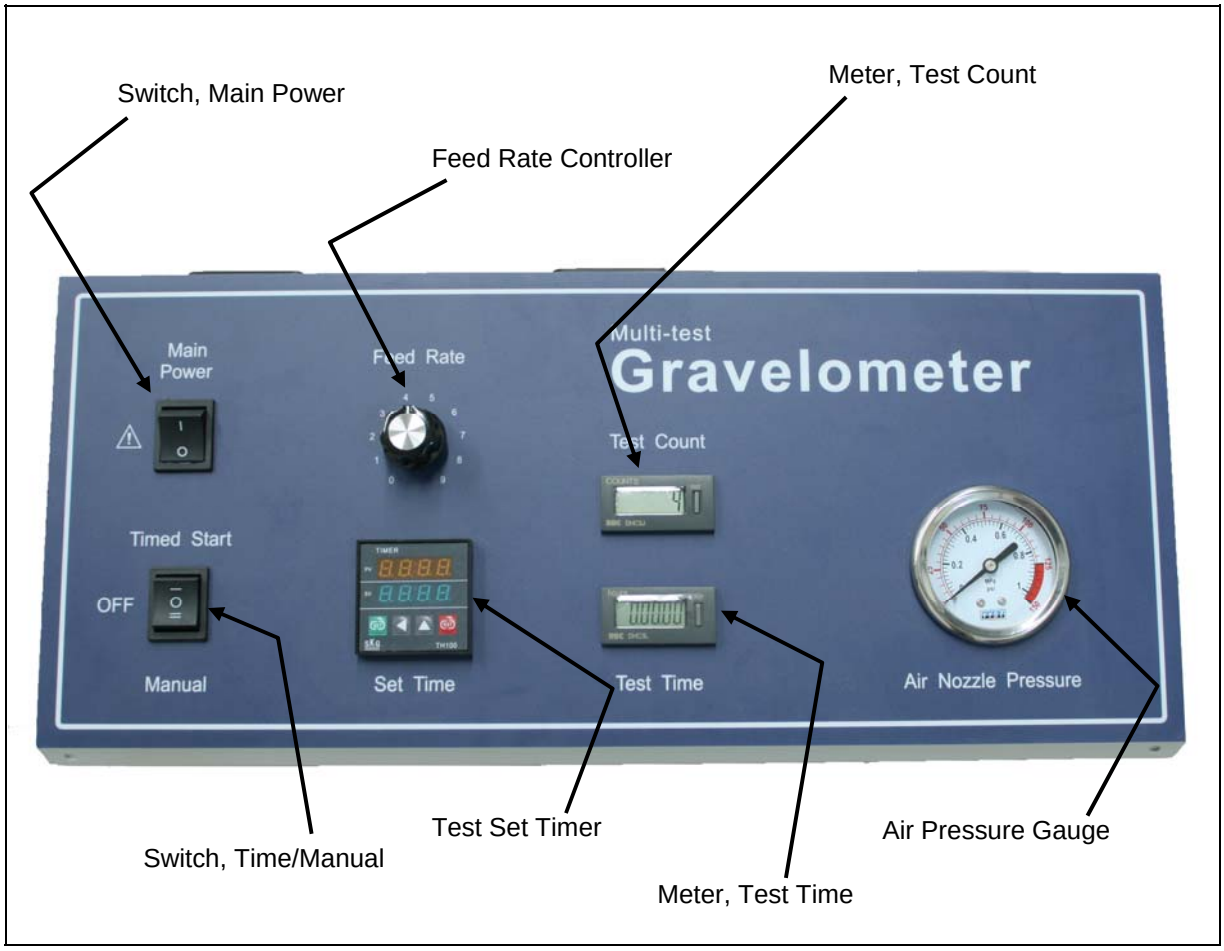
7.7 Gravel Box

The Gravel Box collects the media after it hits the test specimen. It is located directly below the Target Chamber. The Gravel Box should be emptied after every 10 to 15 tests.

Gravel Box under Target Chamber

7.8 Control Cabinet

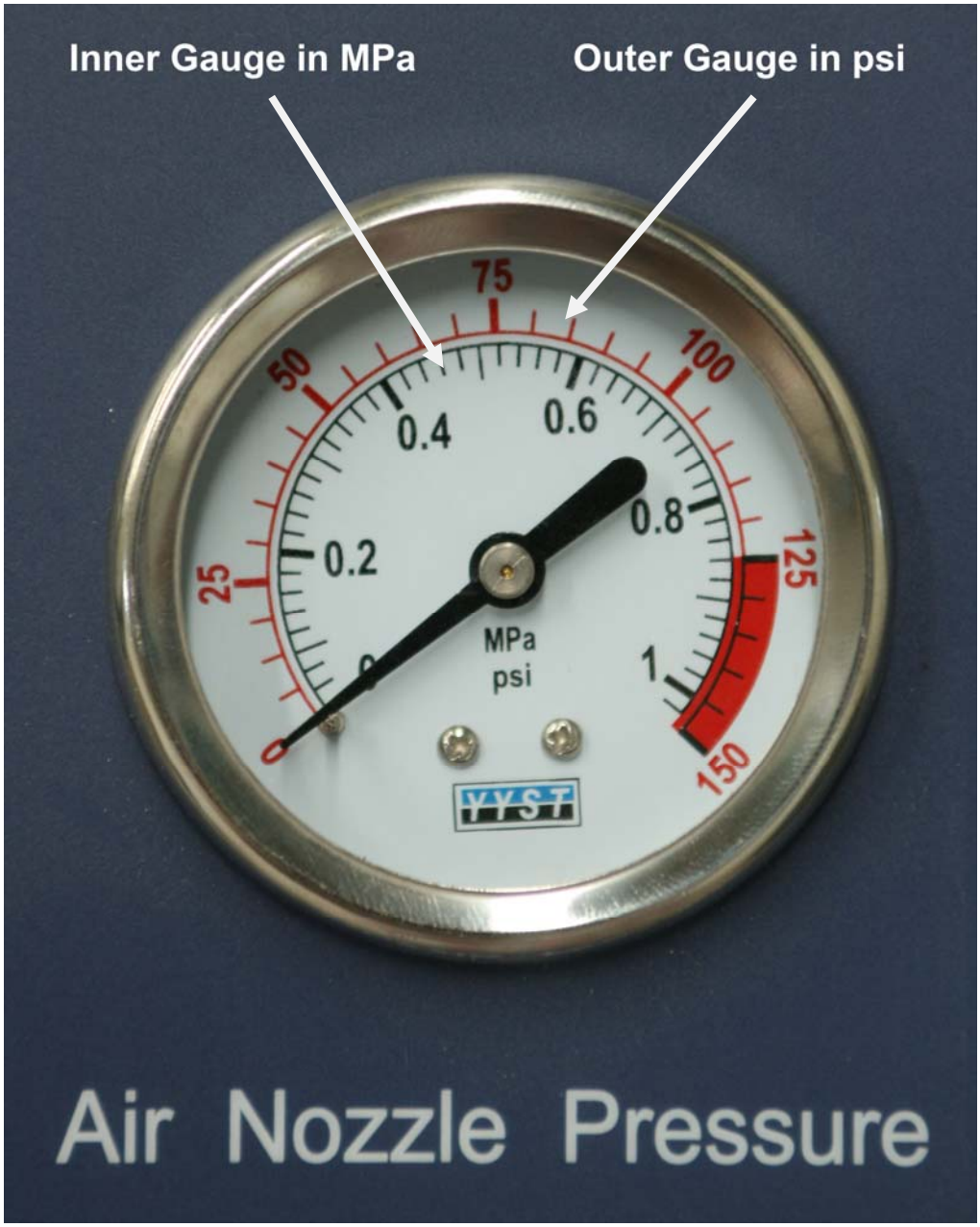
The Control Cabinet contains the Main Power Switch, Test Operation Switch, Feed Rate Adjustment, Preset Cycle Timer, Test Counter, Test Timer and Air Nozzle Pressure Gauge.



Parts of the Controller Overlay Located On Top of the Control Cabinet

7.9 Air Nozzle Pressure Gauge

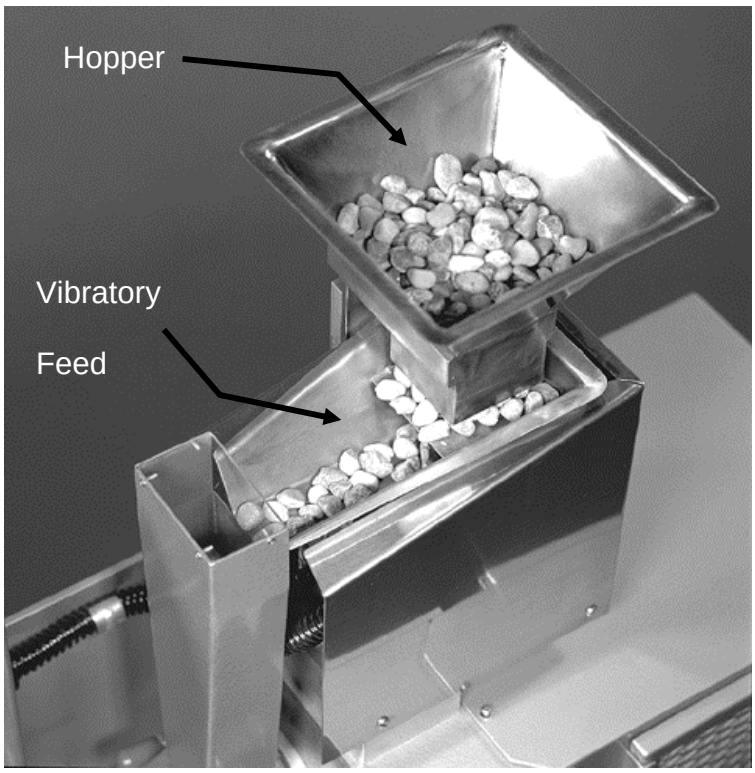
The Air Nozzle Pressure Gauge indicates the air pressure in the gun assembly. On the gauge, the air pressure is indicated in both psi and megapascal units. The inner set of numbers on the gauge indicates the pressure in megapascal, and the outer set of numbers indicates the pressure in psi, or pounds per square inch.



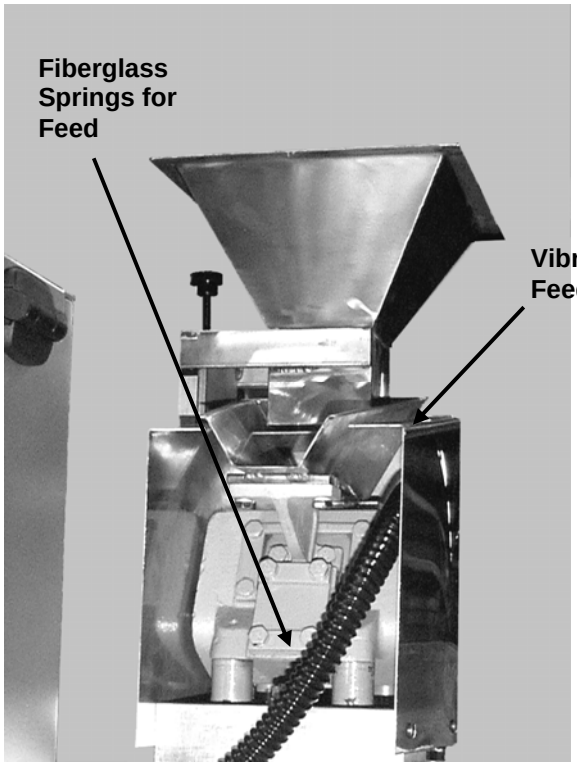
Air Nozzle Pressure Gauge and Two Different Pressure Scales

7. 10 Hopper & Vibratory Feed

The hopper holds the media before the test begins. Although the hopper holds a volume of three pints, none of the standard test methods call for this high of a volume of media for one test. The Vibratory Feed moves the media to the gun.



Gravelometer Hopper and Vibratory Feed



Fiberglass springs counteract electromagnetic forces cycling at 50 Hz or 60 Hz to produce the vibrations for the feed.

Vibratory Feed and Fiberglass Springs

7. 11 Safety Connections

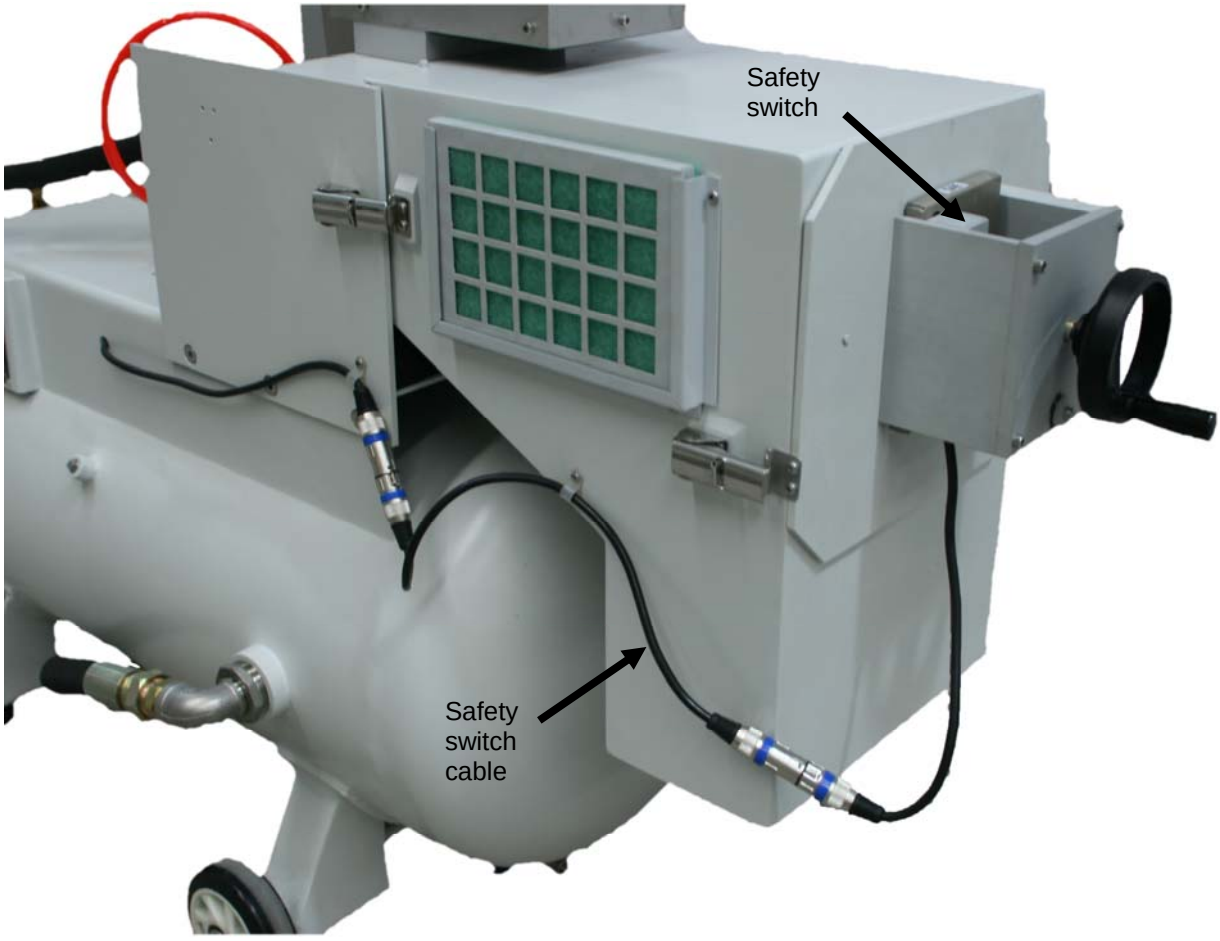
The safety connections are located on the backside of the machine and on the Flat Specimen Holder Assembly. These safety connections must be attached in order to operate the Gravelometer. If the connections become detached for any reason, the Gravelometer will shut down. The Gravelometer will not start if any of the following three conditions are true:

1.) The Target Chamber is not connected to the Base Assembly.

2.) The Flat Specimen Holder Assembly is not connected to the Target Chamber.

3.) The Specimen Holder is open.

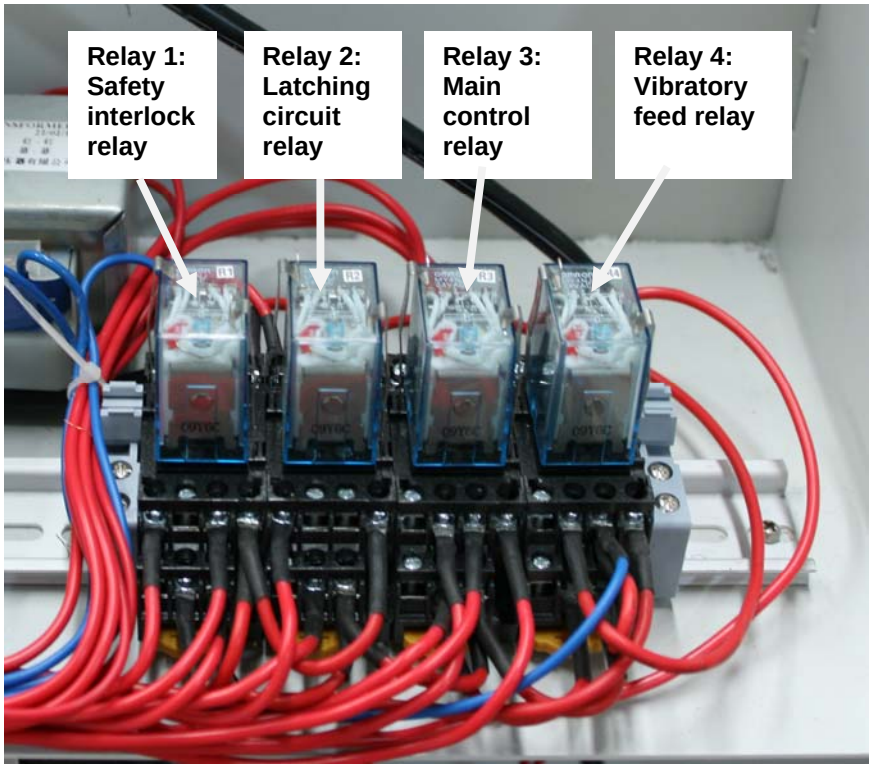
Target Panel Interlock and Safety Connections



7.12 Relays

All relays have LEDs that are illuminated while the relays are energized.

Relay 1 is the safety interlock relay. It monitors all safety circuits. Relay 2 prevents the machine from starting again when an interlock circuit is corrected. If a safety interlock circuit is broken, Relay 2 requires that the control switch is turned to the off position and then back to the desired cycle (either manual or pre-set timed) before the gravelometer can be operated again. Relay 3 is the main control relay. It starts the manual and pre-set timed cycles. Relay 4 is the vibratory feed relay.



Relays

8. Setup

The following setup procedures should be done in the order presented in this operating manual. Before setting up anything, however, make sure the Air Supply Valve is shut OFF. Turn the air supply valve on/off with the handle attached to the Main Air Supply Line on the left side of the back of the Gravelometer. To close the valve, turn the handle in a clockwise direction until it is perpendicular to the valve body. This stops the air from entering the Air Receiver Tank.

8.1 Target Chambers

Target Chambers hold the test specimen at a set distance from the gun and at a precise angle relative to the gun. The type of Target Chamber used varies depending on the type of test you wish to run. The SAE Target Chambers with angles of 90 degrees and 45 degrees should both be used with the SAE J400 gun assembly. The VDA Target Chambers with angles of 90 degrees and 54 degrees should both be used with the VDA gun assembly.

There are four Target Chambers that may be used with the Multi-Test Gravelometer depending on the test to be run.

SAE 90° Target Chamber
SAE 45° Target Chamber
VDA 90° Target Chamber
VDA 54° Target Chamber

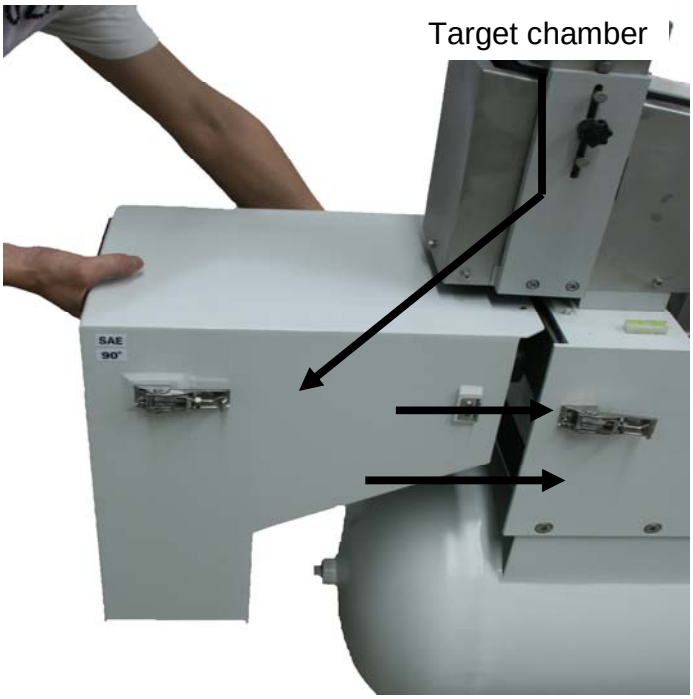
The SAE 90 degree and SAE 45 degree Target Chambers MUST be used with the SAE J400 Gun Assembly. The VDA 90 degree and VDA 54 degree Target Chambers MUST be used with the VDA Gun Assembly.

Attach Target Chamber

The Target Chambers attach to the Base Assembly of the Multi-Test Gravelometer. Regardless of the type or angle of the Target Chamber, they all attach in the following manner.

1. Align the two small holes at the top of the Target Chamber with the two small locator pins on the top of the Gravelometer Base Assembly. When you are facing the control panel, these locator pins are located on the top left side of the machine.

2. Attach the Target Chamber so the pins on the machine insert into the small holes on the top of the Target Chamber.



Attaching Target Chamber

3. Fasten the clamps on the side of the machine to the Target Chamber. These further secure the Target Chamber onto the Base Assembly of the Gravelometer.

4. Attach the safety circuits on the backside of the machine. Attach the female connector on the Base Assembly of the machine to the male connector on the Target Chamber. This safety circuit will shut off the machine if the Target Chamber is removed.

5. Slide the Gravel Box underneath the Target Chamber.

Now the Target Chamber is in place.

Removing the Target Chamber

1. Remove the Gravel Box from underneath the Target Chamber. See Section 8.3 for instructions on removing the Gravel Box.

2. Unhook the black safety circuit by gently pulling the male end of the connection from the female end. The female connector is attached to the Base Assembly, and the male connector is attached to the Target Chamber.

3. Unhook the clamps on the sides of the Target Chamber.

4. Lift the Target Chamber upward in order to lift the box off the small locator pins on the Base Assembly. The Target Chamber should lift off easily.

8.2 Specimen Mounting Options

The test specimen is attached to the side of the Target Chamber in one of two ways. If you are using a flat test panel, it is attached by the Flat Specimen Holder Assembly. The Flat Specimen Holder Assembly includes (a) the Mounting Plate, (b) Panel Backer, (c) Clamp, and (d) Backer Plate Insert Kit. It attaches to any of the above Target Chambers. The Flat Specimen Holder Assembly holds a flat test panel in position at a fixed angle (either 45 degrees, 54 degrees, or 90 degrees depending on the Target chamber chosen) on the wall of the Target Chamber.

The SAE test requires a hollow backer plate that supports the entire specimen. The VDA test requires a solid backer that supports only the specimen edges.

If you are testing a not-flat object, such as springs, shocks, or wheels, you will need to use the 3D (three dimensional) Specimen Chamber to accommodate these objects. The 3D Specimen Chamber attaches ONLY to either the SAE 90 degree Target Chamber or the VDA 90 degree Target Chamber. The 3D Specimen Chamber also holds test specimens at the appropriate gun-to-specimen distance for these procedures.

8.2.A Flat Specimen Holder Assembly

Attach Flat Specimen Holder Assembly

1. Attach the Flat Specimen Holder Assembly to the Target Chamber that should be already attached. For instructions on attaching the Target Chamber, see Section 8.1. Hold the Flat Specimen Holder Assembly with one hand on the bottom and another on the side.

2. Align the small holes on the side of the Flat Specimen Holder Assembly with the small locator pins on the side of the Target Chamber.

3. Fasten the clamps on the side of the Target Chamber. These further secure the Flat Specimen Holder Assembly to the Target Chamber.

4. Attach the safety circuits on the backside of the machine. The female connector on the Target Chamber attaches to the male connector on the Flat Specimen Holder Assembly.
This circuit shuts off the machine if the Flat Specimen Holder Assembly is removed.

5. Now the Flat Specimen Holder Assembly is in place.

Remove the Flat Specimen Holder Assembly

1. Unhook the black safety circuit by gently pulling the male connector from the female connector.

2. Unhook the clamps on the sides of the Target Chamber.

3. Pull the Flat Specimen Holder Assembly off the Target Chamber in order to lift the plate off the small locator pins on the Target Chamber. The Flat Specimen Holder Assembly should lift off easily.

Placing a Test Specimen in the Flat Specimen Holder

1. Turn the handle on the Flat Specimen Holder Assembly several revolutions.

2. Slide the test panel down between the two vertical guides until it stops on the location pin at the bottom of the exposure window.

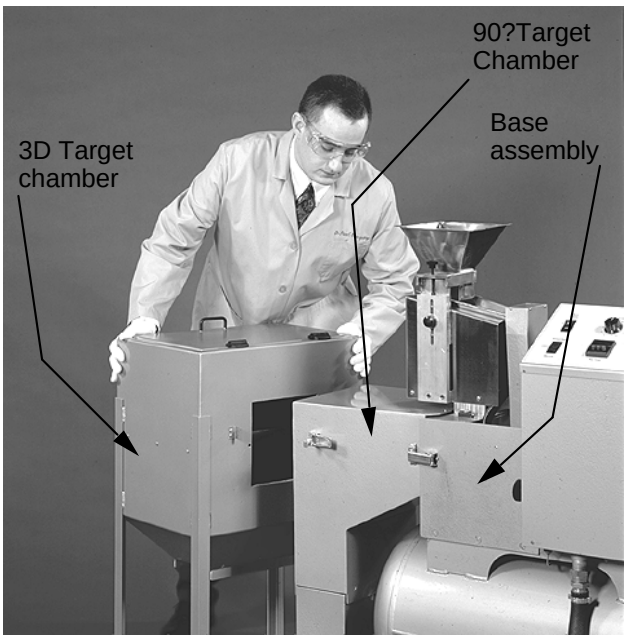
3. Turn the handle on Flat Specimen Holder Assembly until the backer plate presses tightly against the test specimen.

8.2.B 3D Specimen Chamber

(If you do not have the 3D Specimen Chamber, continue on to the next section).

Use the 3D Specimen Chamber only with either the SAE 90 degree Target Chamber or the VDA 90 degree Target Chamber. The 3D Specimen Chamber is equipped with adjusting levelers on each foot. Once the Multi-Test Gravelometer Base Assembly is level and in place, the 3D Specimen Chamber also must be leveled in order to attach securely to the Base Assembly.

The 3D Specimen Chamber also comes with an additional Gravel Box that is identical to the one that attaches to the Target Chamber. If you are using the 3D Specimen Chamber, you will need to use both Gravel Boxes. One attaches below the Target Chamber and the other attaches below the 3D Specimen Chamber. See instructions below.



1. Attach a 90 degree Target Chamber to the Base Assembly. For instructions on attaching the Target Chamber, see section 8.1.

2. Remove the flat specimen holder assembly from the target chamber.

3. Slide the 3D Specimen Chamber next to the 90 degree Target Chamber that is already attached. The opening on the side of the 3D Specimen Chamber should line up with the same size opening on the 90 degree Target Chamber, and the small locator posts on the 90 degree Target Chamber should line up with the small holes on the 3D Specimen Chamber.

4. To level, raise, or lower the 3D Specimen Chamber, use the adjustable leveling feet.

5. Clamp the clamps on the 90 degree Target Chamber to the hooks on the 3D Specimen Chamber.

6. Attach the male safety circuit connection on the 3D Specimen Chamber to the female connection on the 90 degree Target Chamber.

7. While you are facing the front of the Multi-Test Gravelometer, slide the Gravel Box directly underneath the already-attached 3D Specimen Chamber. The handle on the Gravel Box should be facing you as you slide it under the 3D Specimen Chamber.

8. Push the Gravel Box underneath the 3D Specimen Chamber from the front of the machine until the edges of the Gravel Box are even with those of the 3D Specimen Chamber. You may have to push the Gravel Box firmly to position it correctly.

9. The 3D Specimen Chamber is now in place.

Remove 3D Specimen Chamber

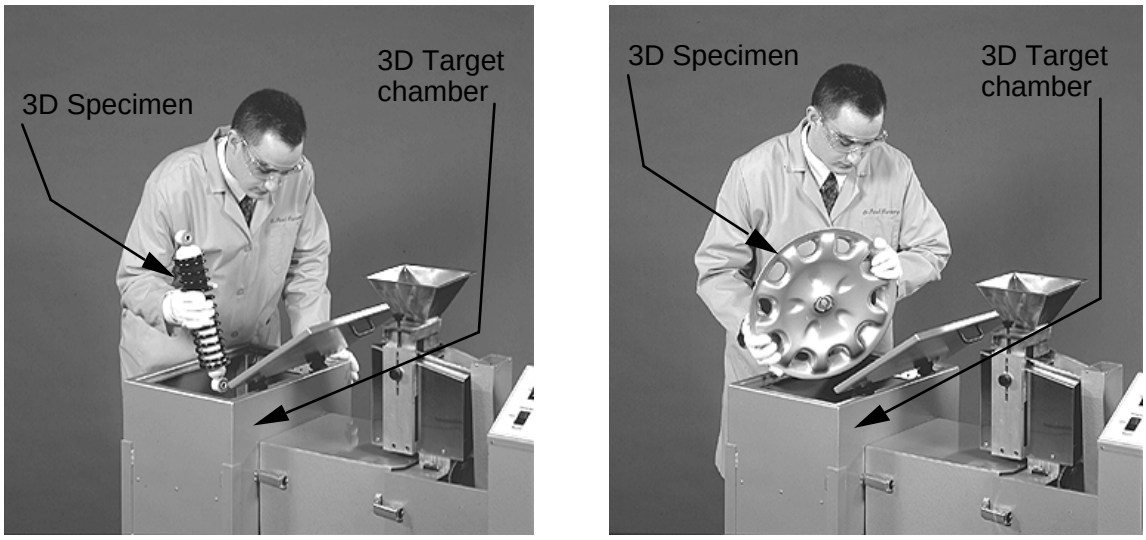
1. Remove the Gravel Box from underneath the 3D Specimen Chamber. See Section 8.3 for instructions on removing the Gravel Box.

2. Unhook the clamps on the sides of the 3D Specimen Chamber.

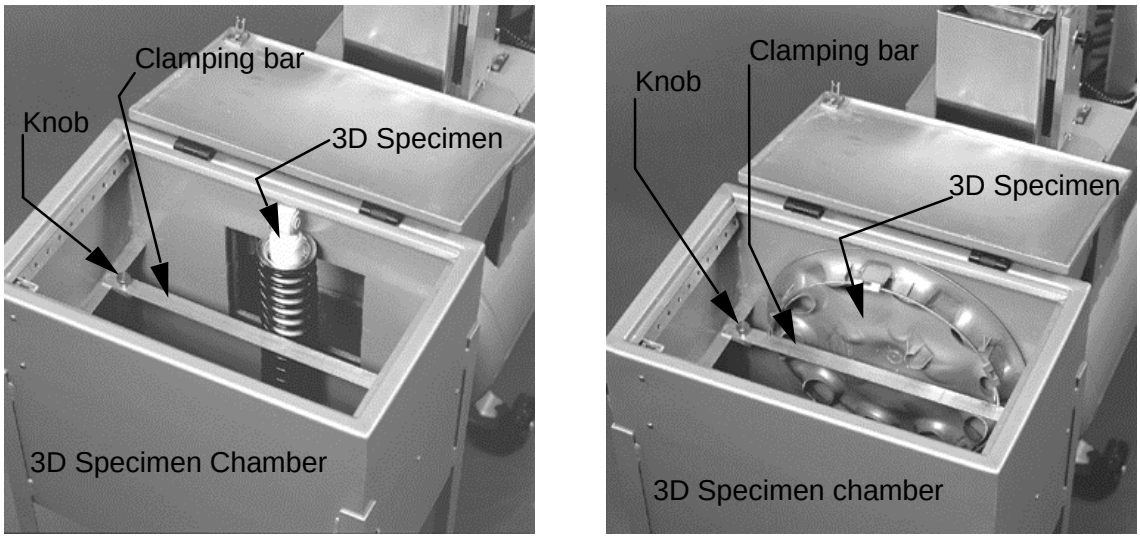
3. Unhook the safety connections from the 90 degree Target Chamber.

4. Slide the 3D Specimen Chamber away from the Gravelometer Base Assembly.

Mounting Specimen in 3D Target Chamber



3D Specimens Being Placed Into Target Chamber



3D Specimens Mounted In Target Chamber With Clamping Bar

If the specimen is heavy (over 10 lbs), use wire ties to hang it from the holes provided in the top rails inside of the 3D Chamber. Then slide the Clamping Bar to the back of the test specimen, forcing it into position against the front wall of the chamber. Turn the knobs on the clamp bar clockwise to tighten (see picture).

If the test specimens are lightweight, the Clamping Bar alone may be sufficient to hold them in place.

8.3 Gravel Box

The Gravel Box collects the media after it hits the target specimen. The Gravel Box is located underneath the Target Chamber. The Target Chamber must be in place before the Gravel Box can be positioned underneath it. NOTE: If you are using the 3D Specimen Chamber, you will use two identical Gravel Boxes. Instructions for installing Gravel Boxes are given below.

The Gravel Box should be emptied after every 10 - 15 tests.

Install Gravel Box

1. Slide the Gravel Box directly underneath the already-attached Target Chamber so that the handle is facing you.

2. Push the Gravel Box underneath the Target Chamber until the edges of the Gravel Box are even with those of the Target Chamber. You may have to push the Gravel Box firmly to position it correctly in place.

3. Turn the lever on the side of the gravel box. This lifts the gravel box up so it presses tightly against the gasket in the bottom of the target chamber.

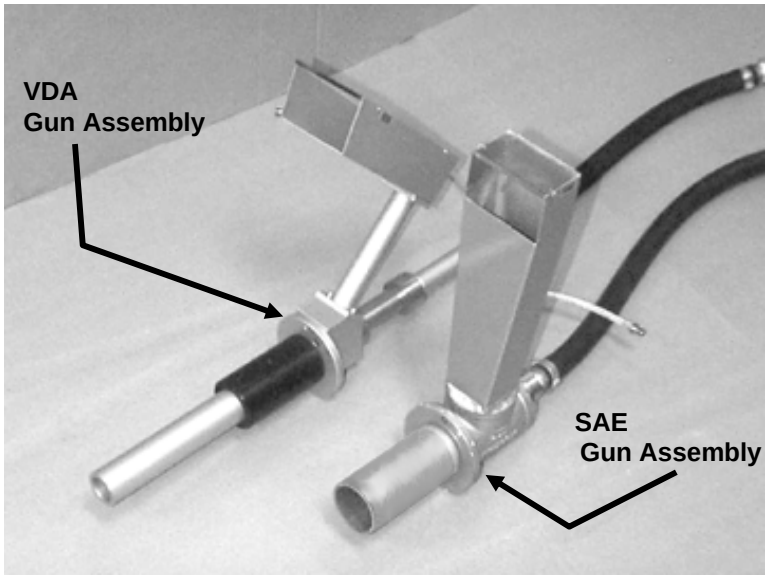
Remove Gravel Box

Turn the lever on the side of the Gravel Box and then pull it forward.

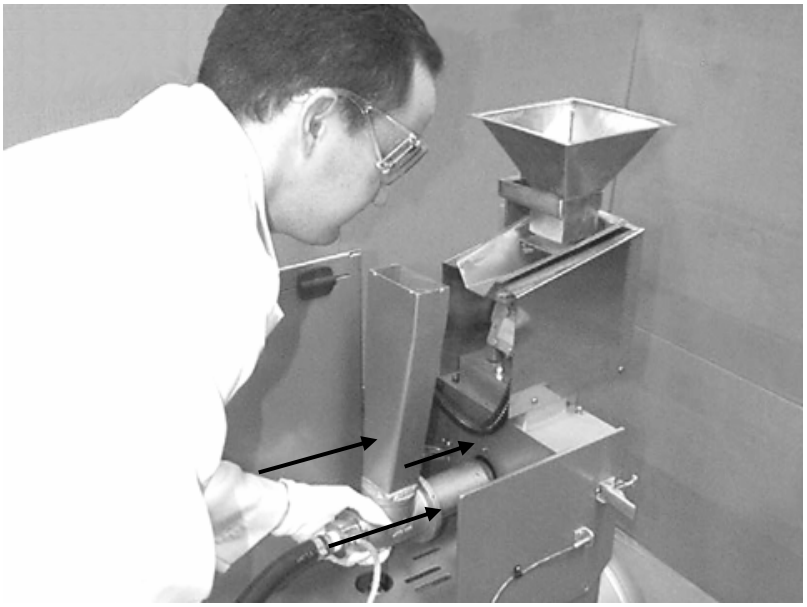
8.4 Gun Assembly

CAUTION: MAKE SURE THE AIRFLOW IS TURNED OFF WHILE INSERTING OR REMOVING EITHER OF THE GUN ASSEMBLIES.

Turn off the air supply valve with the handle at the back of the machine. To close the valve, turn it in a clockwise direction until it is perpendicular to the valve body. This stops air from escaping from the Air Receiver Tank. If the air supply valve is open and the clamps are not in place, the air pressure can be strong enough to blow the gun right off the machine.



SAE and VDA Gun Assemblies



The SAE Gun Assembly and the VDA Gun Assembly, both, attach and detach from the Multi-Test Gravelometer Base Assembly in a similar manner. **You may have to push the gun firmly to insert it correctly.**

Inserting a Gun Assembly

Insert Gun Assembly

1. Insert the circular steel end of the gun into the hole located below the hopper to the left of the Control Cabinet. Insert the gun in such a way that the feed chute is pointing upwards and the hole at the top of the feed chute is lined up with Vibratory Feeder.

2. Line up the hole on the topside of the gun with the small locator post on the side of the machine. This tiny hole may be difficult to see. **It is located between two smaller holes that are facing upwards when the gun assembly is in the correct position.**

3. Clamp the two red toggle clamps onto the gun by pushing them toward the gun. These will ensure that the gun does not blow off of the machine when the air pressure is turned on.

4. Attach the 1/8" I.D. PVC tube (the air supply tube to the pressure gauge) to the "quick connect" coupling on the lower right side of the back of the Control Cabinet. This coupling leads to the Air Nozzle Pressure Gauge.

5. Connect the large black hose (Nozzle Air Line) to the nozzle on the side of the Control Cabinet. To connect, pull back on the gold ring on the end of the hose while plugging the nozzle into the nozzle receptor.

6. Tug on the black hose to ensure that it is securely fastened onto the nozzle.

7. The gun assembly is in place.

Remove Gun Assembly

CAUTION: MAKE SURE THE AIR SUPPLY VALVE IS OFF WHILE REMOVING THE GUN. For instructions on shutting off the air supply valve, see Section 8.4.

1. Disconnect the Nozzle Air Line from the nozzle on the side of the Control Cabinet. To disconnect, pull back on the gold ring on the end of the hose while pulling the nozzle out of the nozzle receptor.

2. Disconnect the 1/8" I.D. PVC tube (the air supply tube to the pressure gauge). When you are facing the back of the machine, it is located on the lower right-hand side of the back of the Control Cabinet. To disconnect the Air Line, push down on the top of the female end of the quick connect coupling while pulling the 1/8" I.D. PVC tube away from the coupling.

3. Unclamp the two red toggle clamps by pushing them away from the gun. The gun can now be removed.

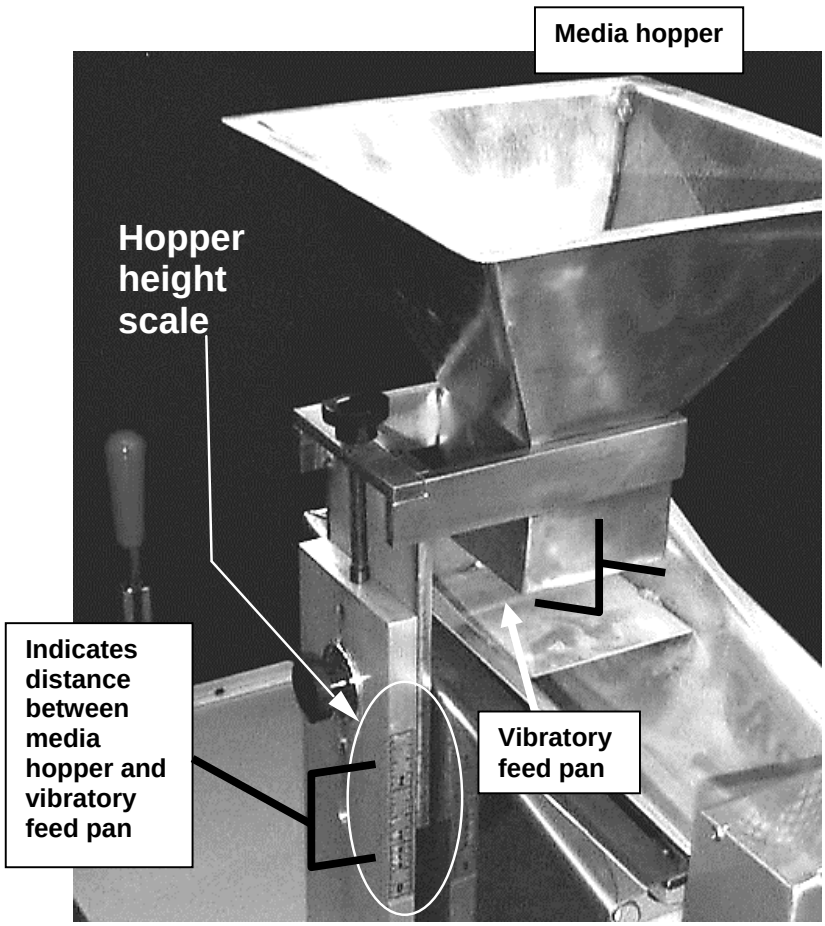
4. Remove the entire gun assembly by pulling the gun out from the Base Assembly of the machine. This might be slightly awkward and caution should be taken while pulling the Gun Assembly out of the machine.

8.5 Open Air Supply Valve

Turn the air supply valve on/off with the (orange) handle at the back of the machine. To open the valve, turn it in a counterclockwise direction until it is parallel to the valve body. To close the valve, turn the handle in a clockwise direction until it is perpendicular to the valve body. This allows the air from the receiver tank to pass through to the Control Cabinet where a solenoid stops it until the control switch is flipped.

8.6 Set Gravel Feed Hopper Height

The Hopper is the square container on the left of the machine that holds the media before a test is started. Located below the Hopper on the front of the Gravelometer are two knobs. The lower knob is the Hopper Locking Knob; the upper knob is the Hopper Adjustment Knob. To the side of the hopper adjustments, there is a scale. This scale indicates heights of the hopper. The hopper height and feed rate must be set to the correct level in order to control delivery of media down the chute and into the air stream. If the hopper height is too high, media will empty too quickly, and if it is too low, the media may not empty quickly enough.



Hopper Height Scale

To Adjust the Height of the Hopper:

1. Turn the Hopper Locking Knob (lower knob) counterclockwise to allow vertical adjustment of the hopper.

2. Turn the Hopper Adjustment Knob (upper knob) clockwise to raise the height of the hopper and counterclockwise to lower the height.

3. Position the Hopper at the correct height for the type of media you are using. The scale on the side of the Hopper adjustments indicates the correct height. After the hopper is at the desired height, turn the Hopper Locking Knob (lower knob) clockwise to tighten the hopper into place.

4. Now the hopper is in position.

Recommended Approximate Media Heights On Hopper:

Gravel for SAE-type tests	7/8 inch (2.14 cm)
Split shot (chilled iron grit)	1/2 inch (1.23 cm)
Steel shot	1/4 inch (0.61 cm)

8.7 Set Correct Air Nozzle Pressure (Revised August 2006)

In order to set the correct airflow pressure, the plant air needs to be engaged into the Air Receiver Tank (See section 6.2.D for instructions) and the air supply valve needs to be turned to ON. The plant air should be plugged into the Air Receiver Tank several minutes before the air pressure is set.

Try to do the following steps in less than 50 seconds to avoid a decrease in air pressure. If these take longer than 50 seconds, the air pressure may begin to decrease. After 50 seconds of running the machine, turn the control switch to STOP for several minutes before attempting again. After 50 seconds of running the air at full pressure, the pressure may begin to decrease. If the pressure begins to decrease, the Air Nozzle Pressure Gauge cannot be set correctly.

Air Nozzle Pressure Gauge Showing 70 psi

Air Nozzle Pressure Gauge Showing 200 kPa

1. Switch the control switch to MANUAL. Look at the Air Nozzle Pressure Gauge on the right of the control panel. Continue looking at the gauge as you do step 2.

2. Use the pressure regulator knob at the left of the Control Cabinet to set the pressure to the correct pressure. (SAE pressure: 70 psi , VDA pressure: 200 kPa)

3. Switch the control switch to STOP.

8.8 Set Correct Vibratory Feed Rate

1. Collect the approximate volume and mass of media according to the specification used. The mass of one pint of the media should fall within a certain mass range for the test you are running. For SAE J400, one pint (473 ml) of gravel should have a mass of 800 g ± 5 g. If the mass is more than 800 g ± 5 g, the gravel pieces are too small. If it weighs less, the gravel pieces are too large. For VDA, there should be 1500 ± 200 particles of chilled grit iron with a mass of 500g. See section 11.1 for further specification on the media used.

2. Make sure the Hopper is set at the correct height for the type of media you are using. For instructions on adjusting the height of the Hopper, refer to Section 8.6.

3. Place a test panel in the Flat Specimen holder. This panel will be sacrificed, so do not use an actual test specimen. See Section 8.2.A for instructions on placing a test specimen in the Specimen Clamp.

4. After the correct amount of media is obtained using step 1, pour the media into the hopper.

5. Switch the Main Power Switch to ON.

6. Switch the control switch to MANUAL. While the test is running, turn the feed rate adjustment to increase or decrease the feed rate as needed to empty the hopper between 5 and 10 seconds.

After all of the media has emptied the Hopper, switch the control switch to STOP.

The set amount of media should empty out of the hopper in less than ten seconds. If there is still media left in the hopper after 10 seconds, repeat steps 1 through 6. You may have to do several trial runs before the correct feeder rate is finally determined.

NOTE: If, after many hours of testing, you cannot obtain the correct feed rate, or you cannot get the correct amount of media to empty from the hopper in the desired amount of time there is a chance that the vibratory springs have become worn out and need to be replaced. Contact an H.J.Unkel Limited Service Represenetive for assistance in ordering these parts.

Now the Multi-Test Gravelometer is properly set up and is ready to perform a test.

9. Operation

Before beginning a test, make sure the Gravelometer has been set up correctly. Refer to Section 8 for detailed instructions.

It is very important that the test is set up properly to ensure best results.

Check to make sure the media has been screened, the air pressure is correct for the test you are running, and the appropriate gun assembly and Target Chamber are attached.

9.1 Pre-Test Checklist

Before running any tests, check the following:

Do you have the correct type of media?

Do you have the correct backer plate installed for SAE or VDA testing?

Do you have the correct amount of media?

Has the media been properly screened?

Are you using the correct Gun Assembly for this particular test?

Are you using the correct Target Chamber with the Gun Assembly?

Is the air pressure set at the correct level for the test you are running?

Is the Hopper set at the correct height?

Is the Gravel Box in place?

Is the test specimen in place?

Are all the safety connections connected?

Are all of the air valves open?

9.2 Running a Test

1. Place a test specimen in the flat specimen holder and clamp in place.

Opening the specimen holder

Pouring Media into The Hopper

2. Pour measured amount of media into hopper (one pint of gravel for SAE J400).

3. Set the Test Timer. There are two ways to operate a test. A Timed Test is a test that shuts off the machine after the preset amount of time has passed. A Manual Test requires the operator to shut off the machine after the desired amount of time has passed.

MAKE SURE YOU ARE WEARING EAR PROTECTION BEFORE YOU GO ANY FURTHER

Timed Test

a) Make sure the control switch is set to STOP.
b) Set the Test Timer to the desired test time. This is typically less than 10 seconds.
c) Turn the main power switch to ON.
d) Flip the control switch to TIMED START.

Manual Test

a) The manual test requires you to manually stop the test. Once started, it will not stop by itself.
b) Make sure the control switch is on OFF.
c) Switch the main power switch to ON.
d) Switch the control switch to MANUAL.
e) After the desired amount of time has passed, flip the control switch to OFF.

10. Routine Maintenance and Calibration

10.1 Safety Checks

General Checklist:

If the answer to any of the following questions is NO, discontinue testing until the problem is corrected. For gravelometers operated on a daily basis, complete this checklist once a month. Otherwise, complete this checklist every six months.

1. Is the air filter clean?
2. Is the air filter clear of obstructions?
3. Does the Tubular Bubble Level on the front of the Gravelometer read level? (Is the bubble located between the two center lines?). If not, adjust the feet of the machine until the machine is level and the bubble is located in the center of the tube.
4. Is the height of the hopper at the recommended level for the media you are using in the test?
5. Is the Target Chamber in place?
6. Is the Gravel Box in place?
7. Is the Flat Specimen Holder Assembly in place?
8. Are all the safety circuits attached?
9. Is the correct gun in place?
10. Is the 2.54 cm (1 inch) air line connected?
11. Are the pipe joints free of leaks?
12. Does the air pressure hold 483 kPa ± 21 kPa (70 psi ± 3 psi) for ten seconds?
13. Does the air pressure hold 200 kPa ± 9 kPa (29 psi ± 1 psi) for ten seconds for VDA testing?
14. Is nozzle orifice clear? Insert the plug gauge into the nozzle to verify that the nozzle orifice is clear.
15. Is the backer panel tight?
16. Is the gravel screened?
17. Does the gravel empty out of the hopper in less than 10 seconds?

Hoses:

All hoses used on the gravelometer need to be checked every three months. Hoses should be checked for cracks, kinks, creases, and loose fittings. All kinked hoses should be unkinked. Loose fittings on external hoses should be tightened. However, replace any nylon hoses inside the controls cabinet that have loose fittings. All hoses with cracks should be replaced before operating the machine.

Condensation:

Check for condensation in the air tank each day, before use, and at the end of the day, after use. See Section 10.2 for details.

10.2 Depressurizing the Air Receiver Tank

Because of varying environmental humidity, the tank should be tested for condensation before and after each day's use. Depressurizing the tank will purge water from it. When water stops draining from the tank and only air is escaping, close the valve to retain pressurized air. The Air Receiver Tank should be drained after each period of testing (i.e., after a full day of testing or before the Multi-Test Gravelometer will be out of use for a while). Any time you are not running tests it is a good idea to relieve the air pressure inside the tank. There are two ways to relieve the air pressure.

Condensation Valve Below Air Receiver Tank

TURN OFF THE AIR SUPPLY AND THE GRAVELOMETER MAIN POWER SWITCH
After these have been shut off, you can choose from either of the following methods to relieve air pressure:

Method A:

1. Turn Main Power Switch to Off.

2. Manually release the air pressure by turning the Condensation Valve located on the bottom left of the Air Receiver Tank. To open the valve, turn it counterclockwise until it is parallel to the valve body. You should hear air escaping from the tank.

3. Close the Condensation Valve when you can no longer hear the air escaping from the tank. To close, turn the valve until it is perpendicular to the valve body.

Method B:

1. Turn the Main Power Switch on the Control Panel to ON.
2. Turn the Main Control Switch to MANUAL EXPOSURE, and the tank will automatically begin to drain.
3. When you can no longer hear the air escaping the tank, switch the Main Control Switch to STOP, and the Main Power Switch to OFF.

10.3 Air Filter

The green air filter is located on the backside of the Gravelometer on each of the Target Boxes. This filter controls the dust that is generated from the breaking of gravel or other media. This filter should be cleaned after at least every 500 to 700 tests, because there is a large amount of dust generated during each test.

Clean the filter with a vacuum or compressed air blower, or rinse it out with warm, soapy water.

10.4 Calibration

The Multi-Test Gravelometer can accommodate calibrations to conform to many applicable ISO standards and other standards.

Several features on the Multi-Tester Gravelometer can be calibrated. The Air Nozzle Pressure Gauge and the air nozzle orifice in the gun barrel should be calibrated, and the Gun Barrel, Flat Specimen Holder Assembly and Target Chamber should be visually inspected. **Calibration procedures and visual inspections should be performed every six months.** Depending on the frequency of use, the calibrated gauges should be sent back to the manufacturer every 6 to 12 months to be recalibrated.

10.4.A Calibration Kit

The Gravelometer comes with an optional calibration kit (Part Number G-9576-X) that includes the following items.

1 1/2 inch Open End Wrench
Go/No-go Plug Gauge for SAE Air Nozzle (0.261 inches, 6.63 mm), (0.271 inches, 6.88 mm)
Go/No-go Plug Gauge for VDA Air Nozzle (0.268 inches, 6.81 mm), (0.284 inches, 7.23 mm)
30 inch (76 cm) Jumper Hose with Quick Connect fittings
Calibrated Verified Dual Range Pressure Gauge
Tool Box to hold Calibration Equipment
4 mm Ball End Hex L-Key

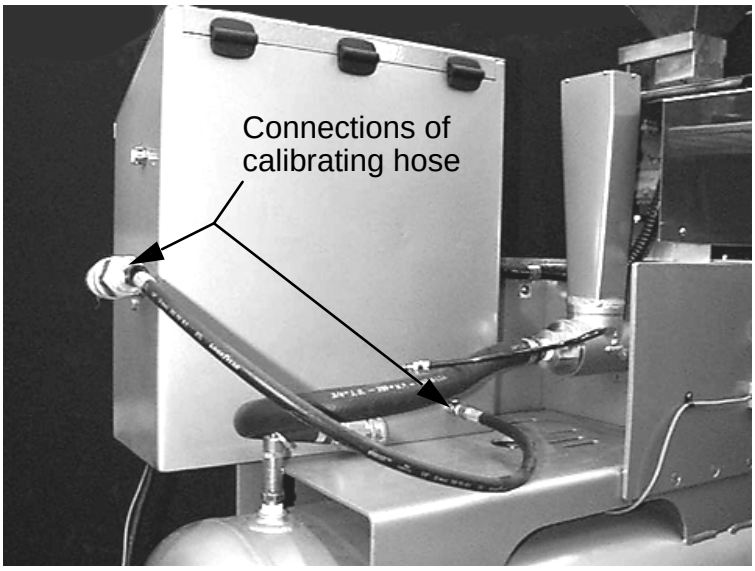
10.4.B Calibrating the Air Nozzle Pressure Gauge

Before calibrating the Air Nozzle Pressure Gauge, make sure the Air Valve on the back of the Air Receiver Tank is turned to OPEN. For instructions on opening the Air Valve, see section 8.5.

1. Disconnect and remove the gun assembly according to the procedures in section 8.4.

2. Connect the black calibrating hose (found in the calibration kit) to the two connections on the back and side of the Control Cabinet.

The larger female connector plugs into the nozzle on the right side panel of the Control Cabinet. To attach this end of the hose, pull back on the gold ring and push the hose onto the nozzle.



Connections of the Calibrating Hose

Air Nozzle Pressure Gauge

3. The smaller male connector plugs into the "quick connect" coupling on the lower right side of the back of the Control Cabinet. This coupling leads to the Air Nozzle Pressure Gauge.

4. Remove the cover on the Air Nozzle Pressure Gauge on the Control Panel. To remove it, turn it to the left until it comes loose, and remove it.

5. Attach the quick connect on the calibrated Air Nozzle Pressure Gauge to the bulkhead fitting on the right side panel of the Control Cabinet.

6. The calibrated Air Pressure Gauge should indicate the same pressure as the gauge on the Control Panel. If it does not, the Air Nozzle Pressure Gauge on the control panel should be set to the pressure indicated by the calibrated gauge.

7. To change the pressure indicated on the Air Nozzle Pressure Gauge, hold the pin in place with one hand while turning the small black dial in a counterclockwise direction with the other hand. The small black dial loosens the indicator pin. Note: Be careful not to bend the pin as you hold it and turn the black dial.

8. Once the indicator pin is loose, turn it until it indicates the same pressure as the Calibrated Air Pressure Gauge.

9. When both air pressure gauges indicate the exact same air pressure, tighten the indicator pin on the Air Nozzle Pressure Gauge on the Control Cabinet. Tighten the small black dial by turning it in a clockwise direction.

10. Replace the cover to the Air Nozzle Pressure Gauge on the control panel and tighten it by turning it in a clockwise direction.

11. Remove the calibrated gauge from the bulkhead fitting on the right side panel of the Control Cabinet.

12. Remove the black calibrating hose. To remove the large coupling, pull back on the gold ring while pulling away from the male connection. To disconnect the small coupling push down on the top of the female end of the connection while pulling the black tube away from the receptor.

13. The Air Nozzle Pressure Gauge is now calibrated.

10.4.C Calibrating the Air Nozzle Orifice in the Gun Barrel

The air nozzle orifice in the gun barrel may become slightly damaged after many hours of testing. Even the slightest variation in the diameter of the nozzle can cause variation in test results. The go/no-go gauge used to calibrate the air nozzle orifice is an Aluminum hex holder with a red tip on one end and a green tip on the other end. The green end of the holder is the smallest diameter of the air nozzle. The red end has the largest diameter air nozzle. If the orifice diameter is within the correct size range, the green end will fit into the orifice (green = go) but the red end will not fit into the orifice (red = no-go).

Calibrating the air nozzle orifice in the SAE Gun Barrel

1. Disconnect the large black hose (Nozzle Air Line) attached to the Gun Assembly from the nozzle on the right side panel of the Control Cabinet. To disconnect, pull back on the gold ring while pulling the hose from the connection.

2. Disconnect the 1/8" I.D. PVC tube (air supply to Air Nozzle Pressure Gauge) that is also attached to the Gun Assembly from the "quick connect" coupling on the lower right side of the back of the Control Cabinet. To disconnect, push down on the top of the female end of the connection while pulling the 1/8" I.D. PVC tube away from the coupling.

3. While the main frame of the gun assembly is still clamped in place, use the wrench provided in the calibration kit to loosen the stainless steel nozzle. Turn the wrench in a counterclockwise direction until it just loosens.

4. Once the nozzle is loose, remove the gun assembly from the Base Assembly of the machine.

5. Twist the nozzle away from the gun assembly and disconnect it.

6. Pick up the plug gauge marked "SAE." Do not use the gauge marked "VDA." Insert the green end of the calibration gauge into the nozzle orifice. If it does not fit inside, the orifice has become too small and the nozzle should be replaced. Now try the red end. If the red end does fit into the nozzle orifice, the diameter has become too large, and the nozzle should be replaced.

Calibrating the air nozzle orifice in the VDA Gun Barrel

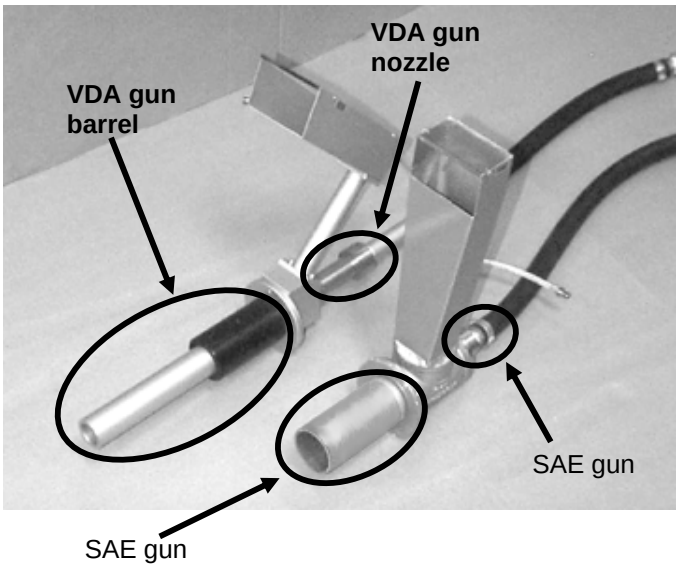
1. Disconnect the Nozzle Air Line attached to the Gun Assembly from the nozzle on the right side panel of the Control Cabinet.

2. Disconnect the 1/8" I.D. PVC tube (air supply to Air Nozzle Pressure Gauge) that is also attached to the Gun Assembly from the "quick connect" coupling on the lower right side of the back of the Control Cabinet.

3. Remove the three bolts on the gun barrel with the wrench provided in the calibration kit.

4. Remove the hose from the gun assembly, but leave the gun barrel clamped in place.

5. Pick up the plug gauge marked "VDA." Do not use the gauge marked "SAE." Insert the green end of the calibration gauge into the nozzle orifice. If it does <u>not</u> fit inside, the nozzle has become too small and the nozzle needs to be replaced. Now try the red end. If the red end <u>does</u> fit into the nozzle orifice, the diameter has become too large, and the nozzle needs to be replaced.



SAE and VDA Gun Barrels and Nozzles

10.4.D Visual Inspections

VDA Gun Barrel
The VDA gun barrel may also become worn out after months of testing. This should be visually inspected at the time you calibrate the Air Nozzle orifice. Look at the gun assembly and down the barrel of the gun. If the barrel has been worn through, it should be replaced.

Rubber Lining
The rubber padding on the inside of the Flat Specimen Holder Assembly and Target Chamber may become worn out after months of testing. Inspect the padding to make sure it is not coming off the steel Flat Specimen Holder Assembly. If the rubber is merely worn out, there is no problem. If the metal beneath the rubber is exposed and worn out, the Flat Specimen Holder Assembly or Target Chamber may need to be replaced.

10.5 Cleaning

Use a soft cloth to clean the gravelometer's exterior. A soft brush should be used to remove heavy dirt from the gravelometer controls. Use a soft brush to remove and loosen the majority of dirt, then wipe the controls with a soft cloth.

Pressurized air can be used to clean the gravelometer (except for the control cabinet). The pressurized air should be less than or equal to 30 psi (207 kPa).

Do not use any cleaning liquids or solvents to clean the gravelometer.

Do not use pressurized air that is over 30 psi (207 kPa).

Do not use pressurized air on or inside the control cabinet.

11. Troubleshooting

1. The machine's power is on but it will not operate in manual or timed start.

    a.) Make sure the time start and manual switch is in the OFF position.
    b.) Check to see that all safety circuit connections are together or complemented.
    c.) Make sure that the flat specimen clamp is closed and that the 3D box lid is closed.

    If the machine is still not operating:

    d.) Carefully open the control cabinet lid. Check Relay #1 to see if the LED is on.
    e.) If Relay #1's LED is not on, check Fuse #1 4/10 amp for 115 V models, or 2/10 amp for 230 V models.

2. The vibratory feed is not working but all other controls are working.

    a.) Check Relay #4 to see if the LED is on.
    b.) Check Fuse #3 6/10 amp for 115V models, or 5/16 amp for 230 V models

3. The solenoid is not working but all other controls are working.

    a.) Check to make sure that the main air pressure is turned on.
    b.) Make sure that the regulator is adjusted to a set pressure.
    c.) Make sure that the flow control knob is turned counter-clockwise, all the way out on the solenoid valve.
    d.) Turn the manual override screw clockwise on the solenoid valve.
    e.) Check the voltage between wires #21 and #10. They should have 24 V between them.
    f.) If the solenoid valve is stuck, you may need to replace it.

4. The air regulator is making a strange noise or it is leaking air.

    a.) Make sure that the main air supply to the air receiver tank is on.
    b.) Adjust the regulator in and out. If the problem continues, replace the regulator.

5. The heaters are not getting warm in the freezer environment.

    a.) Make sure the temperature is below 50°F (10°C).
    b.) Check Fuse #2.
    c.) Check the voltage across wires #29 and #3 for 115 V or 230 V corresponding to the voltage of your machine. If there is zero voltage between the wires, check the thermostat as in the next step.
    d.) Check the voltage across thermostat wires #28 and #3. If you have voltage greater than zero voltage at this location, and you have zero voltage between wires #29 and #3, and the chamber air temperature is below 50°F (10°C), you need to replace the thermostat.

12. Chipping Test Standards

Method	Applicable Method
ASTM D 3170	J400
Chrysler 463PB-39-01	J400
Chrysler 463PB-52-01	J400
Ford	J400
Ford BI 157-04	VDA
Ford BI 157-05	VDA
GM 9119P	J400
GM 9508P	J400
GM 9619P	J400
GME 60 268	J400
JIS M0141	J400
Mazda MES MN 601C	J400
Nissan	J400
Peugeot/Citroen D241312	VDA
SAE J400	J400
Toyota	J400
VDA 621427	VDA
Volkswagen	J400

13. Replacement Parts

Part #	Part Name
G-9430-X	3D Specimen Chamber Assembly With Gravel Box
G-9408-X	Base Assembly, 115 V
G-9409-X	Base Assembly, 230 V
G-9576-X	Calibration Kit
G-700	Ear Protection
G-9490	Hinges, control cabinet
G-9428-X	Flat Specimen Holder Assembly
G-9426-X	Gravel Box Assembly
G-9419-X	Gun Assembly, SAE
G-9463-X	Gun Assembly, VDA
G-9444	Gun Barrel, VDA
G-9464-X	Gun Feed Chute & Tube Assembly, VDA
G-9455-X	Hopper Adjustment Assembly
G-9449	Hopper Adjustment Vertical Plate
G-9481-X	Hopper Assembly
G-9549	Meter, Test Count
G-9552	Meter, Test Time
G-9441	Mixing Block, VDA
G-9416	Nozzle, SAE
G-9440	Nozzle, VDA
G-9511	Pressure Gauge
G-9513	Pressure Regulator
G-9536	Relay, 4PDT
G-9535	Relay, Time Delay
G-9716-X	Safety Switch, Flat Specimen Holder
G-9512	Solenoid Valve
G-9470-X	Target Chamber, 45° SAE
G-9815-X	Target Chamber, 54° VDA
G-9471-X	Target Chamber, 90° SAE
G-9459-X	Target Chamber, 90° VDA
G-9538	Test Set Timer
G-9635-X	VDA Backer Plate
G-9590-K	Vibratory Feed Spring Kit
G-9445	Vibratory Feeder Pan
G-9446	Vibratory Feeder, 115 V
G-9562	Vibratory Feeder, 230 V