AFG1
Operation Manual

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LMAFG1
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I. General Information

1.1 Scope

This manual describes the proper use of the Pine AFG1 SUPERPAVE™ Gyratory Compactor (SGC), including operating instructions, periodic maintenance, standardization procedures, and safety issues. It is assumed that the reader of this manual is already familiar with hot mix asphalt design and general issues pertaining to gyratory compaction.

Figure 1.1: The AFG1 SUPERPAVE™ Gyratory Compactor

1.2 Copyright

1.3 Nameplate

Each Pine SGC is marked with a nameplate that indicates the model number, serial number, power requirements, and patent information.

1.4 Trademarks

- *Microsoft*® *Windows*™ and *Excel*™ are trademarks of Microsoft Corporation (Redmond, WA).

1.5 Security Code

Your Pine Instrument Company SUPERPAVE™ Gyratory Compactor is equipped with built-in calibration routines. To prevent inadvertent access to these routines, a security code must be entered before the machine may be calibrated. This code is not required for verifying calibration.

Your machine security code is :	Calibrate:	1
	Diagnostics:	101

If it is desired that this information not be readily available, please remove and store this page in a safe location.

II. Product Overview

The Pine Instrument AFG1A SUPERPAVETM Gyratory Compactor is designed to compact prepared Hot Mix Asphalt (HMA) specimens at a constant consolidation pressure, at a constant angle of gyration, and at a fixed speed of gyration. Its features include: an integrated computer control system, a control panel with display, a 1.44 Mb (3.5") floppy disk drive, a completely enclosed compacting chamber, a built-in angle measurement system, and an integrated extruder function for removing compacted HMA specimens from the molds. Overall size is approximately 750 mm (29.5") wide x 915 mm (36") deep x 1400 mm (55") high.

An integrated industrial computer controls all functions. The operator simply enters the appropriate compaction parameters, places the prepared mold into the compacting chamber, and presses the start button. Once the start button is pressed, the computer system takes control and applies the consolidation pressure, induces the gyration angle, and gyrates the specimen for the specified number of gyrations or to the specified height. At the end of the test, the specimen is squared and ram pressure is removed. Once the ram pressure has been released, the operator removes the mold top, then presses the ram up button to extrude the specimen from the mold. This integrated extruding function permits easy removal of the specimen from the mold assembly. The compacting chamber is a completely enclosed area with a safety interlocked access door which prevents machine operation when the door is open. Pressing the emergency stop button stops all motion and releases ram pressure.

The control panel permits compaction parameters to be set. Once the test is started, the parameters may not be changed. While compacting, the control panel display indicates the actual consolidation pressure, gyration number, specimen height, and angle of gyration.

The AFG1A stores the specimen height, the consolidation pressure, and the angle of gyration during compaction. This test data may be saved directly to a floppy disk for transfer to a computer for analysis. The printer port allows the data to be printed directly to a printer, and the serial communications port allows data to be sent directly to a computer. The data from the previous twenty (20) specimens are stored in the compactor's memory.

The AFG1 SGC is designed for use in a laboratory environment. The suggested operating conditions are as follows: Temperature range of 50-95ºF (10-35.0ºC) and relative humidity range of 10% to 85%. The AFG1A was designed for the compaction of Hot Mix Asphalt design specimens. Only HMA above 140 degrees Fahrenheit should be compacted with the machine. Compacting other materials may cause damage to the machine.

2.1 Specifications

Power Supply	AFG1A: 115VAC ±10%, 50/60Hz, 1Φ, 15A AFG1C: 230VAC ±10%, 50/60HZ, 1Φ, 10A Cord set Type SJT, rated250V, 15A, 105ºC, 3 conductor(including ground) **NOTE:** The AFG1 may be damaged if operated at an input voltage level greater than specified above, i.e. 126.5VAC for the AFG1A and 253VAC for the AFG1C. If operation above the rated voltage level is necessary due to high power line voltages or local generator operation, a voltage regulator must be employed. Consult the factory for details.
Dimensions	750 mm wide x 920 mm deep x 1400 mm high (~29.5" X ~36" X ~55")
Weights	386 kg (850 lb)
Applied Pressure	600 kPa ±60 kPa gyration 0-5; ±10 kPa gyrations >6
Angle of Gyration	Fixed: 0.82°, 1.16° Internal, or 1.25° External (specify at time of order)
Speed of Gyration	30 ±0.5 gyrations per minute
Number of Gyrations	0-999
Mold Dimensions	150.0 mm +0.0/-0.1 mm ID x 250 mm tall 100.0 mm +0.0/-0.1 mm ID x 200 mm tall (250mm tall available) 0.0 mm minimum specimen height
Mode of Operation	Compact to Number of Gyrations Compact to Specified Height
Data Acquisition	Gyration Number Specimen height (mm) Angle of gyration (degrees) Consolidation pressure (kPa)
Data Output Options	3.5" Floppy rs232 Serial communication (null modem cable required)
Internal Data Storage	Results from twenty (20) tests are retained in memory
Additional Features	Built-in extruder function
Software	PINEPAVE™ software (requires *Microsoft Excel*)

*** These specifications are subject to change without notice. ***

2.2 Accessories

2.2.1 Calibration

Part Number	Description
AFGCLR05C	Proving Ring
AFG123C	Gage Block Set
RATS90	Stop Watch
AFLS1	Internal Angle Measurement Instrument
AFG1A01	Angle Sensor Calibration Jig
AFG1A07	Angle Sensor Verification Jig

2.2.2 Specimen Related

Part Number	Description
AFG1A08	Mold Funnel
AFG1A14	150mm Specimen Lift Handle
AFG1A15	100mm Specimen Lift Handle
AFG1M10	100 mm Mold Assembly
AFG1M15	150 mm Mold Assembly
AFG2X04	100mm Conversion Kit
RAND10	100 mm Paper Disk (1000/pack)
RAND15	150 mm Paper Disk (500/pack)
AFG1A09	Bolt Down Bracket Kit
AFGCA011	Printer Kit w/cable

2.2.3 Lubricants

Part Number	Description
CLGSMOS2T	Ram Foot Lubricant
CLGMOS2	Bearing Grease

2.3 Setting up the SUPERPAVE Gyratory Compactor

2.3.1 Machine Location

Select a level sturdy floor for the compactor location. It is not critical that the machine be exactly level, but it must be stable. Be sure to allow room to access the 3.5" floppy drive at the rear of the control enclosure.

If the unit is installed in a mobile trailer or truck, it must be secured into position using the holes provided in the lower frame brackets (Figure 2.1). Be sure to allow room for servicing the machine or provide for a means to move the machine for servicing purposes.

2.3.2 Unpacking the Gyratory Compactor

The compactor is shipped bolted directly to a wooden pallet. After unbolting the machine from the shipping pallet, slide the frame handles out and insert the lock pin in the handle through the handle to prevent the handle from sliding out of the frame. Carefully remove the compactor from the pallet using the 2x4 spacers under the compactor as ramps (Figure 2.1).

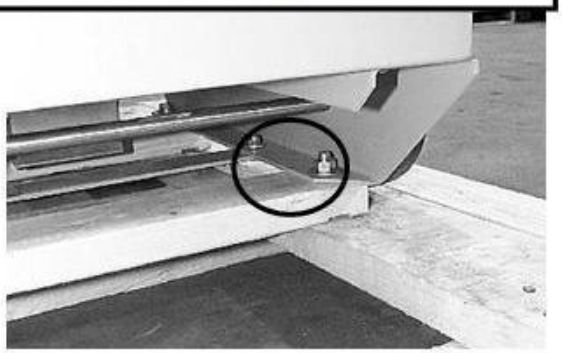
The AFG1A is top heavy. When moving the AFG1A over obstructions (i.e. door jams, concrete cracks, etc.), it is suggested that the compactor be pulled (rather than pushed) to avoid tipping over the machine.

Prior to using the gyratory compactor after it has been transported, the machine should be standardized. This can be accomplished with the calibration devices utilizing the standardization control routines.

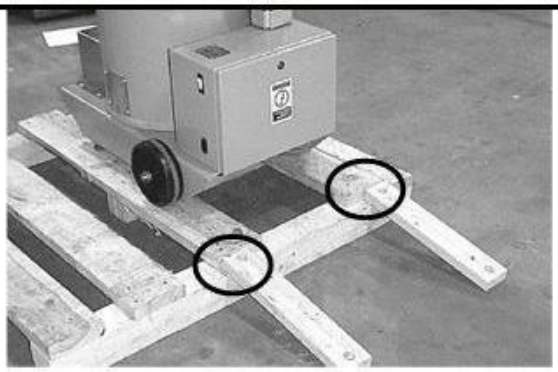
Select a level surface for the compactor location. It is not critical that the machine be exactly level, but it must be stable. A leveling foot is installed on each side at the front of the machine. Adjust these support feet so that the compactor is stable. Be sure to allow room to access the floppy disk drive located on the rear of the control panel. Use the holes in the frame or the optional bolt down bracket to bolt the unit directly to the floor when mounting it in a transportable unit.

Prior to using the gyratory compactor after it has been transported, the machine's calibration should be verified. This can be accomplished with the calibration devices utilizing the built-in calibration/verification routines.

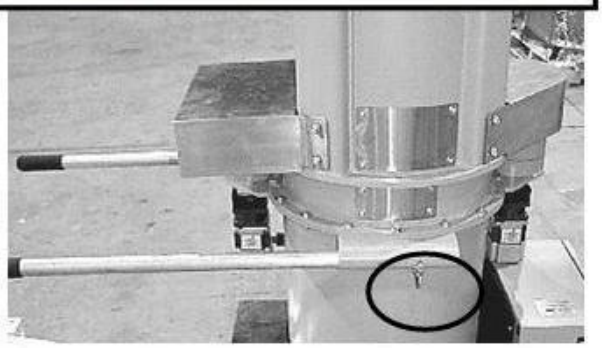
Step 1: Remove carton and accessory box from pallet. Unbolt the compactor from the shipping pallet. (4 places)



Step 2: Set the 2x4 spacers on the pallet with the notch in the 2x4 set on the pallet edge.



Step 3: lock the handles to the frame of the compactor with the safety pins in the handle.



Step 4: Slowly roll the compactor to the edge of the pallet. Use spotters to help balance the load.

Step 5: Roll the compactor down the ramps very slowly using spotters to control the compactor.

Step 6: Remove the safety pins and slide the handles into the frame mounts.

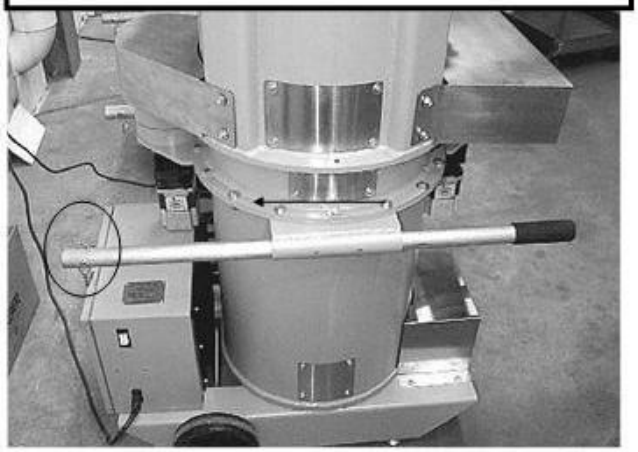


Figure 2.1: Unpacking

2.4 Initial Application of Power

Read and understand this entire manual before applying power to the gyratory compactor.

Read and understand all personal safety warnings before applying power to the compactor.

When the Pine AFG1 is turned on for the very first time, it may not respond to the control panel because the **EMERGENCY STOP** button was pressed at the factory. Simply rotate the button clockwise to release it.

Before using the Pine AFG1 SUPERPAVE Gyratory Compactor to compact hot mix asphalt specimens, be sure to read and understand all of the personal safety warnings found in Section Error! Reference source not found. **of this manual.**

2.5 Safety Precautions

When working with the Pine AFG1 SUPERPAVE Gyratory Compactor, care should be taken to avoid injury. The Pine Instrument Company AFG1 Gyratory Compactor has several safety features built into the machine to prevent injury to the user. However, all improper or unauthorized use of the machine cannot be accounted for. Therefore, before performing any procedures that *are not specifically mentioned in this manual*, contact Pine Instrument Company for authorization.

To ensure minimum risk of injury to the user, Pine Instrument Company advises adhering to the following personal safety warnings as a minimum:

	**Operator should wear eye protection and steel toe shoes.** **Do not wear loose-fitting clothing items (*i.e.*, jewelry, ties, etc.) which may be caught in the moving parts of the compactor. Long hair should be tied back.**
	**Use proper lifting techniques when inserting and removing specimen molds to prevent back injury.**
	**Keep hands and arms away from moving parts and pinch points.** **Keep hands and arms away from the top of the compactor when extruding the specimen.**
	**Always wear heat resistant clothing and gloves when handling hot molds and hot HMA specimens,**
	**Do not operate the compactor with any of the access panels or guards removed.**
	**Use proper lifting techniques when moving the compactor to prevent injury.**

2.5.1 Warning Labels / Symbol Definitions

The Pine Instrument Company AFG1A Gyratory Compactor has warning labels located in several areas to warn users of potential hazards. The following labels are found in these areas of potential hazard.

The "Caution Pinch Point Hazard" label is located adjacent to the compaction chamber door and on top of the compactor. The label adjacent to the compaction chamber door is to warn of potential pinch point between the work surface and the swivel frame during compaction. The label on top of the compactor is to warn of the potential pinch point between the specimen and mold top clamps while extruding the specimen. In general, while the machine is in motion, it is necessary to exercise caution of pinch points.

The "Caution Hot Surface" label / symbol is located on both the front and rear actuator motors. The front and rear actuator motors will become hot after the machine is used continously for an extended period of time. These labels are to warn of the potential burn hazard.

The "Caution Electrical Hazard / Remove Power" label is located on both the control and power supply enclosures. These labels are to warn of the potential for serious injury due to shock inside both enclosures. Service within this enclosure should be only under the direction of a Pine Instrument Company Technical Support Representative.

The fuse definition label is located inside the power supply enclosure adjacent to the fuse block. These fuses are rated at 250 volts 10 amps (time delay). The replacement fuses may be Bussman part number MDA-10 or equivalent. Pine Instrument Company does not permit servicing of the components inside either enclosure unless instructed by a certified AFG1Atechnician. Replacement parts may be purchased from Pine Instrument Company or most hardware stores.

The protective earth ground label is located inside of the power supply enclosure adjacent to the protective earth ground stud. This earth ground is the first point of contact for the line voltage earth ground.

2.5.2 Material Disclosure Table

The AFG1 may contain materials that require special handling for disposal or recycling. These materials should be handled according to the local governing agency requirements. Table 2.1 provides a listing of the components which contain materials that may require special handling at the end of service life disposition.

Hazardous Material Disclosure Table						
Component Name	Hazardous Substances or Elements					
	Lead (Pb)	Mercury (hg)	Cadmium (Cd)	Chromium VI Compounds (Cr^{6+})	Polybrominated Biphenyls (PBB)	Polybrominated Diphenyl Ethers (PBDE)
AFG1 (-A, -C) - GYRATORY COMPACTOR	X	O	O	X	O	O
ACG1 - COMPACTOR MECHANICAL	X	O	O	X	O	O
ACG1S10 - POWER ELECTRONICS	X	O	O	X	O	O
ACG1S11 - CONTROL ELECTRONICS	X	O	O	X	O	O
O: this component does not contain this hazardous substance above the maxiumum concentration values in homogeneous materials specified in the SJ/Txxxx-xxxx Industry Standard.						
X: this component does contain this hazardous substance above the maxiumum concentration values in homogeneous materials specified in the SJ/Txxxx-xxxx Industry Standard						

有毒有害物质披露表						
零部件名称	有毒有害物质或元素					
	铅 (Pb)	汞 (hg)	镉 (Cd)	六价铬 (Cr^{6+})	多溴联苯 (PBB)	多溴二苯醚 (PBDE)
回转式压实机 220伏 50/60 赫兹	X	O	O	X	O	O
压实机机械部分装配	X	O	O	X	O	O
电源设备安装	X	O	O	X	O	O
控制设备安装	X	O	O	X	O	O
\						
X：表示该有毒有害物质至少在该部件的某一均质材料中的含量超出SJ/Txxxx-xxxx 标准规定的限量要求。						

Figure 2.2: Material Disclosure Table

III. Operation

3.1 General

The proper operation of the gyratory compactor requires that the mold and compaction chamber be free of dirt and debris. Small stones and dirt in the compaction chamber and on the mold could result in erroneous data or damage the machine and should be removed prior to starting a test. It is especially important that the bottom flange on the mold be kept clean so that the mold is securely clamped during compaction. Keep the base of the compaction chamber clean also.

A test cannot be started if the machine is not properly parked; that is, the ram and the swivel base must be in their parked position. Press the ram down button to park the machine. The compaction chamber door must be closed, and the mold top must be properly engaged with the hold downs on the top of the compactor before a test can be started. The mold top seated light (green LED on the control panel) is illuminated when the mold top is properly seated. The test sequence is automatic and is initiated with the START button. The AFG1A does not have a manual sequence in which to compact asphalt.

3.2 Emergency Stop

The **EMERGENCY STOP** button is a large red button on the front panel. Pressing this button halts all moving parts on the compactor. To release the **EMERGENCY STOP** button, simply rotate it clockwise. To restart an interrupted test, press the green **START** button.

Figure 3.1: Emergency Stop

3.3 Mold Top Seated Indicator

When the mold top is properly seated, the green MOLD TOP SEATED light on the control panel will be illuminated. A test cannot be started if the mold top is not properly seated.

3.4 Machine Ready Indicator

When the compactor is functioning normally and is ready to begin a test, the green **MACHINE READY** and the **MOLD TOP SEATED** lights on the control panel are activated. Attempting to start a test (by pressing the green **START** button) will not succeed unless both lights are on.

3.5 Fault Indicator

If a machine fault occurs during a test, the test is halted and an error code with a message appears on the main display. Contact the factory for information regarding such error codes.

3.6 Using the Menu System

The main display and the four buttons located immediately below it are used to navigate through various "menus" which control the gyratory compactor. Information in this display appears as black text on a light green background. For purposes of this instruction manual, a similar graphical depiction of the main display is used (Figure 3.2).

```
GYRATIONS (N):   100
HEIGHT (mm):    16.0
MOLD DIAM:    150 mm
COMPACT:   Gyrations
```

Figure 3.2: Liquid Crystal Display Representation

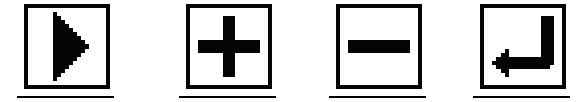


Figure 3.3: Menu Navigation Buttons

The four buttons located below the main display are used to select and change the value of testing parameters. The ▶ button navigates through the system menus by moving from one parameter to the next. When a given parameter is "selected" a flashing triangle appears beside it (on the left side of the display). While selected, the value of the parameter can be changed (incremented or decremented) using the + and − buttons. The new value is accepted by pressing the ↵ button.

```
GYRATIONS (N):   100
HEIGHT (mm):    16.0
MOLD DIAM:    150 mm
COMPACT:   Gyrations
Calibration       +
Test Data         +
Machine Setup     +
Machine Hours:nnn.n
```

Figure 3.4: The Main Menus

The number of gyrations, mold diameter (150mm, 100mm, 4 Inch), compaction mode (Gyration, Height), and the specified height (in Compact to Height mode only) are adjustable on the main menus.

Menus containing additional options (submenus) are marked with a "+" sign on the far right side of the display. To access the submenu, use the ▶ button to select the menu marked with the "+" sign and then press the ↵ button.

3.7 Battery Powered Memory

The internal clock is battery powered so that accurate time is kept when the machine is not powered. The various machine calibration parameters, test settings, and the results from the previous twenty (20) tests are stored in non-volatile memory and do not require battery power. See Section 6.4 for battery information.

3.8 Setting the Date and Time

- Use the ▶ button to navigate through the main menu and select **Machine Setup** submenu. (Remember to press the ↵ button one time to enter a submenu.)

```
 Calibration        +
 Test Data          +
▸Machine Setup      +
 Machine Hours:nnn.n
```

- Select the **Time/Date** option from the submenu, and the display below appears:

```
▸Date/Time
 Serial Port
 Diagnostics        +
 Machine Hours:nnn.n
```

- Use the ▶ button to move to the time or date value to be changed, then use the + and − buttons to change it. Press the ↵ button to store the selected value.

```
Set Time and Date
▶=select ↵=accept
Time: 13:34:06
Date:  9/27/2001
```

IV. Performing a Test

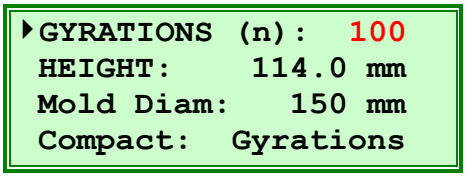
4.1 Settings

4.1.1 Compaction Mode

The AFG1 can be configured to stop at two defined conditions: number of gyrations or a specified specimen height. If it is desired to stop compaction at a predetermined number of gyrations, set the compaction mode to **Gyrations**. If it is desired to stop compaction at a specified target density, set the compaction mode to **Height**.

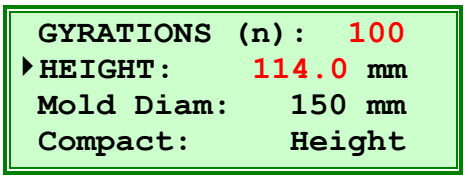
Regardless of the parameter selected to stop the compaction process the compactor will automatically apply the consolidation pressure (typically 600 kPa) then gyrate the specimen (30 rpm) at the programmed angle of gyration (internal; or external) to the preset stopping condition. The compactor will then square the specimen, release pressure, and signal the operator to remove the mold top to extrude the specimen.

4.1.1.1 Number of Gyrations



The number of Gyrations for a test is adjusted by using the ▶ button to highlight the **Gyrations** parameter, and then choosing a value between 0 and 999 with the + and − buttons. Press ↵ to store the selected value. If the machine is set to **Compact to Specified Height**, be sure to set the gyrations number to a value larger than (i.e.: 100) that expected to reach the specified height.

4.1.1.2 Specimen Height



When the compactor is in compact to specified height mode, set the height at which compaction is to be stopped. Use the ▶ button to highlight the **Height** parameter, and choose a value that meets the desired final specimen height. This parameter is only adjustable when the compactor is in **Compact to Specified Height** mode. Press ↵ to store the selected value. Also set the number of gyrations to the maximum the test should run in the case where the specified height is not achieved (i.e.: 100).

Note: **Due to rounding of the specimen height on the display and data file to the nearest 0.1 mm, the preset height may appear to have been reached prior to the compactor stopping. The compactor will stop on the first complete gyration after the specified specimen height is reached. Also, when the specimen is squared and allowed to cool, the height may change slightly. As noted previously, the compactor will also stop at the maximum number of gyrations programmed if the specimen height is not reached.**

4.2 Mold Preparation

Clean the mold, mold base and mold top. A clean mold assembly is essential for repeatable results. Preheat the mold and mold base plate. The mold base plate is usually preheated in the mold. Note the correct orientation of the mold base flange is up. The mold top does not have to be preheated. It is possible to preheat the mold top with a hot plate if desired. The preheat temperature is usually at about 150 degrees Celsius (300 degrees Fahrenheit). Consult the specific test procedure being followed for exact instructions on proper preparation and aging of the specimen. Place the preheated mold with its base plate on the compactor work surface. Next, place a paper disk into the mold on top of the base plate. Load the loose, properly prepared HMA specimen into the mold. Place a paper disk on top of the specimen.

Note: **Studies have shown release paper type can influence specimen density.**

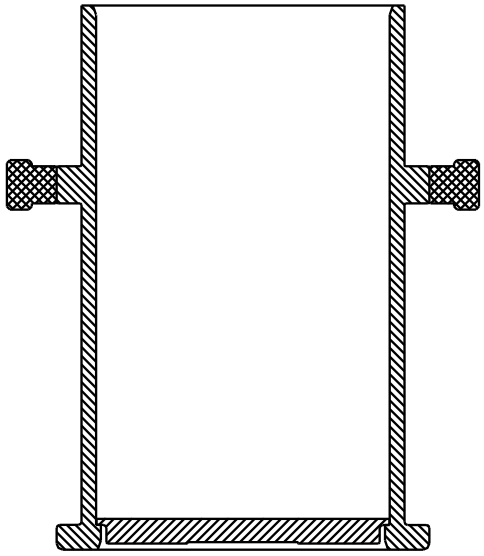


Figure 4.1: Mold Assembly

Note: When inserting the mold into the compaction chamber, be sure the bottom flange is against the rear alignment pins on the swivel base. This can be achieved by pushing near the bottom of the mold.

Lock the mold firmly in place with the clamps located on the left and right side of the swivel frame. Press downward on the clamp handles firmly.

Firmly clamp the mold top to the frame.

Failure to clamp the mold and mold top properly may cause erroneous results.

1 Place a specimen disk on top of specimen.

2 Load the preheated HMA specimen into the mold.

3 Insert the mold base plate into the mold (flange up). Place a specimen disk on the base plate.

Figure 4.2: Mold Preparation

4.3 Starting the Test

Figure 4.3 represents a basic illustration of the steps for performing a test. The machine ready green LED on the control panel must be lit before a test can begin. If the machine ready green LED is not lit, the machine may not be properly parked. Press the **RAM DOWN** button to park the machine.

Prepare the mold assembly for compaction as outlined in Section 4.2. Insert the mold into the compaction chamber. It is convenient to orient the knobs toward the front and the rear of the compactor. Be certain that the mold is fully seated against the rear alignment pins. Clamp the mold firmly to the swivel base with the two clamps, one on each side of the mold. Be sure to press downward on the clamp handles firmly. Close the compaction chamber door.

Install the mold top into the top of the compactor. Rotate the mold top into position clockwise until it is fully engaged with the hold downs and against the stop on the top of the machine. Lock the mold top in place by rotating each clamp handle clockwise until tight. The machine ready light and mold top seated green LED should be illuminated.

Be sure all parameters are correct before starting a test. Press the **START** button to initiate the compaction. The **EMERGENCY STOP** button will pause the test. Opening the compaction chamber door will also suspend the test. If the test is stopped for any reason, the **START** button must be pressed to restart the machine. After the programmed number of gyrations or specimen height has been reached, the machine will automatically stop and release ram pressure. Once the test is complete the final specimen height is displayed and the data is automatically saved. Remove the mold top and extrude the specimen.

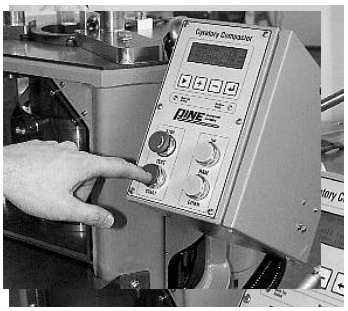
Caution!: Be sure to keep your hands clear of the top of compactor when extruding the specimen.

1 Prepare the mold (see Figure 4.2).

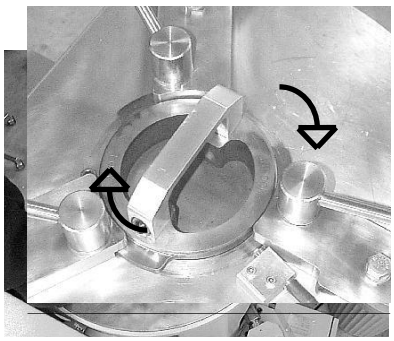
2 Insert the mold into the compaction chamber.

3 Clamp the mold to the swivel frame firmly.

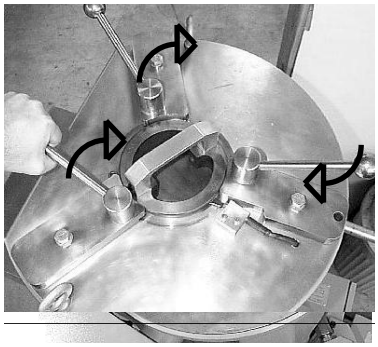
4 Insert the mold Top into the compactor.



5 Rotate the mold top into the hold downs.

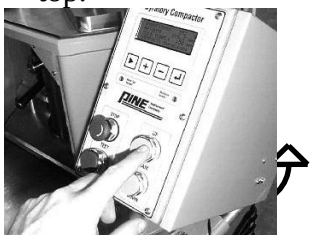


6 Clamp the mold top to the frame.

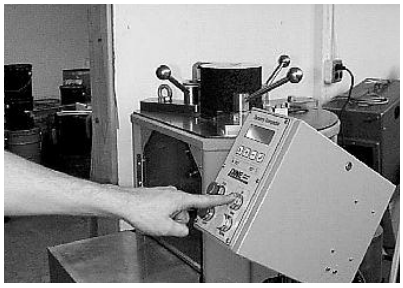


7 Press **START**.

8 After compaction is complete, release the mold top.



9 Rotate mold top fingers out of the hold downs.



10 Remove the mold top.

11 Extrude the specimen. Keep hands clear!

12 Allow specimen to cool slightly. Remove the specimen.

Figure 4.3: Performing a Test

Caution!: Be sure ram pressure has been released and ram is stopped before attempting to remove the mold top.

4.3.1 Interrupting the Test

Pressing the **EMERGENCY STOP** button or opening the compaction chamber door during the test causes the machine to halt. To restart the test, release the **EMERGENCY STOP** (or close the door), then press the **START** button.

4.3.2 Removing the Specimen

The gyratory compactor is equipped with an integrated specimen extruder. When the test is completed, unlock the mold top clamps by rotating the clamps counter-clockwise, remove the mold top, then press and hold the **RAM UP** button to extrude the specimen. It may be necessary to allow the specimen to cool slightly before extruding with high air-void HMA specimens. The ram will stop when the specimen when the button is released. To resume extruding the specimen, press and hold the **RAM UP** button. When complete, remove the specimen and press the **RAM DOWN** button to automatically retract the ram.

Caution: Be sure to keep your hands clear of the top of compactor when extruding the specimen.

Alternatively, the ram may be retracted by pressing the **RAM DOWN** button prior to extruding the specimen permitting the mold to be removed from the machine to allow the specimen time to cool in the mold while additional specimens are compacted. Place the mold back into the machine and press the **RAM UP** button to extrude the specimen.

Remove the paper disks from each end of the specimen and then place the specimen on a bench to cool. A fan can be used to reduce the cooling time. Once the specimen is cooled to ambient temperature, the bulk specific gravity can be measured and any further testing can be performed.

4.4 Retrieving Test Results

The AFG1A Gyratory Compactor automatically records the specimen height, angle of gyration, and consolidation pressure per gyration. The recorded data may be automatically sent to the printer, serial port, and floppy drive when the compaction is complete. Data from 20 tests are stored in the compactor memory and may be transmitted after the compaction is complete. A sample of the data file format is provided (Figure 4.4).

If a 3.5” floppy disk is installed in the compactor at the end of a test, the test data file will be automatically transferred to the storage media. Approximately 140 tests may be stored per 1 Mb of memory.

If no disk is installed, the test data is stored in the internal memory of the AFG1 and may be retrieved later. Up to 20 test files can be stored before the oldest files are overwritten as new files are generated. These data files can be retrieved and saved to a storage device with the following procedure. Tests are stored by the date and time compaction begins.

4.4.1 Retrieving Stored Data

To transfer stored data after a test is complete, select **TEST DATA** from the main menu, then select the appropriate transfer option, **PRINT DATA, SEND TO PC,** OR **SAVE TO DISK**. Choose the appropriate file to be transferred using the **(▶)** key, then press **(↵)**. A "Detailed Report" contains all three of these parameters (specimen height, angle of gyration, and ram pressure) for every gyration of a test. This report can only be sent to the printer directly from the compactor after a compaction is completed. A "Normal Report" contains only the specimen height data and is sent automatically to the printer at the completion of a test.

The serial communications port baud rate setting may be changed in the **MACHINE SETUP** menu. Select **MACHINE SETUP**, then **SERIAL PORT** and choose the desired baud rate setting. The recommended baud rate is 2400. An RS-232, 9 pin, null modem cable is required for data transfer over the serial communication port.

4.5 100mm Mold Conversion

The AFG1A Superpave Gyratory Compactor is capable of compacting 100mm specimens. A conversion kit is available to make the appropriate modifications for compacting 100mm specimens.

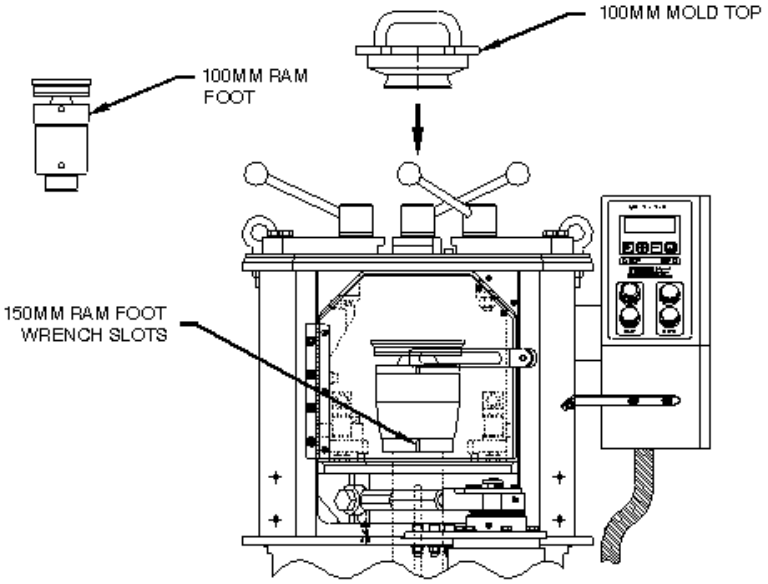


Figure 4.4: 100mm Conversion

To convert the AFG1A from 150mm to 100mm specimen diameter:

Note: The same procedure applies for converting from 100mm to 150mm specimen diameter

- Extend the ram by pressing the **RAM UP** button until the ram foot is above the swivel frame. Remove the 150mm ram foot with the spanner wrench supplied with the 100mm-conversion kit. Reference Figure 4.4. The 150mm ram foot is threaded onto the ram with standard right hand threads. Place the 1-1/8" combination wrench supplied with the AFG1A tool kit around the spanner wrench handle for additional leverage if necessary to remove the ram foot.
- Install the 100mm ram foot by threading it fully into the compactor ram. Use the 1-1/8" combination wrench to obtain additional leverage on the spanner wrench for tightening the foot. The ram foot must be tightened firmly to the ram to prevent the foot from working loose.
- Press the **RAM DOWN** button to retract the ram. Install the 100mm mold top into the compactor.
- Change the mold diameter setting on the AFG1A control panel by pressing the **(▶)** key until the **MOLD DIAM**: flashes. Now press the **(▂)** key to change the setting to **100mm** then press the (↵) key to store the change.

- The height must be calibrated and the force should be verified after changing the ram foot. Refer to the Section 5.4.1 to verify the force and Section 5.5.2 to calibrate the height.

V. Calibration

5.1 General

Before attempting to calibrate the gyratory compactor, be sure to fully understand this procedure. The compactor's calibration should be verified on an annual basis as a minimum, more often under severe usage. Calibration should be verified after the compactor has been transported. Verifying the calibration of the compactor does not affect the calibration data. If the compactor is not within specifications when verified, it must be re-calibrated. To view the date of last calibration or verification, select **CALIBRATION** from the main menu, then select **CALIBRATION REPORT** (see Section 5.2)

Note:	If the compactor passes the verification of the force, height, and angle of gyration, it is properly calibrated and does not require calibration.

The compactor should be turned on and allowed to warm up for approximately 15 minutes prior to calibrating. Room temperature should be 18°C to 25°C. Check that the date and time are correct before starting. The calibration date is stored in memory when this procedure is completed.

The gyratory compactor is programmed with menu driven calibration routines that are reached by selecting **CALIBRATION** from the main menu. The compactor must be parked and the **MACHINE READY** light must be on. Choose to verify calibration or calibrate the compactor. Select **VERIFY** to initiate routines that verify the calibration accuracy without affecting the calibration data. Use these verification routines to check calibration. If the compactor does not pass the verification of calibration, select **CALIBRATE** from the sub-menu to initiate the calibration routines.

It is critical for accurate verification and calibration that the compactor is clean and free of debris. It is especially critical that the ram foot and the mold top be free of debris when calibrating the specimen height measurement.

SUPERPAVE^{TM} specifications require the speed of gyration to be 30.0 ±0.5 rpm, the consolidation pressure to be within 600kPa ±10 kPa, the change in specimen height measurement to be within ±0.1 mm, and the angle of gyration to be ±0.02 ^{0} (21.82 ±0.35mrad) loaded.

A precision, digital stopwatch (P/N: RATS90) should be used to verify the speed of gyration. Precision gage blocks (P/N: RAG123) are used to verify the height measurement. The Pine Instrument Company proving ring (P/N: AFGCLR05C), used to verify applied force, is supplied with a certification document which includes a table of dial readings and corresponding applied forces. It also includes ±1% and ±3% readings for the calibration points of the AFG1 compactor. This certificate is stored behind the foam in the proving ring case lid. The AFG1 has an integrated angle measurement system. An angle sensor verification jig (P/N: AFG1A07) will verify that the angle measuring system is functioning properly.

To calibrate the compactor, an access code is required. This code can be found in Section 1.5. To restrict the availability of the access code, remove the page from the manual and store it in a safe place.

5.2 Calibration Report

To view the calibration and verification dates select **CALIBRATION** from the main menu, then select **CALIBRATION REPORT.** Figure 5.14 is a sample of the calibration report.

AFG1A Calibration Report

Serial Number: 1001 Report Date: 06/09/09
Control Version: 09.05a Run Hours: 90.3

	Calibrated	Verified	Applied	Measured
Force (Newton)	04/30/09	05/01/09	5000/10500	+/- 1.0%
Height (mm)	04/21/09	05/01/09	152.40	152.41
Ext. Angle Unloaded (Deg)	07/11/08	04/21/09	----	1.297
Angle Sensor	07/02/08	05/01/09	0.595/0.605	0.600
Speed (GPM)	N/A	04/20/09	30.0	30.0 +/- .5

Figure 5.1: Calibration Report

5.3 Internal vs. External Angle of Gyration

Superpave Gyratory Compactor (SGC) specifications initially specified an external angle of gyration. Subsequent research demonstrated that the internal angle of gyration provides an improved signal for calibrating an SGC. Devices and techniques were developed to provide a uniform means of measuring the internal angle using a simulated loading technique designed to provide a reproducible load to the SGC frame. Many governing agencies have adopted the internal angle as the calibration specification.

The internal angle typically tracks with the external angle for a properly maintained SGC. If the external angle changes, it is likely the internal angle has also changed. The same is not true for internal angle changes, so it must be measured periodically to ensure the desired performance. However, the external angle does provide information regarding the internal angle between measurements so it is strongly recommended to monitor the external angle for changes.

An external angle may be referred to as a loaded external angle or an unloaded angle. The internal angle is measured using simulated loading so in internal angle of gyration is always a loaded angle. An external angle of gyration reported by the angle measurement instrumentation when the compactor is operated in an unloaded condition (without an HMA

specimen) will be slightly higher than the external angle reported when compacting an HMA specimen. Therefore, when setting up the angle in an unloaded condition, this small change must be considered.

5.4 Verification

Simple routines for verifying the speed of gyration, ram force, specimen height, and angle of gyration are available in the **CALIBRATION** menu. These routines will ensure the compactor is fully calibrated. Be sure the compactor is clean and at room temperature before starting these procedures. If the compaction chamber is still warm from compacting specimens, let it cool to room temperature before verifying calibration. The proving ring used to verify ram force calibration is temperature sensitive and must be used at room temperature.

Note:	**It is important that the appropriate ram foot spacer and mold top be used when verifying force and height (i.e. If compacting 100mm specimens, use the 100mm ram foot spacer and mold top).**

SUPERPAVE™ specifications require the speed of gyration to be 30.0 ±0.5 rpm, the consolidation pressure to be within 600kPa ±10 kPa, the change in specimen height measurement to be within ±0.1 mm, and the angle of gyration to be either 1.25° ±0.02° external or 1.16° ±0.02° internal.

5.4.1 Verify Force/Height

- Using the **(▶)** key, select **CALIBRATION** from the main menu.
- Press the **(↵)** key.
- From the **CALIBRATION** sub-menu, select **VERIFY** then press the **(↵)** key.
- Select **VERIFY FORCE/HEIGHT** then press the **(↵)** key.

  If the mold top is not in position, install the mold top. Make sure the mold top is locked in place with the clamps. Reference Figure 5.2.

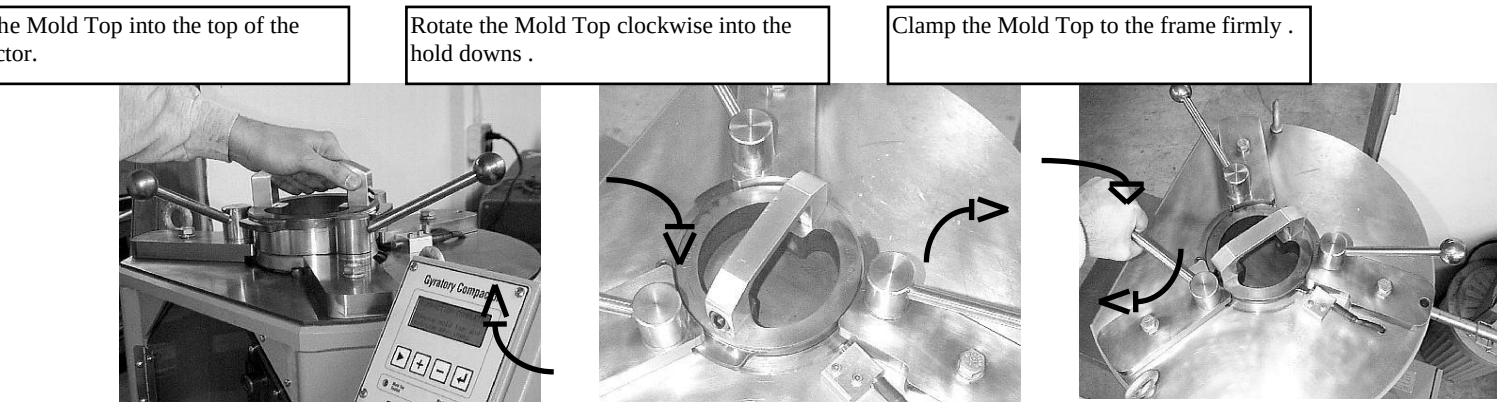


Figure 5.2: Insert Mold Top

- Press the **START** button.

  The ram will automatically move into position for insertion of the ram foot calibration spacer.

- Open the compaction chamber door, thoroughly clean the ram foot thrust bearing surfaces, then insert the ram foot calibration spacer.

  The supplied ram foot calibration spacer must be used during ram force and specimen height calibration (reference Figure 5.3).

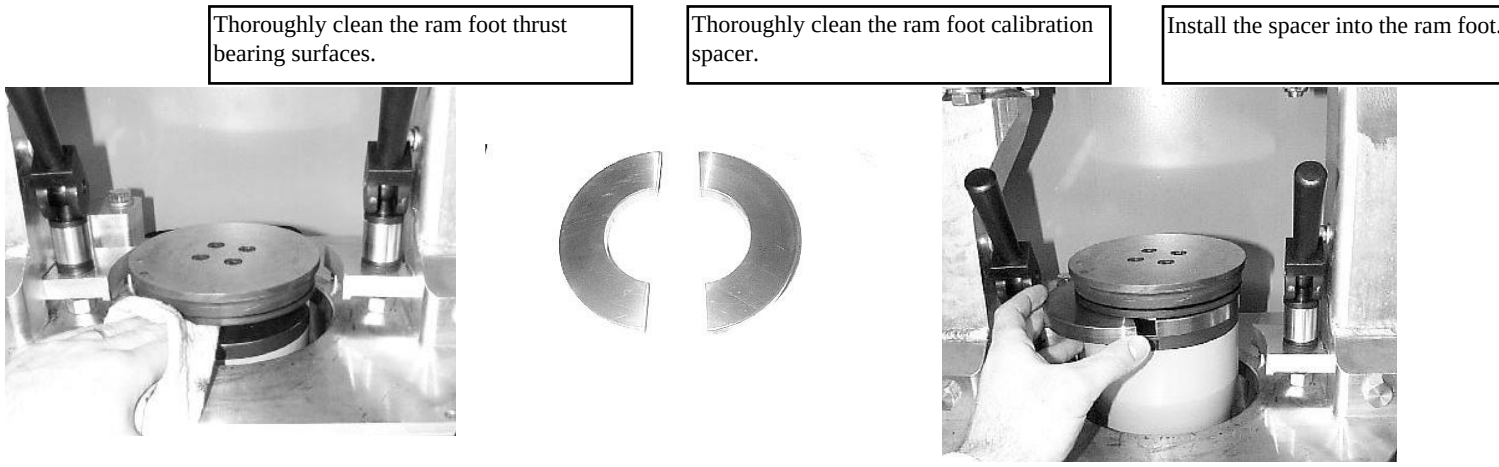


Figure 5.3: Calibration Spacer

- Close the compaction chamber door and press the **START** button.
- Once the ram is retracted, open the chamber door, place the proving ring into the compaction chamber. Center the proving ring on the ram foot. Place the steel plate supplied with the proving ring on the top of the proving ring.

  Reference Figure 5.4 for proper placement of the proving ring in the compaction chamber.
- Close the door then press the **START** button.
- The compactor will automatically flex the proving ring then retract the ram.

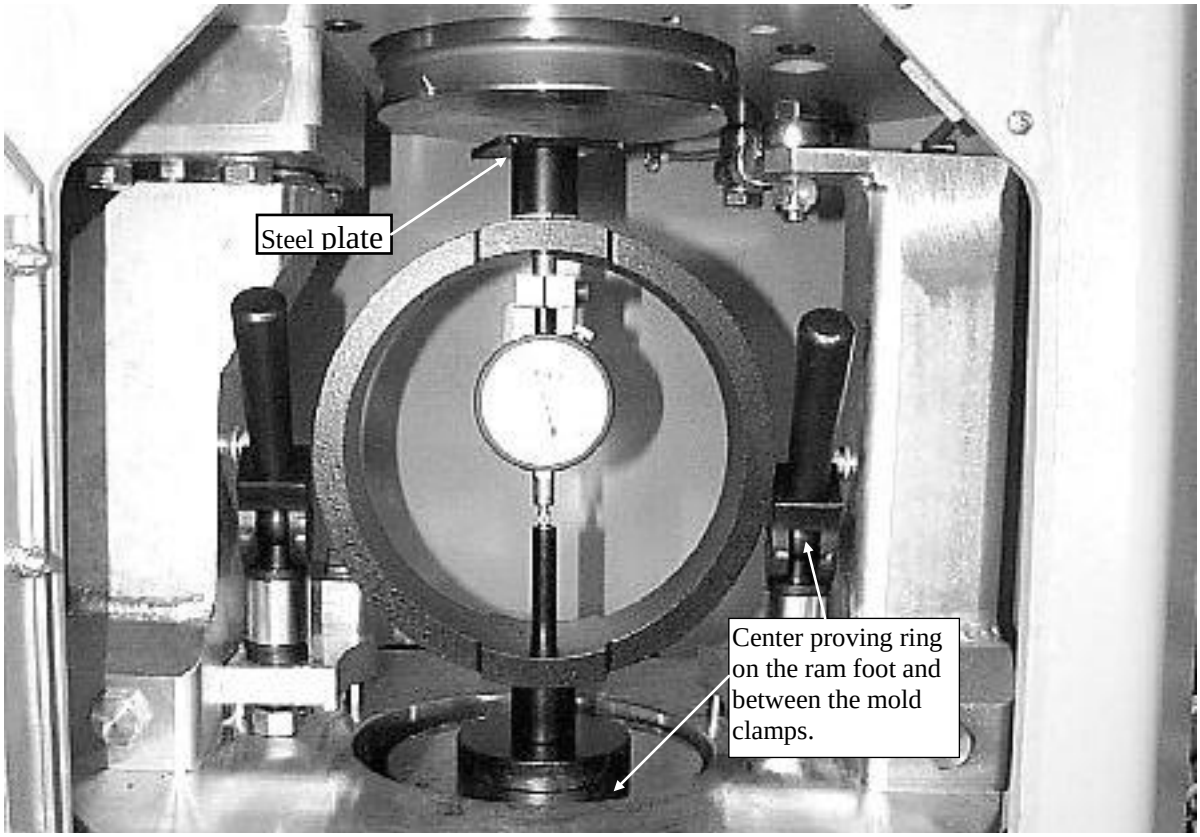


Figure 5.4: Proving Ring Placement

- After the proving ring is flexed and the ram is retracted, open the compaction chamber door, zero the dial indicator on the proving ring by rotating the bezel, close the door, then press the **START** button.
  The compactor will apply a load of 5,000 Newton to the proving ring.
- Verify that the compactor is calibrated by comparing the force indicated by the ring to the force indicated by the compactor.
  The proving ring is supplied with a certification chart of the dial readings at various forces.
- Press the **START** button.
  The compactor will load the proving ring to 10,500 Newton. Verify this force in the same manner.
- Press the **START** button once more and the controls will park the ram.

If the measurements are within specifications, press the **(+)** key. If the force readings exceed ±1.67%, calibration is required. If the readings exceed ±1%, calibration is recommended. If calibration is required, press the **(-)** key. Once the **(-)** key is pressed, the control panel will display the option to repeat the verification or to abort the verification routine. Press the **(+)** key to repeat the verification or press the **(-)** key to abort the verification routine.

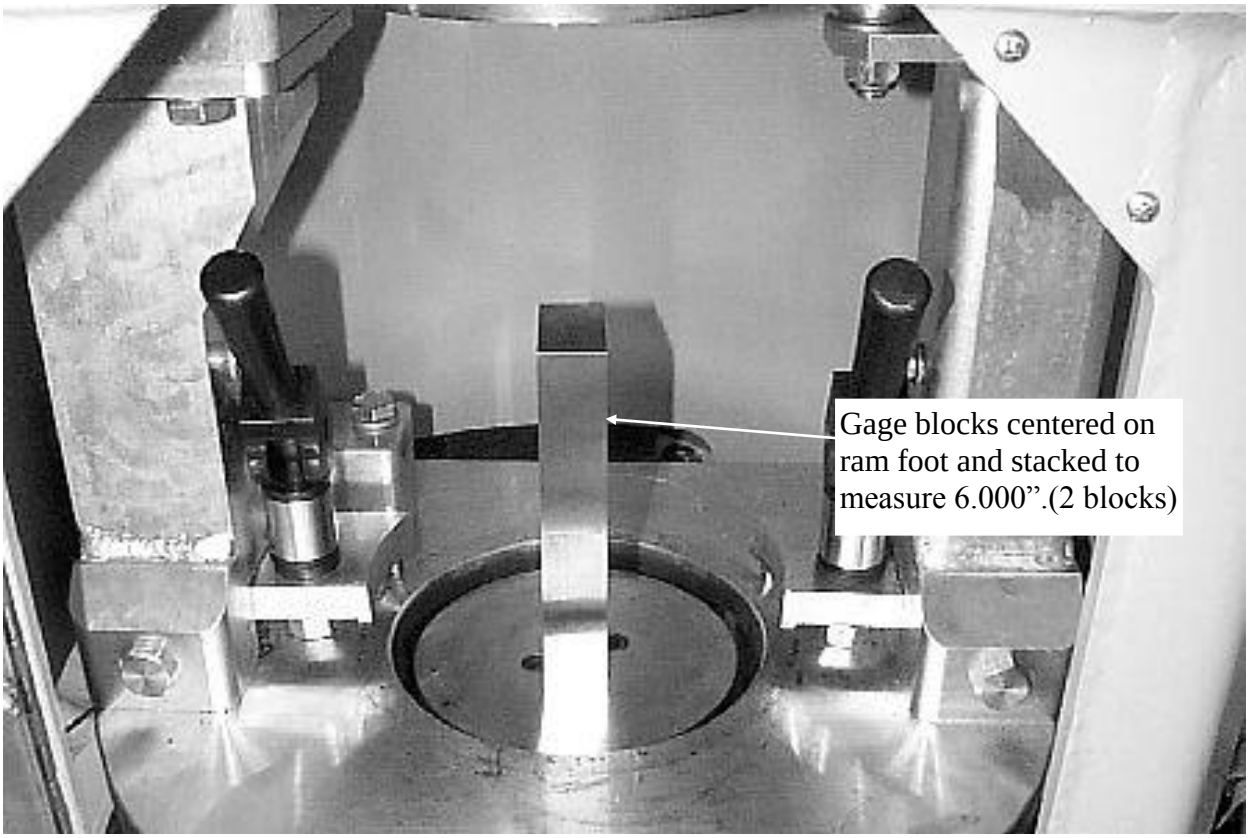


Figure 5.5: Gage Block Placement

- Remove the proving ring from the compaction chamber then press the **(↵)** key to begin height verification.
- Place the gage blocks into the compaction chamber oriented for 152.4 mm (6.000 inch). Reference Figure 5.5.
- Press the **START** button.
  The compactor will move the ram up to contact the blocks with the mold top. Once contact is made, the control panel display will show the target value 152.4 mm (6.000") and the measured value.
- Verify that the height measurement is correct.
  If the measured height differs from the target by more than ±0.1 mm (±0.004 inch) calibration is required. If the measured height differs from the target height by more than ±0.05 mm (±0.002 inch) calibration is recommended. Be sure that no dirt or debris is affecting the measurement.
- Press the **START** button to continue.
- If the measurement is within specification, press the **(+)** key. If not, press the **(-)** key.
  If the **(-)** key is pressed, the control panel will display the option to repeat the verification or to abort the verification routine.

Note: **If the height verification is not within specification, tighten the mold top clamps, clean the mold top, ram foot, and the ram foot spacer. Repeat the verification procedure.**

- Remove the gage blocks and the ram foot calibration spacer from the compaction chamber.

It is extremely important that the ram foot calibration spacer is removed before returning to normal operation. Failure to remove the ram foot calibration spacer will cause erroneous compaction results and may damage the compactor.

- Lubricate the ram foot with (anti-seize) lubricant. See Section 6.2.1
- Press the **START** button to continue.
  The ram will retract to the parked position. Press the (↵) key to return to the main menu.
- If the force is not within specifications, proceed to section 5.5.1.
- If only the height is not within specification proceed to section5.5.2.

Once these routines have been completed, the calibration verification date will be stored if the compactor is within the specifications. The date of last calibration and last verification may be viewed by selecting **CALIBRATION** from the main menu, then selecting **CALIBRATION REPORT**.

5.4.2 Verify Speed/Angle

- Using the **(▶)** key, select **CALIBRATION** from the main menu. Press the **(↵)** key.
- Select **VERIFY** then press the **(↵)** key.
- Select **VERIFY SPEED/ANGLE** then press the **(↵)** key.
- Make sure that the compaction chamber is empty. Press the **START** button to begin verification.
- First, check the speed of gyration by using a stop watch.
  The swivel frame will gyrate at 30 rpm while a counter on the control panel display indicates the number of gyrations. Use the stop watch to time the speed. Ten (10) revolutions should take 20 ± 0.33 seconds for 30 ±0.5 RPM. The display will indicate each complete revolution to aid in timing each gyration. Do not time the first gyration because the acceleration in the first part of rotation will affect the time slightly.
- Verify the **unloaded** angle measurement.
  The unloaded angle is displayed and updated each gyration.

For a 1.25° external angle of gyration with 150mm specimens (e.g.: loaded), the recommended **unloaded** external angle of gyration is approximately $1.29°\pm0.01^{0}$.

For a 1.16° internal angle of gyration with 150mm specimens, the recommended **unloaded** external angle of gyration is approximately $1.21°\pm0.01^{0}$.

For 100 mm diameter specimens, an unloaded external angle of gyration of 1.26°±0.01° will provide approximately a 1.25° loaded external angle.

If the compactor is converted between 150mm to 100mm diameter on a regular basis, the suggested **unloaded** external angle of gyration is 1.27°. For external angle applications, this will allow the conversion to be made without requiring adjustment to the angle of gyration.

- When finished, press the **(↵)** key to stop the gyration.
- If the speed of gyration is within specification, press the **(+)** key. If not, press the **(-)** key.
  If the speed of gyration is not within specified parameters, consult the factory.
- If the angle of gyration is within specification, press the **(+)** key. If not, press the **(-)** key.
  The angle of gyration is displayed during compaction. Therefore, a loaded angle of gyration measurement may be obtained by compacting an HMA specimen whose final height is within specifications.
- Press the **(↵)** key to return to the main menu.

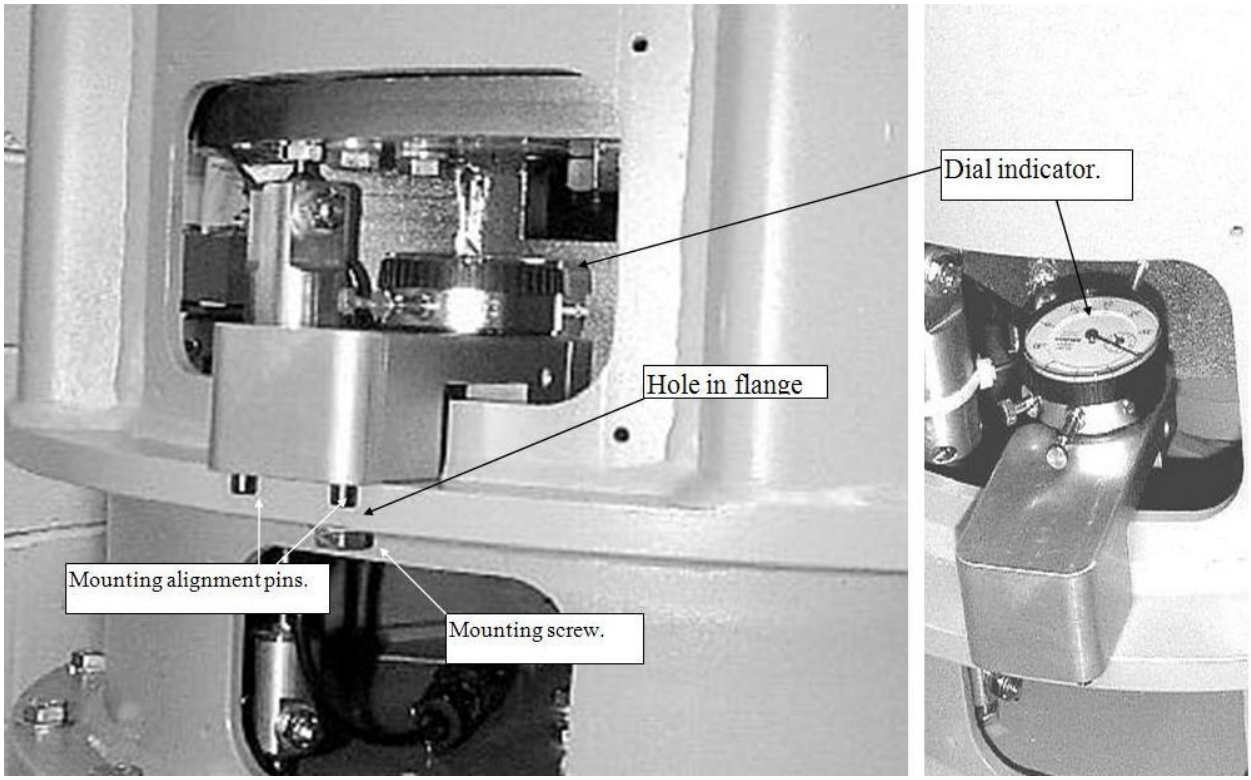


Figure 5.6: Angle Sensor Verification Jig

(mounted through the left side upper access hole)

5.4.3 Verify Angle Sensor Operation

A simple verification of the angle sensor operation is available to quickly give confidence that the sensors are functioning correctly. This routine utilizes an apparatus with a single analog dial indicator which mounts to the compactor through the upper access hole on the left side of the compactor.

To verify the angle sensor operation, reference Figure 5.6 and perform the following procedure:

- Set the dial indicator on the angle sensor verification apparatus to zero.
- With the compactor in its parked position, remove the left side upper access cover and mount the verification apparatus as shown in Figure 5.5. Be sure to clamp the apparatus firmly but do not over tighten the mounting bolt. Make sure the mounting alignment pins are positioned against the edge of the frame. **Do not adjust the dial indicator after it is mounted to the machine.**
- Select **CALIBRATION** from the main menu then press the **(↵)** key.
- Select **VERIFY** then press the **(↵)** key.
- Select **VERIFY SENSORS** then press the **(↵)** key.
- Press the **START** button.

  The compactor will position the swivel frame for the first measurement.
- When the compactor stops, read and enter the first dial reading into the control panel using the (+) and (-) keys. See Section 5.6 for instructions on reading dial indicators.
- After entering the dial indicator reading, press the start button. The compactor will index the swivel frame 180 degrees.
- When the machine stops, read and enter the second dial indicator reading again using the (+) and (-) keys.
- Press **START** to see the result.
- Confirm the verification number is within the range displayed on the control panel. If the verification value is within range the angle sensors are working properly.
- If the verification value is not within the displayed range, an "out of range" message is displayed. Confirm the verification apparatus is properly mounted to the frame and press the **START** button to repeat the measurement.

  If the dial reading is still not within the displayed range, the sensors may not be operating properly or may need to be re-calibrated. To calibrate the angle sensors, a digital angle calibration apparatus is required. If the digital angle calibration apparatus is not available, consult the factory.
- Press the **(↵)** key to exit the **VERIFY SENSORS** routine.
- Press the (+) key to accept the verification results. Press the (-) key to abort.
- Remove the angle sensor verification apparatus from the frame and re-install the access panel.

Failure to remove the angle sensor verification apparatus from the frame may damage the dial indicator and cause false readings.

5.5 Calibration

Routines for calibrating the ram force, specimen height, and angle of gyration are available in the calibration menu. Be sure the compactor is clean and at room temperature before starting this procedure. If the compaction chamber is still warm from compacting specimens, let it cool to room temperature before calibrating the compactor. The proving ring used to verify ram force calibration is temperature sensitive and must be used at room temperature.

> **Note:** **When the compactor is converted from 150mm to 100mm diameter specimens, the force and height should be verified and calibrated if necessary. Calibration is necessary only if the compactor is not within specifications when verified.**

Typical gyratory compaction specifications require the speed of gyration to be 30.0 ±0.5 rpm, the consolidation pressure to be 600 kPa ±10 kPa, the change in specimen height measurement to be within ±0.1 mm, and the angle of gyration to be 1.16° ±0.02° internal or 1.25° ±0.02° external.

5.5.1 Calibrate Force/Height

- Using the **(▶)** key, select **CALIBRATION** from the main menu. Press the **(↵)** key.
- Select **CALIBRATE** then press the **(↵)** key.
- Enter the required access code.
  Use the **(+)** and **(-)** keys to select the proper code then press the **(↵)** key.
- Select **CALIBRATE FORCE/HT.** then press the **(↵)** key.
  If the mold top is not in position, install the mold top. Make sure the mold top is locked in place with the clamps.
- Press the **START** button.
  The ram will automatically move into position for insertion of the ram foot calibration spacer.
- Open the compaction chamber door, thoroughly clean all surfaces of the ram foot thrust bearing, then insert the ram foot calibration spacer.
  The ram foot calibration spacer is supplied with the tool kit and must be used during ram force and specimen height calibration.
- Close the compaction chamber door and press the **START** button.
- Once the ram is retracted, open the chamber door; place the proving ring into the compaction chamber. Center the proving ring on the ram foot. Place the steel plate supplied with the proving ring on the top of the proving ring.
  See Figure 5.4 for proper placement of the proving ring in the compaction chamber.
- Close the door, and press the **START** button.
- Use the **RAM UP** button to load the proving ring to 18,000 Newton.
  The proving ring is supplied with a certification chart of the dial readings at various forces. The **(+)** and **(-)** keys on the compactor control panel are used to select the ram speed and may be used while the ram is stopped or in motion. The control panel display will show the selected ram speed. 400 is the speed recommended for getting the force applied to the proving ring close to the target value.
- With 18,000 Newton applied to the proving ring, press the **START** button. The compactor will automatically retract the ram.

- Zero the dial indicator on the proving ring by rotating the bezel, close the door and press the start button. The control panel will display a target value.
- Using the **RAM UP** button, load the proving ring to the target value displayed on the control panel. Always be approach a target force from a lower value. If the proving ring is loaded beyond the target value, use the **RAM DOWN** button to decrease the force applied to proving ring below the target value (i.e. at least ½ rotation of the large dial on the proving ring).

> **Note:** **The dial on the proving ring should be lightly tapped to achieve an accurate reading.**

- Press the (↵) key to store the data when the proving ring is at the target force. The control panel will display the next target value.
- Repeat the same loading procedure until 18,000 Newton is reached. Once the force data is entered for 18,000 Newton, the control panel display will indicate "calibration table is complete."
- Press the **(+)** key to verify the force calibration

  At this time the control panel will display the options to verify the force calibration or to re-calibrate the force. If a mistake was made during the calibration, press the (-) key and repeat the force calibration procedure.
- Open the compaction chamber door then zero the dial indicator on the proving ring.
- Leave the proving ring in the compaction chamber, close the door, then press the start button. The compactor will automatically load the proving ring to the first target force.
- Compare the force indicated by the proving ring to the force indicated by the control panel display.

  If a force error exceeds ±1.67%, calibration is required. If an error exceeds ±1%, calibration is recommended.
- Press the **START** button.

  The compactor will load the proving ring to the next target value.
- Verify this force also.
- Repeat for all of the target force values.
- If the measurements are within specifications, press the **(+)** key.

  If the measurements were not within specifications, press the **(-)** key and repeat the force calibration.
- Remove the proving ring from the compaction chamber and press the **(↵)** key to begin height calibration.

> **Note:** **When the force is calibrated, the height must be calibrated also.**

5.5.2 Calibrate Height

To calibrate the height measurement only, select **CALIBRATE HEIGHT** from the **CALIBRATE** sub-menu, then press the **(↵)** key. Insert the ram foot spacer. If continuing the **CALIBRATE FORCE/HT.** routine, simply continue with this section.

- Place the gage blocks into the compaction chamber oriented for 10.000 inches (reference Figure 5.7).
- Press the **START** button.

The ram will move up to contact the blocks with the mold top. Once contact is made, the compactor will automatically apply forces to the gage blocks and store the data.

- Reduce the height of gage blocks in the compaction chamber by one (1) inch to 9.000 inches then press the **START** button.
- Repeat this procedure for 8,7,6….3 inches.

  The compactor will repeat the same routine. Once the height calibration is complete, press the (+) key to begin height verification. Once the height calibration is complete, the control panel will display the option to either verify height calibration or to re-calibrate the height. If an error was made during height calibration, press the (-) key and repeat the height calibration procedure. Place 10.000 inches of gage block in the compaction chamber then press the **START** button. The compactor will move the ram up to contact the blocks with the mold top. Once contact is made, the control panel display will show the target value of 254.00mm (10.000") and the measured value.
- Verify that the height measurement is correct by comparing the target height value to the measured height value. If the measured height differs from the target by more than ±0.1 mm (±0.004 inches), calibration is required. If the measured height differs from the target height by more than ±0.05 mm (±0.002 inch) calibration is recommended. Be sure that no dirt or debris is affecting the measurement.
- Press the **START** button to continue.

  The compactor will retract the ram and pause. The control panel will display the next height to be verified. Place the appropriate height of gage block on the ram foot.
- Repeat the verification procedure for 9,8,7,6…3 inch heights.

  The compactor will repeat the same routine to verify 9,8,7,6….3 inches. Once the 3 inch height is verified, remove the gage blocks and the ram foot spacer from the compaction chamber.

It is extremely important that the ram foot calibration spacer is removed before returning to normal operation. Failure to remove the ram foot calibration spacer will cause erroneous compaction results and may damage the compactor.

- While the ram is extended, lubricate the ram foot with anti-seize lubricant. See Section 6.2.1.
- If the verification for the force and height were within specifications, press the (+) key to store the calibration data. If the verification for the force and height were not within specifications, press the (-) key to disregard the calibration data.

Pressing the (-) key will cause the calibration data recorded in this routine to be lost (i.e. the compactor will revert to the previous calibration data).

- Press the start button to continue. The ram will retract to the parked position.
- Press the **(↵)** key to return to the main menu.

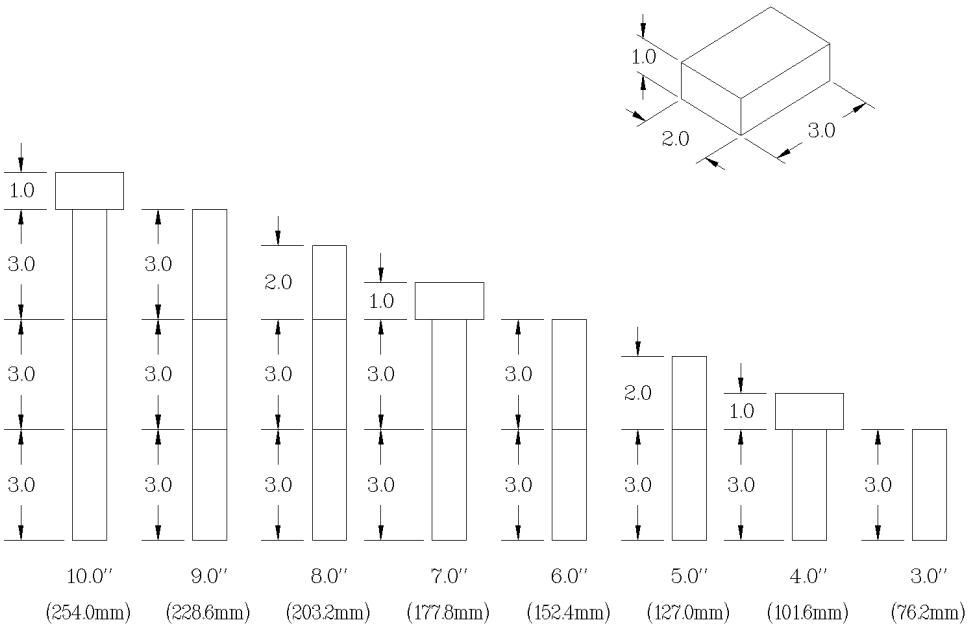


Figure 5.7: Gage Block Orientation

5.5.3 Calibrate Angle of gyration

The AFG1 compactor is equipped with an integrated angle measurement system which reports the external angle of gyration. The angle of gyration is displayed and recorded during normal operation of the compactor. To obtain a printout of the angle at each gyration during compaction, perform the following:

- Select **TEST DATA** from the main menu, then press the **(↵)** key.
- Select **PRINT DATA**, then press the **(↵)** key.
- Select **DETAILED REPORT**, then press the **(↵)** key.
- Select the appropriate test and print the report.
  The angle is included in the file automatically when the test data is saved to a floppy disk.

The angle of gyration is adjustable over a small range to compensate for wear throughout the life of the compactor. This is a manual adjustment and should be done with the machine at room temperature. The required tools are supplied in the tool kit.

For a 1.25° external angle of gyration with 150mm specimens (e.g.: loaded), the recommended **unloaded** external angle of gyration is approximately $1.29° \pm 0.01^0$.

For a 1.16° internal angle of gyration with 150mm specimens, the recommended **unloaded** external angle of gyration is approximately $1.21° \pm 0.01^0$.

For 100mm specimens, an unloaded external angle of gyration of 1.26°±0.01° with provide approximately a 1.25° loaded external angle.

If the compactor is converted between 150mm to 100mm diameter on a regular basis, the suggested unloaded external angle of gyration is 1.27°. For external angle applications,

this will allow the conversion to be made without requiring adjustment to the angle of gyration.

The AFG1 gyratory compactor utilizes two gyration actuators, one in the front and one in the rear, to induce the angle of gyration. The angle of gyration is adjusted by changing the position that each actuator's connecting rod attaches to the swivel frame. Moving this connection point down (away from the swivel-frame pivot), decreases the angle of gyration. Moving the connection point up (toward the pivot), increases the angle of gyration. Each actuator connecting rod, front and rear, must be adjusted independently. The length of each connecting rod is adjustable to center the gyration axis of the mold about the centerline of the compactor. Because each actuator interacts with the other, making an adjustment on one actuator may affect the adjustment of the other.

Note: **The angle of gyration is affected by mix characteristics and specimen height. A stiff mix with high shear resistance may cause the angle of gyration to operate slightly lower than a mix with low shear resistance. Also, a tall specimen may compact at a slightly lower angle of gyration than a shorter specimen. Combine both of these situations and you will notice small variations in the angle of gyration. This is normal. It is more noticeable on the AFG1 which continuously measures and displays the angle of gyration. If the angle is running slightly high on a specific mix, try increasing the specimen height to bring it into tolerance. If the angle is running low, decrease the specimen height slightly. The finished SUPERPAVE specimen height may be within 115 mm ±3 mm. Varying the size of the specimens to achieve the proper angle of gyration is recommended before an angle adjustment is made to the compactor.**

5.5.4 Angle of Gyration Adjustment

If the angle of gyration requires adjustment, use the following procedure:

- Remove the front and rear actuator guards.

Special caution must be used to avoid injury while calibrating the compactor with the guards removed.

- Using the **(▶)** key, select **CALIBRATION** from the main menu then press the **(↵)** key.
- Select **CALIBRATE** from the sub-menu then press the **(↵)** key.
- Using the **(+)** and **(-)** keys, enter the required access code, then press the **(↵)** key.
- Select **CALIBRATE ANGLE** then press the **(↵)** key.

5.5.4.1 DEFINE THE PARK POSITION:

- Select **ADJUST ACTUATORS**, press the **(↵)** key.
- Select **DEFINE PARK POSITION**, press the **(↵)** key.
- Press the **START** button and the compactor will automatically determine the park position for the swivel frame.
- Save this position by pressing the **(+)** key.

- Press the **(↵)** key to continue.

5.5.4.2 DETERMINE THE ANGLE OF GYRATION ACTUATOR SETTINGS:

- Select **ADJUST ACTUATOR RODS**, then press the **(↵)** key.
  The control panel display will indicate that the controls are using the angle sensors for calibration by displaying "SENSORS".
- Press the **START** button.
  The compactor controls will index the swivel frame to position 1. The angle of gyration at this position is measured, displayed, and stored.
- Press the **START** button.
  The controls will index the swivel frame position 2. The angle at this position is measured, displayed, and stored.
- Press the **START** button.
  The controls will index the swivel frame to position 3. Again the angle is measured, displayed, and stored.
- Press the **START** button.
  The controls will index the swivel frame to position 4. The angle again is measured, displayed, and stored.
- Press the **START** button.
  The controls will display the total magnitude of the angles measured for the front and rear actuators.
- Record the front and rear actuator readings on a sheet of paper for later reference.
  The total magnitude of the angle for each actuator should be 1.290° ±0.01°degrees for 150mm operation (1.26° ±0.01° degrees for 100mm operation). The front actuator total angle should be equal to the rear actuator total angle within 0.010°.

For 150mm operation, the following measurements are recommended:

angle at position 1 = angle at position 3 within 0.015°
angle at position 2 = angle at position 4 within 0.015°
total angle of front = total angle of rear within 0.010°
total angle of front and total angle of rear = 1.290°±0.01°

For 100mm operation, the following measurements are recommended:

angle at position 1 = angle at position 3 within 0.015°
angle at position 2 = angle at position 4 within 0.015°
total angle of front = total angle of rear within 0.010°
total angle of front and total angle of rear = 1.260°±0.01°

If adjustment of the total angle magnitude of an actuator is necessary, the swivel frame is indexed to position 1 to adjust the front actuator and indexed to position 2 to adjust the rear actuator. The actuator rod connection points at the swivel frame are moved up or down to obtain a total angle magnitude of 1.290°. Moving the connection up (closer to the pivot) increases the angle of gyration, down decreases the angle. The total angle of gyration for both actuators is displayed after the swivel frame has indexed to position 4 and the **START** button is pressed.

Note: **The angles displayed at positions 1, 2, 3, and 4 are not the total angle of gyration and should not be used to determine the change in the angle of gyration.**

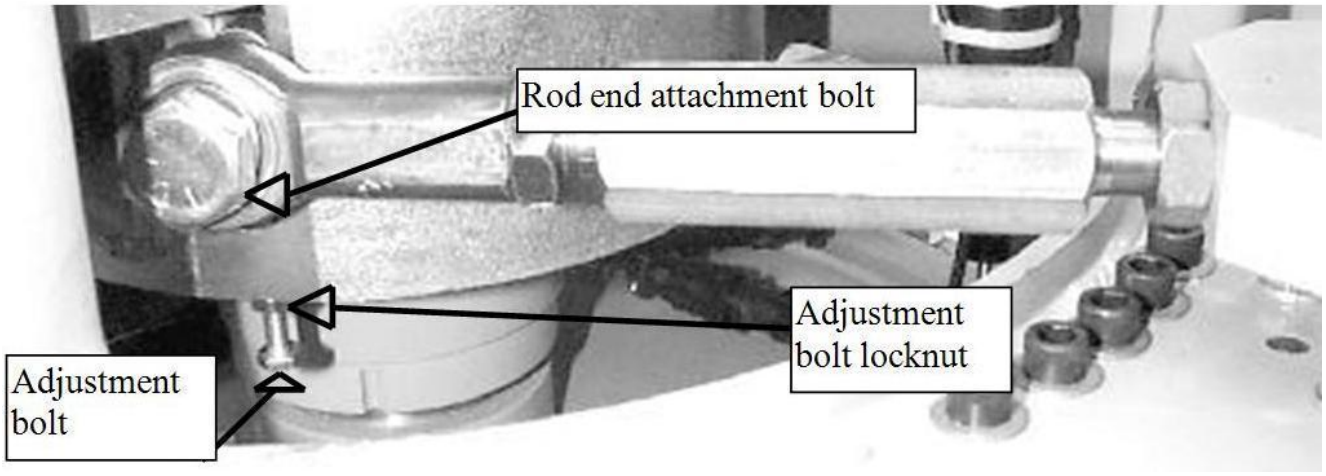


Figure 5.8: Angle of Gyration (Front Actuator)

(front guard removed)

5.5.4.3 ADJUST THE FRONT ACTUATOR MAGNITUDE:

Referring to Figure 5.8 perform the following procedure:

- Index the swivel frame to position 1 by pressing the **START** button.
- Loosen the rod end attachment bolt.
  This bolt is threaded into a T-nut so no wrench is required to keep the nut from rotating.
- Loosen the adjustment bolt locknut.
- Make a reference mark on the adjustment bolt head to track its position.
- Make the necessary angle adjustment by rotating the adjustment bolt.
  One full turn of the adjustment bolt will change the angle of gyration by approximately 0.005°. Turning the adjustment bolt clockwise (i.e. tightening) will increase the angle of gyration. Turning the adjustment bolt counter-clockwise (i.e. loosening) will decrease the angle of gyration.
- Use the adjustment bolt locknut to lock the adjustment bolt in position.
- Tighten the rod end attachment bolt.
  Make sure the T-nut is against the adjustment bolt by pushing down lightly on the rod end.
- Press the **(▶)** key to display the new setting.
- Press the **START** button to index the swivel frame through positions 1-4 and the front and rear actuator total angles several times.
  Indexing the swivel frame through positions 1-4 and the total angles several times ensures that the angle measurements are accurate.
- Press the **START** button at position 4 to display the total angle magnitude for both actuators.
- Record these readings once again on a piece of paper for reference.

- If the total angle magnitude of the front actuator is not what is expected, index the swivel frame through positions 1-4 again to double check the measurement.
- Index the swivel frame to position 1 to make another adjustment if necessary. Repeat step 5.5.4.3 until the front actuator total angle magnitude is at the desired setting.
- The front actuator angle should be 1.290°±0.01°.

5.5.4.4 ADJUST THE REAR ACTUATOR MAGNITUDE:

- Index the swivel frame to position 2 by pressing the **START** button.

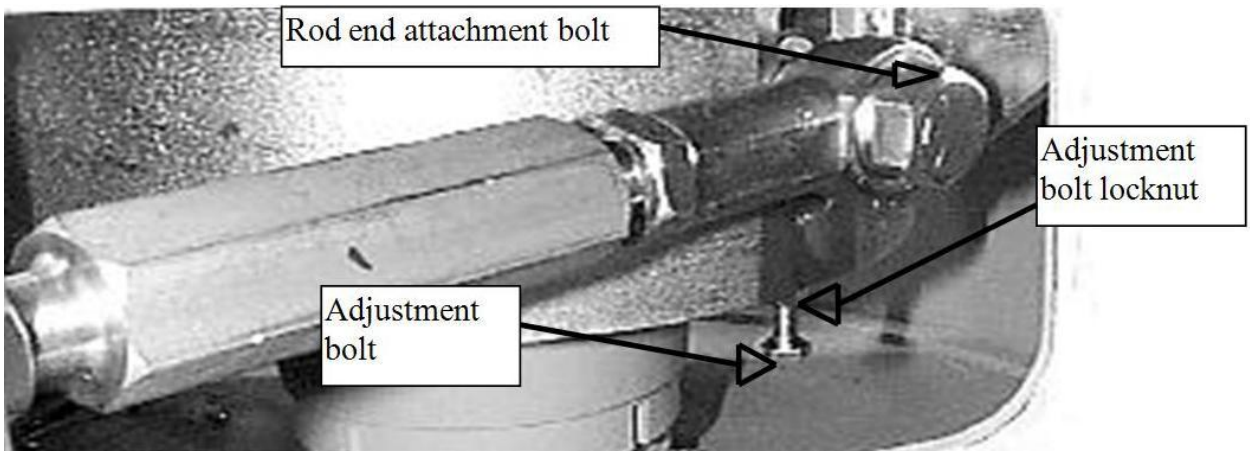


Figure 5.9: Angle of Gyration (Rear Actuator)

(rear guard removed)

- Loosen the rod end attachment bolt.
  This bolt is threaded into a T-nut so no wrench is required to keep the nut from rotating.
- Loosen the adjustment bolt locknut.
- Make a reference mark on the adjustment bolt head to track its position.
- Make the necessary angle adjustment by rotating the adjustment bolt.
  One full turn of the adjustment bolt will change the angle of gyration by approximately 0.005°. Turning the adjustment bolt clockwise (i.e. tightening) will increase the angle of gyration. Turning the adjustment bolt counter-clockwise (i.e. loosening) will decrease the angle of gyration.
- Use the adjustment bolt locknut to lock the adjustment bolt in position.
- Tighten the rod end attachment bolt.
  Make sure the T-nut is against the adjustment bolt by pushing down lightly on the rod end.
- Press the **(▶)** key to display the new setting.
- Press the **START** button to index the swivel frame through positions 1-4 and the front and rear actuator total angles several times.
  Indexing the swivel frame through positions 1-4 and the total angles several times ensures that the angle measurements are accurate.
- Press the **START** button at position 4 to display the total angle magnitude for both actuators.

- Record these readings once again on a piece of paper for reference.
- If the total angle magnitude of the rear actuator is not what is expected, index the swivel frame through positions 1-4 again to double check the measurement.
- Index the swivel frame to position 2 to make another adjustment if necessary. Repeat step 5.5.4.4 until the rear actuator total angle magnitude is at the desired setting.

  The rear actuator angle should be 1.290°±0.01°. The front actuator total angle should be equal to the rear actuator total angle within 0.010°. Adjusting the rear actuator may affect the front actuator adjustment.

5.5.5 Define Park Position :

- Select **ADJUST ACTUATORS**, press the **(↵)** key. Make sure that the rod end attachment bolts on both the front and rear actuator are tight.
- Select **DEFINE PARK POSITION**, press the **(↵)** key.
- Press the **START** button and the compactor will automatically determine the park position for the swivel frame.
- Save this position by pressing the **(+)** key.
- Press the **(↵)** key to continue.
- Repeat steps 5.5.4.3, 5.5.4.4, and 5.5.5 until the front and rear actuator total angle magnitudes are at the desired settings.

  When finished, both the front and rear actuator total angles should be 1.290°±0.010°. Also, the front actuator total angle should be equal to the rear actuator total angle within 0.010°.
- Press the **(↵)** key to return to the angle calibration menu.

5.5.6 Actuator connecting rod length adjustment:

Next, the swivel frame must be properly centered. The angle indicated at position 1 should be equal to the magnitude of the front actuator angle obtained in step 5.5.4.3 achieved by adjusting the length of the front connecting rod. Similarly, the angle indicated at position 2 should be equal to the magnitude of the rear actuator angle obtained in step 5.5.4.4 achieved by adjusting the length of the rear connecting rod. The connecting rod length is adjusted similar to a turnbuckle. However, both ends are right hand threaded with different pitches to allow for fine adjustment of the length. The rotation available in the rod end is used to make the adjustment in small steps. To make adjustments, loosen one locknut at a time. The rod ends must be centered when complete. The front connecting rod length is adjusted at position 1, the rear connecting rod length is adjusted at position 2.

To adjust the length of the connecting rods reference Figure 5.10. This procedure applies to both the front and rear connecting rods. Following this procedure will enable minor adjustments to be easily accomplished.

- Loosen the rod end locknut while holding the rod end in place with the 1”, 90° open end wrench.
- Rotate the rod end in the appropriate direction.
  (i.e.: if the connecting rod is to be rotated clockwise, the rod end must be rotated counter-clockwise and vice-versa).

- Tighten the rod end locknut while holding the rod end in place with the 1”, 90° open end wrench.
- Loosen the bearing mount locknut while holding the connecting rod in place.
- Center the rod end by rotating the connecting rod in the appropriate direction.
- Tighten the bearing mount locknut while preventing the connecting rod from rotating. Make sure that the rod end is centered.

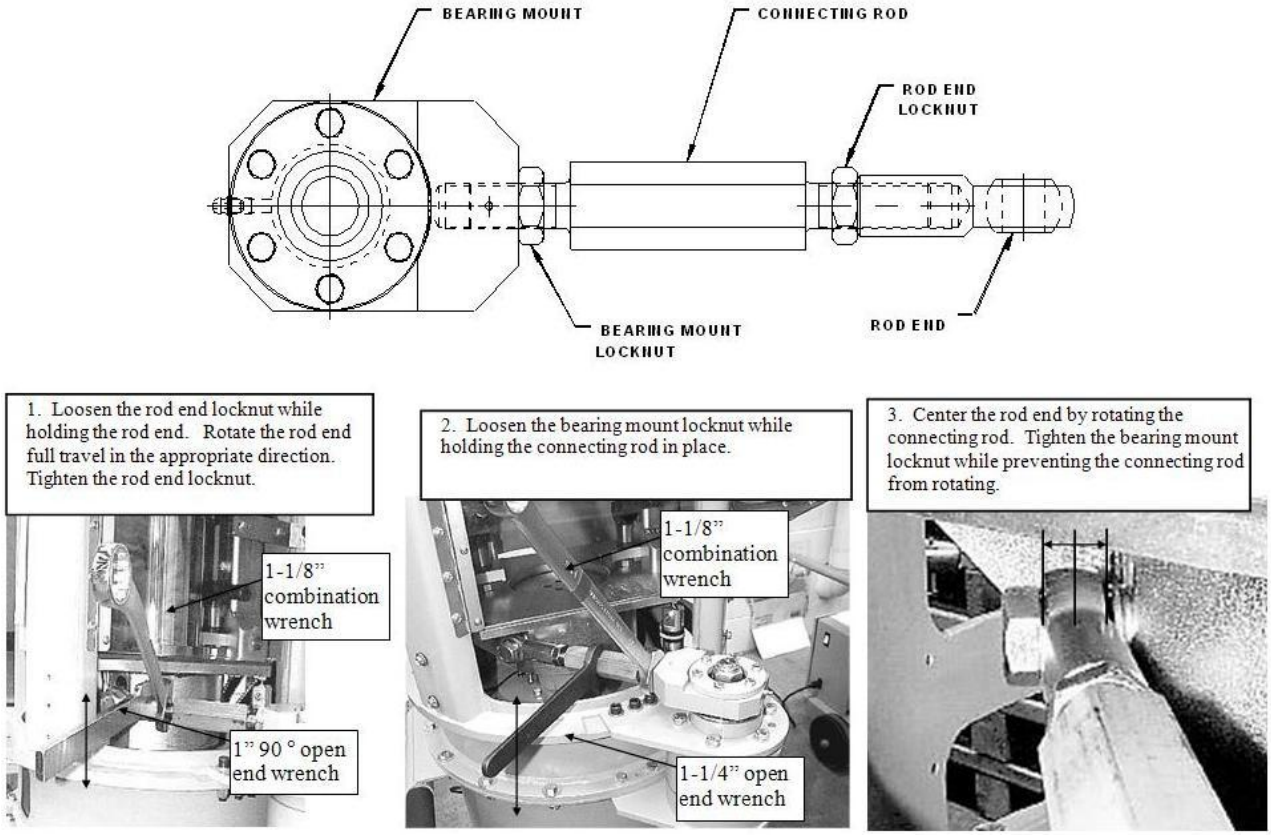


Figure 5.10: Actuator Connecting Rod Length Adjustment

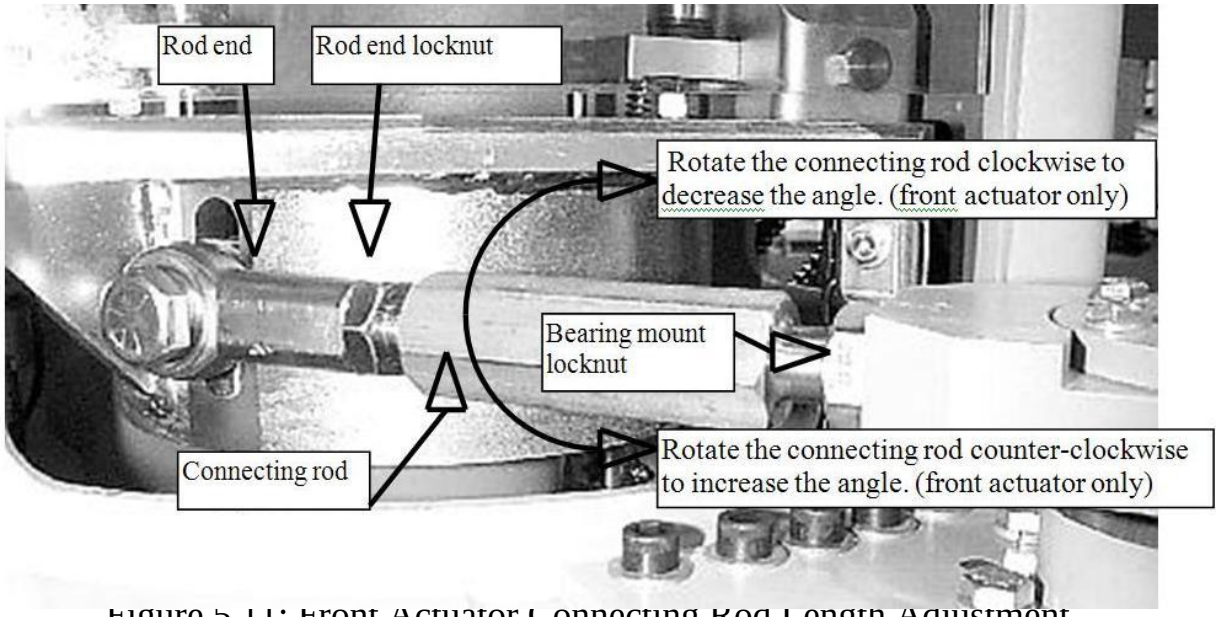


Figure 5.11: Front Actuator Connecting Rod Length Adjustment

5.5.6.1 CENTER THE FRONT ACTUATOR:

Adjust the length of the front actuator so that the angle indicated at position 1 is equal to the total angle magnitude of the front actuator.

- From the **ANGLE CALIBRATION** menu, select **ADJUST ACTUATOR RODS**, then press the **(↵)** key.
- Press the **START** button
  The machine will index the swivel frame to position 1. The angle indicated at position 1 should be equal to the magnitude of the front actuator angle obtained in step 5.5.4.3.
- Following the steps outlined in section 5.5.6, Figure 5.11, loosen the rod end locknut while holding the rod end in place with the 1", 90° open end wrench.
- Make the adjustment by rotating the connecting rod in the appropriate direction. To increase the angle of gyration at position 1, the front connecting rod must be rotated counter-clockwise with respect to the rod end. Therefore, the rod end must be rotated in the clockwise direction. To decrease the angle of gyration at position 1, the front connecting rod must be rotated clockwise with respect to the rod end. Therefore, the rod end must be rotated in the counter-clockwise direction. Rotate the rod end in the appropriate direction.
- Tighten the rod end locknut while holding the rod end in place with the 1", 90° open end wrench.
- Loosen the bearing mount locknut while holding the connecting rod in place.
- Center the rod end by rotating the connecting rod in the appropriate direction.
- Tighten the bearing mount locknut while preventing the connecting rod from rotating. Make sure that the rod end is centered.

- Press the **(▶)** key to display the new angle. Index the swivel frame through positions 1-4 several times with the **START** button to achieve an accurate measurement.
- Repeat step 0 until the desired settings are obtained.
  angle at position 1 = angle at position 3 within 0.015°
  angle at position 2 = angle at position 4 within 0.015°
  total angle of front = total angle of rear within 0.010°
  total angle of front and total angle of rear = 1.290°±0.01°

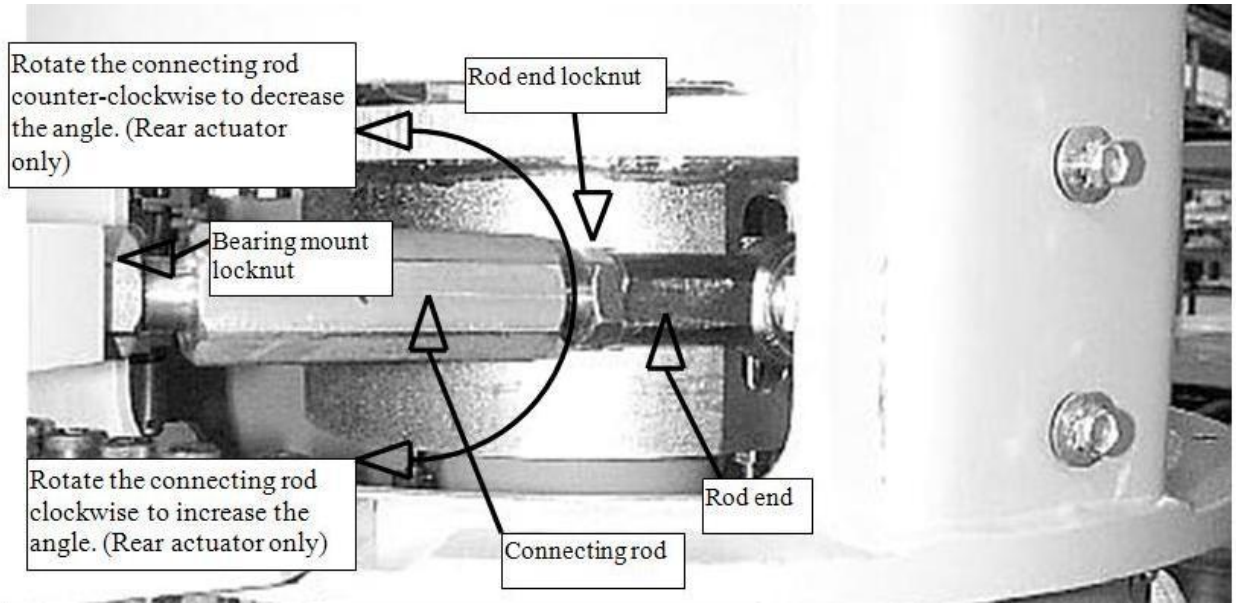


Figure 5.12: Rear Actuator Connecting Rod Length Adjustment

5.5.6.2 CENTER THE REAR ACTUATOR:

Adjust the length of the rear actuator so that the angle indicated at position 2 is equal to the total angle magnitude of the rear actuator. Referring to Figure 5.12, perform the following procedure:

- Press the **START** button to index the actuators to position 2.
  The controls will index the swivel frame to position 2. The angle indicated at position 2 should be equal to the magnitude of the rear actuator angle obtained in step 5.5.4.4.
- Following the steps outlined in section 5.5.6, Figure 5.12, loosen the rod end locknut while holding the rod end in place with the 1", 90° open end wrench.
- Rotate the rod end in the appropriate direction.
  To increase the angle of gyration at position 2, the rear connecting rod must be rotated clockwise with respect to the rod end. Therefore, the rod end must be rotated in the counter-clockwise direction. To decrease the angle of gyration at position 2, the rear connecting rod must be rotated counter-clockwise with respect to the rod end. Therefore, the rod end must be rotated in the clockwise direction.
- Tighten the rod end locknut while holding the rod end in place.

- Loosen the bearing mount locknut while holding the connecting rod in place.
- Center the rod end by rotating the connecting rod in the appropriate direction.
- Tighten the bearing mount locknut while preventing the connecting rod from rotating. Make sure that the rod end is centered.
- Press the **(▶)** key to display the new angle. Index the swivel frame through positions 1-4 several with the **START** button times to achieve an accurate measurement.
- Repeat step 5.5.6.1 and 5.5.6.2 until the proper settings are obtained.

angle at position 1 = angle at position 3 within 0.015°
angle at position 2 = angle at position 4 within 0.015°
total angle of front = total angle of rear within 0.010°
total angle of front and total angle of rear = 1.290°±0.01°

5.5.7 Define park position:

- Select **DEFINE PARK POSIT** from the **CALIBRATE ANGLE** sub-menu and press the **(↵)** key.
- Press the **START** button.
  The compactor will determine the park position for the swivel frame.
- Verify that the angle is within specification.
  The angle should be within 0.00° - 0.10°.
- Save this position by pressing the **(+)** key.

Note: **Defining park position may influence the total angle magnitude and swivel frame settings. Anytime an adjustment is made to the actuators, it is necessary to re-define the park position.**

5.5.8 Re-check settings:

- Check that all locknuts and rod end bolts are tight.
- Index the actuators through positions 1-4 and total angle magnitudes by pressing the **START** button. Index through all positions several times to obtain an average reading. Verify that all settings are within specifications.
  The angles indicated at each position 1, 2, 3, 4 and the total angles of the front and rear indicated after position 4 should all be as indicated below.

angle at position 1 = angle at position 3 within 0.015°
angle at position 2 = angle at position 4 within 0.015°
total angle of front = total angle of rear within 0.010°
total angle of front and total angle of rear = 1.290°±0.01°

- Repeat steps 5.5.4 - 5.5.7 if required to obtain the desired settings.

5.5.9 Verify the angle of gyration:

- **Re-install the front and rear actuator guards**.
- Select **VERIFY ANGLE** from the **ADJUST ACTUATORS** sub-menu. Press the **(↵)** key.

- Make sure that the compaction chamber is empty and press the **START** button to begin verification.

  The swivel frame will gyrate at 30 rpm while a counter on the control panel display indicates the number of gyrations. The unloaded angle is displayed and updated each gyration.
- Verify that the unloaded measurement is within $1.290° \pm 0.01^0$ (to achieve a 1.25° loaded angle). When finished, press the **(↵)** key.
- If the gyration speed was within specification press the **(+)** key. If not, press the **(-)** key and consult the factory.
- If the angle of gyration was within specification press the **(+)** key. If not, press the **(-)** key and repeat steps 5.5.4 - 5.5.7.
- Press the **(↵)** key to return to the main menu.

5.5.10 Verify the loaded external angle of gyration:

The external angle of gyration is displayed during compaction. Therefore, a loaded external angle of gyration measurement may be obtained by compacting an HMA specimen whose final height is within specifications, typically 115 mm.

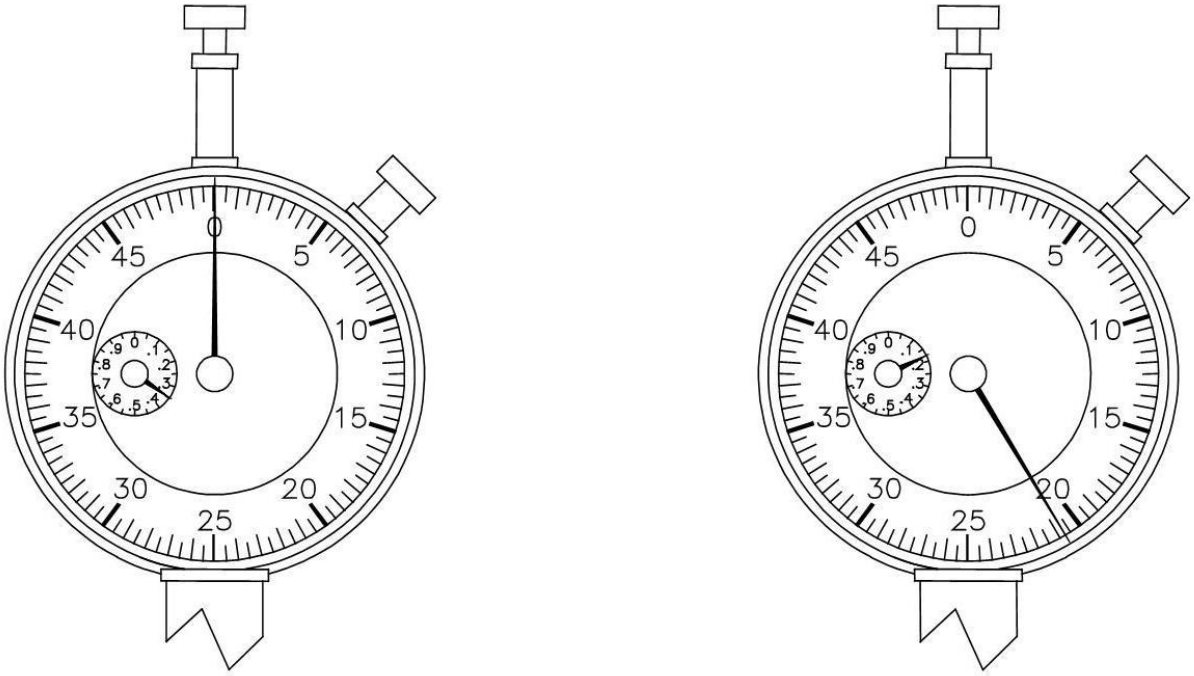
5.6 How to Read Dial Indicators

5.6.1 Reading a Two Turn / 0.1" Dial Indicator

Both the large and small dials are read in a clockwise direction. Each number on the large dial is a multiple of 0.001 inch and each division is 0.0005 inch. Each number on the small dial is inch and each division is 0.05 inch. One revolution of the large dial is also 0.05 inch, so two revolutions of the large dial will rotate the small dial one number (e.g.: 0.1 to 0.2). Obtain a better fourth digit estimate by judging the position of the large needle between divisions on the large dial.

Figure 5.13 shows an indicator on the left which reads 0.3500. Read the small dial first. It reads 0.3500. Next read the large dial. It reads 0.0000. Now add the larger dial reading to the small dial reading, 0.3500 + 0.0000 = 0.3500.

Figure 5.13 also shows an indicator on the right which reads 0.1707. Read the small dial first. It reads 0.1500. Next read the large dial. It reads 0.0207. Now add the larger dial reading to the small dial reading, 0.1500 + 0.0207 = 0.1707.



Dial Indicator at 0.3500 Dial Indicator at 0.1707

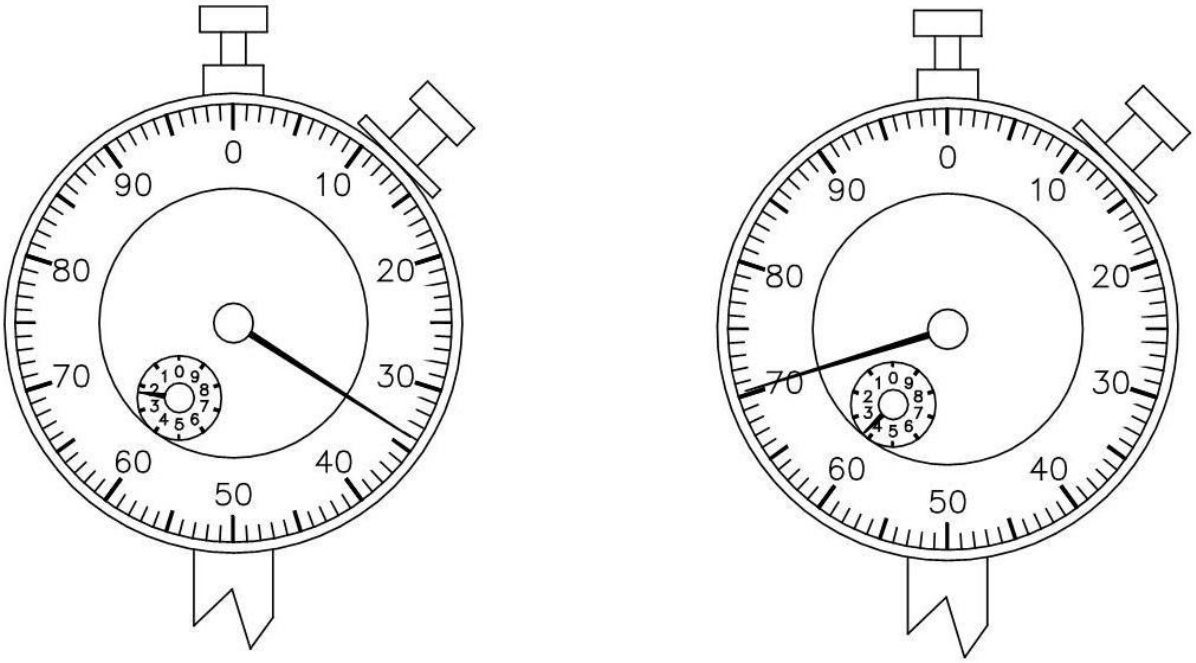
Figure 5.13: Two Turn Dial Indicator

5.6.2 Reading a One Turn / 0.1” Dial Indicator

The large dial is read in a clockwise direction. The small dial is read in a counter-clockwise direction. Each number on the large dial is a multiple of 0.001 inch and each division is 0.001 inch. Each division on the small dial is 0.1 inch. One revolution of the large dial is also 0.1 inch, so one revolution of the large dial will rotate the small dial one number (e.g.: 0.1 to 0.2).

Figure 5.14 shows an indicator on the left which reads 0.234. Read the small dial first. It reads 0.200. Next read the large dial. It reads 0.034. Now add the larger dial reading to the small dial reading, 0.200 + 0.034 = 0.234.

Figure 5.14 shows an indicator on the right which reads 0.370. Read the small dial first. It reads 0.300. Next read the large dial. It reads 0.070. Now add the larger dial reading to the small dial reading, 0.300 + 0.070 = 0.370.



Dial Indicator at 0.234 Dial Indicator at 0.370

Figure 5.14: One Turn dial Indicator

5.6.3 Verification Worksheet

Appendix A is a log sheet that may be used to track the compactor calibration verifications. To use the verification worksheet properly, the technician should first record the serial number of the compactor, the date, technician's name, the proving ring serial number, the date that the proving ring was calibrated, and the +/-1% proving ring readings for 5000N and 10500N. The proving ring calibration date and +/-1% proving ring readings may be obtained from the proving ring calibration certification sheet located behind the foam padding of the case lid.

Follow the procedure outlined in for verifying ram force and specimen height measurement. Record both force and height measurements on the calibration verification worksheet.

Next, the speed of gyration must be verified. Using the procedures outlined in , measure and record the speed of gyration. Verify this measurement is within the specifications listed on. The unloaded angle of gyration will also be displayed on the control panel.

Verify the angle sensor operation using the procedure outlined in Section 5.4.3. Measure and record the dial indicator readings for the first and second measurements. Subtract the first reading from the second reading and record this value, which should be within the range displayed on the control panel, on the worksheet. Also record the verification range displayed on the control panel on the worksheet.

Finally, the loaded angle of gyration measurement can be checked by compacting a SUPERPAVE asphalt specimen whose final height is within 115 mm ±3 mm. Record the loaded angle measurement displayed on the control panel during compaction on the calibration verification worksheet.

If any of the measurements of the speed of gyration, ram force, specimen height, or angle of gyration do not meet the specifications listed in this manual or any applicable state agency specifications, calibration is required.

VI. Maintenance

6.1 Cleaning

It is important to keep the gyratory compactor clean. Dirt and debris that result from the compaction process may affect results if not removed prior to starting additional tests.

Use a rag moistened with a cleaning solvent to clean the surfaces in the compaction chamber (mineral spirits or lacquer thinner works well). All surfaces should be kept free of debris including the ram foot. It is especially important to keep the swivel-frame surface, mold top plate, mold bottom flange, and all mold and mold top clamp surfaces free of debris and lubricants.

Use mineral spirits or lacquer thinner to remove any excess asphalt that may be present. The swivel frame surface should be dry and free of any lubricants during operation.

It is extremely important to keep the mold bottom flange, ram foot, mold top, mold top clamps, mold clamps, and the swivel frame surfaces clean and free of debris or lubricants. Failing to keep these items clean may result in erroneous compaction results.

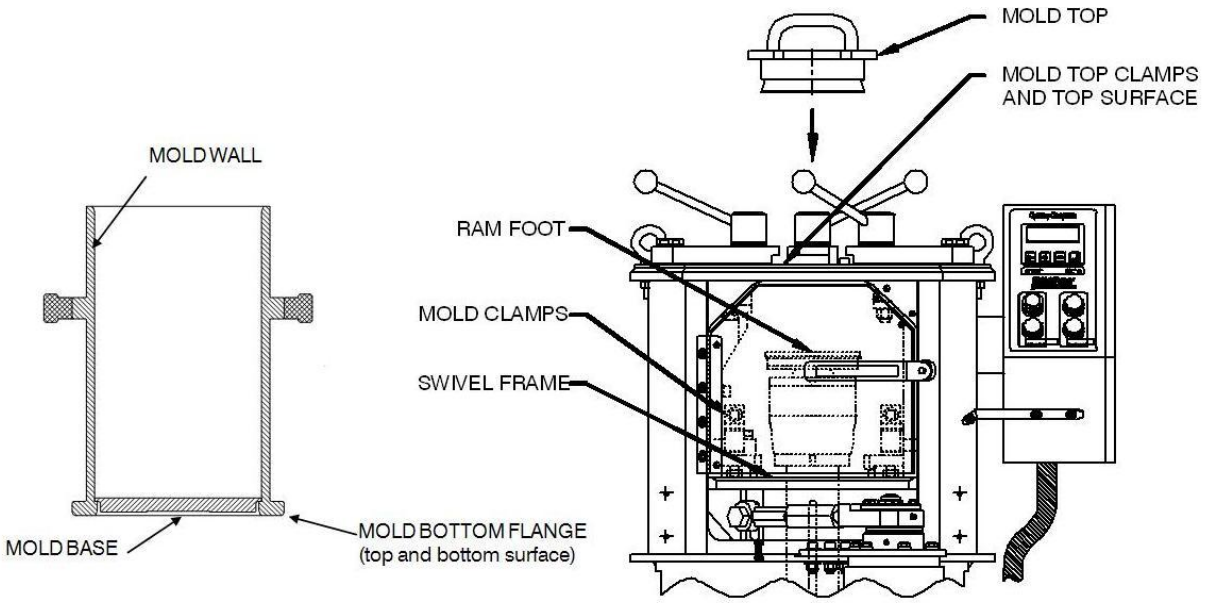


Figure 6.1: Cleaning Points

6.2 Lubrication

Table 6.1 is a schedule of the recommended lubrication intervals in machine run hours. Press the (▶) key to scroll to machine hours. The hours displayed is the actual accumulated running time, and does not include idle time.

Table 6.1: Lubrication Schedule

Component	Daily	initial 5 hrs.	every 100 hr.
Ram Foot	B		
Ball Screw Bearings		A	A
Ball Screw		A	A
Actuator Bearings		A	A
Mold Clamp Pivot			B
Mold Top Clamps			B

Type of Lubricant: A.....Grease (NLGI Grade 2 Lithium Soap Grease) (Pine P/N: CLGMOS2)
B.....(Anti-Seize Lubricant)(Pine P/N: CLGSMOS2T)

Reference Figure 6.7 to locate the following lubrication points:

Actuator Bearings: Remove the front and rear covers. Two grease fittings on each actuator. 2-3 pumps of the grease gun is adequate.

Ball Screw Bearings: Remove the left side lower access panel. Single grease fitting. Apply 6-8 pumps from the grease gun.

Ball Screw: Fully extend the ram. Apply the grease directly to the ball screw through the left side lower access panel. A single grease bead approximately 6" long is adequate.

Mold Top Clamps: Remove by unscrewing each clamp handle from the frame. Clean the threads of each clamp and apply a small amount of anti-seize lubricant to the threads of each clamp then reinstall.

Mold Clamp Pivot: Remove the pivot screw from the swivel frame and clean thoroughly. Apply anti-seize lubricant to the pivot screw and reinstall.

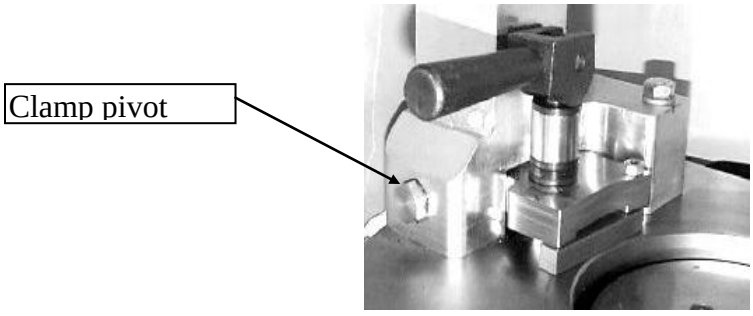


Figure 6.2: Mold Clamp Pivot

6.2.1 Ram Foot Lubrication

The ram foot thrust bearing should be lubricated on a daily basis and after verification or calibration of the force and height. Clean the surfaces of the thrust bearing and apply a light coating of anti-seize lubricant (Pine P/N: CLGSMOS2) to the surfaces (reference Figure 6.3).

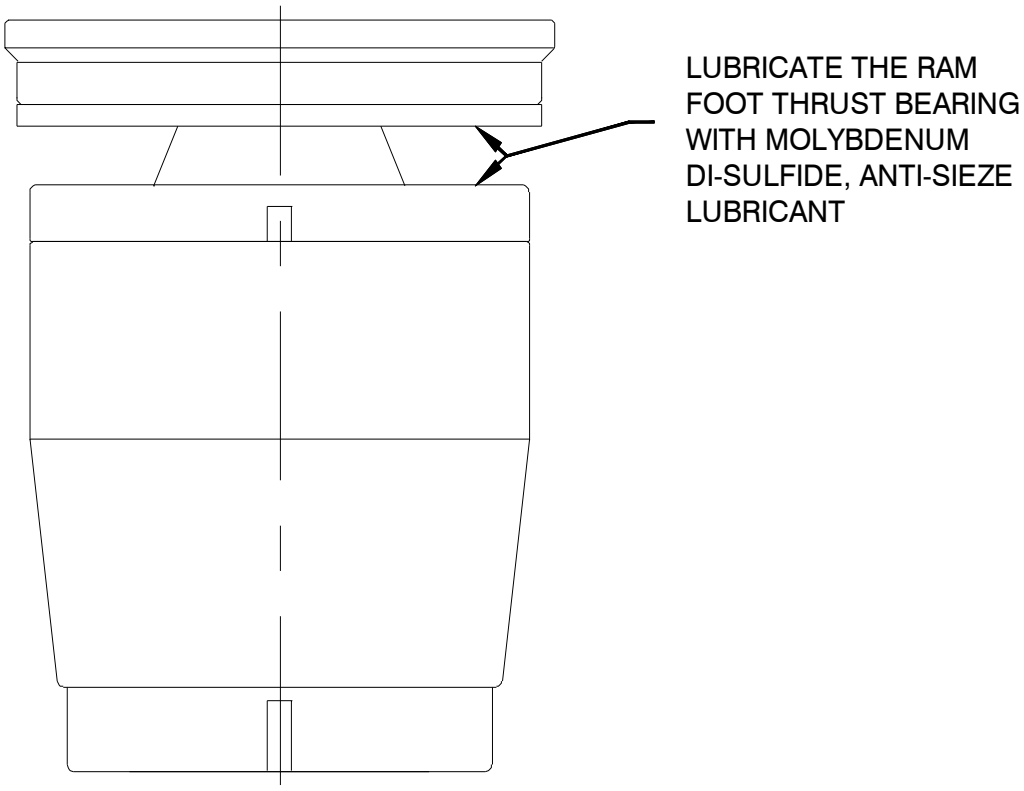


Figure 6.3: Ram Foot Lubrication

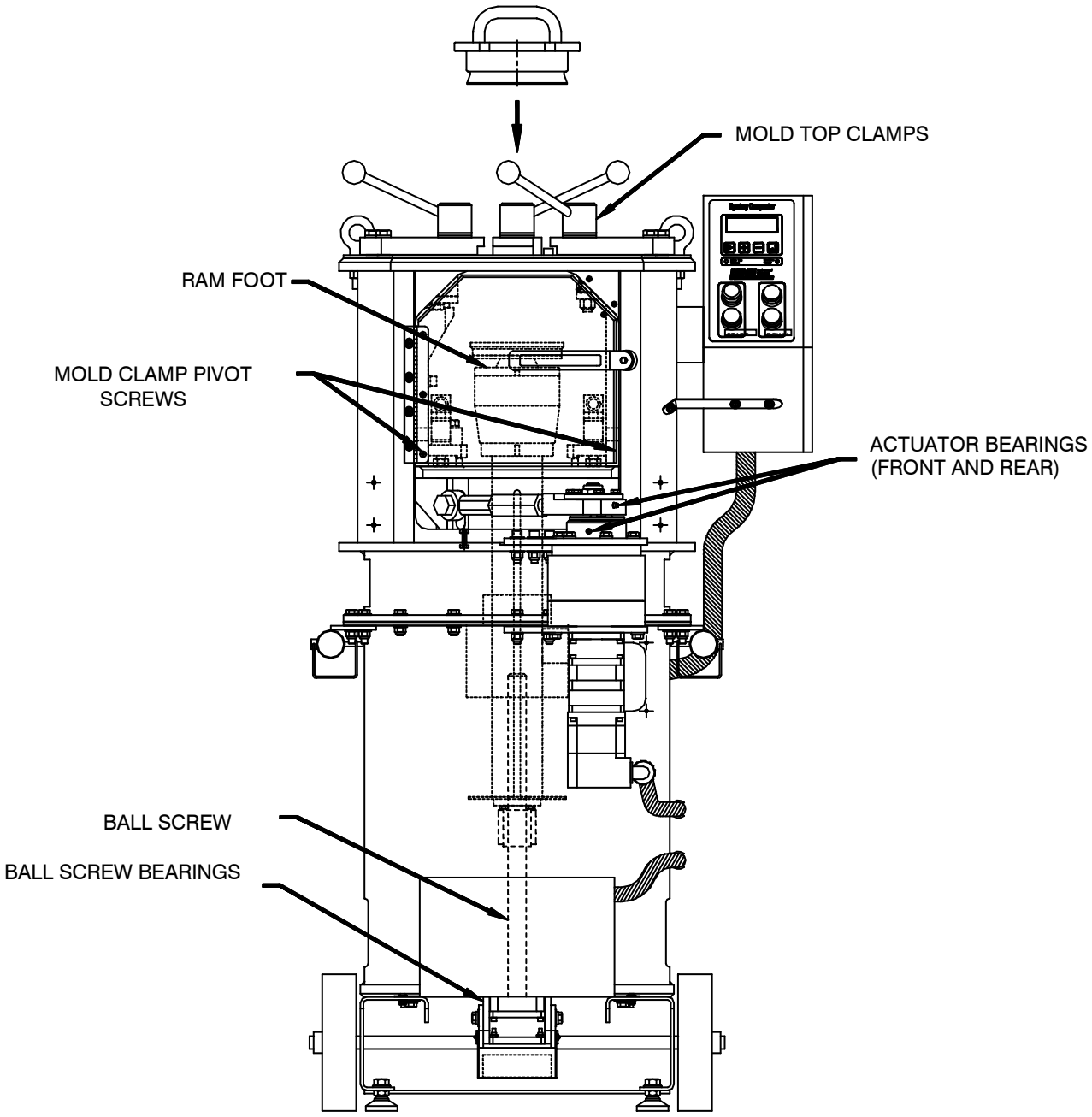


Figure 6.4: Lubrication Points

6.3 Maintenance Schedule

Table 6.2 is a guideline for the periodic maintenance required. Most items should be inspected after the initial 5 hours of operation and adjusted accordingly.

Table 6.2: Periodic Maintenance

Item	Daily	Initial 5 hr.	Every 25 hr.
Clean Compaction Chamber	X		
Clean Mold Top	X		
Inspect Ram Key			X
Check Mold Base Clamps		X	X
Timing Belt Tension		X	X
Inspect Mold Clamps		X	X
Inspect Ram Foot for wear			X

6.4 Batteries

There are two battery configurations on the AFG1: two AA Batteries or one 3.6V lithium battery with a brass extender, depending on the manufacturing date or updates done to the machine. The two AA battery configuration backs up the following data: the date and time, the 20 saved tests, and the test parameters set by the operator. The 3.6V lithium battery configuration backs up the date and time only.

The battery configurations cannot be interchanged due to different motherboards on the gyratory compactor.

To determine the battery configuration press the (▶) to scroll down to Calibration then press the **(↵)** key. Next, scroll (▶) to Calibration Date, and press the **(↵)** key. Once on the Calibration Date screen press (▶) and observe the bottom line. If the last line reads "SX-33" or "DX-100" use two AA batteries. If the last line reads "PCM-SC520" use a 3.6V 1/2AA lithium battery with a brass extender.

Replace Batteries

The AA batteries should be replaced on an annual basis. To replace the two AA batteries, turn the machine ON then remove the batteries from the holder on the back of the control enclosure. Replace with (2) AA alkaline batteries only. Select **MACHINE SETUP**, then select **DATE/TIME** and check that the correct date and time are set. The clock hours are set from 0 - 24.

The 3.6V lithium battery has an expected life of 5 to 8 years. To replace the 3.6V 1/2AA lithium battery, turn the machine ON then remove the battery from the holder on the back of the control enclosure. It is not necessary to remove the brass extender. Install the new 3.6V 1/2AA lithium battery. Select **MACHINE SETUP**, then select **DATE/TIME** and check that the correct date and time are set. The clock hours are set from 0 - 24.

6.5 Ram Key

The ram key should be inspected periodically to check for wear. The key is a oil-impregnated bronze on which some light scoring is to be expected. If the key is worn, rotate the key to use the unworn end. The key has two wear surfaces available. Calibration of the machine is not required when the ram key is removed and re-installed (reference Figure 6.5).

To inspect the key, disconnect power and remove the right side access panel directly behind the front actuator. With a 7/16" wrench, loosen the screws holding the key in position. Remove the key. The ram may tend to rotate without the key installed. Inspect the key for wear and replace if required. Be sure the key is fully seated into the ram keyway before tightening the screws. Re-install the access panel and reconnect power.

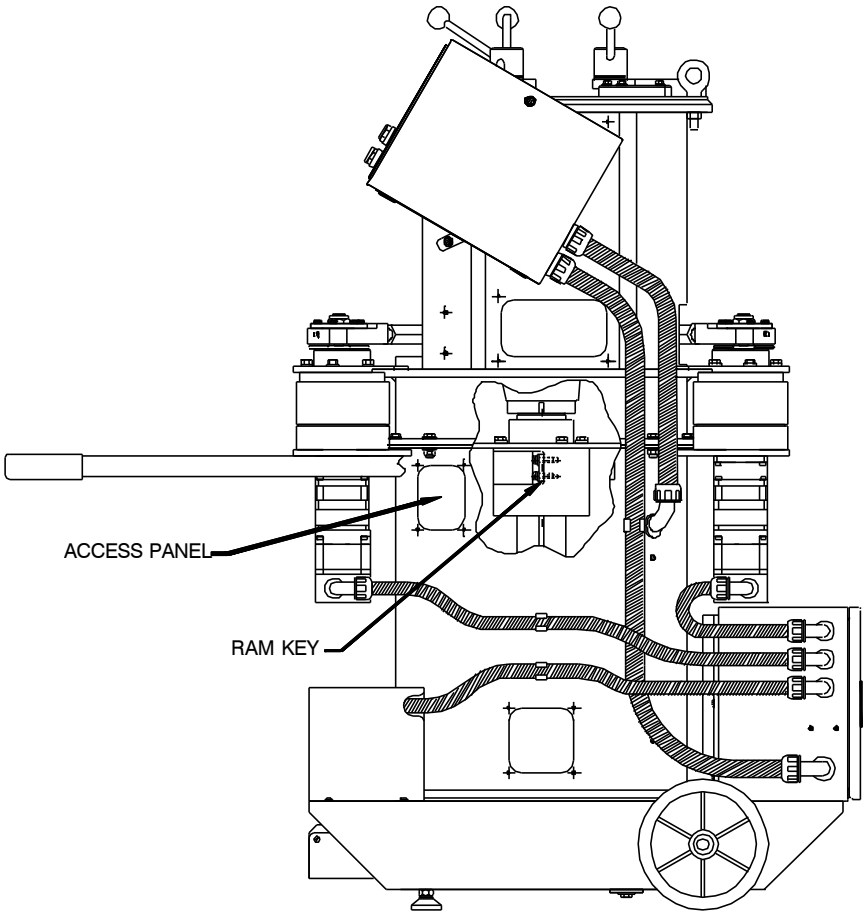


Figure 6.5: Ram Key Inspection

6.6 Mold Clamp Adjustment

The mold clamps should be inspected periodically. These clamps must function properly to achieve correct compaction results. When the clamps are firmly clamped to the mold flange, the mold clamp handles should be at the position shown in Figure 6.6. If the clamp handles are not at this position when firmly clamped, the mold may not stay in the locked position during compaction.

The following procedure applies to both left and right mold clamps.

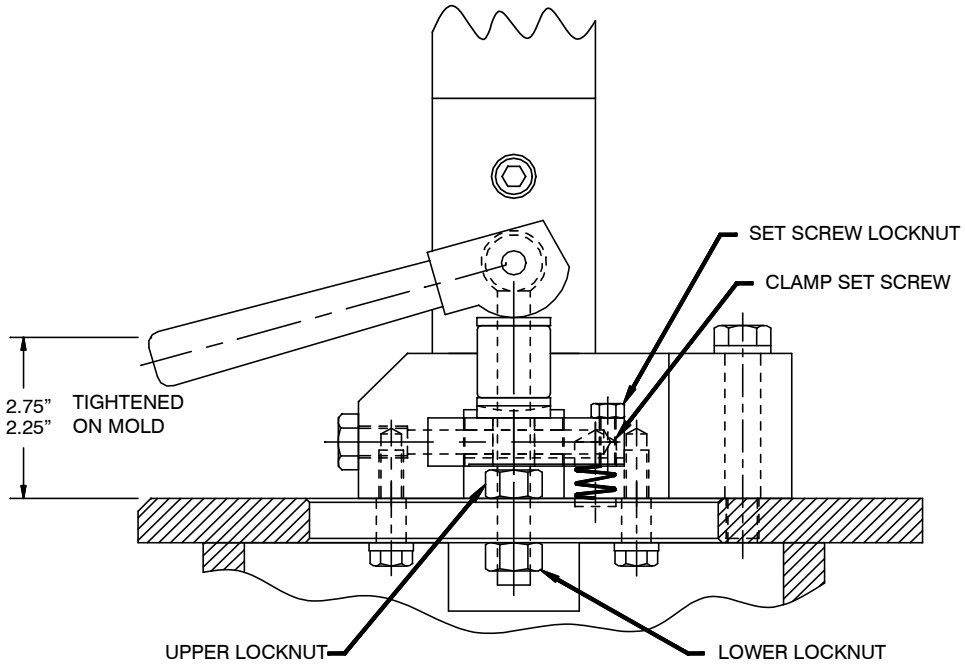


Figure 6.6: Mold Clamp Overview

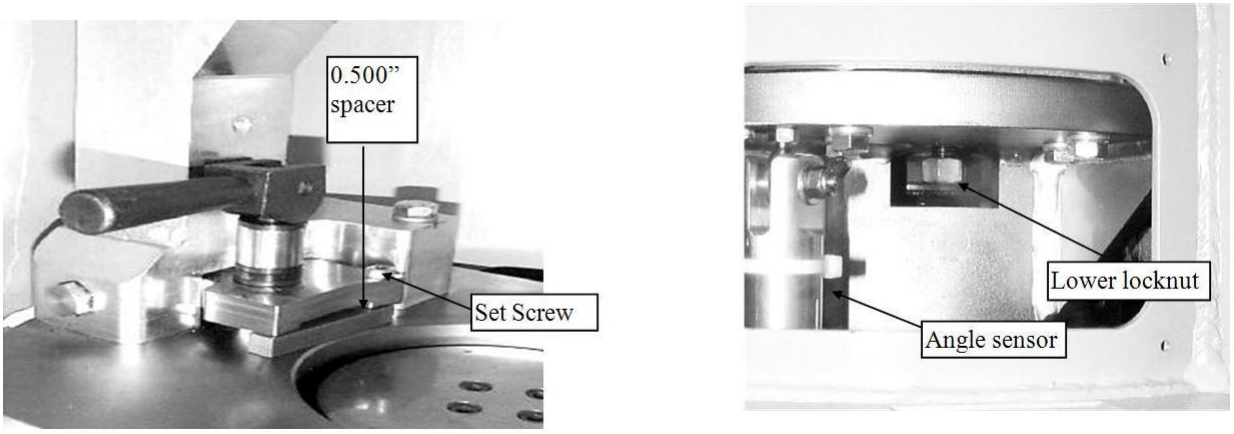


Figure 6.7: Mold Clamp Adjustment

- Remove the upper access panels on the left and right side of the machine.
- Place the 0.500" square spacer under the clamp.
- Bring the clamp down lightly until the front of the clamp contacts the 0.500" spacer.
- With the clamps lightly contacting the 0.500" spacer, turn the set screw to until it lightly contacts the spacer with the 1/8" wrench.
- Lock the set screw in position with the set screw locknut using the 7/16" wrench.
- Remove the 0.500" spacer.

Use a mold for the following measurement. Clamping the 0.500" inch spacer firmly may cause damage to the spacer.

- Firmly clamp a mold to the swivel frame.
- Measure the distance from the base to the top of the clamp handle. (Reference Figure 6.8)
  This measurement should be between 2¼" - 2¾" with the mold firmly clamped into position. If the handle needs to be raised, loosen the upper locknut then tighten the lower locknut. If the handle needs to be lowered, loosen the lower locknut then tighten the upper locknut. The clamp handles should point toward the center slightly but still allow easy insertion of the mold.
- Make sure that the clamp handles clear the mold. The mold handles, pointed slightly toward the center, should still allow the mold to be easily inserted into the compaction chamber.
- Once both clamps are adjusted to the proper position, check that the clamps are operating freely and clamp the mold firmly in place.

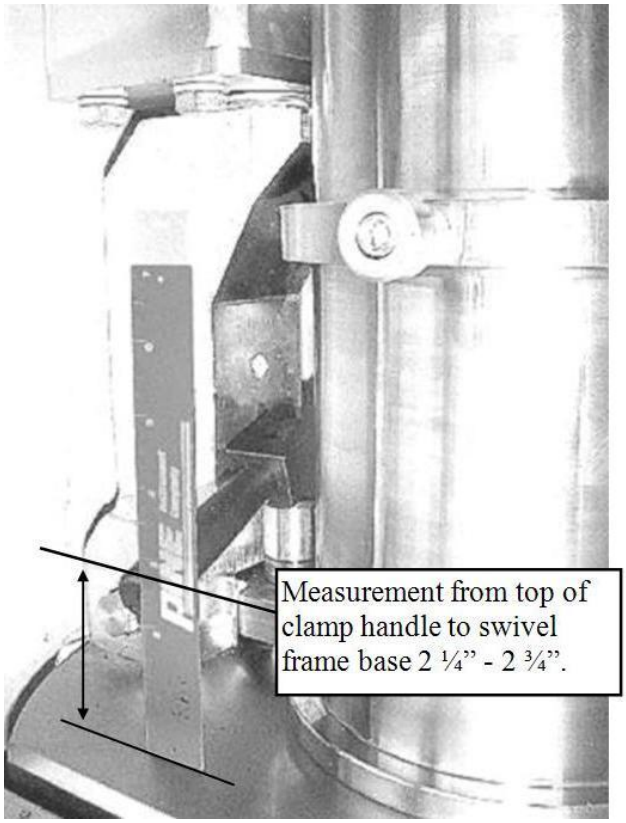


Figure 6.8: Mold Clamp Handle Position

6.7 Mold Top Clamps

The mold top clamps should be lubricated periodically (every 25 run hours) and the hold downs cleaned daily. To lubricate the clamps, simply unscrew the clamp handles from the frame then clean and lubricate the clamp threads. Note: Each clamp has two (2) brass bushings and one (1) stainless steel bushing. The stainless steel bushings are different sizes and are used to adjust the stop position of the clamp. Make sure to reinstall the clamp handles and bushings in the same position from which they were removed. Over time, the brass bushings may wear and need to be replaced.

6.8 Ram Drive Belt

The ram drive belt tension should be checked every 25 run hours. To check the timing belt tension, remove power from the machine and remove the belt guard on the bottom of the machine. The belt should have between ¼" and ½" of movement for proper tension. To tighten the belt, loosen the screws that mount the ram drive assembly (Figure 6.8) and slide the ram drive assembly to tighten the belt. Be sure to keep the pulleys aligned. Do not over tighten the belt. Re-tighten the screws and re-check the ram drive belt for proper tension.

6.9 Storage

The gyratory compactor should be stored in a heated, dry area when not in use. To store the gyratory compactor for extended periods, first thoroughly clean and lubricate the unit. Wipe the swivel-frame, mold top plate/clamps, and work surfaces with a light oil or rust preventative. Molds should also be thoroughly cleaned and coated with a rust preventative. Disconnect power and cover the machine with a dust cloth.

To return the compactor to service, thoroughly clean all surfaces and lubricate the unit. Turn power on and allow the machine to warm up at least 15 minutes. Verify that all machine motions are working correctly. Replacing the AA batteries is recommended. The machine calibration should be checked prior to returning it to service.

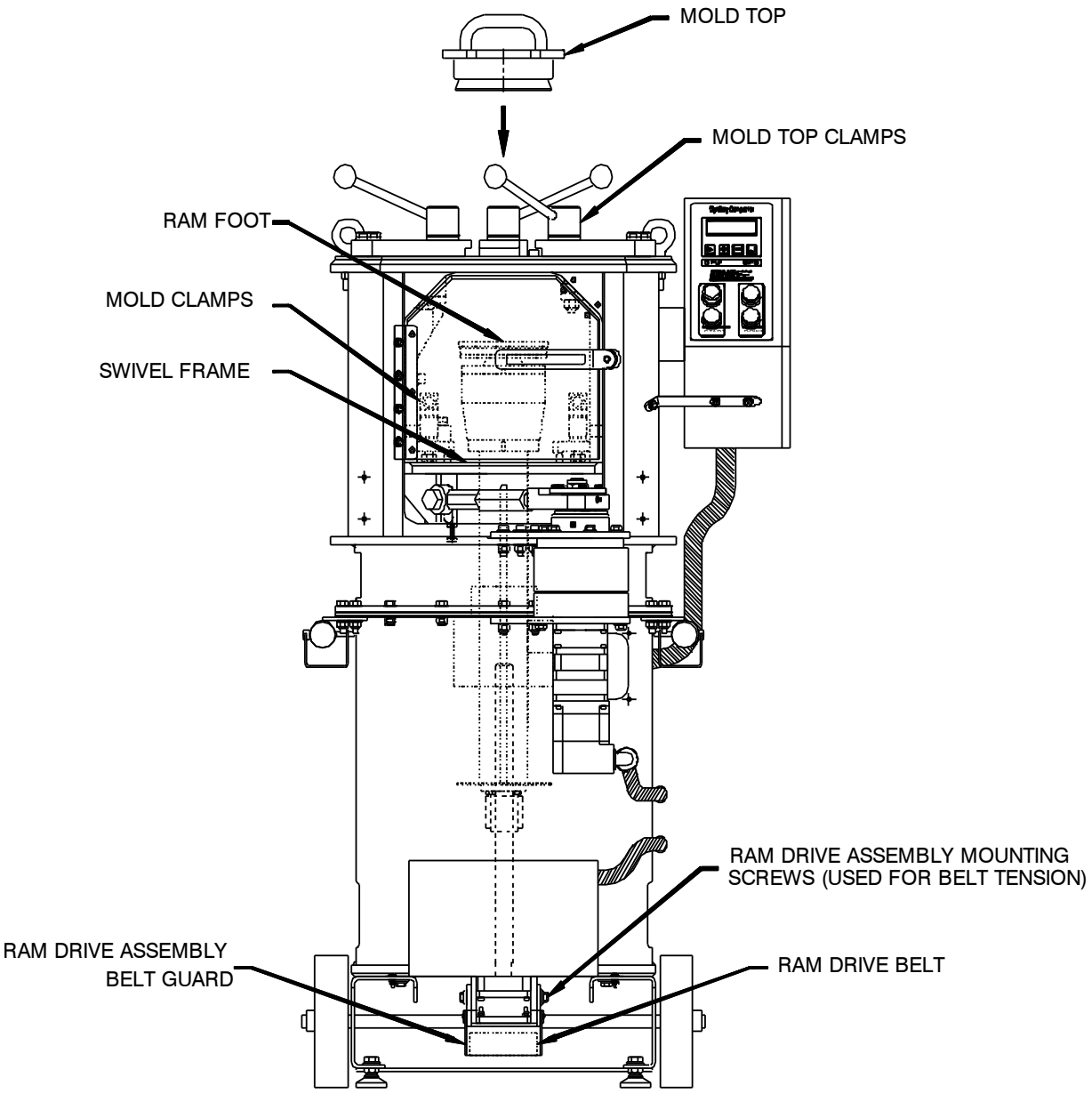


Figure 6.9: Periodic Maintenance Points

6.10 SGC Best Practices for Maintenance and Calibration

1. **Know and follow the applicable governing agency specifications.** Each governing agency may have requirements that differ from these guidelines, such as more frequent equipment inspection intervals or different specific setting or tolerance requirements. This document does not represent the varied requirements of specific agencies. Where conflicts arise, the governing agency specifications take precedence.

2. **Read the Operator's Manual**. There is no substitute for a good understanding of the particular maintenance and calibration issues discussed in the manual for a particular SGC model.

3. **Lubricate all wear surfaces** periodically as directed by the operator's manual. Failure to lubricate wear surfaces often causes premature wear and increased repair costs.

4. **Keep the SGC clean**. Immediately clean any debris or buildup of asphalt binder. Debris and binder buildup often interfere with proper SGC operation and can cause premature wear and increased repair costs.

5. **Clean molds and end plates** after every specimen. Debris and binder buildup on mold end plate surfaces and on critical mold contact points can alter the angle of gyration applied to the specimen.

   DO NOT use an ignition oven to remove binder residue from the mold bore. The extreme heat will damage the mold beyond repair by causing it to go out of round. To clean heavy residue, warm the mold to 60°C (140°F) and use a solvent to remove the residue. WD-40 works well and provides a residual coating that inhibits corrosion.

6. **Calibration Terminology:** The following terms are used to describe calibration of machine parameters.

   Standardize: a process to bring a measuring instrument or measurement system into conformance to a known standard (i.e.: force, height, angle, etc.).

   Verify: a process that establishes whether the results of a previously calibrated measurement instrument or measurement system are stable. Verification is used to maintain the traceability of a system and to determine when to recalibrate. If the machine response is in conformance, no correction is required.

   Calibrate: a process that establishes the relationship (traceability) between the results of a measurement instrument or measurement system and the corresponding values of a reference standard.

7. **Standardize the ram pressure** measurement system a minimum of every six months or every forty (40) hours* of operation, whichever comes first. Use the certified proving ring or load cell appropriate for the SGC model to verify the ram pressure. Electronic load cells should be calibrated annually and mechanical proving rings calibrated every two years.

8. **Standardize the height** measurement system a minimum of every six months or every forty (40) hours* of operation, whichever comes first. Use the certified gage block(s) appropriate for the SGC model. Gage blocks require certification every two years. If blocks are visibly damaged, they should be repaired and recertified.

9. **Standardize the internal angle** of gyration. Standardize the internal angle of gyration** a minimum of once per year or every eighty (80) hours* of operation, whichever comes first. Follow the AASHTO TP71 procedure using molds at room temperature. Top and bottom angles should be within 0.10° of each other.

   Note: The AFGB1 model SGC exhibits a predictable shift between room temperature mold and compaction temperature mold angle of gyration. For this model SGC, a room temperature internal angle of 1.19° represents a 1.16° internal angle at typical compaction temperatures. The Pine SGC models AFG1, AFG2, and AFGC125X do not exhibit the shift. Standardize these SGC models at the target angle (1.16°) with room temperature molds.

10. **Monitor the external angle** of gyration. A shift in the external angle can indicate a shift has occurred in the internal angle as well. Monitor the external angle of gyration a minimum of every three months or every twenty (20) hours* of operation, whichever comes first. On models which display the angle of gyration, the display readout provides the desired information. On models which don't display the angle, refer to the Operators Manual for instructions on checking the external mold angle.

11. **Standardize the speed of gyration.** Standardize the speed of gyration a minimum of once per year or every eighty (80) hours* of operation, whichever comes first.

12. **Verify mold dimensions** a minimum of once per year or every eighty (80) hours* of operation, whichever comes first. Measurement of the inner diameter of the mold should be at three locations along the length of the mold using a bore gage. Two of these locations should be within any observed wear areas (*i.e.* where the HMA material is compacted). The outer diameters of end plates should be verified using calipers or outside micrometers. Mold bores and end plates should also be checked for damage (deep gouges). Consult the SGC Operation Manual for information regarding other mold dimensions (such as flange thickness) that are critical for certain SGC models.
13. **Verify internal angle of gyration for each mold** a minimum of once per year or every eighty (80) hours* of operation, whichever comes first. Each SGC model has specific requirements for the molds to apply a correct and consistent angle of gyration. Measuring the internal angle with each mold confirms the angle is being applied consistently on each mold used with a given SGC. One top and one bottom angle is sufficient for this check. Each mold internal angle should be within +/-0.02° of the average of all molds used with a given SGC.
14. **Maintain a log book**. Create and maintain a log book to record the results of routine SGC standardization and major service events. Monitoring trends in standardization results often permits early detection of machine performance issues.
15. **When a compactor is moved to a new location**, standardize pressure, height, and internal angle after relocation. While SGC units have been moved and used successfully without being standardized, there is a risk of incorrect compaction results if any critical parameters changed from handling during transport.
16. **Turn your SGC off** when not in use for extended periods (i.e.: overnight, weekends, etc.). Saving energy saves you money.

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* The term *hour of operation* applies only to the amount of time the SGC is actually compacting specimens. It is the amount of time required to prepare about ~18 specimens (1800 gyrations).

** The *internal angle of gyration* is the angle between the mold wall and the end plates, as measured from the inside of the SGC mold. Beginning in 2003, AASHTO T 312 permitted the option of specifying an internal angle of gyration of 1.16° in lieu of an 1.25°external angle. Beginning in 2009, AASHTO T312 requires a 1.16° internal angle measured using the AASHTO TP 71 procedure.

6.11 Troubleshooting

The gyratory compactor control system has built-in diagnostics to aid in troubleshooting. If an abnormal condition occurs, an error code number will be displayed. Record this number. Table 6.3 is a listing of some conditions, probable causes, and solutions.

Table 6.3: Trouble shooting

DESCRIPTION	PROBABLE CAUSE	SOLUTION
Machine won't start test	- Machine not parked	- Press **RAM DOWN** key to have the machine self park
	- Door open	- Close door
	- Controls in "SELECT" mode	- Check settings (press the **(↵)** key)
Machine won't print	- Disconnected or damaged cable	- Check cable connections
	- Printer not on	- Turn printer on, check power
Machine serial communications Working	- Disconnected or damaged cable	- Check cable connections
	- Incorrect communications settings	- Check that communication parameters a correct on both the compactor and computer
Thumping sound during gyratior	- Inadequate lubrication on ram foot	- Lubricate ram foot (see section 6.2.1)
	- Calibration spacer in ram foot	- Remove spacer
Mold won't enter Swivel Frame easily	- Mold clamps out of adjustment	- Adjust mold clamps (see section 6.6)
	- Debris on mold flange and or mold clamps	- Clean the mold and compaction chambe
Mold Top won't install easily	- Mold not inserted and clamped properly	- Insert mold and clamp firmly
	- Mold top clamps tight	- Loosen mold top clamps
Compactor fails to park correctl	- Electrical fault	- Consult factory
Door Open light on when door is Closed	- Faulty door switch or circuit	- Replace switch or repair circuit
	- Electrical fault	- Consult factory
Height verification error during calibration	- Dirt on or in ram foot	- Clean the ram foot
	- Incorrect gage block height	- Orient gage blocks for proper height

	- Ram key wear	- Rotate or replace ram key
	- Calibration spacer not installed	- Repeat height calibration with calibration spacer installed
	- Mold top not properly clamped	- Firmly clamp mold top to frame
Mold top sensor not working	- Sensor position incorrect.	- Consult factory

DESCRIPTION	**PROBABLE CAUSE**	**SOLUTION**
Mold Top coming undone during test	- Dirty swivel frame and mold clamp	- Clean swivel frame and mold clam (Note: Do not use WD-40)
	- Mold not firmly clamped to swivel frame	- Clamp mold more firmly to swivel
	- Mold clamps adjusted incorrectly	- Check mold clamp adjustment and necessary
Mold turning or moving during test	- Dirty swivel frame and mold clamp	- Clean swivel frame and mold clamp (Note: Do not use WD-40)
	- Mold not firmly clamped to swivel frame	- Clamp mold more firmly to swivel
	- Mold clamps adjusted incorrectly	- Check mold clamp adjustment and necessary

6.11.1 Error Diagnostic Codes

The AFG1 compactor has error diagnostics programmed into the control software which is used for trouble shooting if a problem occurs during operation of the compactor. If a fault condition occurs, an error code will be displayed on the control panel as well as some brief instructions as to the course of action that should be taken.

If an error code appears on the control panel display of the AFG1 gyratory compactor, the suggested course of action is as follows:

- Record the error code number and under what condition the error code occurred.
- Follow the instructions displayed on the control panel display.
- If the control panel does not display instructions or if the compactor does not respond to the instructions displayed on the control panel, turn the compactor off. Leave the power off for 10-15 seconds, then turn the compactor back on.
- If the error code does not re-occur, resume normal operation of the compactor and monitor for additional occurrences.
- If the error code does not clear, or for additional information contact Pine Instrument Company Customer Service at Ph: (724)458-6391.

The following error codes may be resolved by the customer without factory consultation:

Error code: 950 "real time clock". **Solution**: Replace batteries. Reference Section 6.4

Error code: 601 "Negative force on ram". **Solution**: Check for foreign objects or debris that may obstruct the downward motion of the ram.

VII. Warranty

PINE INSTRUMENT COMPANY

LIMITED WARRANTY

The equipment manufactured by Pine Instrument Company is warranted to be free from defects in material and workmanship for a one (1) year period from the date of shipment to the original purchaser and used under normal conditions. The obligation under this warranty is limited to replacing or repairing parts which shall upon examination disclose to Pine Instrument Company's satisfaction to have been defective. The customer may be obligated to assist Pine Instrument Company personnel in servicing our equipment. Pine will provide telephone support to guide a customer's technician to effect any needed repairs. In the event that telephone support is unsuccessful in resolving the defect, Pine Instrument Company will work to correct the problem. The following restrictions apply:

- Warranty service does not include interfacing the computer to a network.
- Warranty service does not include standard wear items.
- Warranty service does not include routine maintenance or calibration.

This warranty being expressly in lieu of all other warranties, expressed or implied, and all other liabilities. All specifications are subject to change without notice.

The customer is responsible for charges associated with non-warranted repairs. This obligation includes but is not limited to travel expenses, labor, parts and freight charges.

Appendix A: SGC Standardization Log Form

SUPERPAVE Gyratory Compactor Standardization Worksheet **Pine Instrument Company**

Compactor Model Number:________________ Serial Number:________________

Date	Technician	Gyration Speed	Force		Height	Angle of Gyration	
		30 ±0.5 gpm (10 gyr @ 19.67-20.33 sec)	Proving Ring s/n: ________ Cal Date: ________ 5000N ±1% Dial Range: ______-______	10500N ±1% Dial Range: ______-______	6.000 +/-.004 inch (152.4 +/-0.1 mm)	External $\alpha = \text{ArcTan}[(\Delta B-\Delta T)/12]$ α_{ext}: External Angle of Gyration ΔT: Top Indicator TIR ΔB: Bottom Indicator TIR	Effective Internal (see worksheet)
					Mold Size: Height:	ΔT ________ ΔB ________ α_{ext}=________	α_{int}=________
					Mold Size: Height:	ΔT ________ ΔB ________ α_{ext}=________	α_{int}=________
					Mold Size: Height:	ΔT ________ ΔB ________ α_{ext}=________	α_{int}=________
					Mold Size: Height:	ΔT ________ ΔB ________ α_{ext}=________	α_{int}=________
					Mold Size: Height:	ΔT ________ ΔB ________ α_{ext}=________	α_{int}=________
					Mold Size: Height:	ΔT ________ ΔB ________ α_{ext}=________	α_{int}=________
					Mold Size: Height:	ΔT ________ ΔB ________ α_{ext}=________	α_{int}=________
					Mold Size: Height:	ΔT ________ ΔB ________ α_{ext}=________	α_{int}=________
					Mold Size: Height:	ΔT ________ ΔB ________ α_{ext}=________	α_{int}=________
					Mold Size: Height:	ΔT ________ ΔB ________ α_{ext}=________	α_{int}=________
					Mold Size: Height:	ΔT ________ ΔB ________ α_{ext}=________	α_{int}=________

Appendix B: SGC Internal Angle Standardization Form

Superpave Gyratory Compactor

Serial Number:_____ Owner:_____

Model:_____ Location:_____

Manufacturer:_____ Total Gyrations:_____

Pressure (kPa):_____ Mold Temperature_____

Angle Measurement Instrument

Serial Number:_____ Calibration Date:_____

Model:_____ Next Calibration Due:_____

Eccentricity (mm): _____ Tilting Moment:_____

Internal Angle Measurements

Angle Measured (*Top* and *Bottom*)	**Measured Angle** (report to nearest 0.01 degrees)	**Internal Angle Result**
Top	1:_____ 2:_____ 3:_____	Top $_{average}$=_____ $\left[\frac{Top1+Top2+Top3}{3}\right]$
Bottom	1:_____ 2:_____ 3:_____	Bottom $_{average}$=_____ $\left[\frac{Bottom1+Bottom2+Bottom3}{3}\right]$
		Angle $_{effective}$=_____ $\left[\frac{Top_{average}+Bottom_{average}}{2}\right]$