ASPHALT PAVEMENT ANALYZER (APA)

SERIAL

USER'S GUIDE

For use with all PC Controlled APA's

(Updated 11-4-03)

PAVEMENT TECHNOLOGY INC.(PTI)

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Chapter 1
Introduction

1.1 Overview of Pavement Technology Inc. (PTI)

A. Company Mission: To be the industry leader in the manufacture and development of innovative asphalt and aggregate sampling and testing equipment.

B. History: In the spring of 1996, PTI was formed by a joint venture between Ronald Collins and ASTEC Ind. The first Asphalt Pavement Analyzer and Asphalt Vibratory Compactor were manufactured at ASTEC Ind., in Chattanooga, TN. In the fall of 1996 PTI moved to a temporary facility in Conyers, GA. And in the fall of 1998, PTI moved to its current location in Covington, GA.

C. Products: PTI currently manufactures eight products for the asphalt and aggregate industry, they are:

1. **The Asphalt Pavement Analyzer (APA)**
2. **The Asphalt Pavement Rut Tester**
3. **The Mix Verification Tester**
4. **The Asphalt Vibratory Compactor (AVC)**
5. **The Single and Double Pugmill Mixers**
6. **The Laboratory Automatic Gradation Unit (AGU)**
7. **The Robotic Truck Sampling Device**
8. **Mobile and Skid Mounted Laboratories**

D. Research/Training: PTI is dedicated to Asphalt Research and Training for the Hot Mix Asphalt Industry and is available as requested.

E. Service: PTI offers complete service for all company products. We encourage our customers to contact us day or night if they have any problems. Technical help can be given via telephone and if necessary we have a team of fully trained field technicians who can repair any malfunctions.

F. People

1. Ronald Collins, President-PTI. Former Georgia DOT, State Materials and Research Engineer, Retired. He helped in the development of the Georgia Loaded Wheel Tester (GLWT) in 1985 to evaluate rutting characteristics of asphalt while at Georgia DOT. Upon his retirement, Ronald joined with Don Brock, CEO, ASTEC Ind., to develop the modern GLWT known as the APA.

2. Wade Collins, Vice-President-PTI. Wade began working with PTI in 1996. In 1997 Wade took over sales and marketing of all PTI products.

3. Joe DeLisle, Plant Manager. Joe joined PTI in 2000 and manages all of PTI's production facilities. He oversees construction of all eight PTI products.

4. Service Staff
   a. Joe DeLisle

1.2 Warranty Conditions

1. Products manufactured by Pavement Technology, Inc. (PTI) are warranted to be free of defects in materials and workmanship for a period of 90-days domestic and international, from the date of shipment. If, within such warranty period, any machinery or part should be proved to PTI's satisfaction to be defective, it will be repaired or replaced. Domestic repair or replacement of the defective part may take place at the factory or customer's location as necessary. International repair or replacement of defective parts involving the transportation and lodging of company personnel to a customer's location is not covered by this warranty. Other manufacturers' warranties will apply to such components as motors, pumps, cylinders, gauges, etc. which PTI must purchase outside of its facility.

   Note: PTI will not assume responsibility for the cost of repairs or the replacement of parts that result from misuse or abuse of its products in the field by the end user.

2. Should the purchaser cancel a purchase order during or after shipping, it will be the purchasers' responsibility to cover the cost of return shipping.

3. The delivery date on the invoice or proforma is only an estimated date of delivery. PTI will make every effort to insure delivery by the due date. However, should unexpected delays be encountered at the factory, PTI shall not be held financially liable for such delays.

4. PTI's liability insurance does not cover loss or damage to its manufactured products after physical control has been relinquished to the shipping agency. It is recommended, therefore, that the purchaser insure all products ordered from PTI (f.o.b.) to their final destination. If any loss or damage should occur to purchased goods during shipments enroute, PTI is to be held harmless against any claims arising from such loss or damage.

1.3 Machine Specifications

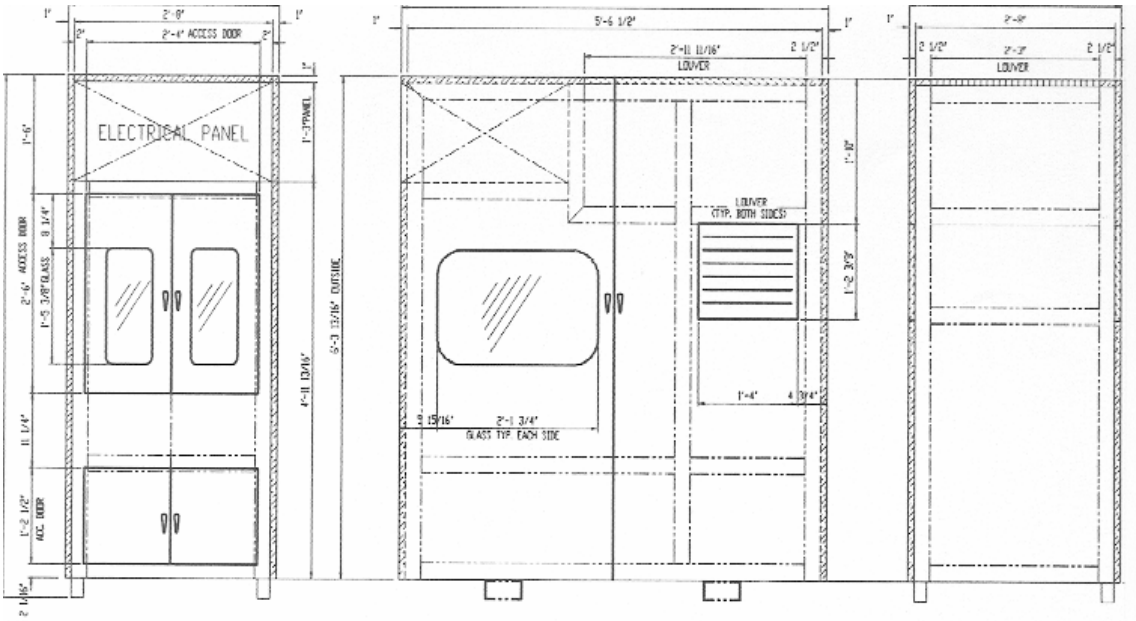
Specifications

Width:	35”
Length:	70”
Height:	80”
Weight:	3,000 Lb.
Water Tank Capacity:	5.33 Cu Ft, 30 Gallon Full
Power Requirements:	208 or 240 VAC, 60HZ, 60Amp, single phase φ
Air Requirements:	7 SCFM @ 120PSI, minimum

Important Note: Although the air consumption is low, the <u>minimum</u> pressure of 120 PSI is critical to maintain adequate hose inflation.

The machine should be located on a level floor, using the leveling pads to level the machine. The machine is normally operated from the front. A space of 1 meter in front of the machine should be adequate for the normal operation. A space of 1 meter is also needed on each side to allow access to the service doors.

For installation instructions, see section 2.3



1.4

SAFETY INSTRUCTION

THE MAIN 240V BREAKER REMOVES ALL POWER EXCEPT THAT FROM THE PLUG TO MAIN 240V BREAKER.

UNPLUG MACHINE BEFORE OPENING CONTROL PANEL.

TURN OFF MAIN 240V BEFORE OPENING SIDE DOORS.

Chapter 2
Unpacking and Installing the Asphalt Pavement Analyzer

2.1 Checking the Parts

The following parts are included with the Asphalt Pavement Analyzer (APA).

1. A digital dial-indicator
2. An aluminum template (rutting measurement guide)
3. A load cell with quick connect plug to digital scale readout
4. Three spare hoses
5. Three rut sample mold assemblies for 125 mm X 300 mm beams
6. Three rut sample mold assemblies for 150 mm diameter round samples
7. Three fatigue sample mold assemblies for 125 mm X 300 mm beams
8. Two copies of the User's Guide
9. The Automated APA will also include a computer tower, monitor, keyboard, mouse and printer

2.2 Names of Parts

This section points out the major parts of the Asphalt Pavement Analyzer and gives a brief description of each component. The part names will be used throughout this manual. The machine, as shown in Figure 1, consists of the following basic components:

(A) Wheel Tracking / Loading system
(B) Sample Holding Assembly
(C) Temperature control system
(D) Water submersion system
(E) Sample temperature conditioning shelves
(F) Air Regulators
(G) Operating controls

(A) Wheel Tracking / Loading System: The wheel tracking and loading system applies wheel loading on repetitive linear wheel tracking actions with controlled magnitude and contact pressure on beam or cylindrical samples for rut testing or fatigue testing. This system consists of the following components.

Figure 2.2.1

(A1) **Drive Assembly:** Consists of a gear motor and a cam and is connected to the loading assembly through the sliding frame and drives the loading assembly at a 60 rpm frequency and 285 mm stroke.

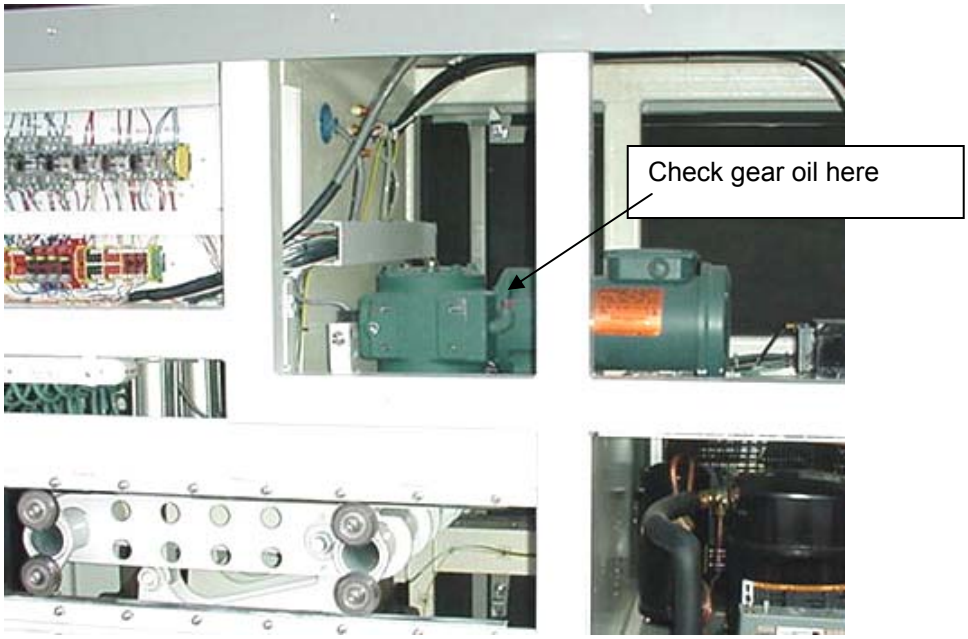


Figure 2.2.2

(A2) **Carriage Assembly:** Consists of a sliding frame, three pneumatic cylinders each attached to an aluminum wheel.

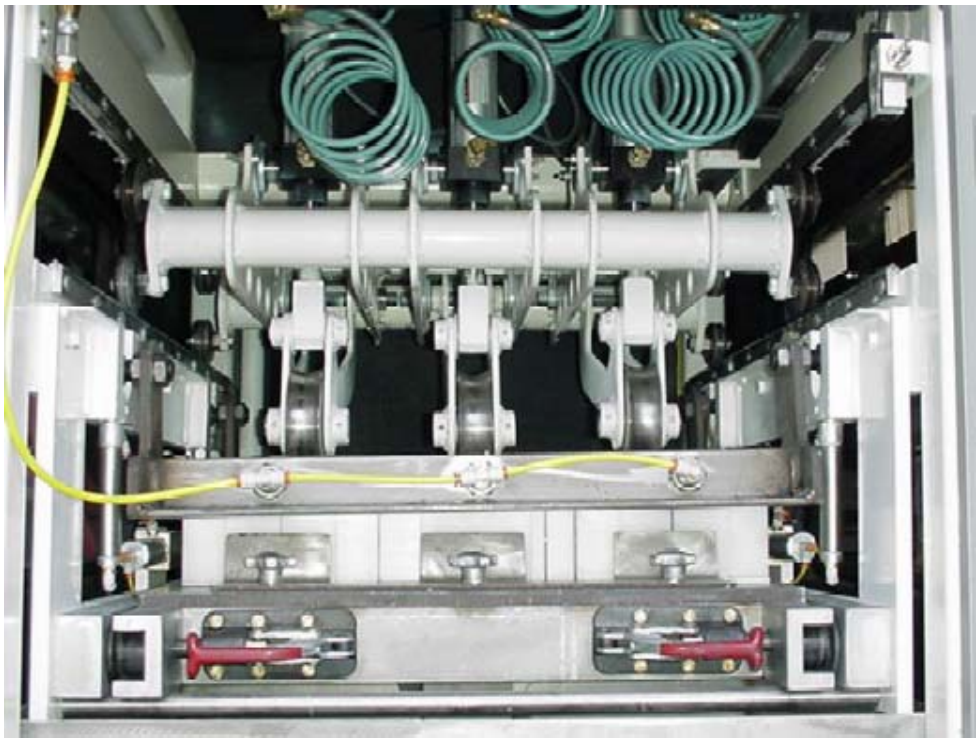


Figure 2.2.3

(A3) **Valve Pack:** for controlling the cylinders.

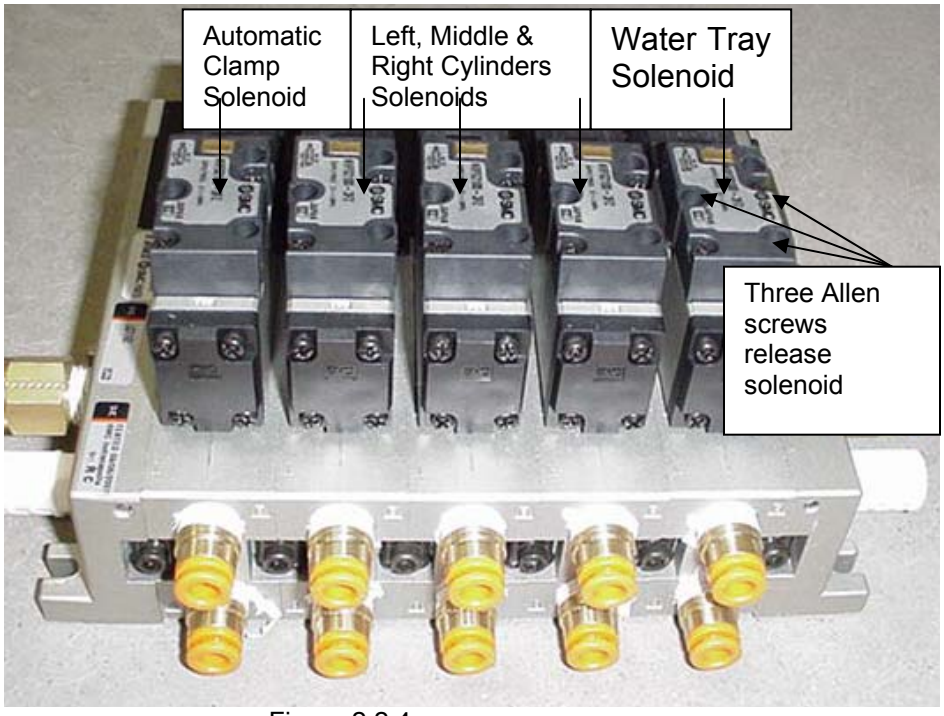


Figure 2.2.4

(A4) Three Gates 77B, 3/4 in., 750-PSI rubber hoses held by the hose rack.

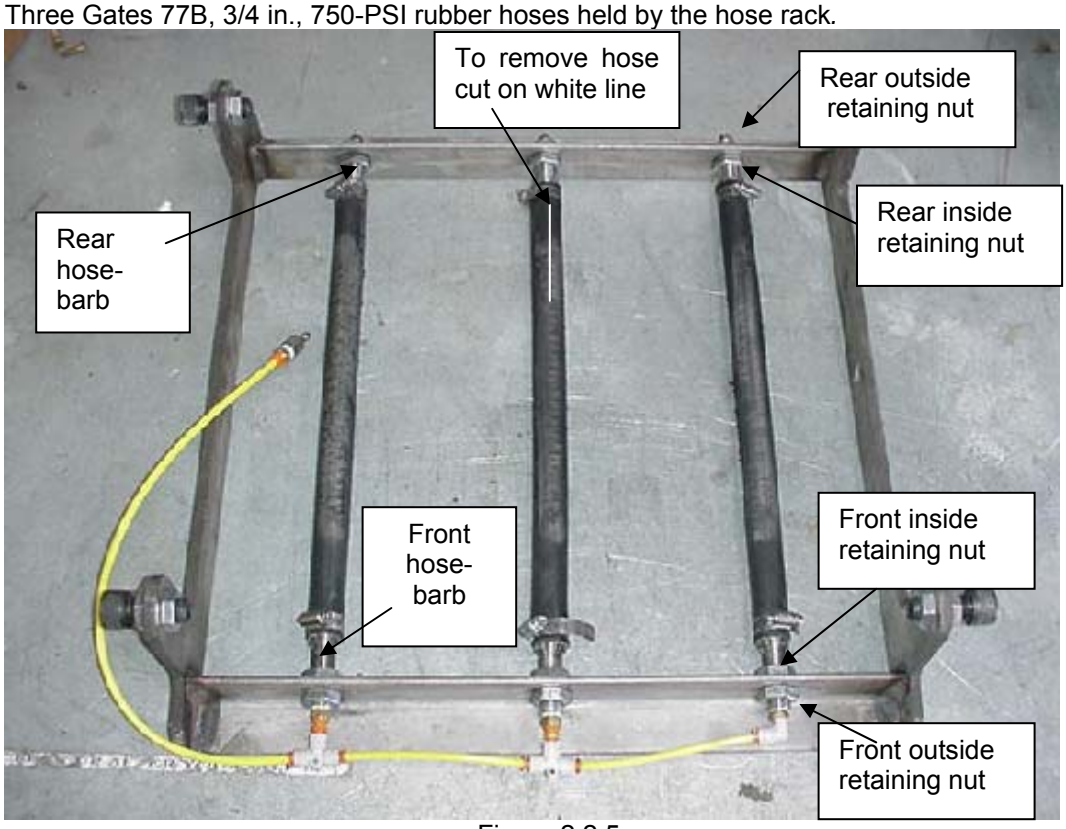


Figure 2.2.5

(B) Sample Holding Assembly: This assembly holds the asphalt concrete samples directly underneath the rubber hoses to allow the samples to be subjected to the wheel tracking actions during rutting or fatigue testing. The sliding tray design allows the samples to be pulled out from inside the machine, making it easier to perform rut-depth measurements and for installing the samples. This assembly consists of the following.

(B1) **Sample Tray:** It has two track rollers on each side bearing against the rails. When the sample tray is pushed in fully, it can be locked against the frame by two toggle clamps.

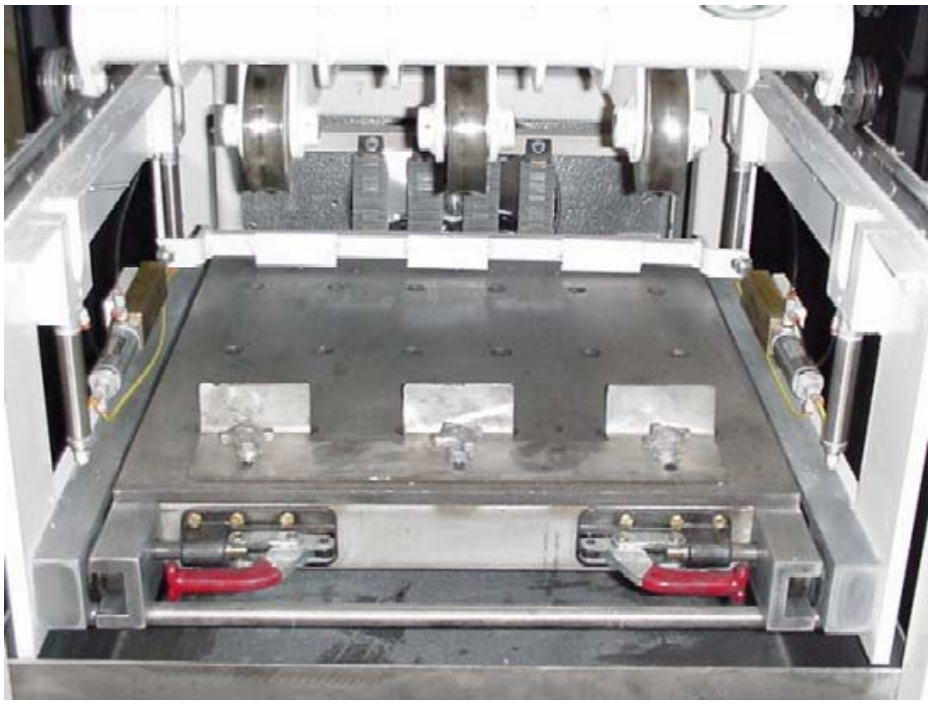


Figure 2.2.6

(B2) Sample Molds: Three different mold types are provided.

1) Cylindrical 150mm Diamater x 75mm Depth Rut Test Mold
2) Beam 300mm Long x 125mm Wide x 75mm Depth Rut Test Mold
3) Beam 300mm Long x 125mm Wide x 75mm Depth Fatigue Test Mold

All three different sample molds have the same length and width and are constrained on the sample tray using the same brackets

***RUT AND FATIGUE MOLDS SHOULD BE CLAMPED 3-3/4" FROM THE FRONT OF THE SLIDE TABLE PLATE.**

Figure 2.2.7

(C) Temperature Control: Heating and cooling of the main chamber is provided by four heat strips, two fans and a cooling unit, which are regulated by a solid state based temperature controller.

Figure 2.2.8

(D) Water Submersion System: The water submersion system allows the water to cover the test samples during the submerged-in-water test and automatically drains the water upon completing the test before the sample tray is pulled out. The system consists of the following components.

(D1) Water tank with heating element, sight tube and an electric pump to pump the water into the water tray. Fill tank within 1" from top of sight tube.

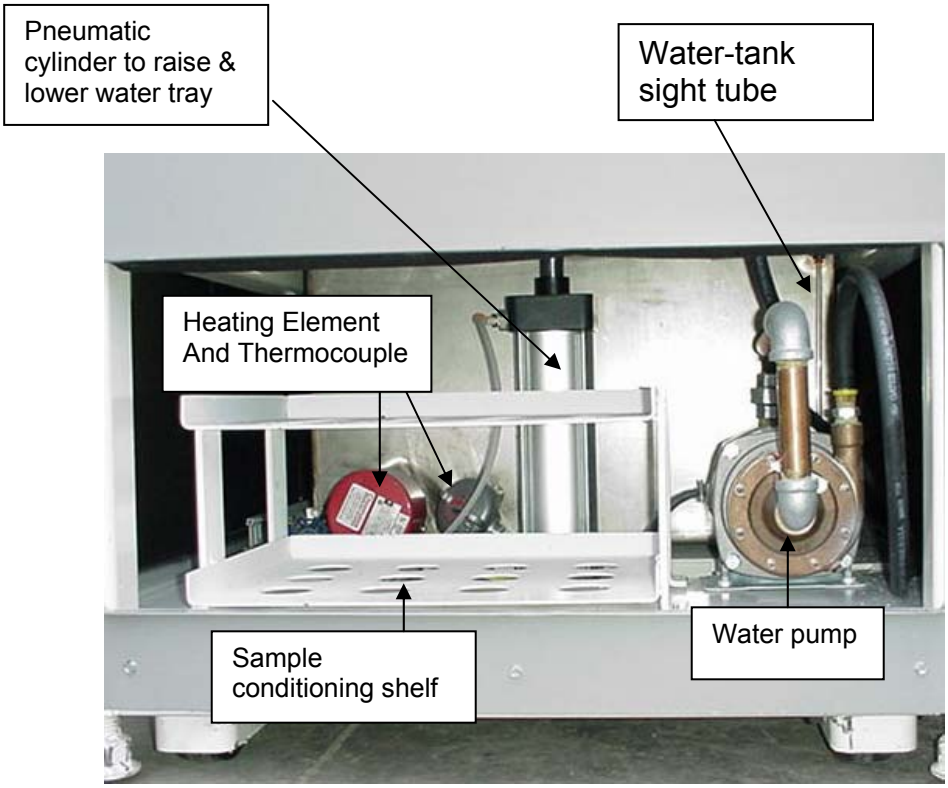

Pneumatic cylinder to raise & lower water tray
Water-tank sight tube
Heating Element And Thermocouple
Sample conditioning shelf
Water pump

Figure 2.2.9

(D2) **Water tray**, which can be raised or lowered by the pneumatic cylinder. It has a drain hole in the back of the water tray to allow water to drain back to the tank automatically. When the water pump is running, the drainpipe maintains a constant water level, which is about ½ inch over the top of the test sample during the immersion-in-water test set by a weir gate.

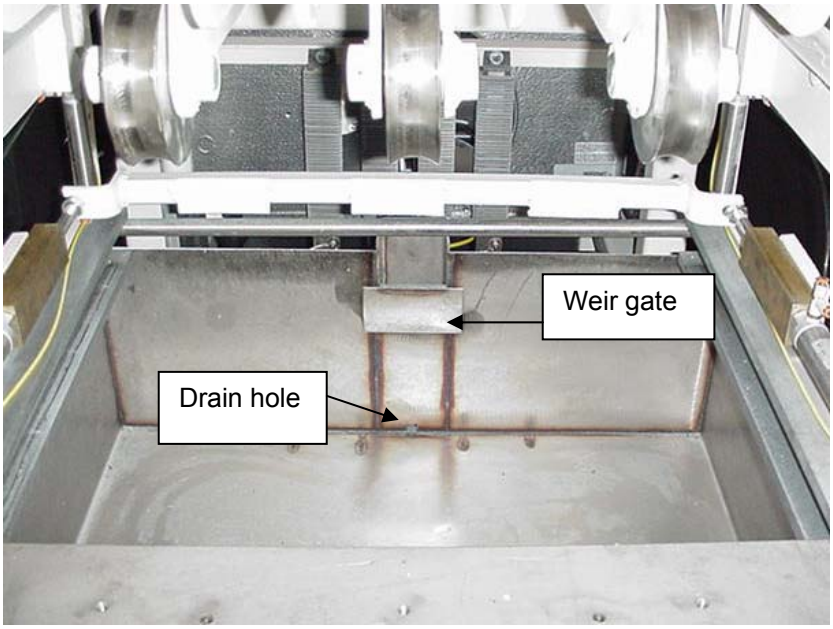


Figure 2.2.10

(D3) **Water tank.** Water can be filled manually through the water pan overflow pipe and drained through the drain valve.

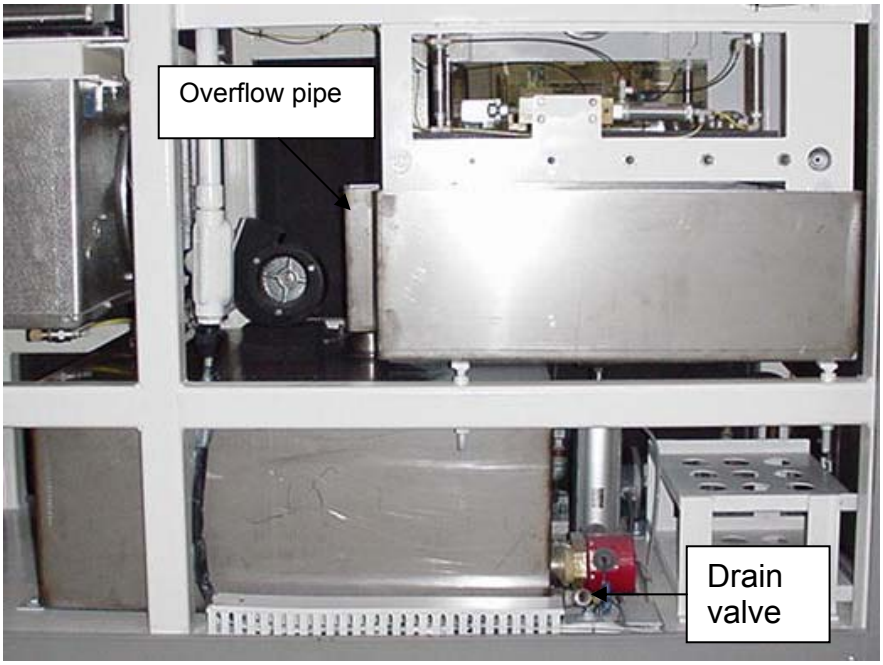


Figure 2.2.11

(E) Sample Temperature Conditioning Shelf: Located inside the lower front doors (Figure 2.2.9) it will hold extra beams or cylinders to allow for heat conditioning.

(F) Air Regulators:

1. Air Inlet Regulator: Controls maximum air pressure to APA, contains water separator and system oiler.

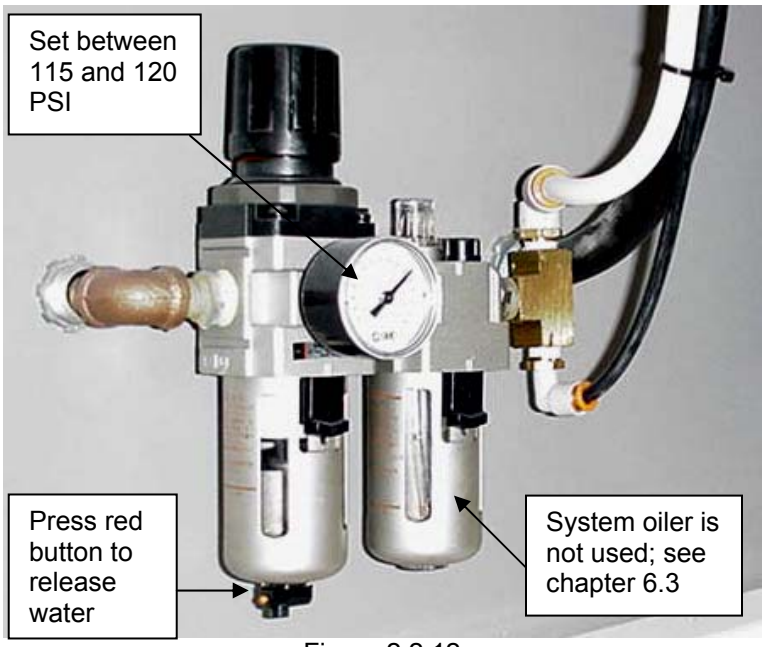


Figure 2.2.12

2. Electronic Regulators: Hose Pressure, Left, Middle and Right Wheel Cylinder Regulators. Figure 2.2.13
3. Pressure Booster Regulator: Doubles the incoming air pressure. Figure 2.2.13

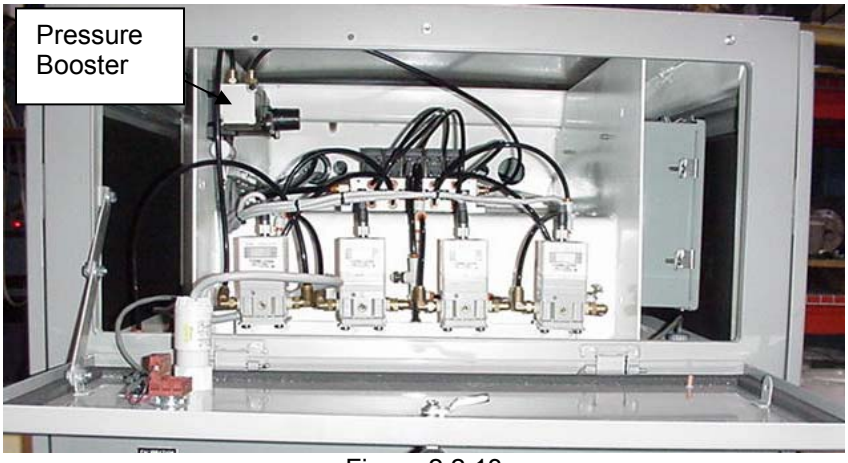


Figure 2.2.13

(G) Operating Controls: The APA is controlled by a PLC (Programmable Logic Computer. The APA Control Bar is the user interface for operating the machine. Figure 2.2.14

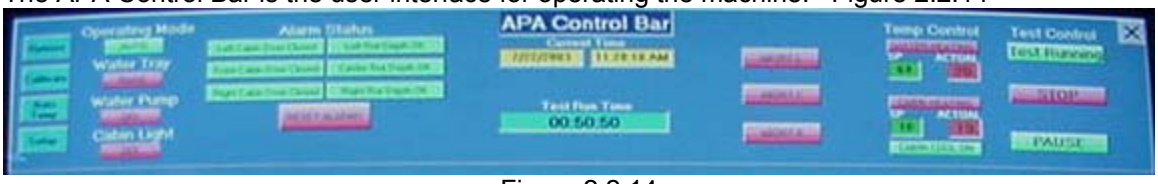


Figure 2.2.14

2.3 Installation

After the machine is moved to the designated location, lower and adjust the leveling pads to stabilize and level the machine. Then perform the following installations.

1. Connect the laboratory compressed air supply to the machine through a ½ inch female pipe connector, located at the back panel of the machine.
2. Check that the power cord is connected to the power source.
3. Unpack and set up the computer. The APA computer cord should be attached to the computer in such a way to avoid placing a side load on the plug.
4. Release the toggle clamps and pull out the sample tray fully. When Power and air is supplied to the APA, the sample molds will automatically be locked into place when the Sample Chamber doors are shut.
5. Prior to running test submerged in water, fill water in the water tank to about 1 inch from the top of sight tube. Temperature changes are very slow when the water tank is filled.

2.4 Testing the Machine

Follow the steps described below to test the machine after completing the installation procedures described in Section 2.3.

1. Make sure that the EMERGENCY STOP button is pulled out on the front panel of the APA.
2. Switch on the computer.
3. Click on the “APA” icon.
4. The APA Control Bar should load up on the top of the computer screen.
5. The APA is now ready to begin testing. Complete any necessary calibrations in Chapter 3 Calibrating the Asphalt Pavement Analyzer. Then proceed to Chapter 4 Asphalt Pavement Analyzer Test Method to begin using the APA.

Chapter 3
Calibrating the Asphalt Pavement Analyzer

The following items should be checked for calibration no less than once per year: (1) APA wheel load, (2) APA Vertical, (3) APA temperature, and (4) APA hose pressure. Instructions for each of these calibration procedures are included in this section.

3.1 APA Vertical Calibration

A. The Vertical Calibration may be performed two different ways. The Automatic Vertical Calibration may be used instead of the more labor intense Template Check. It is recommended that only one or the other be used.

B. To access the Vertical Calibration, click “Calibrate” on the APA Control Bar. In the APA Load Calibration window, click “Vertical”.

C. Remove the hose rack and any sample molds from the APA.

D. Automatic Vertical Calibration
   1. Click “Vertical Cal Off” (Red Button). It will change to “Vertical Cal On” (Green Button).

   2. The Computer will automatically calculate the vertical calibration by extending and then retracting all three wheels at one time. When it is finished the “Vertical Cal On” will shut its self off and revert to “Vertical Cal Off”.

   Note: All Doors Must Be Closed

E. Template Check.
   1. Click “Template Check”.

   2. Place an empty rut mold under the first wheel.

   3. Place the aluminum template on the mold.

Figure 1. Template Orientation for Initial Calibration Position

4. Shut the doors and use the Stroke Jog to bring the wheels to their forward most position.

5. Click "Down"

6. Make sure the lowest part of wheel is on the flat surface of the template. It must not fall into the crevice of the template.

7. After the wheel lowers Click "Zero" .It will fluctuate from 0 to 1.0 E-4. Please note that the value will not be exactly zero.

8. Click "Up" to raise the wheel.

9. Turn template over (legs will be upward on the template)

Figure 2. Template Orientation for Second Calibration Position

10. Click "Down" to lower the wheel.

11. It should be between 11.0mm and 11.2mm. If so, go to step 13.

12. If it does not read between 11.0 and 11.2, the calibration needs to be done again. Complete steps 2 to 11 and calibrate the channel again.

13. Repeat above procedure for each wheel. (Left, Middle and Right)

14. **NOTE: <u>It may take several attempts to Calibrate each wheel.</u>**

15. **NOTE: <u>Vertical Calibration Must Be Done Before Calibrating Load Cell.</u>**

3.2 Wheel Load Calibration: Calibration of wheel pressure using the load cell and the load cell meter

The load cell is used to adjust the air pressure of the APA wheel cylinders. The contact pressure for rut testing is 100 PSI and the contact pressure for fatigue testing is 250 PSI.

The following steps are used to calibrate wheel cylinder load.

1. Remove the hose rack.
2. On the APA Control Bar, click “Calibrate”
3. Click “Set Left Load”
4. Lower and raise each wheel 20 times by clicking “Down” and “UP” to loosen up the cylinders.
5. Plug the load cell into the receptacle on the APA front panel.
6. Place the load cell on the table under the first wheel.
7. If all three wheels will be used during the test, then place two empty specimen molds (turned upside down) under the other two wheels. This simulates the loading the carriage will be under during the test.
8. Lower each wheel by clicking “Down”.
9. If an adjustment must be made, raise the wheel that is being calibrated and move the regulator button up or down. (The other two wheels should be left in the down position.)
10. Lower the wheel and allow the meter to stabilize.
11. All three wheels should be calibrated to within 5 pounds of each other.
12. Repeat steps 5-9 for each wheel.

This procedure should be done each time a mechanical change is made to the APA such as hose replacement.

3.3 APA Hose Pressure Check

(*From APA Calibration; ASTM Format)*

A.5.1 The air pressure in the APA test hoses shall be checked with a NIST traceable test gauge or transducer with a suitable range, before starting test. Since the hoses are connected in series, it is satisfactory to connect the test gauge to the end of the right-most hose. The pressure should not fluctuate outside of the range of 700 ± 35 kPa (100 ± 5 PSI) during normal operation. Adjust the pressure as necessary with the hose pressure setting in the set up menu.

Note: The Ashcroft test gauge model 450182As02L200# has been found to be satisfactory for this purpose. This gauge may available through Grainger (Stock No. 2F008).

3.4 APA Temperature Calibration

(*From APA Calibration; ASTM Format)*

A.2.1 The APA must be calibrated with a NIST traceable thermometer (an ASTM 65 C calibrated thermometer is recommended) and a metal thermometer well to avoid rapid heat loss when checking the temperature.

A.2.2 Temperature Stability

A.2.2.1 Turn on the APA main power and set the chamber temperature set point so that the temperature inside the testing chamber is about 60 C. Also, set the water temperature set point to achieve approximately 60 C water temperature.

Place the thermometer in the well and place them on the left side of the shelf where the samples and molds will be tested. (Note-it may be helpful to remove the hose rack from the APA during temperature calibration to avoid breaking the thermometer.)

A.2.2.2 It usually takes about five hours for the APA to stabilize. After the temperature display on the controller has stabilized, open the chamber doors and read the thermometer without removing it from the well. Record this temperature. Close the chamber doors.

A.2.2.3 Thirty minutes after obtaining the first reading, obtain another reading of the thermometer. Record this temperature. If the readings from step A.2.2.2 and A.2.2.3 are within 0.4 C, then average the readings. If the readings differ by more than 0.4 C then continue to take readings every thirty minutes until the temperature stabilizes within 0.4 C on two consecutive readings.

A.2.3 Temperature Uniformity

A.2.3.1 To check the uniformity of the temperature in the APA chamber, move the thermometer and well to the right side of the shelf where the samples are tested. Take and record readings of the thermometer at the second location every thirty minutes until two consecutive readings at the second location are within 0.4 C.

A.2.3.2 Compare the average of the two readings at the left side with the average of the stabilized temperature at the right side. If the average temperatures from the two locations are within 0.4 C, then the APA temperature is relatively uniform and it is suitable for use. If the average of the readings at the two locations differ by more than 0.4 C then consult with the manufacturer on improving temperature uniformity.

A.2.4 Temperature Accuracy

A.2.4.1 Average the temperatures from the two locations. If that average temperature is within 0.4 C of the desired temperature of 60 C, then the APA temperature is reasonably accurate and calibration is complete.

A.2.4.2 If the average temperature differs from the desired temperature of 60 C by more than 0.4 C, then adjust the APA temperature correction factor (in the calibration menu) to get desired temperature of 60 C.

A.2.4.2.1 If the APA is equipped with a TZ4 controller proceed to Section 3.6 Calibrating the TZ4 Temperature Controller.

A.2.4.3 Place the thermometer and well in the center of the shelf. At thirty-minute intervals, take readings of the thermometer. When two consecutive readings are within 0.4 C, and the average of the two consecutive readings are within 0.4C of the desired test temperature of 60 C, then the APA temperature has been properly adjusted and calibration at that temperature is complete. Record the current set points on the temperature controllers for later reference. If these two conditions are not met, then repeat steps A.2.4.2 and A.2.4.3.

3.5 Calibrating the Temperature Controller

If the temperature in the APA is not correct, this procedure may be used to correct the temperature differential.

a. On the **APA Control Bar** click “Calibrate”.
b. On the **APA Calibration** window click “Temperature”
c. Enter the desired correction factor and press “Enter” on the keyboard.

3.6 Load Cell Calibration

The APA Load Cell is calibrated at the factory and should need no further calibration. The difference between the measured weight and the known weight should be less than 3 lbs @ 100lbs of load. If the discrepancy with the measured load value verses an object of known weight is more than 3lbs @ 100lbs of load, call PTI for instructions.

Chapter 4
Asphalt Pavement Analyzer Test Method

4.1 (ASTM Format)
Standard Test Method For
Determining Rutting Susceptibility
Using The Automated Asphalt Pavement Analyzer

1. SCOPE

1.1 This method describes a procedure for testing the rutting susceptibility of asphalt-aggregate mixtures using dynamic loading applications in the Automated Asphalt Pavement Analyzer (Automated APA) to simulate traffic.

1.2 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.3 This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulations prior to use.

2. REFERENCED DOCUMENTS

2.1 ASTM Standards

D 979 Standard Practice for Sampling Bituminous Paving Mixtures

D 2726 Standard Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Saturated Surface-Dry Specimens

D 2041 Standard Test Method for Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures

D 3203 Standard Test Method for Percent Air Voids in Compacted Dense and Open Bituminous Mixtures

E 178 Standard Practice for Dealing With Outlying Observations

3. APPARATUS:

3.1 Asphalt Pavement Analyzer (APA) – A thermostatically controlled device designed to test the rutting susceptibility of hot mix asphalt by applying repetitive linear loads to compacted test specimens through pressurized linear hoses.

3.1.1 The APA shall be thermostatically controlled to maintain the test temperature at any set point between 5° and 72° C within 1° C.

3.1.2 The APA shall be capable of independently applying loads up to 450N to the three wheels. The loads shall be calibrated to the desired test load by an external force transducer.

3.1.3 The pressure in the test hoses shall be adjustable and capable of maintaining pressure up to 830 kPa. (120PSI)

3.1.4 The APA shall be capable of testing three beam specimens simultaneously.

3.1.5 The APA shall have a programmable master cycle counter which can be preset to the desired number of cycles for a test. The APA shall be capable of automatically stopping the test at the completion of the programmed number of cycles.

3.1.6 The hoses shall be Gates 77B Paint Spray and Chemical 19mm ID (3/4 inch, 5.17 Mpa (750 PSI) W.P. GL 07148. The hoses should be replaced when any of the outer rubber casings has worn through and threads are exposed. Follow the APA manufacturer's instructions for the technique on replacing hoses.

3.2 Balance, 12,000-gram capacity, accurate to 0.1 gram.

3.3 Mixing utensils (bowls, spoon, spatula)

3.4 Ovens for heating aggregate and asphalt cement.

3.5 Compaction device and molds.

4. PREPARATION OF TEST SPECIMENS:

4.1 Number of Test Specimens – One test will use either three beam (75mm x 125mm x 300mm (3"x5"x12") specimens or six cylindrical (150mm diameter x 75mm)(6" diameter x 3") specimens. Note: Mold extensions are available for cylindrical specimens greater than 75mm tall.

4.2 Roadway Core Specimens

4.2.1 Roadway core specimens shall be 150 mm diameter with all surfaces of the perimeter perpendicular to the surface and of the core within 5 mm. Cores shall be trimmed with a wet masonry saw to a height of 75± 3 mm.

4.3 Plant Produced Mixtures

4.3.1 Samples of plant produced mixtures shall be obtained in accordance with ASTM 979 (AASHTO T 169). Mixture samples shall be reduced to the appropriate test size and compacted while the mixture is still hot. Reheating of loose plant mixture should be avoided.

4.4 Laboratory Prepared Mixtures

4.4.1 Mixture proportions are batched in accordance with the desired Job Mix Formula. Required batch sizes are determined in accordance with the Appendix XI.

4.4.2 The temperature to which the asphalt binder must be heated to achieve a viscosity of 170 ± 20 cSt shall be the mixing temperature. For modified asphalt binders, use the mixing temperature recommended by the binder manufacturer.

4.4.3 Dry mix aggregates and hydrated lime first (when lime is used), then add optimum percentage of asphalt cement. Mix the materials until all aggregates are thoroughly coated.

4.4.4 Test samples shall be aged in accordance with the short-term aging procedure in AASHTO PP2

4.4.5 The temperature to which the asphalt binder must be heated to achieve a viscosity of 280 ± 30 cSt shall be the compaction temperature. For modified asphalt binders, use the compaction temperature recommended by the binder manufacturer.

4.5 Laboratory Compaction of Specimens

4.5.1 One of several devices may be used to compact specimens in the laboratory. Details regarding the procedures for compacting specimens in each device should be referenced to the equipment manufacturer's instructions.

Note: Recent studies have shown that samples compacted with different laboratory compaction devices may have significantly different results. Each state agency should select one method as the standard for their agency.

4.5.2 Laboratory prepared specimens shall be compacted to contain 7.0 ± 1.0% air voids or as otherwise specified by the agency.

4.5.3 Compacted specimens should be left at room temperature (approximately 25° C) to allow the entire specimen to cool for a minimum of 3 hours.

5. DETERMINING THE AIR VOID CONTENTS

5.1 Determine the bulk specific gravity of the test specimens in accordance with ASTM: D 2726 (AASHTO: T 166).

5.2 Determine the maximum specific gravity of the test mixture in accordance with ASTM: D 2041 (AASHTO: T 209).

5.3 Determine the air void contents of the test specimens in accordance with ASTM: D 3203 (AASHTO: T 269).

6. CALIBRATING THE ASPHALT PAVEMENT ANALYZER

6.1 The Wheel Load should be calibrated when the APA Control Bar (on the computer) is closed and reopened, when the hoses in the hose rack are changed or when changes are made in the APA air supply system

6.1.1 For instructions see section 3.1 of this manual

6.2 The Vertical Measuring System should be calibrated when the APA Control Bar (on the computer) is closed and reopened or when the rut or fatigue wheels are exchanged.

6.2.1 For instructions see sections 3.2 of this manual

7. SELECTING THE TEST TEMPERATURE

7.1 The test temperature shall be set to the high temperature of the standard Superpave Binder Performance Grade for the specifying agency. For circumstances where the binder grade has been bumped, the APA test temperature will remain at the standard PG high temperature.

8. SPECIMEN PREHEATING

8.1 Place the specimens in the molds.

8.2 Specimens shall be preheated in the temperature calibrated APA test chamber or a separate calibrated oven for a minimum of 6 hours. Specimens should not be held at elevated temperatures for more than 24 hours prior to testing.

9. PROCEDURE

9.1 Set the hose pressure gage reading to 700 ± 35 kPa (100 ± 5 PSI). Set the load cylinder pressure reading for each wheel to achieve a load of 445 ± 22 N (l00 ± 5 lb.).

9.2 Stabilize the testing chamber temperature at the temperature selected in Paragraph 7.

9. Secure the preheated, molded specimens in the APA. The preheated APA chamber should not be opened more than 6 minutes when securing the test specimens into the machine. Close the chamber doors and allow 10 minutes for the temperature to restabilize prior to starting the test.

9.3 Initialize the computer with the APA and begin the test.

9.3.1 For instructions in the operation of the computer see section 4.2 Rutting Test: AVMS Operating Instructions

10. REPORT

10.1 The test report shall include the following information:
10.1.1 The laboratory name, technician name and date of test.
10.1.2 The mixture type and description.
10.1.3 Specimen type.
10.1.4 Average air void content of the test specimens.
10.1.5 The test temperature.
10.1.6 The average rut depth to the nearest 0.1 mm at 8000 cycles.
10.1.7 Print out of the Data Sheet
10.1.8 Print Out of the Rut Chart

ANNEX
(Mandatory Information)

A. CALIBRATION

The following items should be checked for calibration no less than once per year: (1) preheating oven, (2) APA temperature, (See section 3.5 APA Temperature Calibration) (3) APA wheel load, (See section 3.1 Wheel Load Calibration) (4) APA Vertical Calibration, (See section 3.2 APA Vertical Calibration) and (5) APA hose pressure (See section 3.3 APA Hose Pressure Check).

A.1. Temperature calibration of the preheating oven.

A.1.1 The preheating oven must be calibrated with a NIST traceable thermometer (an ASTM 65 C calibrated thermometer is recommended) and a metal thermometer well to avoid rapid heat loss when checking the temperature.

A.1.2 Temperature Stability

A.1.2.1 Set the oven to the chosen temperature (e.g. 60 C). Place the thermometer in the well and place them on the center of the shelf where the samples and molds will be preheated.

It usually takes an hour or so for the oven chamber, well and thermometer to stabilize. After one hour, open the oven door and read the thermometer without removing it from the well. Record this temperature. Close the oven door.

A.1.2.2 Thirty minutes after obtaining the first reading, obtain another reading of the thermometer. Record this temperature. If the readings from step2.1 and 2.2 are within 0.4 C, then average the readings. If the readings differ by more than 0.4 C then continue to take readings every thirty minutes until the temperature stabilizes within 0.4 C on two consecutive readings.

A.1.3 Temperature Uniformity

A.1.3.1 To check the uniformity of the temperature in the oven chamber, move the thermometer and well to another location in the oven so that they are on a shelf where samples and molds will be preheated, but as far as possible from the first location. Take and record readings of the thermometer at the second location every thirty minutes until two consecutive readings at the second location are within 0.4 C.

A.1.3.2 Compare the average of the two readings at the first location with the average of the stabilized temperature at the second location. If the average temperatures from the two locations are within 0.4 C, then the oven temperature is relatively uniform and it is suitable for use preheating APA samples. If the average of the readings at the two locations differ by more than 0.4 C then you must find another oven that will hold this level of uniformity and meets calibration.

A.1.4 Temperature Accuracy

A.1.4.1 Average the temperatures from the two locations. If that average temperature is within 0.4 C of the set point temperature on the oven, then the oven is reasonably accurate and calibration is complete.

A.1.4.2 If the set point differs from the average temperature by more than 0.4 C, then adjust the oven set point appropriately to raise or lower the temperature inside the chamber so that the thermometer and well will be at the desired temperature (e.g. 60 C).

A1.4.3 Place the thermometer and well in the center of the shelf. At thirty-minute intervals, take readings of the thermometer. When two consecutive readings are within 0.4 C, and the average of the two consecutive readings are within 0.4C of the desired test temperature (e.g. 60 C), then the oven has been properly adjusted and calibration is complete. If these two conditions are not met, then repeat steps A.1.4.2 and A.1.4.3.

APPENDIX XI

X. Calculation of Specimen Masses

X.1 Beam Specimens
X.1.1 Volume of specimen = 75 mm x 125 mm x 300 mm = 2812.5 cm^3.
X.1.2 Total mass of beam specimen, g = Gmm @ Opt. A.C. x 0.93 x 2812.5 cm^3
X.1.3 Beams may be batched in 1, 2 or 3 layers. Divide the total mass by the number of layers.
X.1.4 Individual weights for dry aggregate, lime and liquid A. C. per layer.
X.1.4.1 Mass of asphalt cement, g = grams/layer x % A. C. @ Opt.
X.1.4.2 Mass of aggregate, g = grams/layer – grams of A. C. (This includes lime, if used in the mixture).
X.1.4.3 Mass of aggregate excluding lime, g = grams of aggregate/1.01
X.1.4.4 Mass of lime, g = grams of aggregate – grams of aggregate excluding lime.
X.2 Cylindrical Specimens
X.2.1 Volume of Specimen = (0.7854 x (150 mm)^2 x 75 mm)/1000 = 1325.4 cm^3
X.2.2 Total mass of cylindrical specimen, g = Gmm @ Opt. A. C. x 0.93 x 1325.4 cm3
X.2.3 Individual weights for dry aggregate, lime and liquid A. C. per layer
X.2.3.1 Mass of asphalt cement, g = grams/layer x % A. C. @ Opt.
X.2.3.2 Mass of aggregate, g = grams/layer – grams of A. C. (this includes lime, if used in the mixture).
X.2.3.3 Mass of aggregate excluding lime, g = grams of aggregate/1.01
X.2.3.4 Mass of lime, g = grams of aggregate - grams of aggregate excluding lime.

4.2 Rutting Test: Operating Instructions

1. Place the specimens in the sample chamber of the APA.
2. On the Windows Desk Top. Click the “APA” icon.
3. After the APA Control Bar has loaded, click “Calibrate”. Perform all necessary calibrations from Chapter 3 Calibrating the Asphalt Pavement Analyzer.
4. Click “Setup”.
5. Choose **Rut Test** and click “OK”.
6. The next window will be Rut Test Parameters. From this window the user may:
   i. Change the length of the test. The Test Length default setting is 8000 cycles.
   ii. Change specimen type to cylindrical molds if necessary. Beam specimens are the default setting.
   iii. Turn off any wheel that will not be used.
   iv. Change the Max Rut depth Value.
   v. Change the Data Point Settings.
   vi. Set the hose pressure between 90-120 PSI. The default pressure is 100 PSI. If a new value is entered, press “Enter” on the keyboard.
7. After entering any changes, click “Next”.
8. When asked “Are you sure?”, click “Yes”.
9. Click the “Cabin Heating” button (Red) under **Temp Control** to activate the heat system (turns Green).
   i. To change the temperature click on the green box, under the “Cabin Heating” button, labeled **SP** (Set Point) and enter the desired temperature value.
   ii. To delay the start of heating, do not click “Cabin Heating”. Instead click “Auto Temp”, click “Cabin Heat”, enter the date and the desired time to begin heating.
10. The button under **Operating Mode** should be in “Manual” mode (Red). Click “Manual” to enter into “Auto” mode (Green).
11. To start the test, click the **Test Control** “Start” button. It will now be “Test Running” (2 Times).
12. If the test will not start, check **Alarm Status** and close the indicated door. Then click “Reset Alarms”.
13. The test may be paused and restarted at any time. Click “Pause” and the Carriage Assembly will stop but the wheels will stay down.
    a. Opening the front doors will also pause the test. To restart, close the doors and click “Reset Alarms”.
14. To end a test before the end of the cycle countdown, click “Stop”. The Carriage Assembly will stop and the wheels will retract. It will not be possible to restart the same test.
15. To end the test on one wheel without stopping the test, click “Abort L” (Left wheel retracts), or “Abort C” (Center wheel retracts), or “Abort R” (Right wheel retracts). The test will continue to run unless all three wheels are selected.
16. If manual measurements are taken, they can be recorded on the Data Sheet. Record manual measurements in the “white” cells labeled 1, 2, 3, 4, or 5.
17. On the Data Sheet, enter the Project #, Mix ID #, etc.
18. To change the plot setting on the Rut Chart, place the mouse cursor over the white background of the chart and double click. A pop up window will appear with the default setting of 100. The user may choose any value from 1-8000.
19. **DO NOT** save test in the folder that automatically open (APA2), this is part of the program. Creat a folder in MY Documents or on the desktop to save your test in. To save the test click “File” and “Save As”. Enter a file name and click “Save”. If the program is closed before saving, the computer will prompt to save.
    Note: If at any time the computer looses power before saving, all test data will be lost. It is recommended that each customer purchase a UPS (Uninterruptible Power Source) with at least a 30 minute run time.
20. To open a saved test, first open Excel, then click “File” and click “Open”. Find the folder where the file is stored and open the saved test. Do not try to open the test file without first opening Excel. The computer will not be able to find the test file and open it.
21. To print any view, click “File”, “Print Preview” and “Print.”

4.3 (ASTM Format) Standard Test Method For Determining Moisture Damage Susceptibility Using The Automated Asphalt Pavement Analyzer

1. SCOPE

1.1 This method describes a procedure for testing the moisture damage susceptibility of asphalt-aggregate mixtures using dynamic loading applications in the Automated Asphalt Pavement Analyzer (APA) to simulate traffic.

1.2 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.3 This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulations prior to use.

2. REFERENCED DOCUMENTS

2.1 ASTM Standards:

D: 979 Standard Practice for Sampling Bituminous Paving Mixtures

D: 2726 Standard Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Saturated Surface-Dry Specimens

D: 2041 Standard Test Method for Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures

D: 3203 Standard Test Method for Percent Air Voids in Compacted Dense and Open Bituminous Mixtures

E: 178 Standard Practice for Dealing With Outlying Observations

2.2 AASHTO: PP-2 Short and Long Term Aging of Hot Mix Asphalt.

3. APPARATUS:

3.1 Asphalt Pavement Analyzer (APA) – A thermostatically controlled device designed to test the moisture damage (submerged deformation) susceptibility of hot mix asphalt by applying repetitive linear loads to compacted test specimens through pressurized linear hoses.

3.1.1 The APA shall be thermostatically controlled to maintain the test water temperature at any set point between 40° and 65° C within 1° C (104° to 149° F ± 2° F).

3.1.2 The APA shall be capable of independently applying loads up to 450N (208 pounds) to the three wheels. The loads shall be calibrated to the desired test load by an external force transducer.

3.1.3 The pressure in the test hoses shall be adjustable and capable of maintaining pressure up to 830 kPa. (120PSI)

3.1.4 The APA shall be capable of testing three submerged beam specimens simultaneously.

3.1.5 The APA shall have a programmable master cycle counter which can be preset to the desired number of cycles for a test. The APA shall be capable of automatically stopping the test at the completion of the programmed number of cycles.

3.1.6 The hoses shall be Gates 77B Paint Spray and Chemical 19mm ID (3/4 inch, 5.17 Mpa (750 PSI) W.P. GL 07148. The hoses should be replaced when any of the outer rubber casings has worn through and threads are exposed. Follow the APA manufacturer's instructions for the technique on replacing hoses.

3.6 Balance, 12,000-gram capacity, accurate to 0.1 gram.

3.7 Mixing utensils (bowls, spoon, spatula)

3.8 Ovens for heating aggregate and asphalt cement.
3.9 Compaction device and molds.

4. PREPARATION OF TEST SPECIMENS:

4.1 Number of Test Specimens – One test will use either three beam (75mm x 125mm x 300mm (3”x5”x12”) specimens or six cylindrical (150mm diameter x 75mm)(6” diameter x 3”) specimens. Note: Mold extensions are available for cylindrical specimens greater than 75mm tall.
4.2 Roadway Core Specimens
4.2.1 Roadway core specimens shall be 150 mm diameter with all surfaces of the perimeter perpendicular to the surface and of the core within 5 mm. Cores shall be trimmed with a wet masonry saw to a height of 75± 3 mm.
4.3 Plant Produced Mixtures shall be prepared according to Section 4.1.
4.4 Laboratory Prepared Mixtures
4.4.1 Mixture proportions are batched in accordance with the desired Job Mix Formula. Required batch sizes are determined in accordance with the Appendix.
4.4.2 The temperature to which the asphalt binder must be heated to achieve a viscosity of 170 ± 20 cSt shall be the mixing temperature. For modified asphalt binders, use the mixing temperature recommended by the binder manufacturer.
4.4.3 Dry mix aggregates and any solid additive first, then add optimum percentage of asphalt cement. Mix the materials until all aggregates are thoroughly coated.
4.4.4 Test samples shall be aged in accordance with the short-term aging procedure in AASHTO PP2
4.4.5 The temperature to which the asphalt binder must be heated to achieve a viscosity of 280 ± 30 cSt shall be the compaction temperature. For modified asphalt binders, use the compaction temperature recommended by the binder manufacturer.
4.5 Laboratory Compaction of Specimens
4.5.1 One of several devices may be used to compact specimens in the laboratory. Details regarding the procedures for compacting specimens in each device should be referenced to the equipment manufacturer’s instructions.
4.5.2 Laboratory prepared specimens shall be compacted to contain 7.0 ± 1.0% air voids or as otherwise specified by the agency.
4.5.3 Compacted specimens should be left at room temperature (approximately 25° C) to allow the entire specimen to cool for a minimum of 3 hours.

5. DETERMINING THE AIR VOID CONTENTS

5.1 Determine the bulk specific gravity of the test specimens in accordance with ASTM: D 2726 (AASHTO: T 166).
5.2 Determine the maximum specific gravity of the test mixture in accordance with ASTM: D 2041 (AASHTO: T 209).
5.3 Determine the air void contents of the test specimens in accordance with ASTM: D 3203 (AASHTO: T 269).

6. PREPARING THE ASPHALT PAVEMENT ANALYZER

6.1 Set the hose gauge pressure to read 700 ± 35 kPa (100 ± 5 PSI), and set the cylinder pressure for each wheel to a load of 445 ± 22 N (100 ± 5 pounds), or as specified by the agency.
6.2 Set the preset counter to 8000 cycles.

7. SELECTING THE WATER TEST TEMPERATURE

7.1 The water test temperature shall be one performance grade below the high temperature of

the standard Superpave Binder Performance Grade for the project conditions. For circumstances where the binder grade has been bumped, the APA test water temperature will remain at one performance grade below the standard PG high temperature.

8. PRECONDITIONING TEST SPECIMENS:

Specimens may be preconditioned using the following procedures, or by procedures specified by the agency.

8.1 Place the specimens into a vacuum container supported above the container bottom by a spacer.

8.1.1 Fill the container with distilled water at room temperature so that one-inch of water is above the top of the specimens.

8.1.2 Apply a vacuum of 13 – 67 kPa absolute pressure (26 to 10 inches Hg partial pressure) for five to ten (5 – 10) minutes. Remove the vacuum and leave the specimen submerged in water for five to ten (5 – 10) minutes.

8.1.3 Determine the bulk specific gravity of the specimen by ASTM: D 2726 (AASHTO: T-166). Calculate the volume of absorbed water (J) in cubic centimeters (CC) using the following equation:

$$J = B' - B$$

where,

J = volume of absorbed water in CC

B' = Mass of saturated Surface-Dry specimens after partial vacuum, grams (section 8.1.4).

B = Mass of saturated Surface-Dry specimen prior to vacuum saturation, grams (section 5.1).

8.1.4 Determine the degree of saturation by comparison the volume of absorbed water (J) with the volume of air voids (I) from section 5.1 using the following equation:

$$S' = \frac{100J}{I}$$

where,

S' = Degree of saturation, percent

J = Volume of absorbed water, CC

I = Volume of air voids, CC

If the degree of saturation is between 55 and 80 percent, proceed with Section 8.1.6.

8.1.5 If the degree of saturation is less than 55 percent, repeat the procedure beginning with section 8.1 using more vacuum and/or time. If the volume of water is more than 80 percent, the specimen may have been damaged and must be discarded. Repeat the procedure with a new specimen beginning with section 8.1 using less vacuum and/or time. If no Freeze–Thaw is to be applied, proceed to section 8.17.

8.1.6 Cover each of the vacuum saturated specimens tightly with a plastic film such as saran wrap, place the wrapped specimen into a plastic bag containing 10 ml of water and seal the bag. Place the plastic bag containing the specimens into a freezer at a temperature of -18° C ± 3° C (0 ± 5° F) for at least 16 hours. Remove the specimens from the freezer.

8.1.7 Place the specimens into a bath containing water at the temperature specified in Section 7 for 24 ± 1 hour. As soon as possible, remove the plastic bag and film from the specimens if samples were freeze thawed.

9. TEST PROCEDURE:

9.1 Place the preconditioned specimens from Section 8.1.7 into the Asphalt Pavement Analyzer mold and tighten the mold.

9.2 Place the molds with the preconditioned specimens into the APA and center them beneath the hoses.

9.3 Raise the water tank and fill it with water to submerge the test specimens and allow to sit undisturbed for 2 ± ¼ hours.

9.4 Start the APA and allow it to run for 8000 cycles; exercise caution to prevent developing an excessively deep rut to avoid damage to the wheels by their contact with the test specimen.

9.4.1 For instructions in the operation of the computer see section 4.2 Rutting Test: AVMS Operating Instructions

10. REPORT

10.1 The test report shall include the following information.
10.1.1 The laboratory name, technician name and date of test.
10.1.2 The mixture type and description.
10.1.3 Specimen type.
10.1.4 Average air voids and average voids filled with water (%)
10.1.5 The water test temperature.
10.1.6 The average rut depth to the nearest 0.1 mm and the number of APA wheel cycles applied.
10.1.7 Print out of the Data Sheet
10.1.8 Print Out of the Rut Chart

APPENDIX XI

XI. Calculation of Specimen Masses

X1.1 Beam Specimens
X1.1.1 Volume of specicmen = 75 mm x 125 mm x 300 mm = 2812.5 cm^3.
X1.1.2 Total mass of beam specimen, g = Gmm @ Opt. A.C. x 0.93 x 2812.5 cm^3
X1.1.3 Beams may be batched in 1, 2 or 3 layers. Divide the total mass by the number of layers.
X1.1.4 Individual weights for dry aggregate, lime and liquid A. C. per layer.
X1.1.4.1 Mass of asphalt cement, g = grams/layer x % A. C. @ Opt.
X1.1.4.2 Mass of aggregate, g = grams/layer – grams of A. C. (This includes lime, if used in the mixture).
X1.1.4.3 Mass of aggregate excluding lime, g = grams of aggregate/1.01
X1.1.4.4 Mass of lime, g = grams of aggregate – grams of aggregate excluding lime.
X1.2 Cylindrical Specimens
X1.2.1 Volume of Specimen = (0.7854 x (150 mm)^2 x 75 mm)/1000 = 1325.4 cm^3
X1.2.2 Total mass of cylindrical specimen, g = Gmm @ Opt. A. C. x 0.93 x 1325.4 cm3
X1.2.3 Individual weights for dry aggregate, lime and liquid A. C. per layer
X1.2.3.1 Mass of asphalt cement, g = grams/layer x % A. C. @ Opt.
X1.2.3.2 Mass of aggregate, g = grams/layer – grams of A. C. (this includes lime, if used in the mixture).
X1.2.3.3 Mass of aggregate excluding lime, g = grams of aggregate/1.01
X1.2.3.4 Mass of lime, g = grams of aggregate - grams of aggregate excluding lime.

4.4 Moisture Test: Operating Instructions

A. Preheating the water before the test

1. On the Windows Desk Top. Click the “APA” icon.
2. After the **APA Control Bar** has loaded, click “Calibrate”. Perform all necessary calibrations from Chapter 3 Calibrating the Asphalt Pavement Analyzer.
3. Click “Water Heating” (Red) turns to “Water Heat On” (Green).

i. To change the water temperature click on the green box, under the “Water Heating” button, labeled SP (Set Point) and enter the desired temperature value.

4. Click the “Cabin Heating” button (Red) under **Temp Control** to activate the heat system (turns Green).

a. To change the temperature click on the green box, under the Cabin Heating button, labeled SP (Set Point) and enter the same temperature as the water temperature.

5. Under **Operating Mode** click “Water Pump” (Red) turns green. Circulating the water will help it to heat the water tank much faster.
6. When the water reaches temperature, turn off the water pump, allow the water tray to drain and proceed to the next step.

B. Starting the test after the water is preheated

1. Place the specimens in the sample chamber of the APA.
2. Click “Setup”
3. Choose **Moisture Test** and click “OK”.
4. The next window will be Moisture Test Parameters. From this window the user may:
   a. Change the length of the test. The Test Length default setting is 25000 cycles.
   b. Change specimen type to cylindrical molds if necessary. Beam specimens are the default setting.
   c. Turn off any wheel that will not be used.
   d. Change the Max Rut depth Value.
   e. Change the Data Point Settings.
   f. Set the hose pressure between 90-120 PSI. The default pressure is 100 PSI. If a new value is entered, press “Enter” on the keyboard.
5. After entering any changes, click “Next”.
6. When asked “Are you sure?”, click “Yes”.
7. The button under **Operating Mode** should be in “Manual” mode (Red). Click “Manual” to enter into “Auto” mode (Green).
8. To start the test, click the **Test Control** “Start” button (2 Times). It will now be “Test Running”.
9. If the test will not start, check **Alarm Status** and close the indicated door. Then click “Reset Alarms”.
10. The test may be paused and restarted at any time. Click “Pause” and the Carriage Assembly will stop but the wheels will stay down.
    i. Opening the front doors will also pause the test. To restart, close the doors and click “Reset Alarms”.
11. To end a test before the end of the cycle countdown, click “Stop”. The Carriage Assembly will stop and the wheels will retract. It will not be possible to restart the same test.
12. To end the test on one wheel without stopping the test, click “Abort L” (Left wheel retracts), or “Abort C” (Center wheel retracts), or “Abort R” (Right wheel retracts). The test will continue to run unless all three wheels are selected.

13. If manual measurements are taken, they can be recorded on the Data Sheet. Record manual measurements in the “white” cells labeled 1, 2, 3, 4, or 5.
14. On the Data Sheet, enter the Project #, Mix ID #, etc.
15. **DO NOT** save test in the folder that automatically opens (APA2), this is part of the program. Creat a folder in My Documents or on the desktop to save your test in. To save the test click “File” and “Save As”. Enter a file name and click “Save”. If the program is closed before saving, the computer will prompt to save.
    Note: If at any time the computer looses power before saving, all test data will be lost. It is recommended that each customer purchase a UPS (Uninterruptible Power Source) with at least a 30 minute run time.
16. To open a saved test, first open Excel, then click “File” and click “Open”. Find the folder where the file is stored and open the saved test. Do not try to open the test file without first opening Excel. The computer will not be able to find the test file and open it.
17. To print any view, click “File”, “Print Preview” and “Print.”

4.4 (ASTM Format)

Standard Test Method For Determining Fatigue **Susceptibility Using The Automated Asphalt Pavement Analyzer**

1. SCOPE

1.1 This method describes a procedure for testing the fatigue properties of asphalt aggregate mixtures using the Asphalt Pavement Analyzer (APA).

2. APPARATUS

2.1. Asphalt Pavement Analyzer (APA) – A thermostatically controlled device designed to determine the fatigue properties of hot mix asphalt by applying repetitive linear loads to compacted test specimens through a loaded wheel.

2.1.1 The APA shall be thermostatically controlled to maintain the test temperature and conditioning chamber at any set point between 5 and 70° ± 1°C.

2.1.2 The APA shall be capable of independently applying loads up to 1113 N (250 pounds) to each of the three wheels. These loads shall be calibrated to 1113 N (250 pounds) or other desired test load by an external force transducer.

2.1.3. The APA shall be capable of testing up to three beam specimens independently or simultaneously.

2.1.4 The APA shall have a programmable master cycle counter which can be preset to 50,000 or other desired number of cycles for a test. The APA shall be capable of stopping the counter when a specimen strain gauge breaks.

2.1.5 Fatigue Molds – High-density polyethylene molds to hold the asphaltic concrete beam. The top of each end of the mold will securely hold the beam in place while the lower portion of the beam is free to move as load repetitions are applied and the beam flexes.

2.1.6 Automated measurement – The APA shall be equipped with an Automated Vertical Measurement System including a computer program to plot measurements received from transducer signals that represent vertical movement of the beam. The computer program will plot two lines to represent each beam. The solid line is an average of the vertical movement at the ends of the beam and is called the reference line (REF). The dotted line is the vertical movement of the center of the beam length and is called the variable line (VAR). The NET difference in the two lines (values) is the deflection at the center of the beam's length. As the test progresses, the two lines diverge at a relatively constant rate until the beam approaches fatigue failure. The lines then diverge rapidly.

2.1.7 Failure is the number of cycles at which the beam breaks; or when the deflection rate of change (ROC) exceeds 1.0 mm/stroke(default value). Often at this point, deflection changes very rapid and an ROC greater than 1.0 is shown on the Stroke Count Chart display and the Fatigue Test Data Sheet. In such cases very few cycles have been applied after the 1.0 mm occurred in the single stroke. Actually, the 'single stroke' is an average of ten strokes based on a running average and the ROC changes with the running average.

TEST SPECIMENS

3.1 Number of test specimens – One test will consist of three beams (75 mm x 125 mm x 300 mm) specimens tested simultaneously.

3.2 Specimens shall be compacted to 7 ± 1% air voids (VTM).

3.3 Laboratory prepared mixtures – Mixtures shall be proportioned in accordance with the job mix formula.

3.3.1 Following mixing, lab prepares mixtures shall be short-term aged in accordance with AASHTO PP2.

3.4 Plant produced mix – Plant produced mix shall be sampled in accordance with AASHTO T-168 and reduced to the size needed for a beam with 7 ± 1% air voids. It may be necessary to make small adjustments to the reduced sample weight to obtain the desired void content prescribed above.

4. COMPACTION

4.1 Compacting temperature – The temperature to which the asphalt binder must be heated to achieve a viscosity of 280 ± 30 centistokes shall be the compacting temperature. This applies to plant mix and laboratory prepared specimens. Mixture shall not be heated at the compacting temperature more than one hour. It is preferred that the mixture not be reheated therefore compacting should be accomplished before the material cools.

5. AGING TEST SPECIMENS

5.1 Following compaction, the test specimen shall be is long-term aged.

5.1.1 Place the compacted test specimen on a shelf in a forced draft oven for 120 ± 0.5 hours at a temperature of 85° ± 3°C.

5.1.2 After 120 hours, turn the oven off, open the doors, and allow the test specimen to cool to room temperature. Do not touch or removed the specimen until it has cooled to room temperature.

5.1.3 After cooling to room temperature, remove the test specimen from the oven. The aged specimen is now ready for testing as required.

6. DETERMINING THE AIR VOIDS CONTENTS

6.1 Determine the bulk specific gravity of the test specimens in accordance with AASHTO T166.

6.2 Determine the maximum specific gravity of the test mixture in accordance with AASHTO T209.

6.3 Determine the air void contents of the test specimens in accordance with AASHTO T269.

7. PROCEDURE FOR FATIGUE TESTING

7.1 Place the test specimens into the molds so that the top of the specimen during compaction is the top of the specimen during the test.

7.2 Set the APA temperature to 20°C (68°F) until the specimens reach this or agency specified temperature. A dummy specimen with an embedded thermometer shall be placed near the test specimens to determine when test temperature is reached.

7.3 Set the precalibrated pressure gauge reading to 1113 ± 4.5 N (250 ± 1 pound).

7.4 Preset the counter to 50,000 cycles (or other agency specified cycles).

7.5 Start the testing. The APA will stop at the end of the test cycle, or when all three beams have failed the fatigue.

7.5.1 For instructions in the operation of the computer see section 4.5 Fatigue Test: AVMS Operating Instructions

8. REPORT

8.1 The test report shall include the following information:

8.1.1 The laboratory name technician name, and date of test.

8.1.2 The mixture type and description.

8.1.3 Air void content of test specimens.

8.1.4 Number of cycles (fatigue life) of each specimen.

9. ESTIMATE BEAM BATCH MASS

9.1 Volume of specimen (should be measured for each individual mold) = 75 mm x 125 mm x 300 mm = 2812.5 cm^3

9.2 Total mass beam specimen (g) = Gmm @ Optimum AC x 0.93 x 2812.5 cm^3

4.5 Fatigue Test: AVMS Operating Instructions

1. Place the specimens in the sample chamber of the APA.
2. On the Windows DeskTop. Click the “APA” icon.
3. After the APA Control Bar has loaded, click “Calibrate”. Perform all necessary calibrations from Chapter 3 Calibrating the Asphalt Pavement Analyzer.
4. Click “Setup”.
5. Choose Fatigue Test and click “OK”.
6. The next window will be Fatigue Test Parameters. From this window the user may:
   a. Change the length of the test. The Test Length default setting is 50000 cycles.
   b. Alter the Rate of Change (ROC).
   c. Turn off any wheel that will not be used.
   d. Change the Data Point Settings.
7. After entering any changes, click “Next”.
8. When asked “Are you sure?”, click “Yes”.
9. Click the “Cabin Cooling” button (Red) under **Temp Control** to activate the cooling system (turns Green).
   a. To change the temperature click on the green box, under the Cabin Cooling button, labeled SP (SET POINT) and enter the desired temperature value.
   b. Note: Do not leave the light on. The heat from the bulb will slow the cooling inside the APA.
   c. To delay the start of cooling, do not click “Cabin Cooling”. Instead click “Auto Temp”, click “Cabin Cool”, enter the date and the desired time to begin cooling.
10. The button under **Operating Mode** should be in “Manual” mode (Red). Click “Manual” to enter into “Auto” mode (Green).
11. To start the test, click the **Test Control** “Start” button. It will now be “Test Running”.
12. If the test will not start, check **Alarm Status** and close the indicated door. Then click “Reset Alarms”.
13. The test may be paused and restarted at any time. Click “Pause” and the Carriage Assembly will stop but the wheels will stay down.
    a. Opening the front doors will also pause the test. To restart, close the doors and click “Reset Alarms”.
14. To end a test before the end of the cycle countdown, click “Stop”. The Carriage Assembly will stop and the wheels will retract. It will not be possible to restart the same test.
15. To end the test on one wheel without stopping the test, click “Abort L” (Left wheel retracts), or “Abort C” (Center wheel retracts), or “Abort R” (Right wheel retracts). The test will continue to run unless all three wheels are selected.
16. On the Data Sheet, enter the Project #, Mix ID #, etc.
17. **DO NOT** save test in the folder that automatically open (APA2), this is part of the program. Create a folder in My Documents or on the desktop to save your test in. To save the test click “File” and “Save As”. Enter a file name and click “Save”. If the program is closed before saving, the computer will prompt to save.
    Note: If at any time the computer looses power before saving, all test data will be lost. It is recommended that each customer purchase a UPS (Uninterruptible Power Source) with at least a 30 minute run time.
18. To open a saved test, first open Excel, then click “File” and click “Open”. Find the folder where the file is stored and open the saved test. Do not try to open the test file without first opening Excel. The computer will not be able to find the test file and open it.
19. To print any view, click “File”, “Print Preview” and “Print.”

Chapter 5
Maintenance

5.1 Replacement of Rubber Hoses

The special high-pressure hoses have the life expectancy of about 20-30 8000-cycle rutting tests, depending on the abrasiveness of the asphalt mixtures being tested. Use the following type of hose for replacement: Specification: Gates 77B, 3/4 in., 750-PSI hose.

A. Checking for wear on the hoses
   1. Remove the hose rack from the APA.
   2. Observe the bottom of the hoses for excessive wear.
   3. Grab the hose in the palm of the hand and press the worn places with your fingertips.
   4. A good hose will be resistant to deformation, if the hose is easily depressed replace immediately.

B. Hose replacement
   1. If replacement hoses are not immediately available, measure the inside diameter of the rack from front to back.
   2. Have this measurement ready and call PTI for new hoses.

C. Hose Installation
   1. Remove the old hoses and hose clamps before removing the hose barb adapters from the hose rack. Cutting lengthwise through the rubber hose at the hose barb is the easiest method of removal. See Figure 2.2.5
   2. Remove the 3 hose barbs from the rear of the hose rack. The three hose barbs in the front of the rack should be left in place if possible.
   3. Lubricating the hose barb adapters with a small amount of water or Windex may ease the installation of the adapters into the hoses. (Note: **do not** use dishwashing soap or grease or the hose will twist during rut testing.)
   4. Start the hose onto the front hose barbs. It may be necessary to tap them on with a hammer.
   5. Each hose should slide all the way up to the shoulder of each adapter.
   6. Tighten down the hose clamp.
   7. Insert the hose barb into the other end of the hose.
   8. If insertion is difficult, the hammer may be used but place the nut onto the threads to protect it from the hammer head.
   9. Install the rear hose clamp
   10. Install the rear hose barb into the hose rack and put the nut in place.
   11. Tighten the rear hose barb adapters until the hose is stretched 1 inch (2.5 cm) longer than its original length.

D. Calibrating the hoses to the wheel path
1. Place three sample molds onto the sample tray and turn them upside down. This will allow the hose rack to rest on a solid surface for proper calibration.
2. Install the hose rack into the APA and couple the air quick connect.
3. Shut the sample tray doors and use the stroke jog to position the carriage assembly at the back of the test chamber.
4. Turn the Left Cylinder switch (or Middle or Right) to calibrate.
5. Observe the position of the wheel to the hose.
6. If the wheel and hose are in alignment, raise the cylinder and proceed to calibrate the middle and right hoses beginning at step 4.
7. If the hose is out of line with the wheel, turn the cylinder switch to off and remove the hose rack.
8. Loosen the rear-retaining nut and move the hose to the right or left as necessary. Repeat steps 2 through 8.
9. When the rear of the hose rack is finished, close the sample tray doors and use the stroke jog to bring the carriage assembly to the front of the test chamber.
10. Repeat steps 4 through 8 until finished.
11. Turn all of the cylinder switches to auto and start the APA.
12. Be sure that all of the wheels are centered over each hose.
13. If all of the wheels are tracking properly, the APA is ready for use.

5.2 Wheel Removal and Installation

A. Wheel Removal
1. Remove the hose rack and test samples
2. Lower one wheel with the Left, Middle or Right Wheel Calibrate switch
3. With a 5/32 Allen wrench, loosen both set screws
4. Using either a brass or aluminum rod, drive the axle out of the wheel

a. There are also two brass washers on either side of the wheel
b. It is important to **avoid using a steel rod** to drive out the axle, because the axle may be permanently damaged.
c. If the two arms that hold the axle begin to spread apart while the axle is being driven out, use a C-clamp or 12" Channel Lock pliers to press the axle carrier together.

B. Wheel installation
1. Slide the axle through the axle carrier until the first washer will hang on it
2. Hold the wheel in place and slide the axle through it
3. Drop the second washer into position and slide the axle into place
4. The wheel should turn freely, without a lot of side to side movement
5. If movement is excessive, use a C-clamp or 12" Channel Lock pliers to press the axle carrier together. Be careful not to hinder the free rotation of the wheel.
6. Tighten the set screws.

5.3 APA Lubrication

1. The rails of the roller assembly and the carriage drive cam should be lightly greased with a lithium-based grease as needed. See Figure 2.2.3
2. If the APA was equipped with an oiling system it should not be used. The SMC cylinders, regulators and valve pack are pre-lubricated and do not require oil. However, if oil is added, see Section 6.4, then the SMC cylinders, regulators and valve pack will have to be maintained with oil from the system oiler. See Figure 2.2.14
3. The gear oil for the drive assembly should be checked once per year. See Figure 2.2.2

5.4 Keeping Moisture Out of the APA

1. It is essential that the APA air system be kept free from moisture in the compressed air.
2. The connecting rod seals of the 3 wheel cylinders are very susceptible to moisture and may be permanently damaged if moisture is allowed into the APA.
3. In order for PTI to warranty the cylinders, regulators and valve pack in the APA, a refrigerated air dryer must be used.
4. If the customer's location already has a refrigerated air dryer, it is the customer's responsibility to keep it in good working order.
5. PTI offers a refrigerated air dryer specifically for the APA and, if used properly, will guarantee the APA against moisture damage.
6. If moisture does enter the APA,
   a. Discover the reason for the failure of the air dryer.
   b. Disconnect all effected airlines both inside and outside of the APA.
   c. Turn the compressed air on and blow the moisture out of the lines.
7. If moisture does enter the APA or if moisture continues to be a problem, it may be necessary to add 30-weight turbine oil to the system oiler, see Fig 2.2.14. Turbine oil will protect the APA against moisture damage but it must be checked and maintained regularly for the life of the machine.

Chapter 6

Computer Software Installation Instructions

6.1 Computer Software Installation

If an error occurs in the performance of the APA software, it may be reloaded with the following steps.

1. Click “Windows Explorer”
2. On the C drive locate the folder “APA Backup” and click on the folder. A folder labeled “APA VB Prj “ should be visible. If the “APA Backup” folder was not available. Place the APA CD in the CD-Rom Drive and find the folder labeled “APA VB Prj”.
3. Right click and copy the “APA VB Prj” folder.
4. Place the cursor over the “Local Disc (C:)” icon. Right click and paste. Note: Do not paste the “APA VB Prj” over the folder on the C drive labeled “APA VB Prj”.
5. If asked to Overwrite, click “Yes”.

Chapter 7
Trouble Shooting and Electrical Drawings

7.1 Trouble Shooting the APA

1. Loading system will not move.
   a. Check door-warning lights.
   b. Check circuit breaker 1 on left control panel in ON position.

2. Water level low during submerged test
   a. Check water level in tank.
   b. Check valve in water pump discharge line is open.
   c. Check circuit breaker 2 in left panel is on for water pump power.
   d. Adjust Weir Gate.

3. Water will not heat to selected temperature.
   a. Check circuit breaker 3 in left panel for water heater power is on.
   b. Check water heater element.
   c. Check thermocouple.

4. Cabinet will not heat to selected temperature.
   a. Check circuit breaker 7 in left panel for cabinet heat is on.
   b. Check circuit breaker 5 in left panel for fan power is on.
   c. Check thermocouple

5. Cabinet will not cool to selected temperature.
   a. Check circuit breaker 6 in left panel for compressor power is on.
   b. Check circuit breaker 5 in left panel for fan power is on.
   c. Check thermocouple.
   d. Check Freon level in refrigeration unit.

7.2 Diagnosing Irregular Graphs

1. **All three lines** in the graphs experience identical decrease in apparent rut depths, followed by simultaneous increases and decreases of all three lines throughout test. No graph available
   Note: Rut resistant mixes that deform less than 2 mm may show irregularities. This is a normal occurrence in the APA under these conditions. See Figure 8.2.6 and 8.2.7
   a. Air inlet pressure to low, check regulator inside right rear door of APA and adjust. See figure 2.2.14
   b. Air inlet pressure to low, check air compressor and increase minimum pressure at the pressure switch.

Figure 8.2.1

2. **One or more lines** in the graph shows sinusoidal waves. See Figure 8.2.2
   Note: Rut resistant mixes that deform less than 2 mm may show irregularities in the. This is a normal occurrence in the APA under these conditions. See Figure 8.2.6 and 8.2.7

   a. Check transducers for tightness

Switch wheels to CAL and listen for audible leaks:

   b. in the solenoids of the valve pack. See Figure 2.2.4

Switch wheels to CAL and listen for audible leaks and use soapy water to check for leaks:

   c. in the fittings attached to the top of the wheel cylinder.
   d. in the fittings leading from the top of the wheel cylinder to the fittings on the intake manifold of the sample chamber.
   e. in the fittings leading from the valve pack to the wheel regulators. See Figure 2.2.13
   f. in the fittings leading from the regulators to the intake manifold of the sample chamber. See Figure 2.2.13

If the sinusoidal wave persists, it may be necessary to:

   a. Pull out the transducers and replace the O-ring.
   b. Replace the fittings and air hoses attached to the wheel cylinders

Note: Air leaks in the fittings on the bottom of the cylinders cannot cause sinusoidal waves in the graph.

This graph represents the sinusoidal wave that may appear due to an air leak. To determine if there is an air leak point the mouse to the graph on the chart and double click. Enter a value of 1. See Figure 8.2.3 next.

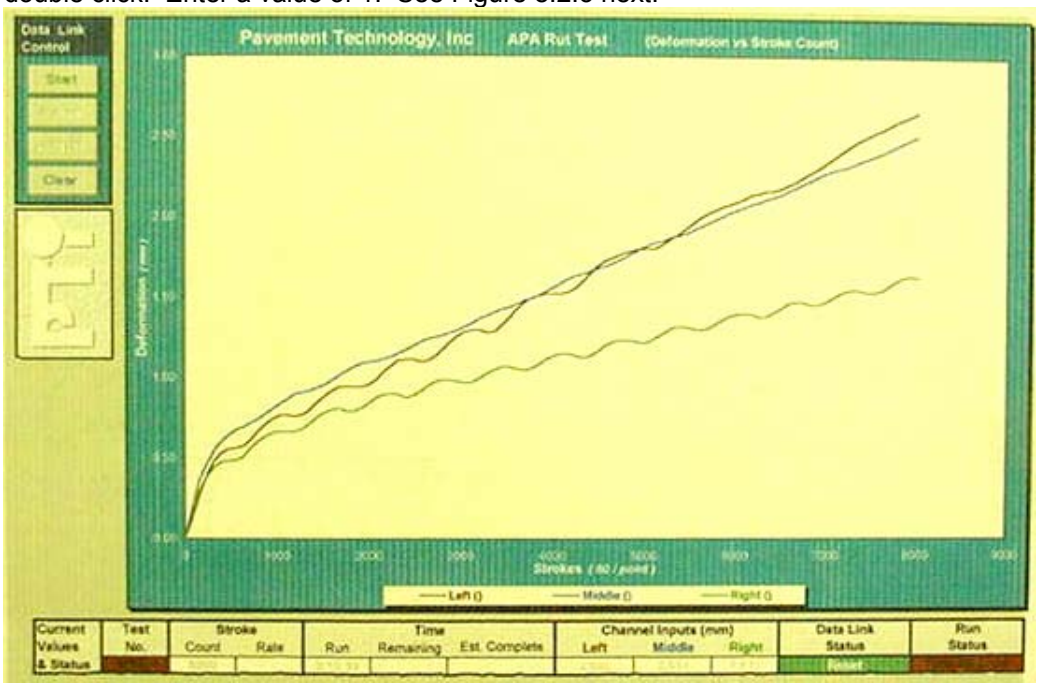


Figure 8.2.2

Figure 8.2.3 shows the graph after it has been plotted at 1 stroke/ point. A system air leak should look similar to this. The trend of the line will closely match the original graph. The lines will be a little thicker and have a fuzzy appearance.

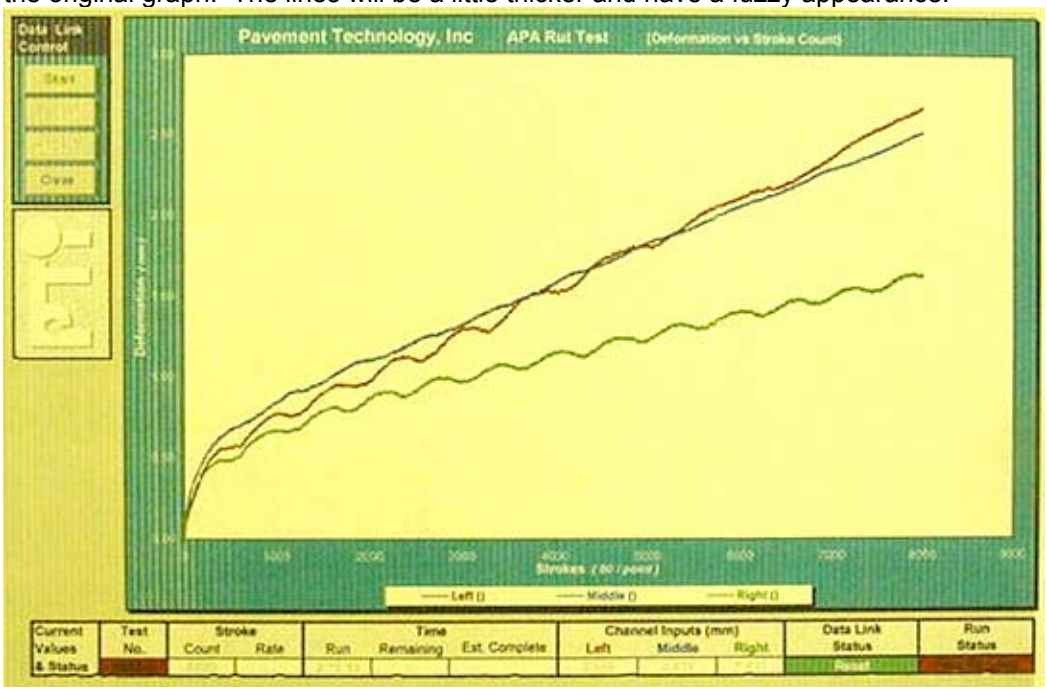


Figure 8.2.3

3. APA does not record rut information or **one or more lines are very erratic**

Note: Rut resistant mixes that deform less than 2 mm may show irregularities in the graph. This is a normal occurrence in the APA under these conditions. See Figure 8.2.6 and 8.2.7

a. Open DAS Calibration and check voltage inputs from Left, Middle, and Right Channels. If voltage is being received, calibrate the Vertical and Horizontal Measuring System, Section 3.2 and 3.4
b. Check APA computer cord attachment to computer
c. Check transducer cable tightness to transducer
d. Check for loose transducer cable and computer cable wires on the terminals of the right panel.
e. Heat induced transducer failure. See Figure 8.2.4

This graph represents a heat induced transducer failure. The test ran 1460 cycles at 185 F. To determine if there is a failure, point the mouse to the graph on the chart and double click. Enter a value of 1. See Figure 8.2.5 next

Figure 8.2.4

Figure 6.2.5 shows the graph after it has been plotted at 1 stroke/ point. A heat induced transducer failure should look similar to this.

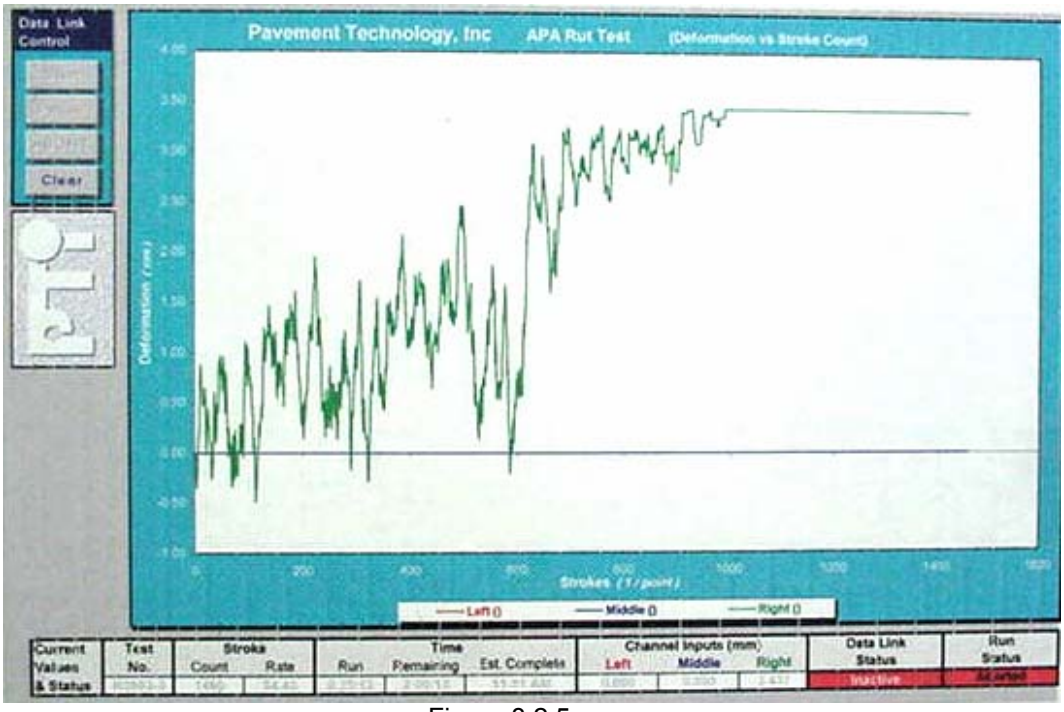


Figure 8.2.5

This graph represents a mix with less than 2mm of deformation. Irregularities in the graph are normal under these conditions. To determine if there is a problem, point the mouse to the graph on the chart and double click. Enter a value of 1.

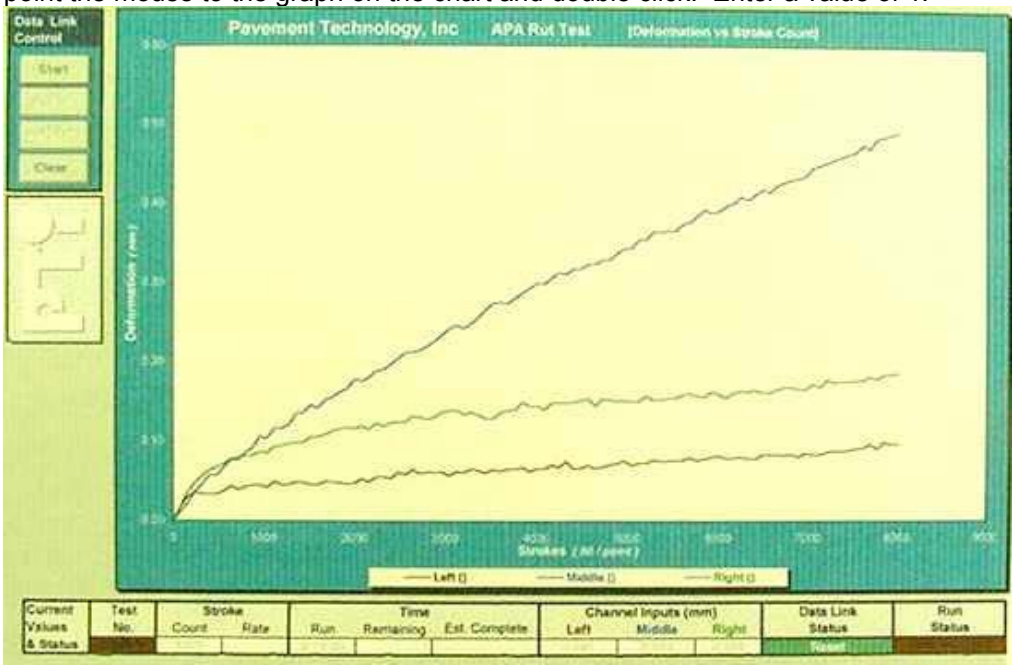


Figure 8.2.6

Figure 8.2.7 shows the graph after it has been plotted at 1 stroke/ point. This is a normal graph when the material deforms less than 2 mm. Notice that the overall trend of the graph is still the same as Figure 8.2.6.

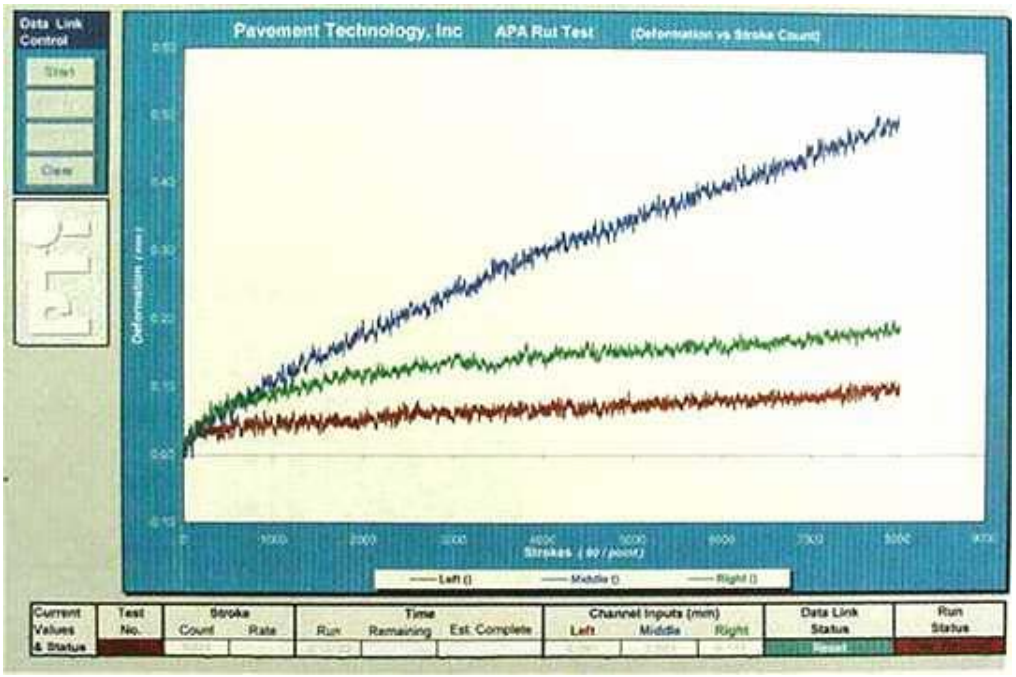


Figure 8.2.7

7.3 APA Electrical Schematics

(Available as Needed)

Chapter 8

CHANGING APA OVER FOR HAMBURG TYPE TESTING

1. Turn the APA on and jog the carriage to the front of the APA chamber.

2. Loosen the Allen head set screws on all wheel shaft collars.

3. Remove the 1” wheel pins and the 3/4” eyelet pins and set aside. (These pins will not be used for the Hamburg type wheels)

4. At the back of the carriage, loosen the Allen head set screws on the wheel support arms and spread the arms apart approximately 2”.

5. Insert the longer 3/4” pins in the arm collar that supports the eyelet. Next install the brass washer. Next install the thick hardened washer and then insert the pin thru the eyelet. Repeat the procedure on the other side of the eyelet and tighten set screws. Follow this procedure for all three wheels.

6. Install the Hamburg Type wheels in the same fashion as you would a Rut or Fatigue wheel. Simply use the longer 1” pins provided.

Hamburg Type Wheel

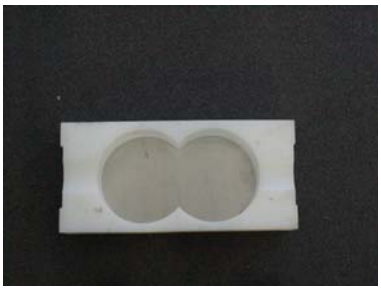
7. With the carriage still jogged to the front of the chamber, loosen the hex nut holding the cam plate bearing. Remove the nut and lock washer. A light tap on the bearing shaft should free the bearing from the cam arm. Insert the bearing into the next hole in the cam arm towards the back of the cam arm. Reinstall the lock washer and hex nut and securely tighten.

8. Check water level in the water tank. Water level should be within 2” from top of sight glass located on the right lower side of the APA.

STARTING HAMBURG TYPE TEST IN APA

1. Turn computer and APA on. Click on Calibrate icon on APA Control Bar. Set the desired wheel load and click on the CAL button.

2. After depth and load calibration is completed, install the samples inside the APA chamber. Install the two clamping bars around the molds and securely tighten.



Hamburg Type Mold
75mm x 152mm

Note:
Each Cylindrical Sample Will Need to Be Cit at a 30° Angle

3. Close APA doors and Click on the Set Up icon on the Control Bar and select Moisture Test Hamburg Type Wheels. The water tray will raise.

4. Follow the ASTM or the User's Hamburg test procedure.