InstroTek® Inc.
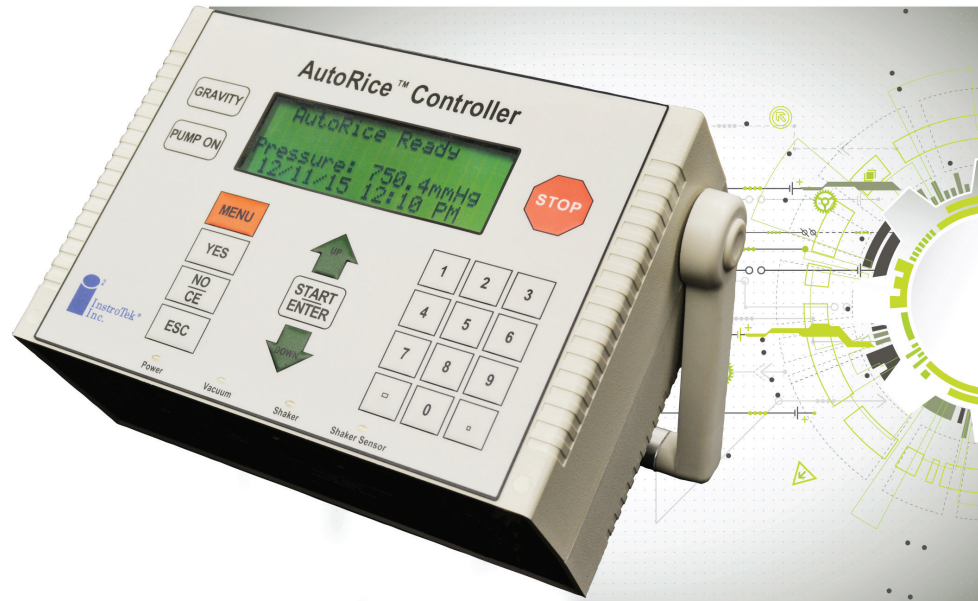
innovators in instrumentation technology

AutoRice™

Automatic Control Unit
for Maximum Specific Gravity Test

AutoRice™ Controller

AutoRice Ready
Pressure: 750.4mmHg
12/11/15 12:10 PM

GRAVITY
PUMP ON
STOP
MENU
YES
NO CE
ESC
START ENTER
UP
DOWN
Power
Vacuum
Shaker
Shaker Sensor

OPERATING MANUAL

InstroTek, Inc.

AutoRice™

Patent Pending

Operators Manual
(#801.2011)

copyright: 2017
version: 4

Important

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PRECAUTIONS WHEN USING THE AutoRice

1.   Voltage of 110/220V is present inside the AutoRice box and electrical outlets. DO NOT PROBE INTO THE MAIN CABINET OR OUTLETS WITH CONDUCTIVE MATERIALS, TOOLS, OR HANDS. IF COVER MUST BE REMOVED, CONTACT INSTROTEK <u>FIRST</u>.

2.   Do not attempt any repairs with the unit plugged into AC power. Maintenance on this unit must be done by trained technicians.

3.   Always use your internal laboratory safety procedures when working with and around this unit.

Introduction

The AutoRice is an automatic control unit designed to improve accuracy and repeatability of the maximum specific gravity test (AASHTO T-209, Rice Test/G_{mm}) for asphalt mixtures. The G_{mm} is used to calculate the percent air voids or relative density (G_{mb}), which is critical for mixture design, pavement quality control and laboratory mixture performance testing.

The three most important factors of the Rice test are vacuum time, vacuum pressure, and shaker vibration and frequency. The AutoRice ensures the vacuum time by automatically starting the vacuum pump and shaker, regulating the vacuum pressure, precisely measuring the vacuum time, and shutting off the pump and shaker at the appropriate time. The vacuum pressure is controlled using a digital vacuum sensor that is temperature compensated.

The vacuum pressure that is measured by the sensor is affected by the length of tubing between the sensor and pycnometer. Therefore, the AutoRice has an offset feature to match the vacuum pressure reading from an independent gauge that is placed in the pycnometer.

The AutoRice also measures the shaker acceleration and frequency using an accelerometer to present a combined value, the shaker factor. This is a feature that is not currently monitored in the standard test. If the shaker factor is too high, the material in the container can compact, which traps air in the sample and, for some materials, the bitumen film can strip away from the aggregates. If shaking is too gentle, air and air bubbles are not removed from the container. Improper shaking of the container during this test can result in inaccurate results and poor repeatability between facilities testing the same mixture.

Setting Up the AutoRice Controller

Properly setting up the AutoRice controller with the vacuum pump, shaker, and desiccant system is important for accurate and repeatable results. Review the steps below and Figure 1 for details.

1. Remove the AutoRice from the box and inspect for any visual damage.
2. Disconnect your manometer from your current maximum specific gravity vacuum setup. Attach the hose that went to the manometer to the vacuum hose port on the AutoRice (See Figure 1).
3. Plug the SHAKER electrical cord into the Shaker outlet on the AutoRice. Turn the switch for the shaker to the ON position.
4. Plug the PUMP electrical cord into the vacuum Pump outlet on the AutoRice. Turn the switch for the vacuum pump to the ON position.

Note: The AutoRice is designed to work with vacuum pumps of up to ¾ HP.

5. Install a system to remove water vapor, such as the PumpSaver™ cold trap or a desiccant canister, between the pump and the pycnometer to avoid moisture damage to the pump. If the PumpSaver is used, plug it into the PumpSaver outlet on the AutoRice.

6. Position the AutoRice controller for easy access to the front panel. The controller can be placed on a flat surface such as a counter or hung on a wall.

Note: Ensure that water is not flowing into the AutoRice when a vacuum is applied to the system.

7. Plug the AutoRice into an outlet with 110/220 VAC.

Note: If 220 VAC power is supplied from the outlet, the pump and shaker will be supplied with 220 VAC power. DO NOT USE 110 equipment if the AutoRice is plugged into a 220 outlet.

8. Turn on the AutoRice controller and verify the settings found in Section 4.

9. Run a trial test to verify there are no vacuum leaks and proper operation of the controller.

AutoRice   Pycnometer &   PumpSaver   Vacuum
             Shaker   (Desiccant)   Pump

Fig 1. Maximum specific gravity (Rice) test equipment configuration

Note: The hose length between the AutoRice or your digital manometer and the pycnometer can cause a pressure drop that results in a difference between the vacuum gauge and the actual vacuum in the pycnometer. Keep hoses as short as possible and it is recommended to use 3/8" ID hose or larger to prevent a pressure drop and error in the results. It is suggested to verify the pressure with an independent vacuum gauge inside the pycnometer. If a difference exists, this can be eliminated by adjusting the offset in menu item 4 on the AutoRice.

Keypad

Gravity: Calculate the maximum (Rice) specific gravity of the sample.

Pump On: Turn the pump on/off manually. Beneficial for vacuum saturating specimens for the AASHTO T283 moisture damage test. This function also allows

a timed pump on/off feature. The time to keep the pump on can be set through Menu item (.1) (Press decimal, then the number).

Menu: Change the default settings of the test. See Section 4 for more details.

Start/Enter: Press to start a test.

STOP: Immediately stops the test and turns off the pump and shaker.

Indicator Lights:

- **Power**: Power is available.
- **Vacuum**: Pump is ON and pulling a vacuum.
- **Shaker**: Shaker is ON.
- **Shaker Sensor**: Measurement of the acceleration and frequency of the Shaker is ON.

Menu Functions

Pressing the 'Menu' Button will bring up the Menu Screen with the following options. Select and configure desired settings by pressing the desired menu item number. Use the arrow keys to scroll through the menu.

Note: Once changed, settings are saved as default for future tests.

1. **Set Vacuum:** The target vacuum during the test. Default is 27.5 mm Hg.
2. **Shaking Time:** The time that the shaker runs after reaching the vacuum setting Default is 15 minutes.
3. **Vacuum Dwell Time:** The time that the vacuum is held before starting the shaker. Default is 0 minutes.
4. **Set Offset:** Adjusts the target vacuum to match the vacuum reading in the test

pot. For example, if a vacuum gauge placed in the pot has a reading of 22.5 mmHg, and the AutoRice sensor has a reading of 27.5 mmHg (the target), the user can enter positive 5 mm Hg to change the offset while the system is in operation. The offset can be entered manually through the keypad, or by using the up and down keys in the calibration mode. Calibration mode requires an independent vacuum gauge inside the pycnometer. Place the gauge in the pycnometer, make certain the AutoRice is connected as it will be normally used to do testing, and press the ENTER key. The AutoRice will turn on the pump, and adjust the vacuum to the target value. Press the UP/DOWN keys until the vacuum reading on the gauge in the pycnometer is at the target pressure. When the pressure reading is correct press the ENTER key, and the new offset will be stored in the AutoRice. Return to the AutoRice Ready screen and start the Rice test. Verify that the pressure in the pycnometer is correct. **Note:** The hose length between the AutoRice or your digital manometer and the pycnometer can cause a

pressure drop that results in a difference between the vacuum gauge and the actual vacuum in the pycnometer/pot. Keep hoses as short as possible and it is recommended to use 3/8" ID hose or larger to prevent a pressure drop and error in the results. It is suggested to verify the pressure with an independent vacuum gauge inside the pycnometer.

5. **Set Date/Time:** Enter the date and time in 12 hour format (MM/DD/YY hh:mm) using the number pad. Press Up arrow to toggle between AM and PM.

6. **Set Beep Time**: Change the length of time that the alarm sounds to alert user that the test is finished.

7. **Data Store**: On/Off: Turn On/Off the data storage to the USB. The data file contains the time and date, pressure every 15 seconds, and shake sensor readings for a test. (See page 15.)

8. **File Storage ID**: Enter a numeric file name.

9. **Shake Sen:** On/Off: Turn On/Off the shaker sensor, which is used to measure the

energy the shaker transmits to the sample. If "On", the sensor will take a reading every 60 seconds and save this to a data storage file if the Data Store is on and an USB is connected.

Press decimal, then the number for the following:

.0 **Diagnostics** (See page 22)

.1 **Set PUMP ON Time**: The time the pump is on when the PUMP ON key is pressed.

.2 **Gravity Method:** Allows the user to input measured data into the AutoRice to calculate and display the G_{mm} using the gravity method performed.

1. Water Bath
2. Flask Pycnometer

Record your AutoRice Settings here for future reference:

- Set Vacuum: _____

- Shaking Time: _____

- Vacuum Dwell Time: _____

- Vacuum Offset: _____

- Beep Time: _____

- Pump On Time: _____

Notes:

Example Data File Printout

```
Serial Number,1073,
Test Start Time,10/24/2016 8:23,
Sample Number:,1,
System Offset, 0.0 mmHg,
Testing Data,,
Time,mmHg,
0 s,760,
15 s,328.4,
30 s,183.7,
45 s,108.4,
60 s,56.5,
75 s,32.3,
90 s,24.2,Shaking Started
105 s,24.3,
120 s,28.5,
135 s,27,
150 s,27.7,
165 s,27.5,
180 s,27.4,
195 s,27.7,
210 s,27.5,
225 s,27.4,
240 s,27.4,
Max Pressure, 28.8 mmHg,
Min Pressure, 23.5 mmHg,
Average Pressure, 27.2 mmHg,
```

Standard CSV data file

	A	B	C
1	Serial Number	1073	
2	Test Start Time	10/24/2016 8:40	
3	Sample Number:		
4	System Offset	0.0 mmHg	
5	Shake Data		
6	Minute	S Factor	Frequency
7	0	5415	64
8	1	1531	52
9	2	1303	50
10	Testing Data		
11	Time	mmHg	
12	0 s	760.2	
13	15 s	328.2	
14	30 s	182.5	
15	45 s	107.2	
16	60 s	57.1	
17	75 s	32.4	
18	90 s	24.6	
19	105 s	26.6	Shaking Started
20	120 s	28.8	
21	135 s	26.8	
22	150 s	27.8	
23	165 s	27.3	
24	180 s	27.5	
25	195 s	27.5	
26	210 s	27.5	
27	225 s	27.5	
28	Max Pressure	29.2 mmHg	
29	Min Pressure	26.6 mmHg	
30	Average Pressure	27.6 mmHg	
31			

Data file in Excel® with Shaker Data

Wall Bracket
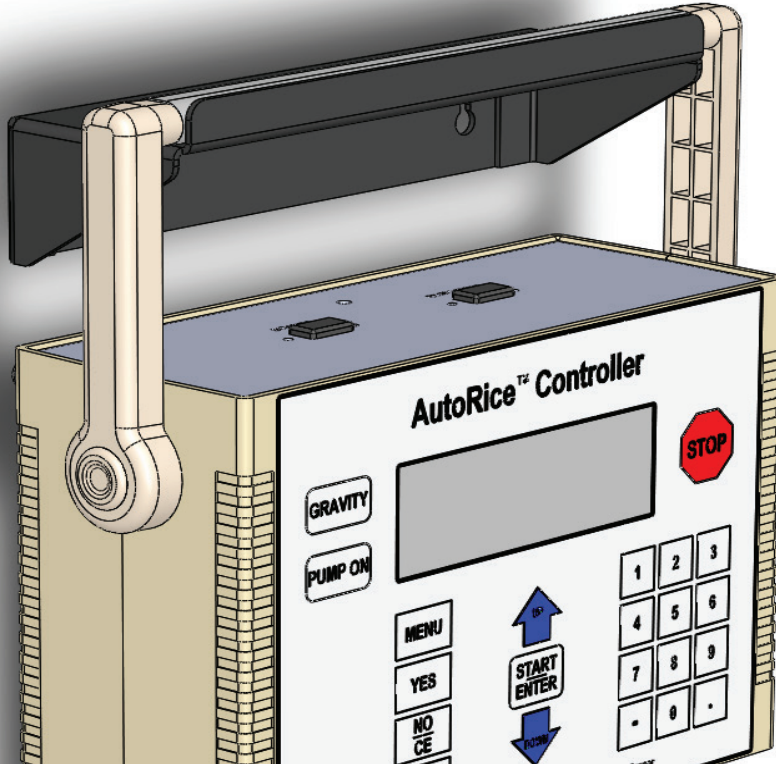
Use the included Wall Bracket to mount the AutoRice on a wall to free up work space.

Use two (2) screws or nails (not included) to mount the bracket.

Be sure the bracket is level to ensure the AutoRice is securely held in place.

Hang the AutoRice by the handle as shown.

Shaker Sensor

The shaker sensor can be used to measure the acceleration and frequency of the shaking of the mixture. This information is combined into a single value by multiplying the frequency and acceleration and is called the shaker factor. If the shaker factor is too high, the material in the container can compact, which traps air in the sample, and for some materials, the bitumen film can strip away from the aggregates. If shaking is too gentle, air and air bubbles are not removed from the container.

Steps for Placing Sensor

1. Attach sensor to controller using the Shaker Sensor USB port.
2. Attach the sensor as close as possible to the center of the lid of the pycnometer with tape, Velcro strips, etc.

Determining Appropriate Shaker Factor

It is important to determine the appropriate settings for your shaker. NCHRP 369 Report provides recommended settings for different manufacturers. The recommend values are listed below.

- **Humboldt Vibrating Table (H-1756) – 7**

- **Gilson Vibro-Deaerator (SGA-5R) – 5**

- **Orbital Shake Table (SHKE 2000) – 240 RPM**

If your shaker is not listed, use a mixture with the lowest PG binder normally used in your laboratory.

1. Make enough mixture for at least 6 samples (9,000 – 15,000 g).
2. Test 2 samples at 3 different intensities (low, medium, and high) to determine the appropriate setting for your shaker.
3. Enabled the Date Store (Menu item 7) and Shake Sensor (Menu item 9).
4. Test the samples at the different intensities.
5. Evaluate the results and select the intensity when the water is not cloudy and the mixture has the maximum Gmm.

Record your notes on Shaker Factor for future reference:

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Trouble Shooting

AutoRice does not turn on –

- Make sure unit is plugged into an electrical outlet.
- Test outlet by plugging another device into the same outlet.
- Check fuse next to power cord.

Vacuum pump/shaker will not start –

- Make sure unit is plugged into the appropriate outlet on the AutoRice.
- Make sure that the pump and shaker are switched ON.

Vacuum not maintained at low pressure setting –

- Make sure that pycnometer lid is tight and O-ring is in place.
- Check operation of the pump without water in the pycnometer.

Shaker sensor does not read correctly –

- Make sure the sensor is plugged into the USB sensor shake port.
- Reposition the sensor on the pycnometer

Further trouble shooting can be performed using the Diagnostics menu below. Contact InstroTek for further details.

.0 Diagnostics: (Press decimal, then the number)

1. Store Shaker Data: Takes a shake sensor reading, and stores the results to a Flash drive inserted into USB data port.

2. Show Shaker Data: Continually reads the shake sensor and displays the results to the LCD screen.

3. Open Valve: Fully opens the internal valve.

4. Close Valve: Fully closes the internal valve

5. Test USB: Writes a file to the inserted USB drive.

6. Test Stepper: This test checks that the stepper motor is operating properly while opening and closing the valve over the valve's full range of travel. It will

take approximately 15 seconds for the motor to open the valve, and then 15 seconds to close the valve. If the motor is changing direction rapidly or not moving, please contact InstroTek for service instructions.

7.   Cal Pressure Sensor: Perform a 3-point calibration procedure on the vacuum sensor.

8.   Cal Shake Sensor: Calibrate the 3 axis shake sensor.

9.   Test Encoder: Test the stepper motor position sensor.

.0   Serial Number: Enter the AutoRice serial number.

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Calibration and Verification Procedure

Important: The calibration for AutoRice is optimized for performing the maximum specific gravity (Rice) test, AASHTO T 209 and ASTM D 2041. The AutoRice is not calibrated for operation outside this range.

Setup

The following items are needed to create a calibration rig for the AutoRice.

- A NIST traceable vacuum gauge with 1/4" NPT Male connector or adaptor to 1/4" NPT Male threads are needed to mate to the manifold pictured on the next page.

  1. The range for the gauge should be 0 - 750mmHg absolute (0-15 PSIA).

  2. A relative gauge (PISG) will not work for this calibration.

  3. Minimum 0.1% full scale accuracy.

- Sealant tape should be used on all screw fittings.

Vacuum Gauge

AutoRice

Pump
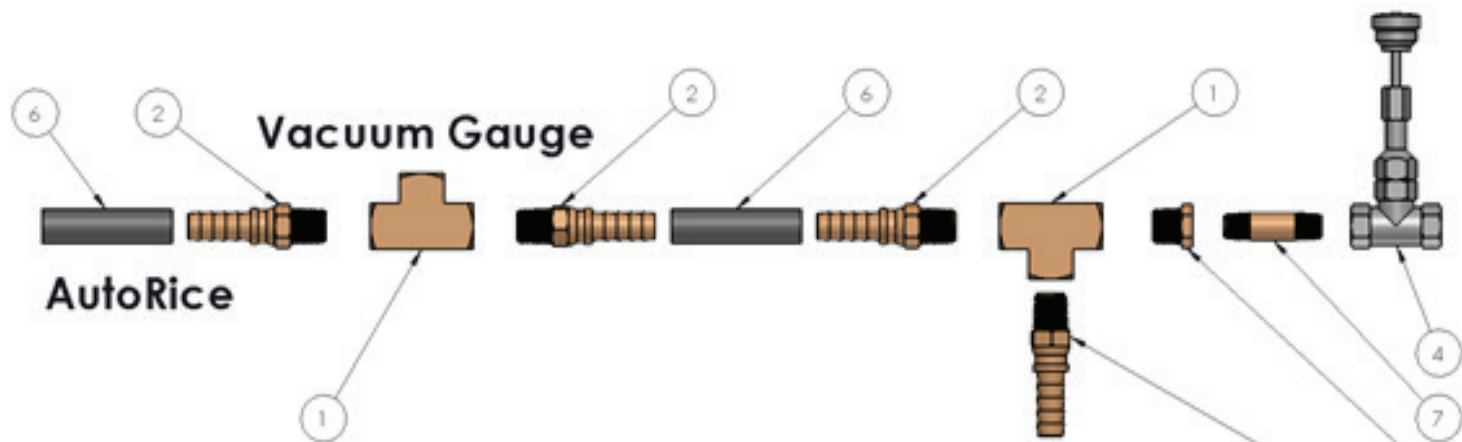
NO.	DESCRIPTION	QTY.
1	Tee Connector: ¼" NPT Female	2
2	Barbed Hose Fitting: 3/8" Hose ID x ¼" NPT Male	4
3	Straight Bushing Reducer: ¼" NPT Male x 1/8" NPT Female	1
4	Flow Adjustment Valve: CV .02, ¼" NPT Female	1
5	Barbed-to-Barbed fitting: 3/8"ID to 3/8" ID	1
6	PVC Tube: 3/8" ID, 1/16" wall thickness 3" length	3
7	Fully Threaded Straight Pipe 1/8" NPT	1

- Hose clamps and Vacuum grease should be used on all barb fittings.

- Connect the AutoRice, vacuum gauge, and pump to the manifold as indicated.

Verification Procedure

Close the external valve, and make certain the system is sealed and leak-free. Plug the pump into the AutoRice if that has not been done already.

- Allow the AutoRice to stablize to normal laboratory temperatures; this can be done by running the AutoRice through a few standard Rice tests or performing the verification twice with the first run as a warmup.

- Close the AutoRice's internal valve.

  1. Press "MENU"

  2. Select Diagnostics (.0)

  3. Select Close Valve (4)

4. Press <ESC> when the valve closes.

- Change the "PUMP ON" Time to 600 seconds. (.1)

- Return to the "READY" screen, and press the "Pump On" key.

- Allow the vacuum to stabilize at its lowest value for 30-60 seconds. **This value must be less than 12 mmHg for the verification to be accurate.** *Check for leaks in the manifold system if the vaccum cannot pull below 12mmHg; no leaks in the manifold could indicate the vacuum pump is not sufficient enough to perform the verification, contact InstroTek for a list of recommended vacuum pumps.*

- When the vaccum is below 12mmHg and stable, the AutoRice's vacuum sensor can be verified against the external gauge.

- The factory verification is performed at 20, 25, 27.5, 35, and 40 mmHg. The AutoRice is meant to be used at 27.5 mmHg, so verifying the sensor at vacuum outside this value is not necessary. Slowly adjust the external valve until the AutoRice reading is at the desired pressure. Read the external gauge

pressure, and notate the readings from the AutoRice and the external gauge. Repeat this at each desired pressure. The AutoRice value and the external gauge value must match within a tolerance of +/- 1.0 mmHg. Re-calibration is not needed if the verification passes.

Calibration Procedure

- Turn off the pump. Open the external valve to let in air and return the system to atmospheric pressure.

- Close the external valve when the system as stablized at atmosphere pressue.

- Start the calibration routine.

    1. Press "MENU"

    2. Select Diagnostics (.0)

    3. Select "Cal Pressure Sen." (7)

    4. Select "New Calib." (1)

- This will start the calibration routine. If the internal temperature is not within the proper range, an error

message will display. Wait until the temperature stablizes to normal lab temperatures before proceeding

- The AutoRice calibration routine will prompt you through these steps:

    1. Plug Pump AC into the AutoRice.

    2. Attach vacuum hose directly to the AutoRice.

    3. Close all valves to ensure lowest vacuum possible.

    4. Attach external vacuum gauge.

- The calibration routine will now ask for the external gauge reading. This is the atmospheric pressure reading; it will be around 750 mmHg. Enter this pressure into the AutoRice.

- Close the external valve when prompted. Press "ENTER" to continue. The pump will power on, pull a vacuum, and stabilize at the lowest value. When the vacuum stabilizes at its lowest value, press "ENTER" to continue. **This value must be less than 12 mmHg for the calibration to be accurate.** *Check for leaks in the manifold system if the vaccum cannot pull below 12mmHg; no leaks in the manifold*

could indicate the vacuum pump is not sufficient enough to perform the calibration, contact InstroTek for a list of recommended vacuum pumps.

- Input the reading from the external gauge into the AutoRice. Press "Enter" to continue.

- Adjust the external valve until the vacuum reading on the external gauge is between 27.5 and 28.0 mmHg.

- Allow the system to stablize for 30-60 seconds and press "ENTER".

- Input the value from the external gauge.

- The calibration is now complete.

- Run a verification procedure to check the new calibration.

Notes:

Program Update

The AutoRice program can be updated to a different version by placing a file received from InstroTek onto the main folder (for example, E:\) of a flash drive, inserting the flash drive into the USB Data Port, and turning the AutoRice on. The screen will show LOADING on the first line, and an increasing number on the third line. When the number stops changing, remove the flash drive, and turn the power off and back on. AutoRice REV X.YZ will appear for a few seconds on the screen. X.YZ should be the new version of software.

Notes:

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Warranty

InstroTek extends a 1-year warranty on the AutoRice to the original purchaser of this equipment. This warranty covers defects in material, workmanship and operation under the conditions of normal use and proper maintenance.

InstroTek will replace, free of charge, any part found to be defective within the warranty period.

This warranty is void if inspection shows evidence of abuse, misuse or unauthorized repair.

This warranty covers replacement of defective materials and workmanship only. It does not cover shipping charges, duties or taxes in the transport to and from the factory or authorized service center.

InstroTek's liability is in all cases limited to the replacement price of its products. InstroTek shall not be liable for any other damages, whether consequential, indirect, or incidental arising from use of its product.

If return of the product is necessary, please include return shipping directions, contact name, phone & fax number and a description of the action needed.

Call InstroTek, Inc. for shipping details at (919) 875-8371.

SETTING NEW STANDARDS

At InstroTek, we specialize in the fusion of product innovation with exemplary service. Our customers are our first priority. That's why we work hard to identify and solve industry problems by creating new, exciting product solutions that are accurate, practical, and cost-effective for you. Contact our staff of highly qualified professionals today, and experience business the InstroTek way.

Our mission is to lead our industry through innovative instrumentation, exemplary customer service, and an infrastructure of proud, dedicated emplolyees.

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CALL A LOCATION NEAR YOU:

Headquarters: **Raleigh, NC** phone: **919.875.8371**

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