Autoturb^3 Operations Manual

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Table of Contents

System Overview

The Autoturb3 Microbiological Assay System

The Autoturb3 is a continuation of the Autoturb series. Created in 1970, the Autoturb was the first automated assay preparation and reading system. In 1985, the Autoturb II was released as a computerized upgrade of the mechanical Autoturb system. The release of the Autoturb^3 is a refinement of the computer controls and the mechanical action of the Autoturb II.

The Autoturb and Autoturb II systems are composed of two cabinets, one containing the Reader module and one the Diluter module. The Autoturb^3 houses both modules in one cabinet. This allows the Autoturb^3 to occupy approximately two thirds of the cabinet space as its predecessors.

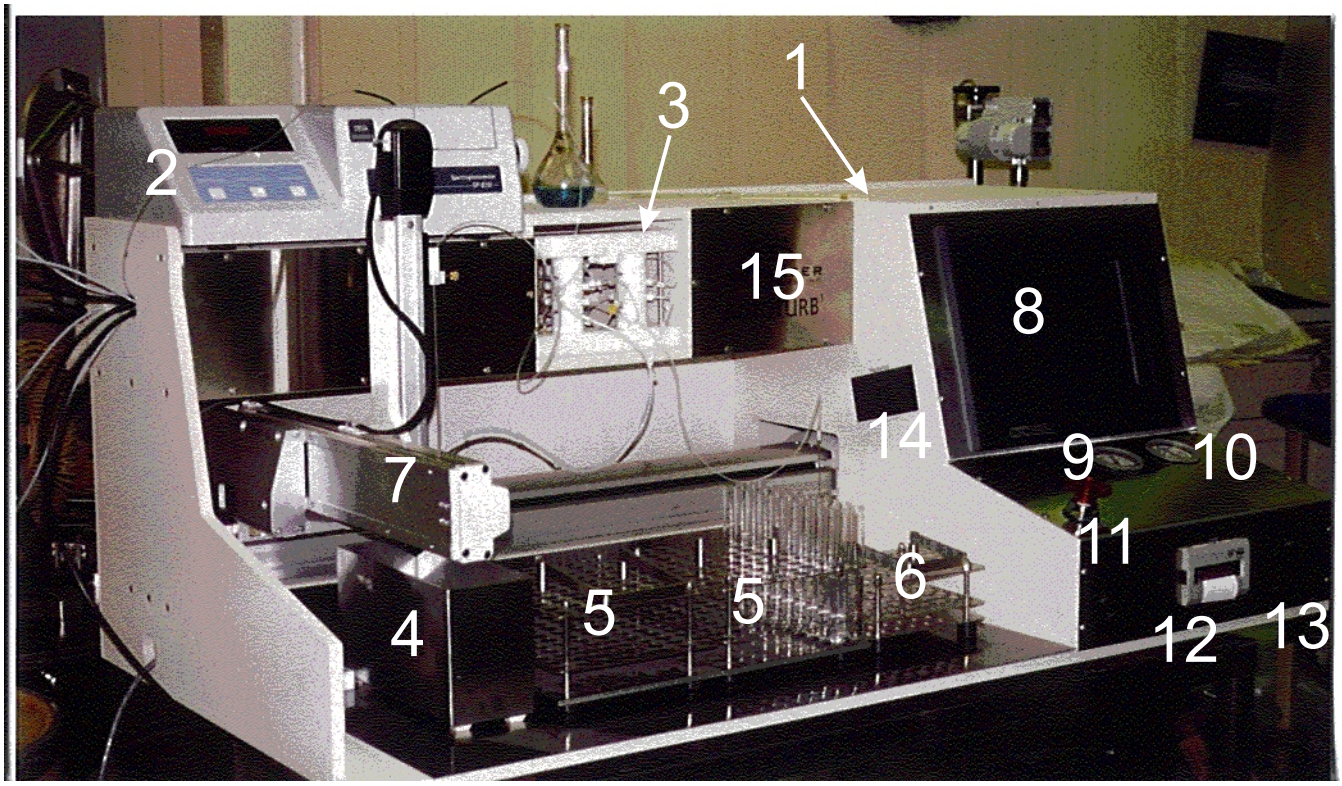
The Autoturb^3 uses a 586 generation of computers with a touch-screen to operate the system. An electronic software keyboard is included to allow typing in of commands where necessary. A robotic arm positions the probes or dispensing tubes over their respective sample or assay tubes. Vacuum is used to draw product for metering or sampling. A dual syringe pump is used to dispense product to create assays.

Procedures for the preparation, incubation and reading of samples are found published in several analytical journals. The most common journals are the AOAC methods, the British Pharmacopoeia and the USP. Other in house procedures can be prepared using these as a guideline. Descriptions of sample preparation in this manual are not specifically described because of the variance in procedure from product to product.

Description of unit:

The following photographs illustrate the various parts of the Autoturb^3 system:

1. Main cabinet
2. Spectrophotometer
3. Mixing valve
4. Waste pan
5. Assay racks
6. Sample rack
7. Arm assembly
8. Computer
9. Air gauge
10. Vacuum gauge
11. Emergency stop switch
12. Printer
13. Main power switch
14. Floppy disk access port
15. Logo panel (Air regulator and Vacuum regulator behind this panel)



Definitions:

Assay Rack: A device capable of holding 80 assay test tubes that prepared samples mixed with growth medium are placed in for incubation and reading.

Sample Rack: A device capable of holding 40 sample test tubes that contain prepared samples for dilution.

Probe: Also referred to as Cannula. A length of hypodermic gauge stainless steel that is used as the sampling probe for the reader and the diluter modes.

Dilution: The combining of growth medium, sample, and a microorganism.

Reading: The comparative analysis of diluted samples of unknown product strength with diluted samples of controls to determine the strength of the antibiotic or vitamin being tested. This is accomplished by measuring the light transmission through a test tube of a liquid medium with a microorganism and the sample to be tested added to the tube.

Medium: Also referenced as Growth Medium. This is a combination of water and organic compounds that bacteria will consume and multiply.

Incubation: The act of immersing assay tubes filled with prepared diluted samples in a heated water bath. The warm environment combined with the growth medium, microorganism and test sample material will allow the microorganism to consume food and multiply. In the case of a vitamin test, the stronger the vitamin concentration, the more active the growth curve for the organism is. In an Antibiotic test, the stronger sample of Antibiotic will inhibit the growth of the organism. These assays are incubated for an amount of time dependent on the substance being tested. The organism is then killed and the tubes are read in the Reader Mode.

Microorganism: Also referenced as Organism or Bug. This is a bacterium that is picked because of its response to growth relative to the presence of vitamins or antibiotics. Different organisms are selected depending on the procedure and the product being tested. The growth curve of these organisms is what is read by the Reader Mode to determine the product strength.

Blue Dye Test: This is a calibration test of the loops on the Diluter-mixing valve. This allows the correct volumes in the calibrated loops to be verified.

Loops: Also referenced as Calibrated Loops. The four loops on the mixing valve of the Diluter. These are calibrated to specific volumes in pairs. Loops one and three are set to deliver 0.1ml of liquid. Loops two and four are set to deliver 0.15ml of liquid. Loops one and two are on the left-hand assembly of the mixing valve three and four are on the right.

Mixing Valve: The assembly in the center portion of the middle shelf of the machine. This is where the medium is combined with precise amounts of sample that is contained in the calibrated loops. This combined product is dispensed into the assay tubes, two during each cycle.

Cycle: The completion of a program loop.

Diluter cycle: The action of positioning over a sample tube. Drawing sample to charge the calibrated loops, and moving over the assay tubes. The cycle is complete when the assay tubes are filled with the medium/sample mixture.

Defintions Continued:

Reader cycle: The action of positioning the probe over the assay tube, drawing the assay into the spectrophotometer flow cell, and reading the light transmission.

Spectrophotometer: A device that registers the amount of light transmitted through a solution. The more organisms present in the solution, the less light is transmitted.

Flow Cell: a small hollow optical glass cell that the assay material is drawn through. The cell is placed in the light path of the spectrophotometer and the relative amount of light transmitted is measured.

Syringe Pump: A device for delivering medium to the mixing valve of the Diluter. This unit is a dual stroke pump that drives two syringes simultaneously. Each syringe delivers a predefined amount of liquid to be combined with the contents of a calibrated loop. In effect, two assays are made with each pump cycle.

Assay: The test tube that contains the sample, growth medium and organism. The process of reading the contents of tubes in the spectrophotometer is also referred to as an Assay.

Sample: The prepared product that is to be tested.

Sample Preparation: The act of separating the product to be tested from to a form that can be diluted in the Diluter. This is accomplished in different manners respective to the products' procedure. Dry products like animal feed or medicine tablets are converted to a liquid and the sample material is extracted from that liquid. That sample may be diluter prior to its introduction to the Diluter if the product density would make the organism grow at to fast of a rate to monitor accurately. The Autoturb system uses small amounts of material to affect moderate organism growth at a time scale that is easily monitored and controlled.

Growth: A comparison of the number of organisms present after incubation.

Delonized Water: Also referenced as DI water. Steam distilled or reverse osmosis conditioned water.

System Overview: Diluter function.

The Diluter mode of the Autoturb[3] allows the user to dilute samples for incubation and reading. Samples are prepared in accordance to their respective procedures and placed in the sample rack of the Autoturb. This is the smaller rack that has the capacity to hold 40 small sample tubes (16mm diameter by 100mm long). Samples are placed in sequence from tube one to tube 40 as shown in diagram one. The rack is then placed with the front feet over the rightmost pair of test tube rack locators. Assay racks are prepared by placing the larger assay tubes (18mm diameter by 150mm long) in sets of four for each sample tube present in the sample rack. These are indexed in the racks from positions one to one hundred sixty as shown in diagram two. The first rack of the two is place in the middle pair of test tube rack locators. The second assay rack, if needed, is placed in the leftmost pair of test tube rack locators. A container of the correct growth medium for the test is placed in front of the syringe pump and the inlet tubes are placed in the medium container.

When the growth medium, samples and assay tubes are in place, selecting the diluter mode and pressing the start switch then starts the diluter. The user is prompted to place the correct cannula in the cannula holder on the z-axis arm. Then the arm moves to the first position on the sample rack. The cannula is lowered into the sample tube. Vacuum is switched on and the sample is drawn into the mixing valve. This fills the calibrated loops 1 and 3 on each side of the valve with sample. Then the valve shifts and the sample material is drawn into loops 2 and 4. Once this cycle is complete, the cannula rises out of the tube and the arm moves to the first pair of tubes in the first assay rack. The valve shifts and the syringe pump is activated. This causes a predetermined amount of growth medium (10ml) to flush out" the sample material in loops 1 and 3. When the pump has stopped its dispensing cycle, the arm positions the dispensing tubes over the next pair of tubes. The valve shifts and the contents of loops 2 and 4 are then dispensed out by the action of the pump. This is one diluter cycle. The arm then positions itself over the second sample tube and the cycle is repeated until each sample tube has been diluted.

System Overview: Reader function.

The Reader mode of the Autoturb[3] measures the amount of growth of the organism that is present in the assay tubes. After the samples have been diluted into assays by the operation of the Diluter mode, the assays are incubated to stimulate growth of the organisms in the tubes. After the proper incubation time has elapsed the assays are removed from the incubator bath and the organisms are killed. This is accomplished in most procedures by immersing the tubes in cold water and killing the organisms by thermal shock.

The first assay rack to be read of a sample run is placed over the middle pair of test tube rack locators. The second assay rack, if the test produced more than 80 assay tubes, is placed over the left-hand pair of the test tube rack locators. The smaller sample rack is not used in the Reader mode.

The Reader mode is selected on the computer screen and the start button is pressed. The user is prompted to place the Reader cannula in the probe holder on the z-axis arm. Then the arm moves to the first position on the first assay rack. The cannula is lowered into the first tube. The vacuum system draws the sample material through the cannula into the flow cell located inside the Spectrophotometer. When the Spectrophotometer reading has settled the computer captures the reading from the Spectrophotometer. The data is recorded in the computer memory for printing later. The Cannula then is lifted out of the assay tube and the arm moves to the next assay tube. This cycle is repeated until all tubes have been read. The data logged by the spectrophotometer in the computer is then sent to the printer for printout. At this time the user is prompted to enter a filename to save the file to the floppy disk drive if that option was selected before the test was started.

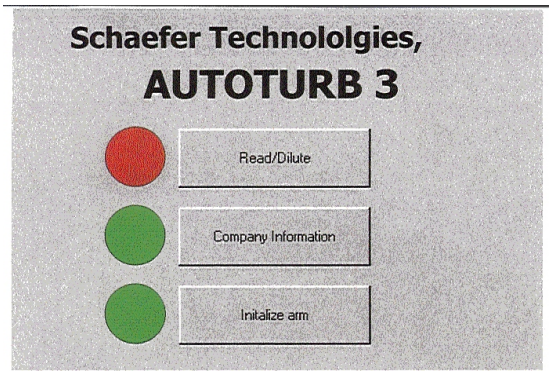
Description of computer operation screens. Part one: Main Screen.

The first screen encountered when the program has the title "Autoturb 3" in the upper window title bar. There are 3 control buttons present. They are listed below with their function.

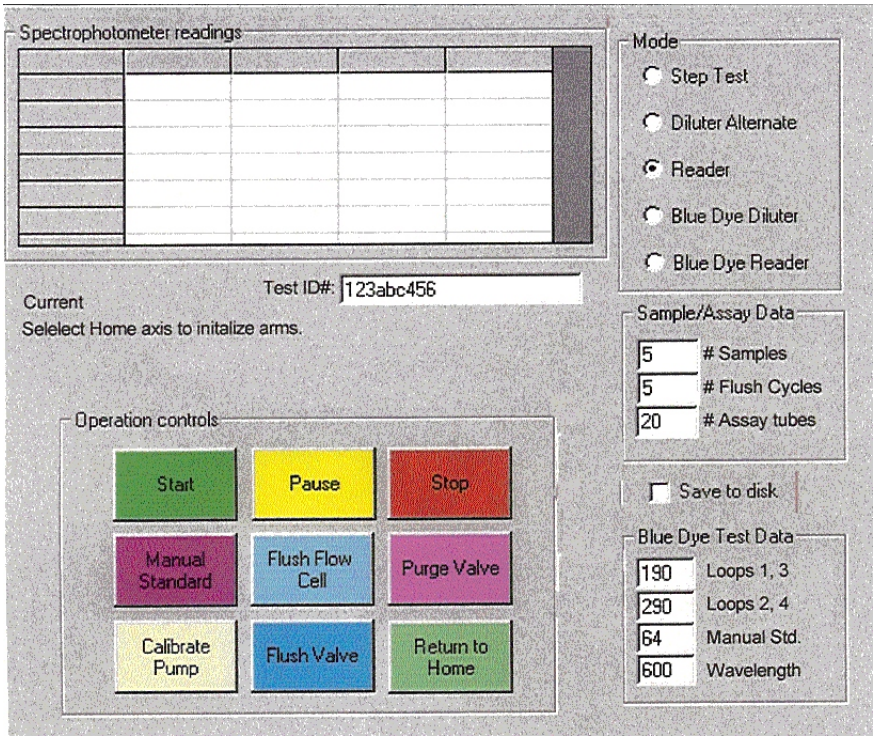
Read/Dilute: This control will switch the user to the second page the Main Operation page. This is grayed, or inactive until pressing the Initialize button has sent the axis arm home. The red indicator lamp shows the availability of the control. It will turn to green when the button is active.

Company Information: This control will display the company information page. This page has company address, telephone numbers and the serial number of the machine. Pressing anywhere on the graphic will close this page and return the user to the main screen.

Initialize: This sets the axis arm components to their home or zero positions. Once the arm has completed it's homing procedures, this command becomes inactive and the Read/Dilute command becomes active. It's status lamp then turns from green to red.



Autoturb^3 Main screen



Autoturb^3 Main Operation screen

Description of computer operation screens. Part two; Main Operation Screen.

The screen of the Autoturb^3 is shown in diagram 3. It's title is the Main Operations Screen. The sections of the screen are described below starting clockwise from the upper left position.

Spectrophotometer readings: This grid shows the spectrophotometer readings during the Reader mode or the Blue Dye Reader mode. The 4-column grid collates the readings under individual mixing valve loops that they were diluted under.

Mode: This collection of radio buttons allows the user to select the following modes of operation:

Step Test: One cycle of 40 sample tubes for the arm assembly but no drawing or dispensing of product. Useful in testing the alignment of racks or troubleshooting arm motion.

Diluter Alternate: Replicates the Autoturb II test of the same name. This test prepares 4 assays of each sample in the sample rack. The older Normal test produces only two assays of the first and last sample tube in the rack after the initial buffers that are in the rack also.

Diluter Normal:This mode replicates the Autoturb II test of the same name. This test produces assays like the orginal Autoturb. Flush buffers are loaded into the first few positions of the sample rack. All are drawn and discarded into the waste except for the second half of the last flush cycle tube (only two tubes dispensed in assay rack). A blank buffer is inserted at the end of the sample rack and half of that assay is also discarded.

Reader: This is the standard read mode for the Autoturb^3. This mode reads each tube in sequence and registers the spectrophotometer reading in the computer's memory.

Blue Dye Diluter: Part one of the calibration test. This mode is similar to the Alternate mode. The exception is the arm does not position over the sample tubes. Product is drawn from a beaker of material. Additional information is in the calibration section of this manual.

Blue Dye Reader: Part two of the calibration test. The tubes prepared in the Blue Dye Diluter part of this test are now read. Statistical analysis is preformed on the results and the calibration of the machine is determined. Additional information is in the calibration section of this manual.

Sample/Assay Data: This collection of text boxes is where the user inputs the following information prior to starting a test.

Number of samples: The number of samples in the sample rack to be diluted. Values 1 to 40 allowed.

Number of flush cycles: The number used for cleaning or test modes in the main pushbutton control box.

Number of assays: The number of assay tubes in the assay rack(s). Values 1 to 160 allowed.

Save to floppy disk: This check box is checked to allow the assay to be saved to a floppy disk. Format is text and the file name is asked for at the end of the reader test.

Description of computer operation screen. Continued.

Blue Dye Test Data: This collection of text boxes is where the preset data for the blue dye test is entered.

Loop 1,3 value: The estimated length of these loops.

Loop 2,4 value: The estimated length of these loops.

Manual Standard: This is a reading logged from the spectrophotometer.

Spectrophotometer wavelength: The setting used for the test.

Operation Controls: This collection of command buttons start certain modes of operation or several self test operations. They are listed below row by row.

Start: This starts any of the Modes selected in the Mode set of radio buttons.

Pause: This pauses the Mode that is in operation. Pausing halts execution at the end of the current cycle of the test in process. A message box pops up indicating that the system is paused. Pressing the message box's "OK" button allows the machine to resume operation.

Stop: This halts operation of the Mode currently running. It clears the Spectrophotometer grid of data and resets the machine. You can not resume a test after pressing stop.

Manual Standard: This command button causes the Reader probe to draw product from one assay tube and log the spectrophotometer reading in the Manual Standard text box. This allows the user to make single tube readings to monitor the growth of the assay in the incubator.

Flush Flow Cell: This button starts a cycle where the reader probe draws fluid through the flow cell. This is used for cleaning or calibration of the Spectrophotometer. It repeats this "cleaning" for a number of cycles equal to the number in the Flush Cycles text box.

Purge valve: This button starts a cycle where the probe on the Diluter valve draws fluid through the pairs of calibrated loops. It is used to clean the valve. It repeats for a number of cycles equal to the number in the Flush Cycles text box.

Calibrate Pump: This button starts a cycle where the syringe pump is turned on for a number of cycles equal to the number in the Flush Cycles text box. This is used to clean the syringes or to calibrate the syringes by cycling them into a volumetric flask.

Flush Valve: This button starts a cycle where the Diluter probe draws liquid from a beaker while the syringe pump pumps fluid through the valve. It cycles through each pair of loops in turn. It repeats this cycle for a number of times equal to the number in the Flush Cycles text box.

Current Status: This is a text box that informs the operator what the current operational status is of the machine.

Test ID: This text box is for messages to be posted on the reader when it prints it's results.

Installation of Autoturb [3]

List of materials.

The following items were packed with the Autoturb[3]:

Autoturb[3] main cabinet
1 Spectrophotometer
1 Filimatic syringe pump
1 4 liter flask, vinyl coated with cap on tubation port
1 2 liter flask, vinyl coated with cap on tubation port
3 waste cannula (AU0003)
3 20cc syringes (AU0006)
1 flow cell & holder assembly with tubing and probe
5 rolls of printer paper (AU0853)
4 assay racks (AU0650)
1 sample rack (AU0651)
1 waste pan (AU0563)
1 flanging tool (AU0058)
20 feet hard plastic tubing (AU0360)
10 feet 1/8 inch thin wall tubing (AU002) in 2 5-foot segments
2 sinker strainers (AU0005) attached to the above tubing
5 tube end fittings 1/8 inch with washers (AU0068 and AU0390)
1 #9 stopper pre drilled (AU0157)
1 #12 stopper pre drilled (AU0155)
2 #10 stoppers undrilled (AU0156)
1 RS232 adapter cable (AU1022)
1 mini phone tip cable
2 power cords

Installation:

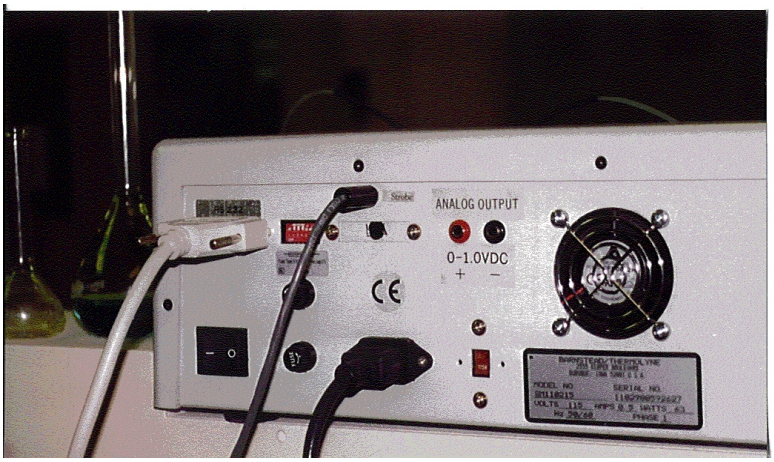
The Autoturb[3] will require a clear shelf space of 53 inches wide by 24 inches deep. It is designed so it will function properly if the front part is overhanging the counter space. The unit requires 24 inches of vertical clearance as well. It has only the power cord at the rear of the machine so it can be pressed back against a wall if necessary. An additional 2 ½ to 3 feet of counter space is required for the syringe pump and the waste flasks. These may be to the side of the machine, on a shelf below it or behind the main unit.

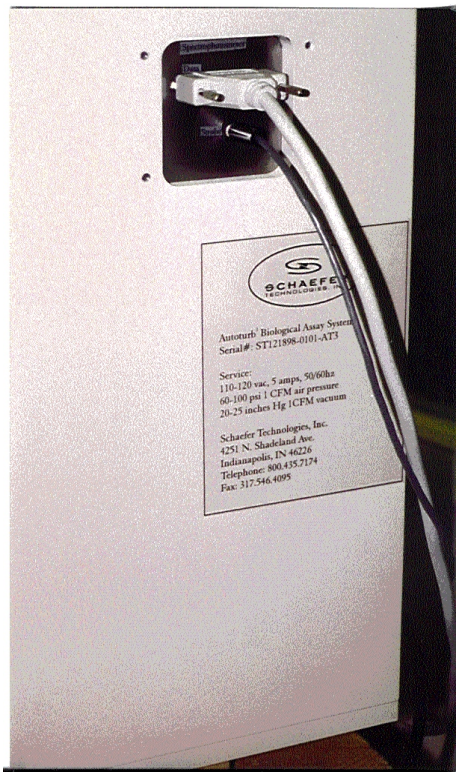
IMPORTANT NOTICE. THIS IS A HEAVY PEICE OF EQUIPMENT. PLEASE TAKE PROPER PRECAUTIONS WHEN LIFTING OR MOVING.

Carefully lift the machine and place it on the counter that it is to be installed on. Caution not to slide the machine onto the counter as this may break the mounting feet. Use a wrench to adjust the height of the mounting pads to level the base of the unit. Press down the red mushroom Emergency stop button. Install the powercord and plug it into the outleton the back of the machine but do not plug it into the wall outlet at this time.

Remove the z-axis arm from the y-axis holder by removing the four socket head screws that hold the mounting plate to the y-axis. Turn the arm so the cord end of is pointing up to the ceiling. Replace and tighten the bolts to set the arm. Attach the white plastic tube holder to the arm mounting plate as shown in Figure 4. Adjust it so the bottom of the plastic unit is flush with the bottom of the z-axis arm assembly.

Unpack the Spectrophotometer and place it on the top of the machine on the left-hand side. Take the power cord and insert it in the back of the machine. Plug it into the power socket. Unpack the RS232 cable (AU1022) and plug it into the serial port on the back of the Spectrophotometer. Plug the other end into the port on the right-hand side of the Autoturb cabinet. The cord with the mini phone tip on either end plugs into the Spectrophotometer and the cabinet in the jack under the RS232 cable.





Syringe Pump: Unpack the syringe pump and place it in position next to the machine. Remove the test tube rack locators and the screws from the stainless "splash tub" that is the bottom shelf of the machine. Remove this tub and set it aside. In the left hand area under the arm assembly is a socket. Feed the cord end of the syringe pump through the hole in the lower portion of the left bulkhead. Insert the cord end on the socket. Screw the locking collar on the cord end until it is finger tight on the socket. Replace the splash tub and re install the fasteners and guides.

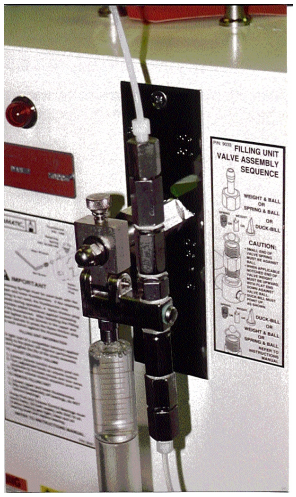
There are two stainless valve assemblies that are shipped attached to the syringe pump. Two of the syringes are attached to them. Unscrew the large knurled fittings on the lower swivel units. Remove the syringe from its box and remove the plunger from the body. Place the plunger through the hole in the knurled ring from the bottom. Replace the ring/syringe plunger assembly back on the lower swivel unit. Make certain that the black rubber pad is between the metal of the lower swivel base and the glass plunger of the syringe. Wet the plunger with some DI water and place the syringe body back over it. There is a plastic piece inside the syringe when it is shipped. Remove this part before attaching the syringe to the machine. Screw the metal tip of the syringe into the fitting on the underside of the upper swivel housing of the valve. Make this fitting finger tight for now. It will be tightened up later.

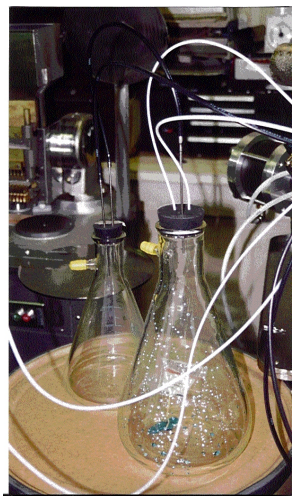
There are two tubes with tube end fittings on one end and stainless sinker/strainer on the other. Screw the fittings into the lowest part of the valve assembly. The sinker/strainer will be placed in a beaker or other container of water later.

There is a switch on the back of the syringe pump and a control knob. Set the knob at 3 and the switch in the "Footswitch" position.

There are two short lengths of 1/8" plastic tubing with one tube end fitting on one end and the second end is plain. The tube end fitted end is inserted in the upper portion of the stainless valve on the syringe pump. The left hand valve assembly's tube has the plain end inserted in the fitting on the left hand side of the autoturb marked LH valve. The right hand valve's tube is attached to the fitting marked RH valve. The fitting is made finger tight.

There are two plastic tubes inserted in the large #12 stopper. A waste cannula is also inserted into the remaining hole of the stopper. There are two waste valve fittings on the left hand side of the machine. The free end of the plastic tubes are fitted into these fittings and tightened. This is placed on the large vinyl coated flask. The remaining two cannulas are inserted in the holes drilled in the small #9 stopper. This is placed on the 2-liter flask. These flasks can be placed behind the syringe pump if it is next to the machine.



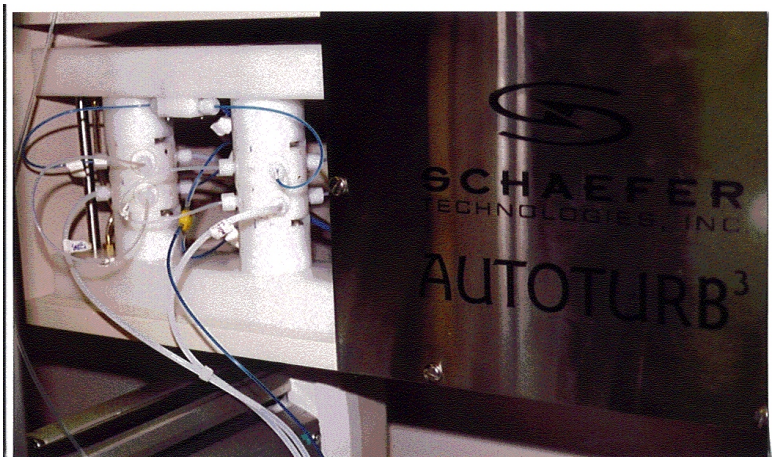


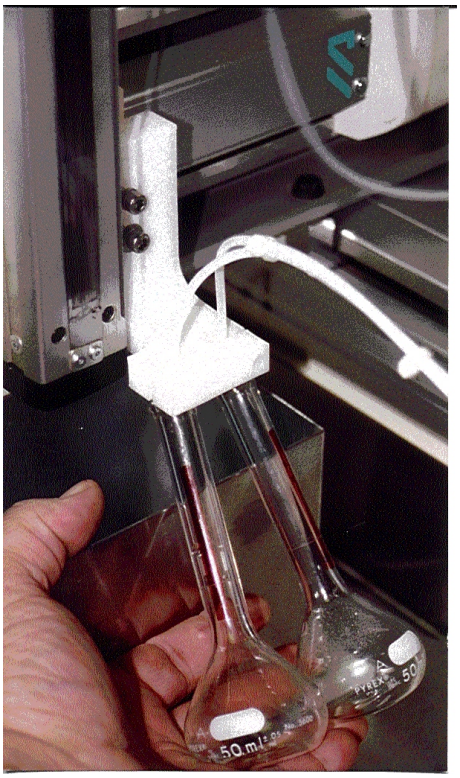
Installation, Continued:

Cut a one-foot length of the black hard plastic tubing. Fit this over the barbed end of the cannula that was inserted into the large rubber stopper. The other end of the tubing is slipped over one of the barbed fittings on the small stopper. Cut a length of the hard plastic tubing to allow you to connect it from the second barbed fitting on the small stopper to the bulkhead fitting marked "LOAD". This is the vacuum load connection. Use the remainder of the black plastic tubing to connect the "SOURCE" and "AIR" connections to your vacuum and air supply. These connections are made by pressing the plastic tube firmly into the fitting. Removal if necessary is accomplished by pressing the small metal ring into the fitting and pulling the tubing free.

Take the two outlet tubes from the mixing valve assembly and place them in the white plastic tube holder on the z-axis arm. The left valve's tube should be placed in the rear position and the right hand one should be in the forward position.

Take the second power cord and put it into the power receptacle in the rear of the autoturb unit. Plug this and the spectrophotometer cord into the wall outlet. Turn on the Spectrophotometer. The switch in on the back of the unit. Push down the large red emergency stop button on the autoturb control panel then switch on the machine. Remove any cannulas from the z-axis tower and slide the cannula holder to the lower position. After the computer display starts its startup you may then pull up on the red mushroom emergency stop button. This powers up the robotic arm.





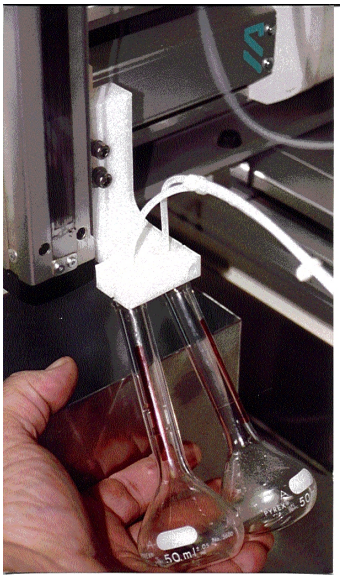
Installation, Continued:

Starting up the Autoturb[3]

Once the computer has come up in the Autoturb[3] menu screen and the robotic arm has been activated, the Autoturb[3] is ready to start. Press the Initialize command button. The arm may make a lurching motion accompanied by a loud 'bucking' noise. This occurs on start up when the arm has to make several attempts to determine which direction it is moving. This only occurs on a cold start up and is not damaging the machine. The arm will then move to the "home" position. This is on the left side of the machine with the z-axis tower assembly out to the front of the machine. After the controller has satisfied itself that the X and Y positions are at home the z-axis slider will slowly move to the top of the arm assembly. Once it has reached it and the controller has internally confirmed this the arm will move to the rear of the machine. This is now considered the final home position. The computer screen will allow access to the rest of the program once the home procedure is complete.

The arm can not be initialized more than once during the running of the program. If the program is halted but the computer has not been turned off, restarting the program will necessitate running the initialization again. To re-initialize the arm the Emergency stop button must be pressed in. Then remove any cannulas in the holder on the z-axis tower and move the holder down to the bottom of the arm's travel. Pull up the E-Stop button and then repeat the procedure in the above paragraph.

Keyboard entry of information. Anytime it is necessary to enter in data the operator will need to call up the screen keyboard. In the upper right hand corner of the active window there is a keyboard icon next to the minimize, fullscreen and close buttons. Double tap the icon and the keyboard pops up on the lower part of the screen. Double tap the text box that the information is to be changed to select that data. Key in the new data using the keyboard as a typewriter. A large minimize button (a square with an underline mark in it) is located in the lower right hand corner of the keyboard. This button will reduce the keyboard to an icon. It can also be called up by the start button in the menu bar. The program is located in the My-T-Touch folder.



Diluter Operation: Alternate Mode.

Prepare the sample tubes per the instructions in the procedure for the specific product. Place the sample rack on the right most pair of locating pins. Place four assay tubes in the assay rack for each sample tube present in the sample rack. Tubes are placed in the upper right hand corner of the rack and follow the column down and then moving to the next column to the left. The pattern is shown in figure 5. Place the first rack on the middle pair of locating pins. The second rack if necessary is placed on the left-hand pair of pins.

Prepare a beaker of DI water to flush the valve. Place the prepared medium by the syringe pump and place the sinker/strainers in the medium container. Place the diluter cannula in the beaker of DI water. Enter in the flush cycle text box the number of flush cycles you want to perform. Press the flush valve command button. The computer prompts the user to place the diluter cannula in the beaker. Press the OK button in the message box. The machine will complete the selected number of cycles.

Once the flush is complete, place the cannula in the z-axis probe holder. Tighten the thumbscrew down to secure the probe in place. Check that the waste flask is empty enough to run this test and that there is sufficient medium in the medium container. Enter in the text box the correct number of samples for this test. Select the Diluter Alternate mode in the mode selection box. Press the start button. A warning that a test is to begin will pop up on the screen. When the test is ready to start, press the OK button.

The arm will move to the first sample tube. The cannula will drop into the tube and start to draw product. The mixing valve will fill one pair of loops (1 and 3) and then shift and fill the second pair (2 and 4). The valve will shut off, stopping the filling process, and the cannula will rise up out of the tube. The arm will then position the two dispensing tubes over the first pair of test tubes in the first assay rack. The mixing valve will shift to loops 1 and 3 and the syringe pump will be activated. The contents of the loops will be pushed out of the valve and into the assay tubes by the action of the pump. 10 milliliters of medium will also be deposited into the assay tube at this time. When the pump has stopped, the valve shifts to loops 2 and 4 and the arm moves the dispensing tubes over the next pair of assay tubes. The pump is activated again and the contents of loops 2 and 4 are similarly dispensed with medium into the assay tubes. The arm then positions over the next sample tube and the process is repeated until all samples have been diluted.

As with the Autoturb II it is important that the operator correctly enters the number of sample tubes to be diluted. There is no method of the machine knowing if there is a tube under the probe.

Reader operation: Reader Mode.

Once the samples have been diluted and incubated, they are ready to be read. The assay racks are replaced on the Autoturb in the same order they were diluted in. The spectrophotometer probe is placed in the tube holder and secured by the thumbscrew. The number of assays is entered in the number of assays text box. The reader mode is selected and the option of saving to a floppy disk is selected if wanted at this time. The start button is pressed and the operator is informed that the reader test is about to start. After verification by the operator that the test is ready to start, the OK button is selected. The arm moves to the first tube and the probe is gently lowered into it. The solenoid for the spectrophotometer is cycled to draw sample from the assay tube and when the reading has stabilized (5 seconds) the spectrophotometer is strobed and the reading is sent to the computer. The current readings are displayed on the computer screen. Readings that have scrolled off the grid section can be scrolled back for viewing. The arm raises the probe and moves to the next assay tube where the process is repeated. This cycle is repeated until all tubes have been read as indicated by the number of assays data in that text box.

At the end of the test, the arm returns to home. The printer starts to print out the results and the computer clears its self to await further commands. If the floppy disk option was selected, the user will be prompted for a filename and to insert a disk. The file is saved in standard ASCII format to allow it's importation into a spreadsheet.

Blue Dye Operation: Reader and Diluter modes.

The basic operation of the machine in the blue dye modes are similar to the standard modes with the following exceptions:

Diluter Dye Test: The "sample" (blue dye stock) is placed in a beaker rather than in sample tubes. The arm omits the sample part of the test and just positions over the assay tubes, pausing to fill the loops. The number of samples text box determines the number of assay tubes filled by the test, four to a sample, just as a diluter alternate test.

Reader Dye Test: The Manual Standard must be read before starting the test. There is no prompting for this. The mode then proceeds as a normal reader assay. After finishing, the computer prints out the blue dye test results. Further information is in the Calibration section.

Calibration: Syringe pump.

The syringe pump is calibrated to deliver 10ml of medium through each side of the pump to each of the mixing valve halves. The lower portion of the syringe assembly, the Volume control, is adjusted to deliver more or less fluid as desired.

To calibrate the pump the operator needs two 50-ml volumetric flasks and a container of DI water. The sinker strainers of the two syringe / filling units are placed in the container of water. The number of flush cycles on the screen of the computer is set to 5 and the two flasks are placed under each of the output tubes of the valve assembly. The test is started and the computer allows five cycles of the pump to be dispensed into the flasks, with a slight pause between cycles. This pause allows the pump to recover and make a stable delivery. After the cycles are complete the operator checks the water level in each flask. The water line will be slightly curved as a fingernail. It should be resting on the meniscus of the flask. The outer ends can touch the line or the lower center part of the curve may touch the line, the difference in volumes is not great enough to matter.

If the valve needs to be adjusted at this point, loosen the 9/16" crown nut on the pivot shaft of the volume control. Turn the knurled knob clockwise looking down on it to decrease volume, or counter clockwise to increase volume. Cycle the pump once by reaching behind it and flipping the Continuos/foot switch off and on once to allow the pump to cycle. This allows the setting to stabilize. Empty the volumetrics or get dry ones and repeat the test until the water line rests on the meniscus of the flask.

Calibration of spectrophotometer.

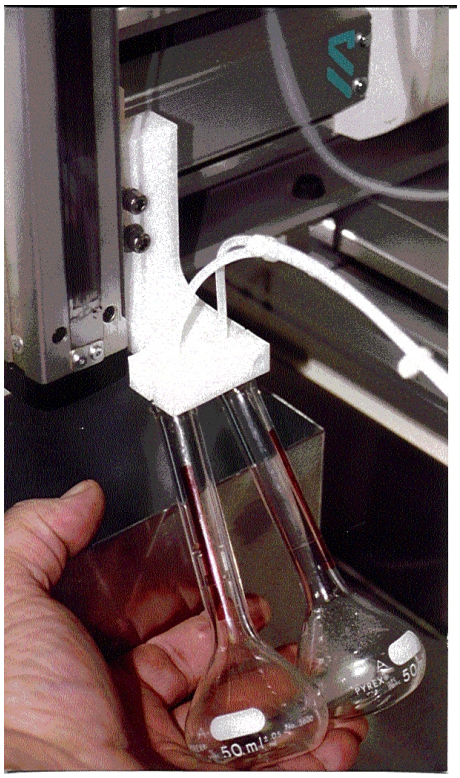
To set the spectrophotometer to 100%T place the probe in a beaker of water or medium, depending on the requirements of the procedure. Select a number of flush cycles for a minimum of 3. Start the flush flow cell mode. During the second cycle, press the 100%T button on the front of the spectrophotometer (middle button). The display should blank then the spec should make a click and reset to 100. This is done so the unit can be set while the medium is flowing. For precise calibration of the wavelengths standards may be purchased and the instructions followed to calibrate them. This is not considered a necessary operation for Autoturb assays, as the eventual drift is not sufficient to affect the operation.

Calibration of the mixing valves: The Blue Dye Test.

The four loops are calibrated at the factory prior to shipping and should not need to be changed during normal operation of the machine. If they are damaged the blue dye test will allow the operator to calibrate a new loop to the proper volume. The blue dye test also tells the operator the status of the valve and the internal parts. The port faces (AU0045) and the 4-way sliders (AU0106) are to be replaced on a periodic basis. The sliders usually need replacing after 6 months of normal use (3-5 assays per day). The sliders are inspected at this time and replaced if they show signs of wear (scratches). The blue dye test also indicates if any of the fittings are loose and need to be tightened (high deviation). The following series of steps are performed to execute a blue dye test.

1. Preparation of the dye stock: Blue dye powder (FD&C #1 blue) is mixed with DI water to make a working stock solution. 300 mg of the dye powder are mixed with 1liter of water and mixed well. After mixing, the dye stock is used to dilute in the Dye Diluter test and to make a manual standard. The working shelf life of this solution is 4-6 months.
2. Prepare the manual standard: Prior to each test the operator needs to prepare a manual standard. The dye stock is diluted in a ration of 1:100. A 100-ml standard solution is usually prepares and lasts for one week. If you change blue dye stock make a new standard from that stock.
3. Dilute the samples. Place 20 assay tubes in an assay rack and place the rack in the first position as in a normal dilution. Enter 5 in the samples box on the computer. Agitate or stir well the blue dye stock and place the diluter probe in this container. Place the stock container in a safe place, either on top of the machine or just behind where the sample rack would normally be placed. The arm may knock this beaker over and spill the dye stock, which is indelible. Verify that there is enough DI water in the medium container for the syringe pump. Start the Dye Diluter mode.
4. Agitate the assay: The blue dye must be well agitated prior to running the Dye Reader Mode. Tubes may be vortexed or agitated with our churning plate (20 tube AU0167 or 80 tube AU0163, optional purchased item). When vortexing tubes, do not allow fluid to escape the tube or place them back in incorrect order.
5. Read tubes: Enter 20 tubes in the assay box and read the manual standard by pressing the manual standard button. After the standard is logged, select and start the Dye Reader mode. Place the probe in the holder when prompted. The tubes will then be read and the results will be printed.
6. Blue dye tests may be run with more than 20 assay tubes. 40 tubes (10 samples) are a common amount. Longer tests do not increase accuracy, only time.
7. Evaluation of data: Each loops readings are collected and analyzed individually. The Mean value for each loop is calculated as well as the deviation and absorbance data. The means of loops one and three should be close and should match the manual standard. The deviation for each of the four loops should be between 0.000 and 0.180, with lower numbers being better. High numbers indicate that that loop is loose and the tube end fittings need tightening. If this deviation can not be corrected, port faces and maybe sliders need replacing. The absorbance of each loop is the transmission (Mean) converted to absorbance. Absorbance data for each loop and the Manual absorbance data should be within 0.003 when read at 600mn. Loop ratios indicate that the long loops (two and four) are 1.5 times longer than the short loops (0.1ml vs. 0.15 ml). The ratio should be between 1.480 and 1.520. Ratio will be 1.000 for same size loops and 2.000 for .1 and .2 ml.

8. Estimated loop lengths: The computer has preset values of 190mm and 290mm for the lengths of the pre cut loops. These lengths are the correct lengths for perfect loops. The actual loops will be shorter in length as the internal diameter of the material can not be controlled. The computer calculates the estimated length of the loops. If they are correct they will measure out as 190 and 290 in the estimated loop section. If they are too long the estimated length will show as being shorter than the ideal length. This is very important and needs to be understood. The original Autoturb 2 calculated this value "backwards" It is maintained with the Autoturb3. If the estimated length is shorter than the ideal for that loop, the loop is long by the difference. That loop may be altered to make it the correct length.
9. Example of loop length: In an imaginary test, the estimated lengths for the four loops are as follows: Loop one, 187mm. Loop three, 170mm. Loop two, 291mm. Loop four, 310mm. Loop one is 3mm long, loop three is 20mm long, loop two is 1mm long and loop four is 20 short. 3mm can be cut off of loop one. 20mm could be cut from loop three but it is better to take half the difference in case there is a large section in the tubing diameter. Loop two is 1mm short but can be used. Loop four is 20mm short and must be remade longer. It is important and bears repeating a third time: Estimated loop lengths shorter than the ideal lengths are actually longer not shorter by the difference in the lengths.
10. Cutting loops: When measuring a loop to cut, allow 3mm of the length when cutting the flange. For example, if cutting 5mm off a loop, cut the flange plus 2mm. Reflange the loop per the section on flanging.
11. Loop tolerances: Since 3mm is the length lost to a flange, the acceptable tolerance for loops is 3mm. With loops being 190 and 290mm respectively, the tolerance is X87-X93mm. It is better to have the loops within the same 3mm range if possible. For example 188, 189, 287, 290 rather than 188, 187, 292, 293. This larger spread would probably fail in the loop ratio part of the blue dye test.



General Maintenance

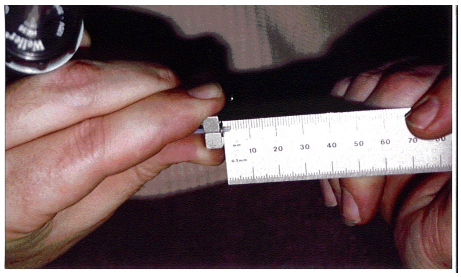
Flanging Loops:

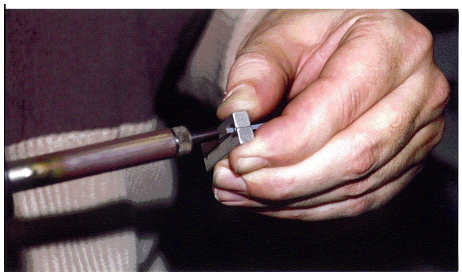
It may become necessary to replace a section of the tubing in the filling section of the autoturb. These tubes have a small threaded connector on their ends. This tube end fitting has a flanged portion of the tubing that is pressed to seal the connection by tightening the fitting down. This flange is delicate and may need to be re made. On all the tubing except calibrated loops the operator may reflange and reuse the tubing. Reflanging the calibrated loops will change the volumes and they may need to be completely replaced.

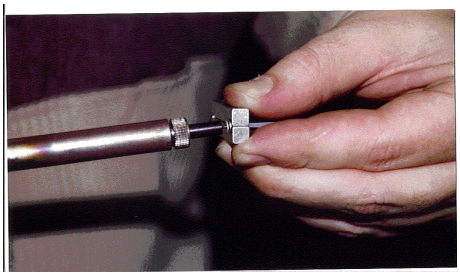
Tubing is flanged by using the flanging tool. This is a special soldering iron with a stainless steel tip that makes the flared fitting. Plug in the tool and allow it to heat up. Caution with this tool, it generates enough heat to melt plastics, scorch paper and burn fingers. Clip the end of the tube square and place the tubing in the tube holder. Allow about 2mm to extend beyond the holder and place the washer over the tube. The washer has a flat side and a side that has a slight curve. The washer is placed on the tubing with the flat edge facing the end of the tube so that it will contact the flange once it has been made.

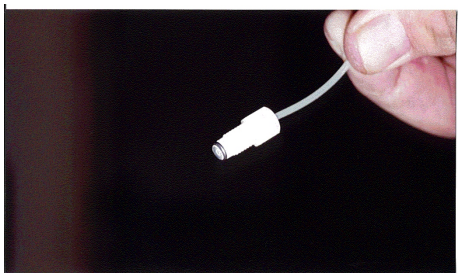
Grasp the tubing holder firmly so the tube can not slip. Take the flanging tool and place the tip of it inside the tubing. For the small tubing, press and rotate the tool until the tubing flares out flat against the washer. Remove the tool and press the newly flanged tubing against a smooth surface, a counter top or the stainless base of the autoturb is adequate. Hold the flanged tubing for a few seconds until it cools and the flange sets. When flanging large tubing, insert the tool and roll it around for a few seconds until the tubing softens and starts to flare. Press it against the tool once it flares and then continue flanging similar to small tube flanging.

Flanging must be done quickly so the heat of the tool does not melt a hole in the tubing, especially where the holder has grasped the tube. A correct flange is one that is the same diameter as the washer. If the flange fits in the fitting it is the correct size. Small flanges may not correctly seal or may even come loose when the fitting is tightened.









Spectrophotometer maintenance:

Every six months examine the tubing on the spectrophotometer. If the tubing has yellowed or has become stiff, it needs to be replaced. If the unit has excessive air leakage it may be necessary to replace the tubing as the joints have become loose and allow air to enter. The following procedure is for changing the tubing.

1. Cut four pieces of silastic tubing (AU0013) 3/8 to ½ inch and place them in a small amount of chloroform (20-50ml in a small container). Leave them there for at least 5 minutes so they can swell.
2. Open the cover to the spectrophotometer and remove the tubes from the slots in the lid. Remove the probe from the holder and remove the front cover of the autoturb under the spectrophotometer. Loosen the connector on the reader waste valve port and remove the tube from the fitting on the side of the machine.
3. Remove the cannula from the tubing. Set it aside to reuse. Remove the short piece of 1/8 tubing form the other end of the assembly and set it aside also. Withdraw the flow cell holder from it's pocket in the spectrophotometer. Remove the two screws and disassemble the halves of the holder, removing the flow cell and tubing.
4. Carefully remove the tubing from the flow cell and set the cell aside. Remove the two black plastic tubes from the clear tubing and set them aside. The flow cell, black plastic tubes, 1/8 white tube and cannula will be used again if undamaged.
5. Cut a five-foot length of AU0011 tubing flare the ends slightly (a small pair of hemostats or a pair of tweezers can flare this well) so the ends fit over the stubs of the flow cell about 2mm. Remove the tubing from the flow cell. Place a piece of soaked silastic tubing over the tube and replace it on the flow cell, slip the silastic over the junction of plastic tube and glass cell stub. Allow the silastic to dry. This will shrink the tubing and seal the joint. Repeat for the other end of the tubing and the second flow cell stub.
6. Once dry, about five minutes, lay the cell and tube assembly down on a flat surface, measure from the bottom of the cell where the curved stub bends up the side of the cell up 26 inches up the tube attached to the lower stub. Cut the tubing at the 26-inch mark.
7. Replace the two holder halves around the flow cell. It should be properly assembled when the 26-inch tube is on the right hand side of the holder when the large opening is facing the operator. Fasten the screws to secure the assembly. Slip the black plastic tubes over each of the tube lengths and slide them down to the holder. Place the holder back in the spectrophotometer with the small opening facing the back of the machine. Reinsert the tubes in the notches in the cover and close the cover. If properly assembled, the short tube (26") should be coming out of the right hand side of the cover.
8. Take the short tubing and slip it's end over the cannula about 1/8". Remove the tube and place a piece of silastic over it and reassemble. Slide the silastic over the joint of plastic tube and stainless cannula. Place in the probe holder and allow it to dry.

Spectrophotometer maintenance: (continued)

9. Take the large length of tubing and test fit it in the end of the 1/8 white tubing with the angle cut on it. Once it has slipped inside the larger tube by at least 1/8" remove the two tubes. Slip a piece of silastic over the small tubing and reinsert the tube in the large tube. Bend the small tube so it touches the leading edge of the bevel cut (touching the long end of the cut). Slip the silastic over the large tubing until the silastic is half on the large and half on the small tubing. Allow the joint to dry.
10. Feed the tube back inside the fitting on the side of the machine and reinsert the free end in the waste valve port and tighten the fitting. Firm finger tight is all that is necessary to secure the fitting.
11. Fill a container with alcohol (IPA is fine or any alcohol that is available) and place the reader probe in it. Select the flush flow cell mode and flush the cell for at least 5 cycles. Repeat with a water wash then set the reader by pressing the 100%T button on the spectrophotometer when running a water flush.

Syringe pump maintenance:

Once a month remove the syringes from the syringe pump. Remove the lower swivel bearing by removing the 9/16" crown nut and washer. Remove the bearing from the pin assembly and clean both with soap and water or alcohol. Dry and replace bearing pin and bearing. Replace the washer and nut and tighten them. Re attach the syringe after cleaning the holder assembly. Recalibrate the syringes.

The syringes will leak and the medium will collect on the lower volume controls. The bearing and the pin it mounts on can become stuck if this medium is not removed. Once stuck it can not be completely cleaned and remain functional. It is recommended that it be cleaned often to keep this from damaging the syringe pump.

Mixing valve maintenance:

Every six months of regular use the mixing valve needs to be rebuilt. As the valve wears out, the blue dye test's deviations will get worse and finally fall out of specification. Refer to the following diagram and description for rebuilding the valve.

1. Swing out the valve assembly and remove the syringe pump tubes and the waste tube from the valve. Unscrew the pivot bolt and detach the two air lines from the valve assembly, marking which fitting they are from. Remove the valve from the machine for easier work.
2. Remove the loops and set aside. They should be marked to allow proper replacement.
3. Remove the dispensing tubes (1/8" diameter and 2' long) and set them aside.
4. Remove the cannula tee assembly and set aside
5. Cut 3 pieces of silastic tubing (AU0013) and soak them in chloroform for at least 5 minutes.
6. Remove the cannula from it's tubing and set aside. Disassemble the rest of the tee assembly, saving the yellow tee and short tubes, discard the long tube.
7. Remove the four screws from the top of the mixing valve assembly and save them. Remove the top half assembly and set aside.
8. Remove the four valve assembly wafers unscrew the port faces (AU0082) and set them aside after removing the port faces (AU0045) from them. Discard the port faces. Remove the four-way slider (AU0106) and inspect them for scratches. If they are not damaged save them for reuse.
9. Install 16 port faces in the port face bushings. Hold one of the four way sliders in side one of the body segments aligning the black mark on the body to the black mark on the slider. Install four of the port face / bushing assemblies in the body by using a coin as a screwdriver. Drive the units in until they stop threading, do not overtighten. Repeat this assembly for each body segments.
10. Referring to the assembly drawing for the valve assembly, place the body segments in the valve assembly. Make certain that the black marks on the sliders and bodies are oriented in the same direction as the diagram indicates. Replace and tighten the four long screws to tighten the assembly. Do not overtighten the valve assembly. Replace the valve in the autoturb and attach the tubing as indicated in the assembly drawing. Replace the air lines so that the line that has air pressure present when the autoturb is turned off is in the upper manifold block.

Mixing valve maintenance: (continued)

11. Rebuild the yellow tee and cannula assembly by slipping silastic tubing over the end of the short tubes and placing them back on the yellow tee. Slide the silastic over the joint of metal and plastic. Cut a two foot length of diluter probe tubing (AU0012) and slip one end over the third stub of the tee, sealing with silastic. The free end of the tube fits over the end of the cannula probe, fitting and sealing like the other end with silastic tubing. Allow to dry and replace on the valve assembly.
12. Turn on the autoturb and start a purge valve test. Monitor in the slots of the valve pistons that the four way sliders are moving when the valve cycles. If the valve does not move, loosen the tube end fittings. Check for leaks and tighten tubing that is leaking or drawing air. Then run a flush valve cycle to check for more leaks and that the unit is functioning. Run a flush valve using alcohol to clean the valve.
13. After reassembly a blue dye test needs to be run to confirm the proper function of the valve assembly.

Autoturb troubleshooting:

1. Arm will not move or initialize: Verify that the arm stop button is pulled up. If it has been depressed, the machine will have to be started over. Press the stop button down and turn machine off for 10 seconds. Turn machine on and once the computer screen starts showing information, lift up on the arm stop button. Then initialize the arm with the program command.
2. Syringe pump will not come on: Check that the fuse is good in the back of the pump. Check that the on/off speed control is set to 3. If the pump still does not operate, check the cable that connects to the machine. If none of these items solve the problem check that the pump is not blocked and trying to move due to a tubing blockage. Usually a blockage of this type will break a syringe instead of stopping the pump.
3. Syringe pump will not stop: Check that the continuos / foot switch is not set to continuos. Check the relay inside the autoturb (under computer) to see if it is stuck.
4. Syringes break on pump: A blockage in the valve assembly will cause the top of the syringe to break. Check that the valve shifts and look for kinked or pinched tubing. A loose locking collar on the lower valve unit causes a syringe that breaks at the base of the inner cylinder.
5. Spectrophotometer will not zero: Check the cables between the spec and the autoturb. Check that the light is on. Check that the flow cell holder is properly installed with the small slit to the back of the machine. Check that the filter selector is set to the range that the light wavelength is set to.
6. Spectrophotometer or mixing valve will not draw fluid: Check that vacuum is present. Check that there is no kinked or pinched tubing. Check that all vacuum flasks have stoppers firmly in place. Remove upper left hand cover and replace the appropriate solenoid.
7. Spectrophotometer or mixing valve will not stop drawing fluid. Remove upper left hand cover and replace the appropriate solenoid.
8. Mixing valve will not shift: Check that air pressure is present. Check that valve is not too tight. Remove upper left hand cover and replace the appropriate solenoid.
9. Printer will not print: Check that paper is in correctly (shiny side up) and does not have a loose loop of paper between roll and print head feed slot. Turn autoturb off for two minutes and restart. Check windows printer selection and make certain that the generic text printer is selected as default printer.

Items #6 and #7 above are the most common problems with the autoturb. The waste solenoids cycle on and off several times during an assay and eventually they will fail. Failure rates are usually once every 2-3 years depending on the amount of use the machine sees. The next common problems stem from loose connections of cables or vacuum stoppers being loose.

Cleaning the machine:

The autoturb may be cleaned with a towel that has been dampened with water. The computer screen should be cleaned only with a damp towel. The rest of the machine may be cleaned with a mild detergent or alcohol and wiped dry. No abrasive cleaners should be used on the machine. Window cleaners should be avoided on the computer screen.

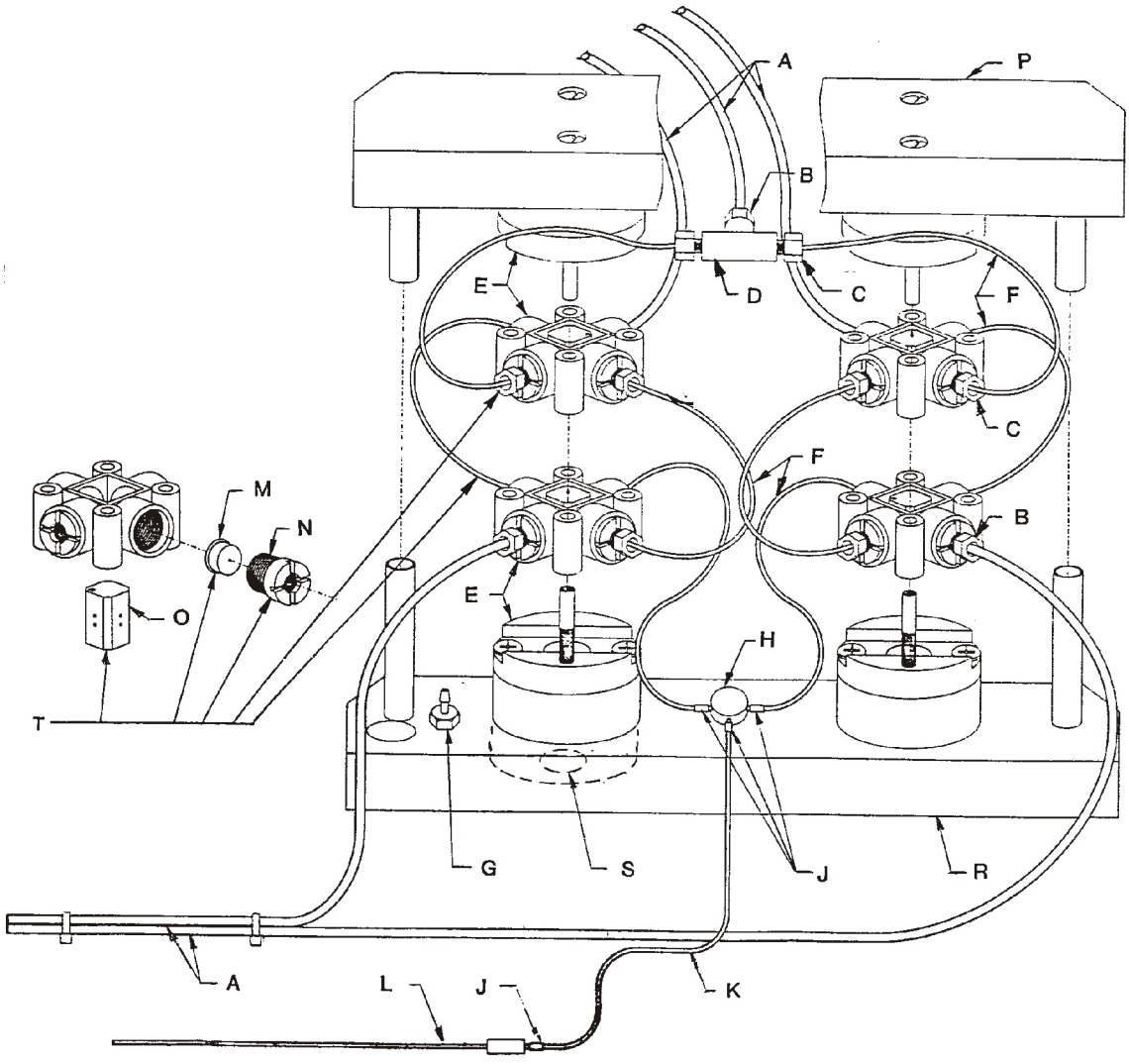
Cleaning the valve and flow cell:

Rinse the inlet lines of the filling pump with water, and place the lines in a rinse solution. Use the flush valve mode to clean out the diluter valve assembly. Following are the guidelines for cleaning the autoturb.

1. Same organism: If the same organism is to be used from one test to the next, the lines should be flushed with the new inoculated medium.
2. Different organism: If a different organism is to be used in the next test, the lines should be flushed with 400ml hot water 200ml cold water (room temp), and 400ml new medium.
3. Antibiotic test to Vitamin test: If antibiotic has been assayed and the next test is vitamin, the wash is the same as for "Different organism" (#2 above).
4. Vitamin to Antibiotic test: if vitamins have been assayed and the net test is antibiotic, the lines should be flushed with 400ml of 3% hydrogen peroxide. Then follow the procedure for " Different organisms" (#2 above).
5. End of testing: After testing has completed for the day, the system should be flushed with 400ml of 3% hydrogen peroxide if vitamins were assayed followed with 400ml of hot and cold water. Hot and cold water need only be used when assaying antibiotics.
6. Once every two weeks disassemble the lower volume adjustment assembly on the syringe pump. Remove and disassemble the syringe holder / swivel assembly and remove the 9/16" crown nut, washer, bearing and bearing pin. Clean all these items with hot water and dry. Remove any buildups of medium that may have dripped on these units. Reassemble unit when dry. Lubrication is not necessary.
7. Once every six months remove the stoppers to the waste flasks, soak remove the tubing attached to them. Soak in hot water and clean any buildup on the stoppers. Clean the short hard plastic tube that connects the two flasks, this tube is a source for fungal buildup over time. A dilute chlorine solution (1 tbsp. per gallon water) may be used to sanitize this tubing or just run hot water through it.

Mixing Valve Assembly: Parts Diagram

Det.	Code No.	Description
A	AU0007	Teflon Tubing 0.060 ID x 0.125 OD
B	AU0068	Tube End Fitting 0.125 ID
C	AU0069	Tube End Fitting 0.065 ID
D	AU0008	Waste Tee
E	AU0009	Stream Sample Valve assembly
F	AU0095	Teflon Tubing
G	AU0334	Barb fitting
H	AU0017	Sample Tee
J	AU0013	Silicone Tubing (Silastic)
K	AU0012	Polyethelene Tubing 0.047 ID x 0.067 OD
L	AU0507	Cannula (probe)
M	AU0045	Port Face 0.045 ID
N	AU0082	Port Face Bushing
O	AU0106	4-Way Slider
P	AU0589	Manifold Top
R	AU0590	Manifold Base
S	AU0370	O-Ring #015 Buna-N
T	AU0010	Sample Valve Repair Kit



RS232 Communications

The Autoturb^3 has a standard RS232 serial communication port on the right hand side of the machine. It has a 25 pin connector and can be connected to a PC computer with a standard serial cable.

The communications port is set with the following:

Baud rate:	9600
Parity:	Even
Stop bits:	one

These settings are compatible with the Autoturb software package that was used with the older Autoturb II systems. That software will work with the Autoturb^3 as well. To use the serial port with other programs, the following communication protocol must be followed.

Once communiacations is started, a header is sent in the following format:

(STX)ttttt,nnn,cccVbCrLf

'where

STX = start of text character (control B or 02)
ttttt = Test ID, the first five characters from that text box
nnn = number of assays. Three digits with leading spaces for null characters (i.e " 1" or " 10" or "160")
ccc = 8 bit checksum (mod 256). With leading spaces as in nnn above
VbCrLf = Carriage return (13) and linefeed (10) characters

After the header is sent, an Acknowledge (ACK, decimal 06) or a Not Acknowledge (NACK, decimal 21) is sent back to the Autoturb. If an ACK is sent, the Autoturb continues to assay data in the following format:

nnn=sxxxxx nnn=sxxxxx,cccVbCrLf

where

nnn = tube number (" 1" to "160")
s = sign ("-" or "+")
xxxxx = reading data
xxx.x if transmittance was read
x.xxx if absorbance was read
'ccc = checksum
'VbCrLf = Carriage return (13) and linefeed (10) characters

CHECKSUM

A checksum is calculated for each line of data and transmitted at the end of each line. This information may be used by the receiving computer to verify that data was transmitted correctly. The checksum is calculated by adding up all the ascii code values for each character in the data string, spaces and commas included. The number is then divided by 256 and the remainder is the checksum value.

The x mod y function returns the remainder (or modulus) of the value x divided by y.

Sample checksum for header

(STX) 123, 80,184VbCrLf

(STX)	=	2
" "	=	32
" "	=	32
"1"	=	49
"2"	=	50
"3"	=	51
","	=	44
" "	=	32
"8"	=	56
"0"	=	48
","	=	44
sum		440

440 mod 256 = 184

checksum = "184"

Sample checksum for reading data

1= 67.5 2= 67.4,232VbCrLf

" "	=	32
" "	=	32
"1"	=	49
"="	=	61
" "	=	32
" "	=	32
"6"	=	54
"7"	=	55
"."	=	46
"5"	=	53
" "	=	32
" "	=	32
" "	=	32
" "	=	32
"2"	=	50
"="	=	61
" "	=	32
" "	=	32
"6"	=	54
"7"	=	55
"."	=	46
"4"	=	52
","	=	44

sum 1000

1000 mod 256 = 232

checksum = "232"

Serial communications are achieved by selecting the check box “Send to PC”. This must be done before starting a reader mode. Once the Autoturb has completed it’s readings, then the serial communications are started. If at any time during the communications, your computer sends three consecutive NACK signals, the communications port is terminated. The printer has printed the results independently of the serial communications.

line item #	Autoturb III bill of materials Part Number	Description	Quantity for One machine	Recommended Spare
1	AU0002	TEFLON TUBE .095ID X .127OD	30	*
2	AU0003	#10 CANNULA W/ 1/8 BARB	3	
3	AU0005	SINKER/STRAINER 1/8 TUBE	2	
4	AU0006	20 cc SYRINGE	2	*
5	AU0007	TEFLON TUBE .062ID X .125OD	20	*
6	AU0008	TEE .060 BORE	1	*
7	AU0011	POLY TUBE .055ID X .075OD	5'	*
8	AU0012	POLY TUBE .047ID X .067OD	2'	*
9	AU0013	SILASTIC TUBE .581ID X .077OD	1	*
10	AU0017	Tee fitting	1	*
11	AU0018	VINYL FLASK 4 LITER	1	
12	AU0019	VINYL FLASK 2 LITER	1	
13	AU0025C	FLOWCELL VIAL	1	*
14	AU0025N-A	Flowcell holder part A	1	
15	AU0025N-B	Flowcell holder part B	1	
16	AU0026F	THUMB SCREW 6-32 X 3/4 BRASS	3	
17	AU0027	MALE 1/8 TUBE 1/8 NPT	4	
18	AU0032	FILIMATIC PUMP	1	
19	AU0045	PORT FACE .045 LAPPED	16	*
20	AU0058	FLANGING TOOL	1	
21	AU0068	1/8 TUBE END FITTING	8	*
22	AU0069	1/16 TUBE END FITTING	16	*
23	AU0071	FILLNG UNIT VALVE	2	
24	AU0072	Valve Balls	2	
25	AU0073	Valve Weight	2	
26	AU0082	PORT FACE BUSHING	16	*
27	AU0083	VAC REGULATOR	1	
28	AU0090	Valve Upper End	2	
29	AU0091	Valve Lower End	2	
30	AU0092	Valve End Cap	4	
31	AU0095	TEFLON TUBE 10 FT	1	*
32	AU0106	4-WAY SLIDER	4	*
33	AU0111	filter	1	
34	AU0124	REDUCING RING 20cc	2	
35	AU0155	#12 STOPPER	1	
36	AU0156	#10 STOPPER	2	
37	AU0157	#9 STOPPER	1	
38	AU0322	scotchmate fastener	5	
39	AU0324	BRANCH TEE	1	
40	AU0325	ELL 1/8 NPT	5	
41	AU0326	ELL 1/4 NPT	3	
42	AU0329	VACUUM GAUGE (PUMP)	1	
43	AU0334	barbed fitting (10-32)	2	
44	AU0336	Air Regulator Bracket	1	
45	AU0349	MANIFOLD	1	
46	AU0351	MUFFLER	1	
47	AU0353	BARB FITTING	2	
48	AU0354	POLY-U-TUBE 1/16 NAT	5	
49	AU0355	1/8 NPT PLUG	4	

line item #	Autoturb III bill of materials Part Number	Description	Quantity for One machine	Recommended Spare
50	AU0356	MALE CONNECTOR	6	
51	AU0357	STREET TEE	2	
52	AU0358	UNION TEE	2	
53	AU0359	FEMALE CONNECTOR	2	
54	AU0360	POLY E TUBE 1/4 BLACK	20	
55	AU0368	PISTON DRAIN KIT	1	
56	AU0370	O-Ring Buna N	4	
57	AU0372	MANIFOLD BLOCK OFF	1	
58	AU0378	O-Ring	4	
59	AU0379	AIR GAUGE (PUMP)	1	
60	AU0380	FILTER FLASK CAP	2	
61	AU0389	FLAT WASHER .072 ID	14	
62	AU0390	FLAT WASHER .136 ID	8	
63	AU0507	CANNULA	2	*
64	AU0550	Test Tube Locating Feet	6	
65	AU0563	WASTE PAN	1	
66	AU0589	MANIFOLD TOP	1	
67	AU0590	MANIFOLD BASE	1	
68	AU0602	Manifold Spacer	2	
69	AU0644	Valve Body	4	
70	AU0645	Valve Piston	4	
71	AU0646	Valve Cap	4	
72	AU0647	Single slider body	4	
73	AU0650	ASSAY RACK	4*	
74	AU0651	SAMPLE RACK 40T	1*	
75	AU0704	ON/OFF SWITCH	1	
76	AU0706	7-PIN BOX CONNECTOR	2	
77	AU0708	Octal Socket, DIN mount	2	
78	AU0712	PRESSURE SWITCH	1	
79	AU0713	VACUUM SWITCH	1	
80	AU0716	#8 TERMINAL BLOCK	3	
81	AU0717	MARKER STRIP	3	
82	AU0718	2 POLE JUMPER	16	
83	AU0746	50 conductor ribbon cable	20	
84	AU0773	Female screw lock assembly	2	
85	AU0800	Ribbon cable connector	5	
86	AU0852	printer	1	
87	AU0853	Thermal printer paper	1	*
88	AU0858	SAMPLE VALVE ASSY	Listed as individual parts	
89	AU1001	disk drive door ball plunger	4	
90	AU1002	5amp fast acting fuse AGC-5 250 volt	1	*
91	AU1003	solenoid valve 24 v	2	*
92	AU1004	valve shift solenoid 24v	1	*
93	AU1005	Ribbon cable breakout board	1	
94	AU1006	Vibration damping pads (replaced after unit #101)	6	
95	AU1007	Touchscreen computer Model p3	1	
96	AU1008	1/4 prestolock bulkhead union fitting	3	
97	AU1009	M3 0.5 x 35 SHCS	4	
98	AU1010	turner 830 specrophotometer	1	

line item #	Autoturb III bill of materials Part Number	Description	Quantity for One machine	Recommended Spare
99	AU1011	X-Y axis arm and SEL control	1	
100	AU1012	db25 male panel connector ribbon cable type	1	
101	AU1013	db9 m solder type connector	1	
102	AU1014	1/8 phone tip jack NO	3	
103	AU1015	belden type 8770 cable (or equiv)	6	
104	AU1016	nylon 1/8 tube compression bulkhead fitting	5	
105	AU1017	db25 m solder type connector	1	
106	AU1018	DS arm and control	1	
107	AU1019	power entry module with fuse	1	
108	AU1020	power entry cord to wall plug	1	
109	AU1021	power cord euro male female	2	
110	AU1022	rs232 cable 25f-25m	1	
111	AU1023	db25 f solder type connector	1	
112	AU1024	db9 f solder type connector	1	
113	AU1025	My-T-Touch Virtual Keyboard	1	
114	AU1026	1/8 phone tip plug	3	
115	AU1027	computer diskdrive power supply adapter cord	1	
116	AU1028	24v power supply DIN mount	1	
117	AU1029	24v control relay	2	
118	AU1030	Air Regulator	1	
119	AU1031	NC contactor for E-stop	1	
120	AU1032	cinch 2 wire male connector	2	
121	AU1033	cinch 2 wire female connector	2	
122	AU1034	Mushroom E-stop operator	1	
123	AU1035	#10 capscrew cap	1	
124	AU1036	AC auxilary connector	2	
125	AU1039	RS232 Access Plate (Obosolote, Prototype only)	1	
126	AU1040	Tubing Access Plate (Obosolote, Prototype only)	1	
127	AU1041	Spectrophotometer Shelf	1	
128	AU1042	Top Shelf	1	
129	AU1043	Middle Shelf	1	
130	AU1044	Axis Shelf	1	
131	AU1045	Support, Axis Shelf, Left Hand	1	
132	AU1046	Support, Axis Shelf, Right Hand	1	
133	AU1047	Support, Middle Shelf, Right Hand	1	
134	AU1048	Support, Middle Shelf, Left Hand	1	
135	AU1049	Conduit Tube	1	
136	AU1050	Left Bulkhead	1	
137	AU1050A	Left Bulkhead Ledgend Plate	1	
138	AU1051	Middle Bulkhead	1	
139	AU1052	Right Bulkhead	1	
140	AU1053	Base Plate	1	
141	AU1054	Back Cover	1	
142	AU1055	Computer Mounting Plate	1	
143	AU1056	Switch/Printer Mounting Plate	1	
144	AU1057	Left Hand Cover	1	
145	AU1058	Right Hand Cover With Logo	1	
146	AU1059	Splash Tub	1	
147	AU1060	Disk Drive Cover	1	

line item #	Autoturb III bill of materials Part Number	Description	Quantity for One machine	Recommended Spare
148	AU1061	Humphrey Mounting Angle	1	
149	AU1062	Kip Mounting Angle	1	
150	AU1063	Vacuum Regulator Mounting Angle	1	
151	AU1064	Air Filter Mounting Angle	1	
152	AU1065	Z-Axis Arm Plate	1	
153	AU1066	Diluter Tube Holder	1	
154	AU1067	Cannula holder	1	
155	AU1068	Corcom-Auxillary Power Modules Mounting Plate	1	
156	AU1069	Support Angles	1	
157	AU1072	Waste pan locator	1	
158	AU1073	DIN rail 36"	1	
159	AU1074	Vlier Socket Feet	6	