PORTACOUNTB® Plus Model 8020

Operation and Service Manual

Chapter 1

UNPACKING

The following items are included with the PORTACOUNT® Plus Respirator Fit Tester. If any are missing or damaged, notify TSI immediately.

Standard items included with the PORTACOUNT Plus Model 8020

Qty	Description
1	PORTACOUNT Plus Model 8020
1	Alcohol Cartridge
1	Alcohol Fill Capsule*
1	Storage Cap
2	Zero Check Filter
2	Spare Alcohol Wicks
1	1/8 to 3/16 Tube Adapter
1	1/8 to 1/4 Tube Adapter
1	AC Adapter
1	Training Video
16	30 ml Alcohol Bottles (480 ml total)
1	Operation & Service Manual (this manual)
1	Carrying Case
1	FitPlus for Windows Fit Test Software** (Diskette or CD)
1	Disk/CD Holder
1	RS-232 Interface Cable (9-pin)
1	9-Pin to 25-Pin Serial Cable Adapter

If the optional Model 8925HS Portable Printer was purchased, the following items will be included:

**Components Supplied with
Model 8925HS Portable Printer**

Qty	Description
1	Model 8925 HS Portable Printer
1	AC Adapter/Charger
1	9-Pin to RJ-45 Printer Interface Cable
4	Rolls of Thermal Paper

Chapter 2

IDENTIFYING THE PARTS

Use the numbered paragraphs with the correspondingly numbered arrows to identify the various parts of the PORTACOUNT® Plus Respirator Fit Tester and its accessories. It will be necessary for you to be familiar with the part names in order to follow the instructions in this manual.

Keypad
"Keypad" refers to all the keys on the front panel as a group.
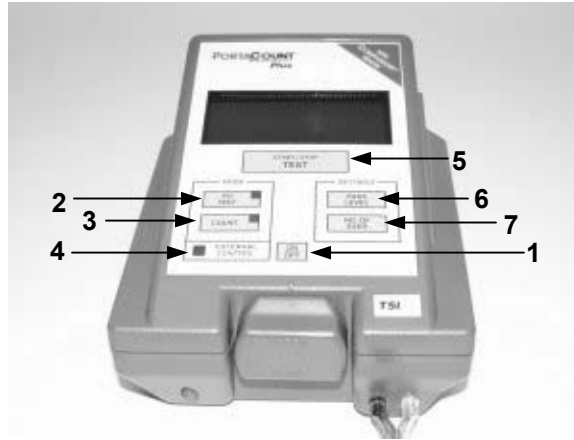
1.   ON/OFF Key
The ON/OFF key turns the instrument ON or OFF.

2.   FIT TEST Key
Pressing the FIT TEST key puts the PORTACOUNT Plus into Fit Test Mode. The indicator light on the FIT TEST key will be on when in Fit Test Mode.

3.   COUNT Key
Pressing the COUNT key puts the PORTACOUNT Plus into Count Mode. The indicator light on the COUNT key is on when in Count Mode.

4.   EXTERNAL CONTROL Indicator
When the indicator light next to EXTERNAL CONTROL is on, the PORTACOUNT Plus is being controlled through the Data Port by an external computer. All keypad controls except the ON/OFF key will be disabled.

5.   TEST START/STOP Key
In Fit Test Mode, the TEST START/STOP key is used to start a fit test and also to terminate a fit test early (a fit test will automatically stop when the preset number of exercises is completed).

When in Count Mode, the TEST START/STOP key is used to toggle between 1-Second Count Mode and 15-Second Count Mode.

6.   PASS LEVEL Key
Use the PASS LEVEL key to view and change the fit factor pass level. Press the key momentarily to check the fit factor pass level without changing it. Press and hold the key down to scroll through the available fit factor pass level values. Release the key to set the level at the value shown on the display at that moment.

7. NO. OF EXER Key

Use the NO. OF EXER key to view and change the number of exercises to be used in the fit test protocol. Press the key momentarily to check the number of exercises without changing it. Press and hold the key down to scroll through the available values. Release the key to set the number of exercises at the value shown on the display.

Display

The Display is a liquid crystal display (LCD) used to present numeric data and status information to you. The elements that can be shown on the Display are:

NOTE: The Display is always blank when FitPlus for Windows Software is controlling the PORTACOUNT Plus.
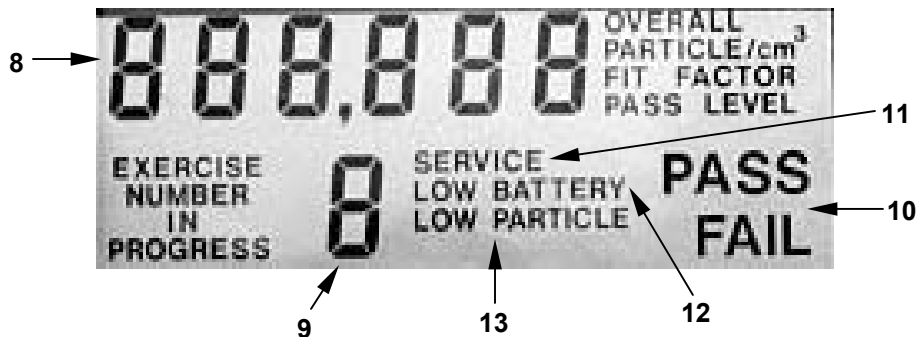
8. Numeric Values

Numeric values for fit factor, overall fit factor and particle concentration are displayed as full digit numbers truncated to 3 significant digits. Fit factor pass levels are displayed as integers. The units associated with the numeric value are displayed to the right of the number. The units that can be displayed are:

- FIT FACTOR
- OVERALL FIT FACTOR
- PARTICLE/cm^3
- FIT FACTOR PASS LEVEL

9. Exercise Number

The exercise number display is used to check or set the number of exercises needed for a complete fit test and to display the exercise number in progress during a fit test. During a fit test, the "IN PROGRESS" message will appear next to the exercise number and will flash on and off.

10. PASS/FAIL Message

A "PASS" or "FAIL" message will appear in the lower-right hand corner of the Display every time a fit factor or an overall fit factor is displayed. "PASS" will appear if the displayed fit factor is equal to or greater than the fit factor pass level and "FAIL" will appear if the displayed fit factor is less than the fit factor pass level. The fit factor pass level is set with the PASS LEVEL key.

Status Messages

There are three warning indicators that can be displayed by the PORTACOUNT Plus. They are:

11. SERVICE

When the message: "SERVICE" is displayed, the PORTACOUNT Plus is usually low on alcohol, however, there can be other reasons. Consult the section on status messages in Chapter 4, "Operating the PORTACOUNT Plus."

12. LOW BATTERY Warning

The flashing message: "LOW BATTERY" warns you that there are about 15 minutes remaining before the PORTACOUNT Plus turns itself off due to lack of sufficient battery power. Finish the fit test in progress and then install a fresh battery, or plug in the AC adapter.

13. LOW PARTICLE

The "LOW PARTICLE" message indicates that the PORTACOUNT Plus has measured a particle concentration during the ambient sample that is below the pre-programmed cut off of 1000 particles/cm^3 (the cut off is 70 particles/cm^3 when the optional N95-Companion is in use). This message can only appear during operation in Fit Test Mode.

Sampling Ports

There are three ports that permit air to flow into and out of the PORTACOUNT Plus. They are:
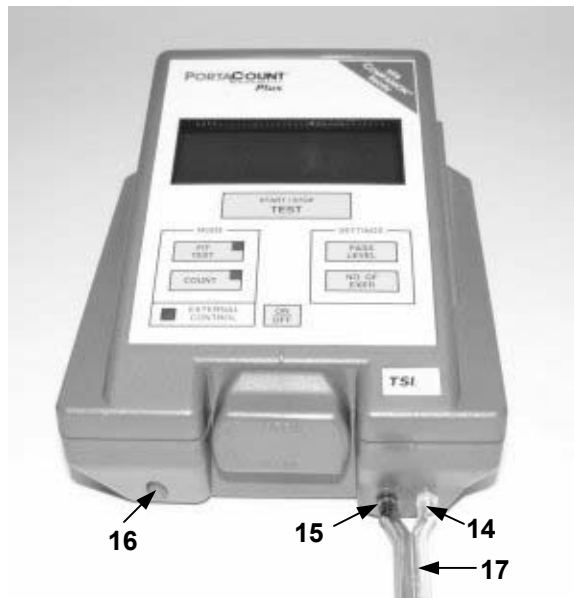
14. Sample Port

The Sample Port is the inlet used by the PORTACOUNT Plus when sampling air from a respirator during a fit test in Fit Test Mode and at all times while in Count Mode. The clear tube marked "SAMPLE" of the Twin Tube Assembly connects here. The Sample Port fitting is silver in color and marked with the letter "S".

15. Ambient Port

The Ambient Port is used to sample ambient air during a fit test in Fit Test Mode. It is never used in Count Mode. The blue tube marked "AMBIENT" of the Twin Tube Assembly connects here. The Ambient Port fitting is colored blue and marked with the letter "A".

16. Exhaust Port

The Exhaust Port is where all sampled air exits the PORTACOUNT Plus.

17. Twin Tube Assembly

The Twin Tube Assembly consists of a pair of tubes. The Sample Tube is clear in color, has the word "SAMPLE" marked on it in several places along its length, and connects to the silver colored Sample Port. The Ambient Tube is blue in color, has the word "AMBIENT" marked on it, and connects to the blue colored Ambient Port. The Twin Tube Assembly is about 5.5 feet (165 cm) long and must never be lengthened by more than a few inches for fit testing. The Sample Tube is 1.5 inches (40 mm) longer than the Ambient Tube.

Electrical Connections
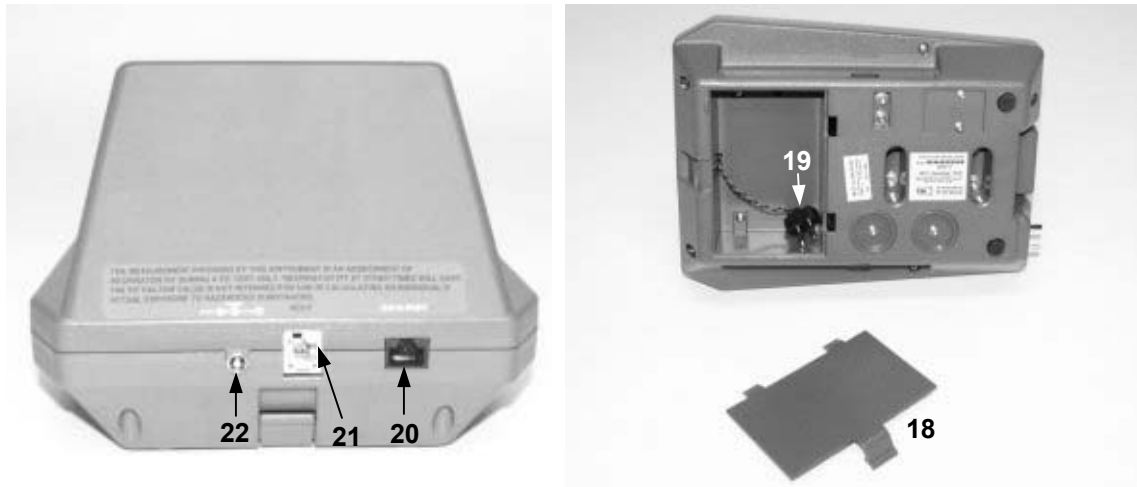
18. Battery Cover & Battery Cover Latch
The battery compartment is located underneath the PORTACOUNT Plus behind the Battery Cover. Slide your finger under the Battery Cover Latch and lift to remove the cover. Tools are not required.

19. Battery Connector
The Battery Connector is located inside the battery compartment. The connector is polarized (one pin is larger than the other) so that it cannot be plugged into a battery pack backwards. A TSI Model 8903 Rechargeable Battery Pack must be used for battery operation of the PORTACOUNT Plus. If the AC Adapter is used, a battery pack need not be installed and the connector can be loose inside the battery compartment.

Note: As of January 2003, battery packs are no longer available from TSI.

20. Data Port
The Data Port allows RS-232C serial communication with the PORTACOUNT Plus. It is used to transmit data to a printer like the TSI Model 8925 Portable Printer or for communications with a microcomputer. The Data Port uses a standard RJ-45 modular connector.

21. Accessory Port for Optional Model 8095 N95-Companion
This port is used to connect the optional Model 8095 N95-Companion accessory used for fit testing lower efficiency disposable respirators. N95-Companion capability can be added to older PORTACOUNTs that do not have this port. Contact TSI.

22. External Power Connector
The External Power Connector is on the back of the PORTACOUNT Plus. The coaxial metal connector is labeled "POWER" just above it. The voltage requirement and polarity are also marked. The connector used is 5.5 mm x 2.5 mm. Many instruments on the market use similar connectors. Always be certain that you are connecting the AC Adapter that was supplied with the PORTACOUNT Plus.

23. AC Adapter Model 8024

The AC Adapter plugs into the External Power Connector on the PORTACOUNT Plus and your AC wall outlet. The AC Adapter senses the input voltage automatically. Older PORTACOUNTs were shipped with single voltage AC Adapters.

24. Computer Interface Cable with 9/25 Pin Adapter

The Computer Interface Cable (Model 8927) is used to connect the PORTACOUNT Plus to an IBM-PC compatible computer. It is needed whenever the FitPlus Fit Test Software is used with the PORTACOUNT Plus. The cable has a RJ-45 modular connector on the PORTACOUNT Plus end and a 9-pin D-connector on the other. The 9/25-Pin Adapter is used when the computer is equipped with a 25-pin serial connector instead of a 9-pin serial connector.

NOTE: If your computer has no RS-232 serial port you can use your USB port instead by purchasing a USB to Serial Converter.

Alcohol Related Parts

25. Alcohol Cartridge

The Alcohol Cartridge holds isopropyl alcohol that is consumed by the PORTACOUNT Plus. There is a porous wick inside that is soaked with alcohol.

26. Cartridge Cavity

The Cartridge Cavity is where the Alcohol Cartridge is inserted during use. It is very important to make certain that dirt and lint do not enter the Cartridge Cavity. Cover the Cartridge Cavity with the Storage Cap when the PORTACOUNT Plus is not being used.

27. Storage Cap

The Storage Cap is used to cover the Cartridge Cavity of the PORTACOUNT Plus or to cover the Alcohol Fill Capsule, whichever does not currently hold the Alcohol Cartridge.

28. Spare Alcohol Wicks

Two spare Alcohol Wicks are included with the PORTACOUNT Plus. They can be used to replace the wick inside the Alcohol Cartridge.

29. Alcohol Fill Capsule

The Alcohol Fill Capsule is used to store and fill the Alcohol Cartridge.

NOTE: The Training Video refers to a black sponge located inside the Alcohol Fill Capsule. That sponge is no longer necessary or provided.

30. Alcohol Supplies

The PORTACOUNT Plus is shipped with 16 bottles of reagent grade (99.5% or better) isopropyl alcohol. Each bottle contains 30 ml. The PORTACOUNT Plus consumes alcohol at the approximate rate of one ml per hour and the alcohol wick holds approximately 8 ml of alcohol. Do *not* use isopropyl alcohol that is less than 99.5% pure.

Miscellaneous Parts
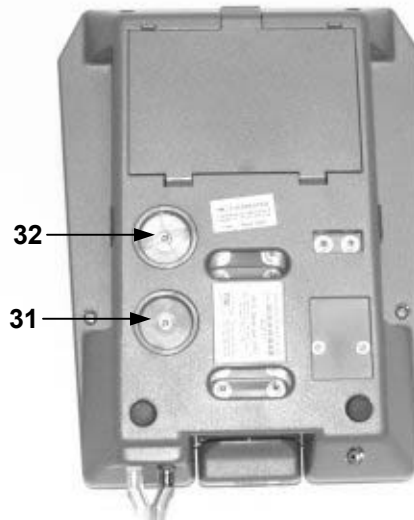
31. Excess Filter

The Excess Filter cleans the air that goes through the internal bypass, before it reaches the pump.

NOTE: It is unlikely that either filter will need to be replaced except during factory service.

32. Sensor Filter

The Sensor Filter cleans air that has passed through the internal sensor, before it reaches the pump.

33. Tube Adapters

There are two Tube Adapters shipped with each PORTACOUNT Plus. The adapters are used to connect the Sample Tube to a respirator sample fitting (or probe) that is larger than the 1/8 inch (3 mm) inside diameter of the Sample Tube. One of the Tube Adapters fits 3/16 inch (4.7 mm) fittings and the other fits 1/4 inch (6.3 mm) fittings. An adapter is not needed for respirators equipped with a 1/8 inch (3 mm) fitting.

34. Zero Check Filter

The Zero Check Filter is provided for the purpose of performing a Zero Check and Max FF Check on the PORTACOUNT Plus to make sure it is working properly. A spare filter is also provided.

35. PORTACOUNT Plus Operation & Service Manual (this manual)

The *PORTACOUNT Plus Operation & Service Manual* provides detailed instructions on operating, servicing and troubleshooting. It covers all aspects of the instrument with the exception of use with FitPlus Fit Test Software. It also does not cover use of the Model 8095 N95-Companion or Model 8026 Particle Generator.

36. FitPlus Fit Test Software and Technical Reference CD

This Compact Disc (CD) contains FitPlus Fit Test Software for Windows in addition to manuals and other information related to TSI fit testing products and fit testing in general. There is no longer a printed FitPlus manual in lieu of the built-in online help functions.

37. Diskette or Compact Disc (CD) Storage Case

The diskettes or CD that contain the Fit Test Software are located in one of these convenient storage cases.

38. Carrying Case

The Carrying Case is a rugged case that provides protection and convenience. The case is designed to hold the PORTACOUNT Plus and standard accessories as well as the optional Model 8925 Portable Printer and Model 8021 Battery Kit.

39.   Optional—Model 8095 N95-Companion

The N95-Companion is an optional accessory that allows the PORTACOUNT Plus to fit test lower efficiency filtering-facepiece (disposable) respirators such as class N95, R95 and P95 varieties available in the USA and P1 and P2 classes available in many other countries. Class-99, class-100 (USA), and P3 (other countries) disposables can be fit tested with the PORTACOUNT Plus alone. Older PORTACOUNTs can be made "N95-Companion Ready" via a factory upgrade.

40.   Optional Model 8026 Particle Generator

Some locations do not have the minimum 1000 particles/cm^3 ambient particle concentration needed for the PORTACOUNT Plus to do a fit test. The optional particle generator supplements the naturally occurring room concentration with non-toxic salt (NaCl) particles in the right size range for the PORTACOUNT to use.

Chapter 3

CONDUCTING A FIT TEST

NOTE: This chapter describes how to conduct a quantitative respirator fit test using the PORTACOUNT®
Plus Respirator Fit Tester. This procedure assumes that the mask being tested is a negative-pressure air-
purifying respirator or a positive-pressure mask temporarily converted to function like a negative-pressure
air-purifying respirator.

Why Fit Test?
There are two primary reasons for respirator fit testing:

1   Verification of Training
After the individual has received respirator training, you perform a fit test to make certain that the
person has learned how to properly put on and wear a respirator without assistance.

2   Sizing
It is important to make sure that the individual will be issued a respirator that is capable of
providing protection when worn properly, i.e., it is the right size.

Preparations for Fit Testing

Training the Trainer
The person conducting the fit test must have a clear understanding of respiratory protection,
respirators and fit testing to be effective. Anyone can master the operation of the PORTACOUNT
Plus simply by studying this manual, but the background knowledge required to proficiently fit
test cannot be obtained from here. Consider attending a one-, two- or three-day seminar on fit
testing provided by various consultants. Contact TSI for references.

Respirator Training
Respirator training is critical for any respiratory protection program. All employees who wear
respirators must be taught how and why they are used. This training should be done prior to the fit
test, not during the fit test. Consult the regulations or standards that pertain to your industry for
information on training requirements.

Respirators for Quantitative Fit Testing

Probed Test Respirators
The conventional way to quantitatively fit test is through the use of probed test respirators. A
probed respirator has a fitting (probe) installed that allows air from inside the respirator to be
sampled by an instrument like the PORTACOUNT Plus. The probed respirator is only used for fit
testing and cannot legally be used in a hazardous environment. You will need at least one
respirator of each make, model and size your company issues. After the fit test, the individual
should be issued a respirator with the identical facepiece, only without the probe.

Most probed respirators are obtained from the respirator manufacturer or distributor. You should
be able to buy probed versions of most if not all models. Be sure to buy class-100 or class-99
filters also if you don't already stock them. You must use class-100, class-99 or P3 filters for fit
testing even if you use another type of cartridge in the workplace.

Probes for filtering-facepiece (disposable) respirators

Disposable respirators can be fit tested by inserting a test probe through the filter material. The optional TSI Model 8025-N95 Probe Kit includes disposable probes and insertion tools. Order TSI Model 8025-N95R Probe Refill Kit for additional probes (no tools).

NOTE: *The PORTACOUNT Plus Model 8020 can successfully fit test class-100, class-99 and P3 disposable respirators. Lower efficiency disposable respirators such as class 95, P2 and P1 will usually require use of the optional TSI Model 8095 N95-Companion accessory.*

Fit Testing with the Person's Own Assigned Respirator

Some respirators, especially older models, do not have mask sampling adapters available. In that case, a permanently probed test respirator is the only option.
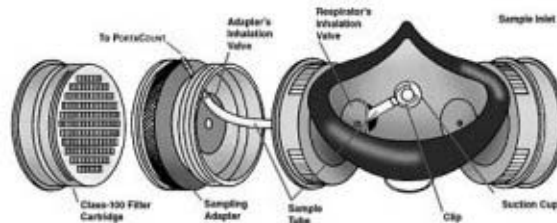
Respirator manufacturers' technique

There is a growing number of respirator manufacturers who provide sampling adapters that permit fit testing in one's own respirator. Contact your distributor or call the manufacturer direct and ask if such accessories are available.

TSI mask sampling adapter kits

TSI Sampling Adapters allow you to fit test using the respirator that is actually used by that individual. Sampling Adapters for most major brands of respirator are available.

Homemade adapters

A sampling adapter can be made by modifying a respirator cartridge. This usually involves running a tube through the cartridge and into the respirator. TSI recommends that you avoid this option because it is so easy to do poorly. The most fundamental mistake that is often made is to not extend the sampling tube through the inhalation valve and into the breathing zone. This combined with problems sealing around the outside of the tube make this option unattractive.

Precautions

The following is a discussion of several precautions that should be considered prior to conducting a fit test:

Fit Testing People Who Smoke Cigarettes or Cigars

Smokers exhale particles for at least 30 minutes after they have smoked a cigarette or cigar. The PORTACOUNT Plus can count these particles and will interpret them as if they were caused by face seal leakage. It is very important to instruct individuals not to smoke for at least 30 minutes prior to fit testing. Fit factors for anyone who has smoked recently will be lower than that individual deserves and may even cause him or her to fail the fit test entirely.

Fit Testing with Generated Aerosols

The PORTACOUNT Plus is designed to operate using the microscopic particles in the ambient air. It can measure particle concentrations and fit factors when generated aerosols (like corn oil, salt or DOP) are used, however, these aerosols may cause the PORTACOUNT Plus to need more frequent cleaning and calibration.

Fit Testing Near Irritant Smoke

Do *not* conduct fit tests in close proximity to sources of irritant smoke like those used for qualitative fit testing. The irritant smoke is corrosive and can damage the PORTACOUNT Plus. Fit testing near sources of amyl-acetate (banana oil) is not a problem.

Sample Tube Length

The Twin Tube Assembly is about 5½ feet long and must not be lengthened except for the few inches added by a Tube Adapter. The two sample tubes must be nearly the same length for accurate fit testing.

TSI recommends that the Zero Check Filter be left attached to the sample line whenever the PORTACOUNT Plus is turned on but not in use. This prevents lint and debris from being drawn into the instrument and blocking the airflow.

Fit Testing with FitPlus Fit Test Software (version 2.12 or higher)

Most PORTACOUNT Plus users conduct fit testing with the included FitPlus Fit Test Software because it makes the fit test process easy and provides documentation and record keeping functions. When used, FitPlus software controls all PORTACOUNT functions making it unnecessary to use the keypad controls other than the ON/OFF key. For detailed help using FitPlus software, please use the online help functions built into FitPlus. If you want to conduct fit testing without computer software, skip to the next section in this chapter. For more detailed instructions on the operation of FitPlus software use the online help function built into the software.

1.   Install FitPlus for Windows Software from the provided diskette or CD.

2.   Connect the AC Adapter (or battery) to the PORTACOUNT Plus and turn it on by pressing the ON/OFF key. The PORTACOUNT Plus will go through a 60-second warm-up period before it's ready to go.

3.   Connect the PORTACOUNT's Data Port to your computer's RS-232 serial port using the cable provided. If the computer port has 25 pins instead of 9, use the provided 25 to 9-pin adapter. Computers that do not have an RS-232 serial port can use a USB port by purchasing a USB to Serial Converter.

4.   Add alcohol to the PORTACOUNT Plus. Follow the instructions under "Adding Alcohol" located in the chapter on maintenance.

5.   Start FitPlus for Windows software by double-clicking the PORTACOUNT icon or selecting FitPlus for Windows from the Start Menu.

6.   FitPlus software starts and asks if you want to do the Daily Checks. TSI recommends that you Click **YES** the first time you use the PORTACOUNT Plus each day. Subsequent Daily Checks are optional. You can have FitPlus software perform the Daily Checks at any time by using the drop-down menus.

7.   Perform the Daily Checks as directed by the software when it first starts or by selecting Daily Checks from the PORTACOUNT Menu. You will need to use the Zero Check Filter provided. See Chapter 6, "Troubleshooting," if any of the tests fail.

8.   Next, FitPlus will offer to begin the fit test process at Step 1. Type in the information about the person you will be fit testing. Next time you fit test that person you will be able to pick the name off a list. Click **NEXT** when done.

9.   Step 2 (on screen) requires you to select a respirator. Type in the information about the respirator that will be used. Next time you use that same respirator you will be able to pick it off a list. In the USA, OSHA requires a fit factor pass level of 100 and 500 for half masks and full-face masks, respectively. Click the Help button if necessary. Click **NEXT** when done.

10.   Step 3 (on screen) requires you to enter the size of the mask being used and the fit test operator's name or initials. You can also review the other settings to make sure they are correct. Pay special attention to the current default fit test exercise protocol to make sure it's the one you are required to use. USA protocols and some non-USA protocols are pre-defined. If yours is not on the list you can create it by duplicating an existing protocol and editing it. Use the online help if necessary. Click **NEXT** when done.

11.   Now you are ready to start the fit test itself. Attach the clear sample hose to the respirator worn by the person being fit tested. When ready, click **START**. You will then be guided through the entire fit test exercise protocol automatically. Just have the person being fit tested perform each exercise as directed by the computer. The computer automatically performs the fit test, calculates all fit factors and saves the information to the database. After each fit test is completed, you may review the results, print a report, or start another fit test.

Fit Testing Without Computer Software

Follow the steps below to setup the PORTACOUNT Plus for fit testing in "stand-alone" mode instead of using FitPlus Fit Test Software. In stand-alone mode, you will have to manually record the fit test results and information about the person and respirator being fit tested. Use of the optional Model 8925 Portable Printer eases the record keeping burden by printing the numerical fit test results.

1.　　Connect the optional Model 8925 Portable Printer if you intend to use it. Use the cable that came with the printer. The word "PRINTER" is molded into the printer end.

2.　　Connect the AC Adapter (or battery) to the PORTACOUNT Plus and turn it on by pressing the ON/OFF key. The PORTACOUNT Plus will go through a 60-second warm-up period before it's ready to go.

3.　　Turn the printer on (if used).

4.　　Add alcohol. Follow the instructions under "Adding Alcohol" in the Maintenance chapter.

5.　　Perform the Daily Checks if this is the first time today that the PORTACOUNT Plus has been used. Follow the instructions in the Maintenance chapter. TSI recommends that the Daily Checks be performed at the start of each day of fit testing. Subsequent Daily Checks are optional. If any of the Daily Checks fail, see the Troubleshooting chapter.

6.　　Set the number of exercises to be used. Check the current setting by momentarily pressing the NO. OF EXER key. If the number of exercises is not correct for the protocol you wish to perform, press and hold the NO. OF EXER key to scroll through the available choices. Release the key as soon as the correct number appears on the display. Press the key again momentarily to make sure the setting is right. The PORTACOUNT will remember this setting until you change it again.

　　　NOTE: Most fit testing in the USA involves 8 exercises. If necessary, consult the appropriate regulation or standard that applies to your organization.

7.　　Check the fit factor pass level by momentarily pressing the PASS LEVEL key. Press and hold the PASS LEVEL key to scroll through the available choices. Release the key as soon as the number you want to use appears on the display. Press the key again momentarily to make sure the setting is correct

　　　NOTE: In the USA, OSHA requires a minimum fit factor of 100 for half masks and 500 for full-face masks. If necessary, consult the appropriate regulation or standard.

Conducting a Fit Test in Stand-alone Mode

The instructions below assume that you want to perform a fit test using a half-mask respirator in compliance with the US Dept. of Labor, Occupational Safety and Health Administration (OSHA) Respiratory Protection Standard 29 CFR 1910.134. Make appropriate adjustments for other fit test protocols.

OSHA 29 CFR 1910.134 Protocol Details:

Minimum fit factor: 100 for half masks, 500 for full-face masks
Exercise duration: 60 seconds each
Number of exercises: 8
Exercises:
   1-Normal breathing
   2-Deep breathing
   3-Head side-to-side
   4-Head up-and-down
   5-Talking out loud
   6-Grimace*
   7-Bending
   8-Normal breathing

  *The OSHA protocol includes special provisions for the grimace exercise. It is allowed to be 15 seconds long and the resulting fit factor may be discarded (excluded) before calculating the overall fit factor. This is allowed because the grimace exercise is done to intentionally break the face seal in order to make sure the mask reseats itself before the next exercise. In Stand-alone mode, the PORTACOUNT Plus cannot perform an exercise in less than 30 seconds and cannot "exclude" the resulting fit factor. These details are automatically handled when using FitPlus software. If a person fails a fit test due to the grimace exercise while using stand-alone mode, OSHA allows you to manually recalculate the overall fit factor with the grimace exercise excluded. See the appendix on "Calculating Fit Factors."

1. Instruct the person to be tested to don the respirator 5 minutes before the fit test starts. This purges the particles trapped inside the respirator when it was donned and permits the wearer to make certain the respirator is comfortable. The individual should have already been trained on how to wear the respirator properly.

2. Attach the clear Sample Tube to the respirator. Use one of the Tube Adapters if necessary.

3. Press the TEST START/STOP key to start the fit test and instruct the individual to begin the first exercise. A single audible "beep" signals the end of an exercise and the immediate beginning of the next exercise. There is no pause between exercises. During an exercise, the fit factor from the

previous exercise will remain visible on the display along with the PASS or FAIL message. As originally shipped, the PORTACOUNT Plus will use 60-second exercises to comply with U.S. OSHA Standard 29CFR1910.134.

Normal breathing
Remain still and breathe as usual.

Deep breathing
Take long deep breaths as if working hard. Don't overdo it.

Head side to side
Breathe normally while slowly turning the head from side to side. Turn far enough to each side to stretch the neck muscles. Each cycle from left to right should take several seconds, pausing momentarily at each side to take a breath.

Head up and down
Breathe normally while slowly alternating between looking up at the ceiling and down at the floor. Each up and down cycle should take several seconds.

Talking out loud
Read a prepared paragraph (like the Rainbow Passage located in the appendix of this manual) or count out loud to simulate the workplace.

Grimace
Grimace by smiling and/or frowning to create a leak in the respirator face seal. This exercise will often result in a failed fit factor if you are "good" at grimacing, which is why the OSHA standard allows you to not count or "exclude" that fit factor when computing the overall fit factor. The idea is that you are intentionally creating a break in the face seal in order to see if the mask re-seals afterwards. Successful re-sealing is proven by achieving a passing fit factor on the *next* exercise.

NOTE: *FitPlus fit test software is designed to automatically "exclude" the grimace exercise result for you. However, in stand-alone mode, the PORTACOUNT Plus cannot exclude the results of an exercise. If you are using the PORTACOUNT in stand-alone mode and the person being fit tested fails the overall fit factor due to a low grimace fit factor, OSHA permits you to manually recalculate the overall fit factor without the grimace fit factor. See the appendix on "Calculating Fit Factors" in this manual for details.*

Bend and touch toes
Bend at the waist as if you were touching your toes while breathing normally.

Normal breathing
Remain still and breathe as usual.

4.   After displaying the last exercise fit factor for a few seconds, the PORTACOUNT Plus will sound a triple "beep" and automatically calculate and display the overall fit factor for the entire set of exercises. The overall fit factor is what counts. The PASS or FAIL message will indicate whether or not the test was successful. If the test was a PASS, the fit test is over.

5.   Assuming the fit test was successful, you will need to keep a record of the test on file. If you used the optional printer, you can attach the printout to a larger sheet of paper that contains the individual's identification and information describing the make, model and size respirator used, test date, etc.

TSI recommends that the Zero Check filter be left attached to the sample line whenever the PORTACOUNT Plus is turned on but not in use. This prevents lint and debris from being drawn into the instrument and blocking the airflow.

Common Problems Resulting in Low Fit Factors

Here is a list of the most common problems that result in lower than expected fit factors. *Assuming the PORTACOUNT Plus passes the Daily Checks*, explore the following possibilities.

Not using high efficiency filters
If you are not using high-efficiency class-99 or class-100 filters (P3 for non-USA users) on the respirator, you may never get a high fit factor. Filters such as class-95. (P1 and P2 for non-USA users) allow some ambient air particles to get through and be interpreted as face seal leakage by the PORTACOUNT Plus.

NOTE: The optional Model 8095 N95-Companion will allow the PORTACOUNT to fit test lower efficiency respirators including class-95, P1 and P2 filtering-facepieces (disposables).

Cartridges not tight or gasket is missing
Make sure the cartridges are tight and all gaskets are in position.

Starting fit test too soon after mask is donned.
When the mask is first donned ambient air particles are trapped inside. These particles clear out as the person breathes. Half mask respirator clear very quickly, however full-face masks can take over one minute.

Sample tubes too long
You must not extend the sample lines more than the few inches needed to add a Tube Adapter. Longer sample tubes prevent proper purging between the ambient and mask sample.

Leaking respirator probe or mask sampling adapter
Make certain that the respirator probe (if used) or mask sampling adapter does not leak around the outside.

PORTACOUNT sample tube leaks where attached to probe or adapter due to wear.
Cut a short piece off the end of the tube to expose a fresh end.

Hair interfering with face seal
Make sure there is no hair between the respirator face seal and the individual's skin.

Hair or foreign material in exhalation valve
Make sure the exhalation valve is clear. A single hair can make a big difference.

Cigarette smoker
Do *not* allow the individual to smoke for **at least** 30 minutes prior to the fit test.

Disclaimer: The measurement provided by the PORTACOUNT Plus is an assessment of respirator fit during a fit test only. Respirator fit at other times will vary. The fit factor value is not intended for use in calculating an individual's actual exposure to hazardous substances.

Chapter 4

OPERATING THE PORTACOUNT PLUS

This chapter contains detailed instructions for operating the PORTACOUNT® Plus Respirator Fit Tester manually as a stand-alone instrument. You should learn to operate the PORTACOUNT Plus in this manner even if you plan to use the IBM-PC compatible FitPlus Fit Test Software included with the instrument. After becoming familiar with manual operation, if you want to automate fit testing with a computer and the fit test software, refer to the FitPlus for Windows online help for detailed instructions.

Connecting Power

There are two ways to provide power to the PORTACOUNT Plus. You can use the AC adapter supplied with the instrument or use optional rechargeable battery packs available from TSI. After the AC adapter and/or battery pack is installed, you can turn the instrument on or off simply by pressing the ON/OFF key.

Using the AC Adapter

The AC adapter is a power supply with two cords attached to it. One cord plugs into an AC wall outlet and the other plugs into the power connector on the back of the PORTACOUNT Plus. Make sure your AC wall outlet voltage matches the input voltage listed on the AC adapter. Newer PORTACOUNTs are supplied with a voltage-sensing AC adapter.

Using the Optional Batteries

NOTE: As of January 2003, battery packs are no longer available from TSI.
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The optional Model 8021 Rechargeable Battery Kit contains three battery packs and an external battery charger. The external charger allows you to charge batteries separately, while using the PORTACOUNT Plus at the same time. A fully charged battery pack will power the PORTACOUNT Plus for about 3 hours. Refer to Chapter 5, "Maintenance," for more details regarding batteries and battery charging.

NOTE: When the optional Model 8095 N95-Companion is in use, battery life will be reduced to less than two hours.

You may leave a battery pack inside the PORTACOUNT Plus when the AC adapter is being used. The battery will recharge, however, the rate of charge is very low. A battery pack will take 24 hours to fully charge when inside the PORTACOUNT Plus. Having a battery pack installed during AC operation will prevent loss of data in the event that the AC adapter is accidentally disconnected or there is a power failure.

To use the PORTACOUNT Plus with a battery pack, follow these steps:

1.   Turn the PORTACOUNT Plus over and remove the battery compartment cover with your finger.

2.   Locate a fully charged battery pack and plug it into the battery connector located inside the battery compartment. Note that the two connector pins are different sizes. Make certain that the connector is inserted into the battery pack with the correct polarity. DO **NOT** force the connector into the battery pack. It should slide in easily. If it does not slide in with little effort, you probably have the pins reversed.

3.   Place the battery pack into the battery compartment in the orientation shown. Tuck the wires in so that they do not interfere with closing the battery cover. Make sure the wires are not allowed to be underneath the battery.

4.   Replace the battery compartment cover. Make sure the cover snaps back in place tightly.

When a battery inside the PORTACOUNT Plus runs low on power the LOW BATTERY warning message will flash on the Display. When this occurs, you have about 15 minutes before the PORTACOUNT Plus automatically turns itself off. Finish the fit test in progress and then install a fresh battery. If the optional printer is connected, the message "Low Battery" is printed just before the PORTACOUNT Plus turns itself off.

Connecting the Optional Printer

The PORTACOUNT Plus can be used with an optional portable printer. The printer provides hard copy documentation of the fit test and eliminates the tedious and error-prone task of manually recording fit test results. Of course, if you want the ultimate degree of automation, you should use the FitPlus Fit Test Software included with your PORTACOUNT Plus. The PORTACOUNT Plus is used either with the small portable printer, or with the Fit Test Software, not both. The reason for this is because the Data Port cannot be used to communicate directly with a printer and a computer at the same time. The FitPlus Fit Test Software can be used with any printer you normally use with Windows® while fit testing.

To connect a TSI Model 8925 Portable Printer directly to the PORTACOUNT Plus, locate the interface cable that was shipped with the printer. It has a modular RJ-45 (telephone type) connector on one end and a 9-pin D-connector on the other. Simply connect the appropriate connector to the printer on one end and to the PORTACOUNT Plus Data Port on the other. If you find that the printer prints only question marks "???????", turn the printer off and then on again. Refer to the small manual that was shipped with the Model 8925 printer for details on how to operate it.

Modes of Operation

When you turn the PORTACOUNT Plus on, the instrument automatically begins a 60-second warm-up period. The display will show the number of seconds remaining in the warm-up period. When the warm-up period is over, a single "beep" will sound and the PORTACOUNT Plus will be in Fit Test Mode. There are two other modes that are also available; Count Mode and External Control Mode. Each mode is described separately below.

Count Mode

Count Mode is used mostly for diagnostic purposes such as Zero Checking and measuring ambient particle concentrations. Press the COUNT key to put the PORTACOUNT Plus into Count Mode. The indicator light on the COUNT key will go on.

While in Count Mode the PORTACOUNT Plus continuously measures and displays particle concentrations in units of particles per cubic centimeter (particles/cm³). The message "PARTICLE/cm³" will flash in 1-second intervals. This is called 1-Second Count Mode because the particle concentration displayed is an average over a 1-second period, updated every second. Pressing the TEST START/STOP key will toggle the PORTACOUNT Plus between 1-Second Count Mode and 15-Second Count Mode. In 15-Second Count Mode the particle concentration displayed is an average over a 15-second period, updated every 15 seconds. In 15-Second Count Mode the message "PARTICLE/cm³" will flash every other second. When you initially switch to 15-Second Count Mode, the particle concentration displayed will be zero until 15 seconds have elapsed.

If a printer is used, the data printed in 1-Second Count Mode is actually 2-second averages, printed every 2 seconds (because the printer is too slow to print every second). The Display shows 1-second averages, updated every second. In 15-Second Count Mode, both the Display and printer will show 15-second averages, printed and updated every 15 seconds.

In Count Mode, the PORTACOUNT Plus always samples through the Sample Tube marked "SAMPLE".

Count Mode is used along with the small Zero Check Filter supplied with the instrument to make certain that there are no leaks in the PORTACOUNT Plus and that it is working properly. This procedure is called "The Daily Checks" and should be done at least once per day or preferably, each time the PORTACOUNT Plus is turned on. See "Daily Checks" in Chapter 5, "Maintenance," for the procedure.

Fit Test Mode
Fit Test Mode is the mode that you will be using most often unless the FitPlus Fit Test Software is utilized. Press the FIT TEST key to put the PORTACOUNT Plus into Fit Test Mode. The indicator light on the FIT TEST key will go on.

Disclaimer:	The measurement provided by the PORTACOUNT Plus is an assessment of respirator fit during a fit test only. Respirator fit at other times will vary. The fit factor value is not intended for use in calculating an individual's actual exposure to hazardous substances.

When the initial 60-second warm-up period is over, the PORTACOUNT Plus will be in Fit Test Mode. The Fit Test Mode indicator light will be on. At this moment the PORTACOUNT Plus is idle, i.e., it is not yet performing a fit test. It will turn itself off in 10 minutes if left idle.

The TEST START/STOP key is used to start a fit test and also to terminate a fit test in-progress. The PORTACOUNT Plus will automatically stop the test at the completion of the last exercise and go back to the idle condition. The only time you would normally want to use this key to stop a test would be to abort the fit test in progress before the last exercise was complete. An example of when you might want to abort a test would be if one of the exercises had such a low fit factor that there was no point to continuing. In most cases, the TEST START/STOP key will only be used to start a fit test or to stop a Maximum Fit Factor Test which is one of the Daily Checks (see Troubleshooting chapter).

You can tell if the PORTACOUNT Plus is in the middle of a fit test or idle by observing the Display. While idle, the "IN PROGRESS" message will not be visible. While in the middle of a fit test, the "IN PROGRESS" message will be flashing. See Chapter 3, "Conducting a Fit Test," for more details on how the PORTACOUNT Plus works in Fit Test Mode.

When a fit test is started, the PORTACOUNT Plus begins a preprogrammed test sequence, sampling alternately from the Sample Tube and the Ambient Tube. Each exercise includes an ambient sample, a mask sample, and then another ambient sample. When the PORTACOUNT Plus was originally shipped from the factory, each exercise was set up to use a mask sample time of 40 seconds. The mask sample time along with the ambient sample time and in-between purges add up to 60 seconds per exercise which complies with The U.S. OSHA Respiratory Protection Standard 29CFR1910.134. Refer to the section on "Changing the Exercise Duration" later in this chapter for more information on altering the sampling times.

A single audible "beep" signals the end of an exercise and the immediate beginning of the next exercise. There is no pause between exercises. During an exercise, the fit factor from the previous exercise will remain visible on the display along with the PASS or FAIL message. When the final exercise is completed, a single "beep" signals that the fit factor for the final exercise is being

displayed. The fit factor for the final exercise will be displayed for only 3 seconds. Then a triple "beep" will sound, indicating that the fit test has been completed and the overall fit factor and PASS/FAIL message is visible on the display. If the fit test is terminated before the last exercise is completed (by pressing the TEST START/STOP key), the fit factor display will go blank and the exercise number will reset to zero. No overall fit factor will be displayed and if connected, the Model 8925 Portable Printer will print "Test Terminated".

Refer to the Appendices for technical details on exercise/sample timing, calculating exercise fit factors, and calculating overall fit factors.

If a TSI Model 8925 Portable Printer is connected to the PORTACOUNT Plus during a fit test, a printout will be provided that lists all the ambient and mask particle concentrations, the fit factor for each exercise and the overall fit factor. An example of the printout from a six exercise fit test is shown below. The comments to the right side do not print.

```
                                          COMMENTS
          NEW TEST  PASS = 100      Start of new test
          Ambient    4750 #/cc      Ambient concentration
          Mask      11.30 #/cc      Mask concentration
          Ambient    4800 #/cc      Ambient concentration
          FF    1     422 PASS      Fit factor exercise 1
          Mask       5.20 #/cc
          Ambient    4700 #/cc
          FF    2     894 PASS      Fit factor exercise 2
          Mask       9.80 #/cc
          Ambient    5000 #/cc
          FF    3     505 PASS      Fit factor exercise 3
          Mask      13.50 #/cc
          Ambient    4800 #/cc
          FF    4     359 PASS      Fit factor exercise 4
          Mask       7.90 #/cc
          Ambient    4900 #/cc
          FF    5     610 PASS      Fit factor exercise 5
          Mask       4.10 #/cc
          Ambient    5100 #/cc
          FF    6    1231 PASS      Fit factor exercise 6
          Overall FF  560 PASS      Overall fit factor
```

The overall fit factor is the most important data item. It is the overall result of the entire fit test and usually the only fit factor value that must be retained as part of your record keeping. The fit factors for the individual exercises are not so important. It is possible to have a passing overall fit factor even though one of the exercises resulted in a failing fit factor.

The overall fit factor is not simply an average of all the exercise fit factors. It is a weighted average related to the amount of airborne hazard that the person might have inhaled if he/she were in the workplace. One breath at a fit factor of 100 and then another at a fit factor of 1000 is not the same as two breaths at a fit factor near 550, it is the same as two breaths at a fit factor of about 180. This is due to the fact that the breath at a fit factor of 100 contains 10 times the amount of hypothetical hazard as the breath at a fit factor of 1000. See the appendix on "Calculating Fit Factors" for more details.

Fit Test Mode can be used along with the supplied Zero Check Filter to determine if the PORTACOUNT Plus is functioning properly. This process is called a Maximum Fit Factor Check or Max FF Check and is one of the Daily Checks that should be done once a day or whenever a

question arises as to whether or not the PORTACOUNT Plus is functioning properly. See the maintenance chapter for instructions on performing the Daily Checks.

External Control Mode
External Control Mode is used when the PORTACOUNT Plus is being controlled through the Data Port by an external computer. You cannot invoke External Control Mode from the PORTACOUNT Plus keypad. A computer with software such as the FitPlus Fit Test Software included with the PORTACOUNT Plus must be used. When the External Control Mode indicator is on, all keypads are disabled except for the ON/OFF key. All other functions will be controlled by the external computer when the PORTACOUNT Plus is in External Control Mode. Refer to the online help built into FitPlus for Windows Fit Test Software for details on operation using a computer and software.

Checking/Setting the Fit Factor Pass Level for Stand-alone Operation

NOTE: This describes the Pass/fail setting that is stored inside the PORTACOUNT Plus and used in stand-alone mode. This setting is totally ignored when fit testing with FitPlus software. FitPlus software controls ALL PORTACOUNT functions when in use.

The PORTACOUNT Plus has a number of internally stored, user selectable fit factor pass values. Press the PASS LEVEL key just long enough to hear the audible "beep" to display the currently set pass level. Press and continue to hold the PASS LEVEL key to scroll through the various pass levels available. The list will start again at the beginning after you go past the last value. When you see the value you want to use, let go of the key. This will permanently change the pass level to that value until you change it again, even if the PORTACOUNT Plus is turned off. Press the PASS LEVEL key momentarily to check that the level you desire has been set properly. The fit factor pass level was set to 100 when the PORTACOUNT Plus was shipped new from the factory. In the USA, OSHA requires a minimum fit factor of 100 for half masks and 500 for full-face masks.

The fit factor pass level and number of exercises can be "locked" by setting an internal DIP switch. This feature can be used to prevent unauthorized tampering with the fit test protocol.

The list of fit factor pass levels are preprogrammed at the factory, however, using the software supplied with the PORTACOUNT Plus, you can permanently change the list of values. The new values will remain available until you change them again, even if the PORTACOUNT Plus is turned off. Refer to the online help in FitPlus for Windows software (v2.12 or higher) for details on changing the internal list of pass levels.

A fit factor pass level of zero is one of the choices. Using zero for the pass level has the effect of disabling the PASS/FAIL message on the display. All other functions remain the same. Disabling the PASS/FAIL message can be useful if you want to use a pass level that is not among the preprogrammed choices or to conceal the pass/fail determination from curious bystanders. You will have to determine pass or fail manually when the fit factor pass level is set to zero. The numerical fit factor values measured and displayed by the PORTACOUNT Plus are unaffected by the pass/fail setting.

Checking/Setting the Number of Exercises for Stand-alone Operation

NOTE: This describes the number of exercise settings that are stored inside the PORTACOUNT Plus and

used in stand-alone mode. This setting is totally ignored when fit testing with FitPlus software. FitPlus software controls ALL PORTACOUNT functions when in use.

The PORTACOUNT Plus needs to know how many exercises there are in the fit test protocol you plan to use (typically 8 for OSHA compliance). This allows the PORTACOUNT Plus to automatically stop and compute the overall fit factor at the completion of each test without you having to stop it manually.

Refer to the regulation or standard that applies to your industry or hazard for guidance on which exercises should be performed and how many there should be.

Press the NO. OF EXER (number of exercises) key just long enough to hear the audible "beep" to display the number of exercises currently set. Press and continue to hold the NO. OF EXER key to scroll through the available values. The list will start again at the beginning after you go past the last value. When you see the number of exercises you want to use, let go of the key. This will permanently change the number of exercises to that value until you change it again, even if the PORTACOUNT Plus is turned off. Press the NO. OF EXER key momentarily to check that the value you desire has been set properly. The number of exercises was set to 8 when the PORTACOUNT Plus was shipped new from the factory.

You may set the number of exercises to zero. This forces the PORTACOUNT Plus to function much like the original (discontinued) TSI PORTACOUNT Model 8010. Once the fit test is initiated, it will continuously perform up to 255 fit test exercise cycles unless it is stopped by pressing the TEST START/STOP key. The PORTACOUNT Plus will display the exercise number in progress. An exercise count of up to 19 can be displayed. If the 20th exercise is reached, the display will start again at zero. Beyond 20 exercises, the display will count from zero to 9 over and over until the test is stopped. All fit factor data is retained and used to calculate the overall fit factor regardless of the number of exercises performed (up to 255 exercises). When the test is stopped, the overall fit factor for all the previous exercises will be displayed. Setting the number of exercises to zero allows the PORTACOUNT Plus to be used with the original TSI Model 8015 Fit Test Software and FitPro DOS software designed for the PORTACOUNT Model 8010. When the PORTACOUNT Plus is in 8010 Mode (i.e., the number of exercises is set to zero), the exercise timing will be just like that used in the PORTACOUNT Model 8010. The timing intervals will be:

Ambient purge	4 seconds
Ambient sample	5 seconds
Mask purge	11 seconds
Mask sample	40 seconds

Therefore, in 8010 Mode (number of exercises set to zero) all exercises will be 60 seconds in duration and cannot be changed.

Changing/Checking the Exercise Duration for Stand-alone Operation

NOTE: This describes the exercise duration settings that are stored inside the PORTACOUNT Plus and used in stand-alone mode. These settings are totally ignored when fit testing with FitPlus software. FitPlus software controls ALL PORTACOUNT functions when in use.

The duration of each fit test exercise can be individually adjusted for stand-alone operation. This requires temporary use of the FitPlus for Windows Software program Version 2.12 or higher, which is supplied with the PORTACOUNT Plus and cannot be done from the PORTACOUNT Plus Keypad. Once the exercise duration has been programmed, they remain in effect until you change them again, even if the PORTACOUNT Plus is turned off. This allows you to take advantage of the variable exercise feature even when the PORTACOUNT Plus is used without FitPlus for Windows Software. Refer to the FitPlus Software online help for details on changing exercise duration.

Refer to the regulation or standard that applies to your industry or hazard for guidance on exercise duration.

To check all the internal PORTACOUNT Plus settings using a Model 8925 Portable Printer, simply attach the printer to the PORTACOUNT Plus prior to turning the PORTACOUNT Plus on. Turn the PORTACOUNT Plus on and then immediately turn the printer on. During the 60-second warm-up period, a printout will be produced showing all current internal settings.

All exercise durations were set to 60 seconds when the PORTACOUNT Plus was shipped new from the factory. The factory timing sequence is:

Ambient purge	4 seconds
Ambient sample	5 seconds
Mask purge	11 seconds
Mask sample	40 seconds
TOTAL	60 seconds

NOTE: *If the optional Model 8095 N95-Companion is attached and active, the printout will show the timing used with the N95-Companion. These settings are different than those used by the PORTACOUNT Plus alone.*

Status Messages

There are three different status messages that can be displayed by the PORTACOUNT Plus.

Low Battery Warning Message

NOTE: *As of January 2003, battery packs are no longer available from TSI.*

If the PORTACOUNT Plus is being powered by an optional rechargeable battery pack and the battery approaches depletion, the message "LOW BATTERY" will flash near the center of the Display. At this point you have approximately 15 minutes of run-time left before the PORTACOUNT Plus turns itself off.

If the low battery warning message comes on during a fit test, you should complete that test and then install a fresh battery before starting another test or plug in the AC Adapter. It is unwise to start a fit test when the low battery warning message is visible because the instrument may turn itself off before the test is complete.

If a printer is connected, the message "LOW BATTERY" will be printed just before the PORTACOUNT Plus turns itself off.

Low Particle Message

If the ambient sample in Fit Test Mode is below 1000 particles/cm^3, the message "LOW PARTICLE" will appear near the center of the Display and the fit test will be automatically terminated. If a Model 8925 Portable Printer is attached, the message

```
xxx/cc Low Particle Count
Test Terminated
```

prints, where xxx is the particle concentration. The PORTACOUNT Plus is factory programmed not to allow fit testing when the ambient particle concentration is below 1000 particles/cm^3. This message may appear in Fit Test Mode only, for one of the reasons outlined below. Consult Chapter 6, "Troubleshooting," if necessary.

NOTE: *If the optional Model 8095 N95-Companion is in use, the minimum ambient particle count is 70 particles/cm^3.*

Possible reasons for LOW PARTICLE warning:

▪ The local ambient particle concentration in the area may actually be too low. This is unusual unless you are in an area or building where the ventilation system is equipped with special

filtration equipment. Try another location or generate additional particles with a candle or TSI Model 8026 Particle Generator if this is the case.

- The Ambient Tube may be blocked or restricted in some way, or the sample tubes may be reversed such that the ambient sample is being drawn from the respirator instead of the ambient air.

- The PORTACOUNT Plus is low on alcohol or the Alcohol Cartridge is not installed in the Cartridge Cavity. The message "SERVICE" may also be on if this is the case. Try refilling the Alcohol Cartridge even if the service message is off.

- The PORTACOUNT Plus is in need of cleaning and recalibration. Contact TSI.

Service Message

When the message "SERVICE" appears on the display, it can mean one of several things. Usually it means that the PORTACOUNT Plus is low on alcohol, but there are other reasons that can cause this message to appear. When the service message appears, it does not necessarily mean that the PORTACOUNT Plus will stop working soon. Fit test results are accurate even when this message is on. If none of the suggestions below cause the message to go off, you should schedule a time in the near future to send the PORTACOUNT Plus to TSI for service.

It is normal for the service message to stay on most of the time when the PORTACOUNT Plus needs cleaning and recalibration.

TSI recommends annual factory recalibration and cleaning regardless of the status of the service message.

The most probable reasons for the service message to be on are listed below. Consult Chapter 6, "Troubleshooting," if necessary.

- The PORTACOUNT Plus is low on alcohol. Refill the Alcohol Cartridge.

- Excessive moisture has accumulated in the Alcohol Cartridge. Refer to Chapter 5, "Maintenance," for details on changing the Alcohol Wick.

- The ambient temperature is unusually high. Ignore the service message in this case.

- The battery is low. Ignore the service message and install a fresh battery.

- The PORTACOUNT Plus is in need of cleaning and recalibration. Contact TSI.

Shipping & Storage Precautions

It is important to remove all alcohol from the PORTACOUNT Plus during transportation and storage. Anytime you put the PORTACOUNT Plus back into the carrying case you should:

1. Remove the Alcohol Cartridge from the PORTACOUNT Plus and store it in the Alcohol Fill Capsule.

2 Cover the Cartridge Cavity with the Storage Cap.

The Alcohol Fill Capsule is designed to be a safe transportation and storage container for alcohol. The Alcohol Cartridge can be left soaking in alcohol indefinitely. Installing the Storage Cap into the Cartridge Cavity prevents dirt or lint from getting inside the PORTACOUNT Plus.

NEVER TRANSPORT OR STORE THE PORTACOUNT Plus WITH THE ALCOHOL CARTRIDGE INSIDE IT. Flooding of the optics may occur.

NEVER SHIP THE PORTACOUNT Plus BACK TO TSI WITH ANY ALCOHOL BOTTLES.

ALWAYS KEEP THE ALCOHOL CARTRIDGE IN THE ALCOHOL FILL CAPSULE DURING TRANSPORT AND STORAGE.

ALWAYS USE THE ALCOHOL STORAGE CAP TO COVER THE CARTRIDGE CAVITY OF THE PORTACOUNT Plus DURING TRANSPORT AND STORAGE.

NEVER LEAVE THE CARTRIDGE CAVITY OPEN LONGER THAN NECESSARY.

KEEP THE STORAGE CAP AND ALCOHOL CARTRIDGE CLEAN. ALWAYS SET THEM DOWN WITH THE END STANDING UP AS SHOWN BELOW. This precaution prevents dirt or debris from entering the instrument and inhibiting operation. The pin-hole size orifice inside the PORTACOUNT Plus can easily become clogged.

ALWAYS RECAP ALCOHOL FILL CAPSULE AND OTHER CONTAINERS IMMEDIATELY TO PREVENT ABSORPTION OF MOISTURE AND THE ESCAPE OF ALCOHOL VAPORS.

Chapter 5

Model/Part No.	Description
8016	Box of 16, 30 ml bottles of isopropyl alcohol (480 ml total)
8023	Box of 10 Alcohol Wicks with screens
1602066	Zero Check Filter
8017	Sampling Hose Kit with 3 Twin Tube Assemblies and 10 each 3/16 in. and 1/4 in. Tube Adapters.
800197	Twin Tube Assembly (Quantity 1)
8924	20 rolls of thermal paper for Model 8925 Portable Printer
8024	AC Adapter for Model 8020 (voltage sensing)
1980092	PORTACOUNT Plus Operation & Service Manual
8022	Alcohol Cartridge and Fill Capsule Kit for Model 8020
1081601	Alcohol Fill Capsule with Storage Cap
800629	Storage Cap
1081241	Alcohol Cartridge with wick

Adding Alcohol

	W A R N I N G
⚠	Isopropyl alcohol is hazardous material. Do *not* ingest or allow alcohol to contact your eyes or skin. Refer to the Material Safety Data Sheet (MSDS) located in the box of alcohol for handling precautions and first aid procedures.
	Always recap alcohol fill capsule and other containers immediately to prevent absorption of moisture and the escape of alcohol vapors.
	Dispose of any alcohol with visible contamination.

The PORTACOUNT Plus consumes isopropyl alcohol at a rate of about one ml per hour. The alcohol is used to grow microscopic particles in the air into larger droplets that are easier to detect and count. Refer to the appendices for details on how the PORTACOUNT Plus works.

The isopropyl alcohol that is required to properly operate the PORTACOUNT Plus must be very high purity "reagent grade" (99.5% pure) alcohol. Isopropyl alcohol that is available from pharmacies, drug stores, or other consumer outlets is low purity and usually contains significant percentages of water and other substances that can cause performance problems with the PORTACOUNT Plus. DO **NOT** USE INFERIOR ISOPROPYL ALCOHOL.

MAINTAINING AN ADEQUATE ALCOHOL SUPPLY INSIDE THE PORTACOUNT Plus IS CRITICAL TO ITS OPERATION AND REQUIRES STRICT ADHERENCE TO THE DIRECTIONS THAT FOLLOW.

To add alcohol to the PORTACOUNT Plus you must first identify and locate the alcohol-related components and accessories that are included with the instrument. You will need the following items:

- Isopropyl Alcohol
- Alcohol Fill Capsule
- Storage Cap
- Alcohol Cartridge

Isopropyl alcohol is supplied by TSI in 30 ml plastic bottles. The Alcohol Fill Capsule is located in the PORTACOUNT Plus Carrying Case. The Storage Cap should be either sealing the Alcohol Fill Capsule or inserted into the PORTACOUNT Plus Cartridge Cavity. The Alcohol Cartridge will also be either in the PORTACOUNT Plus Cartridge Cavity or in the Alcohol Fill Capsule, whichever one is ***not*** holding the storage cap.

1.   Turn the PORTACOUNT Plus off.

2.   Open the Alcohol Fill Capsule by twisting the Storage Cap or Alcohol Cartridge. Set the Storage Cap or Alcohol Cartridge down on a clean surface with the end standing up to prevent contamination.

3.   Open a bottle of alcohol. Invert the bottle and insert the nozzle end into the Alcohol Fill Capsule as far as possible to make certain that you cannot inadvertently spray alcohol anywhere except down into the Capsule.
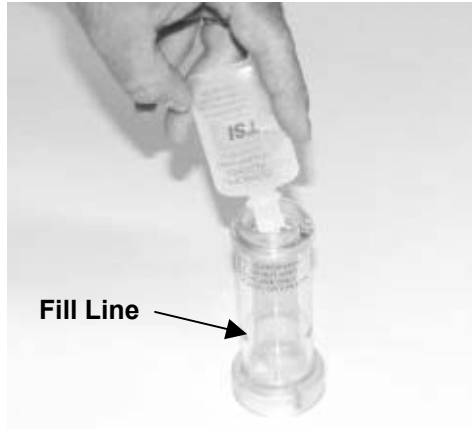
Fill Line

4.   Squeeze alcohol into the Alcohol Fill Capsule until it is even with or slightly above the scribed fill-line near the base. RECAP THE ALCOHOL BOTTLE IMMEDIATELY.

> *NOTE: TSI used to provide a black sponge located at the bottom of the Fill Capsule. That sponge is no longer used and should be removed from the Fill Capsule.*

5.   MAKE CERTAIN THAT THE ALCOHOL CARTRIDGE IS CLEAN. Insert the Alcohol Cartridge into the Alcohol Fill Capsule and turn it clockwise until it locks in place.

6.   Set the Alcohol Fill Capsule down and wait at least 2 minutes while the alcohol wick inside the Alcohol Cartridge soaks up alcohol.

7.   Remove the Alcohol Cartridge from the Capsule and gently shake it to allow excess alcohol to drain back into the Alcohol Fill Capsule. Stop when excess alcohol is no longer dripping. It is not necessary to wait until the outside surface of the Alcohol Cartridge is dry. Insert the Alcohol Cartridge into the Cartridge Cavity of the PORTACOUNT Plus. It should slide in easily with little effort. **DO NOT FORCE IT.** Align the tab on the Alcohol Cartridge with the corresponding tab on the PORTACOUNT Plus located just above the Cartridge Cavity. As you approach full insertion, firmly twist the Alcohol Cartridge clockwise until it locks into position. RECAP THE ALCOHOL FILL CAPSULE WITH THE STORAGE CAP.

ALWAYS RECAP ALCOHOL FILL CAPSULE AND OTHER CONTAINERS IMMEDIATELY TO PREVENT ABSORPTION OF MOISTURE AND THE ESCAPE OF ALCOHOL VAPORS.

If you do not intend to use the PORTACOUNT Plus right now, you should store the Alcohol Cartridge in the Alcohol Fill Capsule. The Alcohol Fill Capsule is designed to be a safe transportation and storage container for alcohol. The Alcohol Cartridge can be left soaking in alcohol indefinitely. Install the Storage Cap into the Cartridge Cavity to prevent dirt or lint from getting inside the PORTACOUNT Plus.

NEVER TRANSPORT THE PORTACOUNT Plus WITH THE ALCOHOL CARTRIDGE INSIDE IT. Flooding of the optics may occur.

ALWAYS KEEP THE ALCOHOL CARTRIDGE IN THE ALCOHOL FILL CAPSULE DURING TRANSPORT AND STORAGE. ALWAYS KEEP THE ALCOHOL CARTRIDGE CLEAN.

NEVER LEAVE THE CARTRIDGE CAVITY OPEN LONGER THAN NECESSARY. USE THE STORAGE CAP TO COVER THE CARTRIDGE CAVITY WHEN THE PORTACOUNT Plus IS TRANSPORTED OR STORED.

KEEP THE STORAGE CAP AND ALCOHOL CARTRIDGE CLEAN. ALWAYS SET THEM DOWN WITH THE END STANDING UP. This precaution prevents dirt or debris from entering the instrument and inhibiting operation. The pin-hole size nozzle inside the PORTACOUNT Plus can easily become clogged.

TSI recommends that the Zero Check Filter be left attached to the sample line whenever the PORTACOUNT Plus is turned on but not in use. This prevents lint and debris from being drawn into the instrument and blocking the air flow.

Alcohol Cartridge

The Alcohol Cartridge holds alcohol that is used by the PORTACOUNT Plus. There is a porous wick inside that is soaked with alcohol. Two spare wicks were shipped with the PORTACOUNT Plus when it was new.

Because the Alcohol Cartridge gets inserted into the Cartridge Cavity of the PORTACOUNT Plus, it is critically important to keep it clean. Any dirt or debris that gets into the PORTACOUNT Plus may plug the small internal nozzle and prevent operation. Do **not** allow the black part of the Alcohol Cartridge to make contact with any surface that may be dirty. KEEP THE STORAGE CAP AND

ALCOHOL CARTRIDGE CLEAN. ALWAYS SET THEM DOWN WITH THE END
STANDING UP.

Changing the Alcohol Wick
The wick and screen inside the Alcohol Cartridge may be changed in the field. Two spare wicks
and screens were included with the PORTACOUNT Plus when it was new. Normally, the wick will
not need to be changed unless one of the following problems develops:

1.   Moisture accumulates in the wick and causes the SERVICE indicator to come on even
        when there is an adequate alcohol supply. This may happen when the PORTACOUNT Plus
        is used extensively for weeks on end. Especially if you are fit testing in an area with high
        humidity.

2.   The wick becomes contaminated with dirt, oil or other foreign substances. This should
        not happen unless the instrument is used to sample aerosols other than those normally
        found in ambient air.

3.   The fine mesh screen inside the Alcohol Cartridge becomes plugged with foreign
        material that was inadvertently drawn in though the Twin Tube Assembly.

When moisture accumulation occurs, the Alcohol Wick can be removed, allowed to dry, and then
re-installed into the Alcohol Cartridge. If the Alcohol Wick or screen is contaminated, it should be
discarded and replaced with a new one. Each new wick has a new screen with it. Note that some
discoloration of the wick is normal and will not influence performance.

Removing the Wick from the Alcohol Cartridge
To remove the Alcohol Wick from the Alcohol Cartridge, grasp the cartridge with both hands
with your thumbs near the seam and firmly apply pressure as if you wanted to break it into two
pieces. The cartridge will snap apart exposing the end of the white Alcohol Wick.

NOTE: *Older PORTACOUNTs (pre-1992) were supplied with a screw-apart alcohol cartridge
        rather than the current snap-apart design. Screw-apart cartridges will be replaced with a
        new cartridge during factory service.*

After separating the two halves, push the Alcohol Wick and screen out of the Wick Retainer Cap
from the opposite end with the Wick Removal Tool (wood dowel) provided with each new
alcohol wick. Do *not* use a pencil point because bits of lead could break off. Allow the small,
circular, fine-mesh screen to fall out on the table.

Hold the screen up to the light and look through it to make sure it is clean. All openings in the mesh should be clear. If any of the openings are blocked, clear them by blowing air through the screen. If the screen cannot be 100% cleaned, replace it with a new one. A new screen is included with each new wick.

Examine the white Alcohol Wick. Some light brownish-yellow discoloration of the wick is normal. If the wick is severely discolored, discard it. If the wick is in good condition, see the section on "Drying the Wick" later in this chapter.

Re-assembling the Alcohol Cartridge

Before re-installing an alcohol wick, you must make certain that all parts are clean. Small bits of the wick or lint can cause serious problems if they get into the PORTACOUNT Plus.

Inspect the inside surfaces of the Alcohol Cartridge and the Wick Retainer Cap. Blow air into them, if necessary, to make certain that there are no dust particles present.

Blow air onto all surfaces of the Alcohol Wick that will be used to make certain that any loose particles that may have shed from the wick are removed.

Drop a clean screen into the Wick Retainer Cap and make sure it lies flat on the bottom. Examine both ends of the wick. You will notice that one end is smoother than the other. Slide the smooth end of the wick into the Wick Retainer Cap and push firmly until the wick hits bottom. Blow everything off again.

Align the two halves of the Alcohol Cartridge and press firmly until they snap together.

Drying the Alcohol Wick

An Alcohol Wick that is in good condition can be reused after it dries out. Place it on a clean surface in a well-ventilated area and allow it to dry for at least two days. Discard wicks that are severely discolored or physically damaged. Some light brownish-yellow discoloration of the wick is normal.

Daily Checks

There are three maintenance checks that should be performed once each day the PORTACOUNT Plus is used and whenever a problem is encountered.

The Daily Checks must be performed in the order given below.

1. Particle Check

2. Zero Check

3. Max FF Check

NOTE: FitPlus fit test software automatically guides you through the Daily Checks and stores the results in a database. The procedures below are for performing Daily Checks without computer software.

Passing the Daily Checks provides confidence that the PORTACOUNT Plus is working properly. Failure of any of the Daily Checks requires immediate attention. See the chapter on Troubleshooting if any of the Daily Checks fail.

If the PORTACOUNT Plus passes the Daily Checks, and you are still having difficulty fit testing, the problem is probably not in the PORTACOUNT Plus. Examine the respirator very carefully for leaks or pinched tubes. You can perform a fit test manually (stand-alone mode) to determine if the computer or software is causing the problem. See the chapter on Troubleshooting, if necessary.

Particle Check

The Particle Check is done to determine if the PORTACOUNT Plus is working at all and if the concentration of particles in the ambient air is sufficient to conduct fit testing.

1. Make sure the PORTACOUNT Plus has alcohol in it and turn it on. Wait until the 60-second countdown is complete.

2. Initiate Count Mode by pressing the COUNT MODE key.

3. Remove all filters or other attachments from the PORTACOUNT sample hoses.

4. Observe the displayed particle concentration. It must be at least 1000 for the PORTACOUNT to allow fit testing. (70 when the N95-Companion is attached). Preferably you should see a much higher number in the 3000 to 50,000 range. See the Troubleshooting section if necessary.

5. If the number shown is above 1000, the Particle Check passed. Proceed to the Zero Check.

Zero Check

The Zero Check should be performed each time the PORTACOUNT Plus is turned on. Passing this test provides assurance that there are no leaks in the system.

1. Put the PORTACOUNT Plus into Count Mode if it's not there already.

2. Attach the supplied Zero Check Filter to the clear Twin Sample Tube and observe the particle concentration on the display. It should drop quickly to zero (0.00) in less than 30 seconds. An occasional value of 0.60 or 1.20 is acceptable, but it should read 0.00 most of the time. If the PORTACOUNT Plus will not Zero Check, consult Chapter 6, "Troubleshooting."

3. If the particle count went to zero, the Zero Check passed. Leave the Zero Check Filter on the sample hose and proceed to the Max FF Check.

If the PORTACOUNT Plus will not Zero Check, any fit tests you conduct may result in lower fit factors than would be measured otherwise. The risk is that you may fail people who actually have good fits, thereby wasting time and effort. There is no possibility that failure to Zero Check could result in overstated fit factors. This is because any particles leaking into the PORTACOUNT Plus will be interpreted as mask leakage, resulting in lower fit factors.

Max FF Check

This check determines if the PORTACOUNT Plus is capable of measuring high fit factors and if the internal switching valve is functioning properly. This test is essentially a fit test on a HEPA filter which simulates a perfectly fitting respirator. A very high fit factor above 50,000 should result if all is well.

1. Make sure the PORTACOUNT Plus has already passed the Particle Check and Zero Check. Performing this test is futile unless there are leaks in the system.

2. Attach the Zero Check Filter to the Sample Tube if it's not already there. If necessary wait until the display reads zero while in Count Mode.

3. Put the PORTACOUNT Plus into Fit Test Mode. This initiates a fit test on the filter. The exercise number "1" will show and "IN PROGRESS" will be flashing.

4. Initiate a fit test by pressing the TEST START/STOP key. It will take about one minute to make measurements and display the result.

5. At the completion of one test cycle (exercise) a fit factor of at least 50,000 should be displayed. If the fit factor is below this number, allow the test to continue for another cycle. If the fit factor remains too low, consult Chapter 6, "Troubleshooting."

NOTE: *If the optional Model 8095 N95-Companion is attached and active, the display should show "200" rather than 50,000.*

6. Press the TEST START/STOP key to end the test.

    The Max FF Check actually measures the maximum fit factor that can be determined by the PORTACOUNT Plus given the local ambient particle concentration and the mask sample time programmed into the PORTACOUNT Plus. Assuming the Zero Check Filter is perfect, the maximum fit factor will be the local ambient particle concentration divided by a mask concentration equivalent to one particle during the mask sample time. When the PORTACOUNT Plus actually measures zero particles during the mask sample, one particle is artificially added to prevent division by zero when calculating the fit factor.

TSI recommends that the Zero Check Filter be left attached to the sample line whenever the PORTACOUNT Plus is turned on but not in use. This prevents lint and debris from being drawn into the instrument and blocking the air flow.

Battery Maintenance

NOTE: As of January 2003, battery packs are no longer available from TSI.

The optional rechargeable battery kit contains three battery packs and an external battery charger. The external charger allows you to charge batteries separately, while using the PORTACOUNT Plus at the same time. If you are diligent about recharging the battery packs without delay, you will be able to operate the PORTACOUNT Plus continuously. A fully charged battery pack will power the PORTACOUNT Plus for about 3 hours.

NOTE: Battery life is limited to less than 2 hours if the Model 8095 N95-Companion is in use.

TSI Model 8903 Rechargeable Batteries are lead-acid type batteries, not NiCad, so they do not develop "memory problems" common to NiCad batteries.

When a battery inside the PORTACOUNT Plus runs low on power the "LOW BATTERY" warning message will flash on the Display. When this occurs, you have about 15 minutes before the PORTACOUNT Plus automatically turns itself off. Finish the fit test in progress and then install a fresh battery. If a printer is connected, the message "Low Battery" will be printed just before the PORTACOUNT Plus turns itself off.

To charge a battery pack, remove it from the PORTACOUNT Plus if necessary and plug it into the battery charger. The connector is polarized (one pin is larger than the other) so that it cannot be plugged into a battery pack backwards. **DO NOT FORCE IT.**

Plug the battery charger into an AC outlet. Be certain that the outlet is the proper voltage for the charger (115 VAC or 220 VAC). Allow the battery to charge for at least 6 hours.

DO NOT ALLOW A BATTERY TO CHARGE FOR MORE THAN 24 HOURS. THIS CAN REDUCE THE LIFE OF THE BATTERY.

ALWAYS STORE BATTERIES FULLY CHARGED. STORING BATTERIES IN A DISCHARGED CONDITION WILL RESULT IN REDUCED LIFE.

You may leave a battery pack inside the PORTACOUNT Plus when the AC adapter is being used. The battery will recharge, however, the rate of charge is very low. A battery pack will take 24 hours to fully charge when installed in the PORTACOUNT Plus. Having a battery pack installed during AC operation will prevent loss of data in the event that the AC adapter is accidentally disconnected or there is a power failure.

Shipping & Storage Precautions

It is important to remove all alcohol from the PORTACOUNT Plus during transportation and storage. Anytime you put the PORTACOUNT Plus back into the carrying case you should:

1.   Remove the Alcohol Cartridge from the PORTACOUNT Plus and store it in the Alcohol Fill Capsule.

2.   Cover the Cartridge Cavity with the Storage Cap.

The Alcohol Fill Capsule is designed to be a safe transportation and storage container for alcohol. The Alcohol Cartridge can be left soaking in alcohol indefinitely. Installing the Storage Cap into the Cartridge Cavity prevents dirt or lint from getting inside the PORTACOUNT Plus.

NEVER TRANSPORT OR STORE THE PORTACOUNT Plus WITH THE ALCOHOL CARTRIDGE INSIDE IT. Flooding of the optics may occur.

ALWAYS KEEP THE ALCOHOL CARTRIDGE IN THE ALCOHOL FILL CAPSULE DURING TRANSPORT AND STORAGE.

ALWAYS USE THE ALCOHOL STORAGE CAP TO COVER THE CARTRIDGE CAVITY OF THE PORTACOUNT Plus DURING TRANSPORT AND STORAGE.

NEVER LEAVE THE CARTRIDGE CAVITY OPEN LONGER THAN NECESSARY.

KEEP THE STORAGE CAP AND ALCOHOL CARTRIDGE CLEAN. ALWAYS SET THEM DOWN WITH THE END STANDING UP. This precaution prevents dirt or debris from entering the instrument and inhibiting operation. The pin-hole size orifice inside the PORTACOUNT Plus can easily become clogged.

ALWAYS RECAP ALCOHOL FILL CAPSULE AND OTHER CONTAINERS IMMEDIATELY TO PREVENT ABSORPTION OF MOISTURE AND THE ESCAPE OF ALCOHOL VAPORS.

DISPOSE OF ANY ALCOHOL WITH VISIBLE CONTAMINATION.

TSI recommends that the Zero Check Filter be left attached to the sample line whenever the PORTACOUNT Plus is turned on but not in use. This prevents lint and debris from being drawn into the instrument and blocking the air flow.

When returning your PORTACOUNT Plus to TSI for service, DO **NOT** SEND ALCOHOL IN BOTTLES. Remove them first.

Chapter 6

TROUBLESHOOTING

TSI recommends that the PORTACOUNT® Plus Respirator Fit Tester be cleaned and recalibrated annually. Try to arrange your fit testing schedule to allow for annual factory recalibration. If your fit testing schedule is seasonal or you expect heavy usage during an upcoming period (such as an outage) we recommend that you have the PORTACOUNT Plus serviced prior to that time. TSI's Customer Service Department provides fast service in order to minimize your down time.

This chapter lists a series of symptoms, their possible causes and recommended solutions for the PORTACOUNT Plus. If your symptom is not listed, or if none of the solutions solves your problem, please contact TSI.

Always replenish the alcohol supply as the first step in solving a problem. It is safe to "top off" the alcohol at any time.

Eventually, the Alcohol Wick inside the Alcohol Cartridge will absorb enough moisture to prevent proper operation. Symptoms of excess moisture are low particle counts even though there is plenty of alcohol and plenty of particles in the room, and also having to frequently replenish the alcohol supply (such as every hour or less). Changing the Alcohol Wick is the best way to solve the problem. You could also dry the wick by leaving the Alcohol Cartridge in the PORTACOUNT Plus and then running it overnight, or by removing the wick from the cartridge and letting it dry for 48 hours.

Troubleshooting the PORTACOUNT Plus

ALWAYS perform the Daily Checks as outlined in the chapter on Maintenance as the first troubleshooting step. Passing the Daily Checks usually indicates that the PORTACOUNT Plus is working properly and that the problem is someplace else. The connection to the respirator and/or the respirator itself are the most common problem sources.

If you are using the optional N95-Companion to fit test class-95, P1 or P2 disposable respirators, refer to the *Model 8095 N95-Companion Operation and Service Manual* for additional help.

Symptom	Possible Causes	Solution
SERVICE Message Appears	Low on alcohol	Refill Alcohol Cartridge.
	Excessive moisture inside PORTACOUNT.	Change Alcohol Wick inside Alcohol Cartridge. Dump old alcohol from the Alcohol Fill Capsule and add fresh alcohol. Run 2 hours to dry optics (remove the alcohol cartridge and install storage cap).
	Ambient temperature unusually high.	Ignore service message.
	Battery is low.	Ignore service message and install fresh battery.
	PORTACOUNT needs recalibration and cleaning.	Return to factory for service.
	Nozzle is plugged.	See Nozzle Cleaning at the end of this chapter.
LOW PARTICLE Message Appears	Low on alcohol.	Replenish alcohol.
	Hoses are reversed on Twin Tube Assembly.	Connect the hoses properly to the PORTACOUNT and mask.
	Wrong tube is connected to respirator.	Connect the proper tube to the respirator (clear tube).
	Twin Tube Assembly is kinked, pinched, or blocked.	Straighten out the Twin Tube Assembly or remove the obstruction.
	Particle count in area really is low.	Move to another location. Or use a particle generator (e.g., candle or a TSI Particle Generator).
	Moisture build-up inside PORTACOUNT.	Change Alcohol Wick inside the Alcohol Cartridge. Dump old alcohol from the Alcohol Fill Capsule and add fresh alcohol. Run 2 hours to dry optics (remove the alcohol cartridge and install storage cap).
	Inferior or contaminated alcohol.	Change Alcohol Wick inside the Alcohol Cartridge. Use only approved alcohol (99.5 % or better isopropyl).
	Plugged internal nozzle.	See Nozzle Cleaning at the end of this chapter.
	Unit needs recalibration and cleaning.	Return to factory for service.

Symptom	Possible Causes	Solution
LOW BATTERY message appears	Battery pack is discharged.	Replace the discharged battery pack with a charged pack.
	AC Adapter is malfunctioning.	Replace AC Adapter.
	Poor contact with AC adapter.	Clean contacts and spread spilt-pin on back of PORTACOUNT.
Does not switch on	AC Adapter not plugged in to unit or AC outlet.	Connect AC Adapter.
	Poor contact.	Clean contacts and spread split-pin on pack of PORTACOUNT.
	Battery pack is discharged.	Replace the discharged battery pack with a charged pack.
	Battery connector is unplugged.	Plug the battery connector into the battery pack.
	Battery pack is not installed.	Install the battery pack.
	Keypad ribbon cable is disconnected inside the PORTACOUNT.	Open the instrument and plug the keypad ribbon cable into the PORTACOUNT electronics.
	Battery plugged in backwards.	Reverse the battery connector.
Fails Zero Check	Alcohol Cartridge is loose.	Tightly close the Alcohol Cartridge
	Twin Tube Assembly leaks.	Repair or replace the Twin Tube Assembly.
	Filter leaks.	Repeat the test with a different filter.
	Ends of Twin Tube Assembly are poorly sealed.	Cut off the worn ends on the Twin Tube Assembly.
	Twin Tube Assembly is disconnected.	Connect the Twin Tube Assembly to the PORTACOUNT.
	Slightly flooded with alcohol.	Remove Alcohol Cartridge and run for 15 minutes, then try again.
	Switching valve is not functioning.	Return to factory for service.
	O-ring on alcohol cartridge is not sealing.	Replace O-ring. Smearing a *very* small amount of grease (e.g., Vaseline) on the O-ring will usually help.

Symptom	Possible Causes	Solution
Fit factor of 1 or very low (If the PORTACOUNT passes the Daily Checks, the problem is with the respirator, not the PORTACOUNT.)	Respirator is not equipped with HEPA, class-99, class-100, or P3 filters.	Install proper filter for fit testing. Use the optional N95-Companion for class-95 disposable respirators.
	Respirator leaks, has loose filters, or a malfunctioning exhalation valve.	Repair the respirator.
	Twin Tube Assembly is disconnected.	Connect the Twin Tube Assembly to the PORTACOUNT.
	Twin Tube Assembly is not connected to respirator sampling port.	Connect the Twin Tube Assembly to the respirator sampling port. (clear tube).
	Twin Tube Assembly Leaks.	Repair or replace the Twin Tube Assembly.
	Sample Tube too Long.	Use standard 5-foot Twin Tube Assembly.
	PORTACOUNT is flooded with alcohol.	Run 2 hours to dry optics (remove the Alcohol Cartridge and install Storage Cap).
	Alcohol level is low.	Add alcohol to the PORTACOUNT.
	Switching valve is not functioning.	Return to Factory for service.
Suspicious readings (If the PORTACOUNT passes the Daily Checks, the problem is the respirator, not the PORTACOUNT.)	PORTACOUNT is flooded with alcohol.	Run 2 hours to dry the optics (remove cartridge and install storage cap).
	PORTACOUNT leaks.	Zero-Check the PORTACOUNT and fix any leaks.
	Alcohol level is low.	Replenish alcohol is the PORTACOUNT.
	Sample lines too long.	Use standard 5-foot Twin Tube Assembly.
	Alcohol Cartridge is loose.	Tightly close the Alcohol Cartridge.
	Respirator is not equipped with HEPA filters.	Install HEPA filters for fit tests.
	Twin Tube Assembly is kinked, pinched, or blocked.	Straighten out the Twin Tube Assembly or remove the obstruction.

Symptom	Possible Causes	Solution
Suspicious readings *(continued)*	Leaking respirator probe.	Tighten or seal probe.
	Tubing in mask sampling adapter is kinked or pinched.	Straighten out tubing.
	Respirator is faulty.	Fix or replace the respirator.
Particle count is zero or near zero	Alcohol level is low.	Replenish alcohol.
	Sampling through HEPA Filter.	Remove filter.
	Twin Tube Assembly is blocked.	Remove the blockage.
	Moisture build-up in Alcohol Wick.	Change Alcohol Wick inside Alcohol Cartridge. Run 2 hours to dry optics (remove the alcohol cartridge and install storage cap).
	Inferior or contaminated alcohol.	Change Alcohol Wick inside the Alcohol Cartridge. Use only approved alcohol.
	PORTACOUNT is flooded with alcohol.	Run 2 hours to dry optics (remove Alcohol Cartridge and install Storage Cap).
	Filter cover leaking.	Replace cover and O-ring.
	Plugged nozzle.	See Nozzle Cleaning at the end of this chapter.
Requires frequent refill of alcohol (every hour or less)	Moisture build-up inside Alcohol Wick.	Change Alcohol Wick inside cartridge. Run 2 hours to dry optics (remove the alcohol cartridge and install storage cap) Use only approved alcohol.
Alcohol visible in Twin Tube Assembly or coming out of Exhaust Port	PORTACOUNT is flooded with alcohol.	Run overnight to dry optics. (remove Alcohol Cartridge and install storage cap).

Nozzle Cleaning

The following procedure can be used to clear the small (pin-hole size) internal nozzle if it becomes clogged with lint or other debris. The symptom of a clogged nozzle is a low (perhaps zero) ambient particle count usually, but not always, causing the Particle Check and/or Max FF Check to fail.

Procedure A

To perform this procedure you will need a source of clean compressed gas such as AccuDuster® III by CleanTex or equivalent. It must have a long nozzle (straw) in order to reach deep into the PORTACOUNT.

- Turn the PORTACOUNT off and remove the alcohol cartridge.

- Insert the long nozzle up inside the PORTACOUNT as shown. Keep the end of the nozzle centered in the cavity and gently push it in as far as possible. The internal nozzle is located just past the far end of the cavity and cannot be seen.

- Apply two or three bursts of gas. It is not possible to damage the PORTACOUNT.

Reinsert the alcohol cartridge. Turn the PORTACOUNT on. Perform the Daily Checks. If the problem persists, try Procedure B below.

Procedure B

This procedure is only necessary if Procedure A fails to clear the internal nozzle.

- Turn the PORTACOUNT off and remove the alcohol cartridge.

- Turn and hold the PORTACOUNT up on end so that you can look down into the cartridge cavity.

- Take a bottle of the alcohol used to operate the PORTACOUNT and drip 3 to 4 drops down into the cartridge cavity. Try to keep the drops centered so they hit bottom without touching the sides. Don't overdo it. One drop is enough if it all reaches the nozzle.

- Keep the PORTACOUNT in this vertical position for about 5 minutes so the alcohol can soften or dissolve the blockage.

Set the PORTACOUNT down in normal operating position and perform Procedure A above.

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Appendix B

THEORY OF OPERATION

How the PORTACOUNT Plus Works
The PORTACOUNT Plus measures respirator fit by comparing the concentration of microscopic particles outside the respirator to the concentration of particles that have leaked into the respirator. The ratio of these two concentrations is called a fit factor. A fit factor of 100 means that the air inside the respirator is 100 times as clean as the air outside.

$$\text{Fit Factor} = \frac{\text{Outside Concentration}}{\text{Inside Concentration}}$$

Since the microscopic particles in the air cannot pass through the class-100 or class-99 filters used on the respirator, any particles that get into the respirator must have come in through a leak.

The PORTACOUNT Plus has two sample tubes, one samples the ambient air and the other attaches to the respirator and samples from inside it. A valve inside the PORTACOUNT Plus switches from one tube to the other according to a programmed sequence.

How the PORTACOUNT Plus Counts Particles
The PORTACOUNT Plus is based on a miniature, continuous-flow Condensation Nucleus Counter (CNC), also known as a Condensation Particle Counter (CPC). A CNC takes particles that are too small to be easily detected, grows them to a larger, easily detectable size, and then counts them.

The idea of CNCs/CPCs is not new. As early as 1888, Aitken described a dust counter that grew particles to detect them. In 1943 the Nolan-Pollack photoelectric CNC was described. In the 1950s and 1960s, commercial, automatic CNCs were available. However, none were of the continuous-flow type, and the PORTACOUNT is the first highly portable continuous-flow CNC.

The concept of using a condensation nucleus counter (CNC) for the purpose of quantitative respirator fit testing was first demonstrated in 1981 by Dr. Klaus Willeke of the University of Cincinnati.

> Reference: Willeke, K., H.E. Ayer, J.D. Blanchard. "New Methods For Quantitative Respirator Fit Testing With Aerosols," *American Industrial Hygiene Association Journal,* Feb. (1981).

PORTACOUNT Schematic

The PORTACOUNT Plus grows submicron particles to supermicron alcohol droplets and then measures the concentration of the alcohol droplets. This makes the PORTACOUNT Plus sensitive to particles having diameters as small as 0.02 microns, but insensitive to variations in particle size, shape, composition, and refractive index. Thus, quantitative fit testing can be performed with virtually any aerosol, including ambient air.
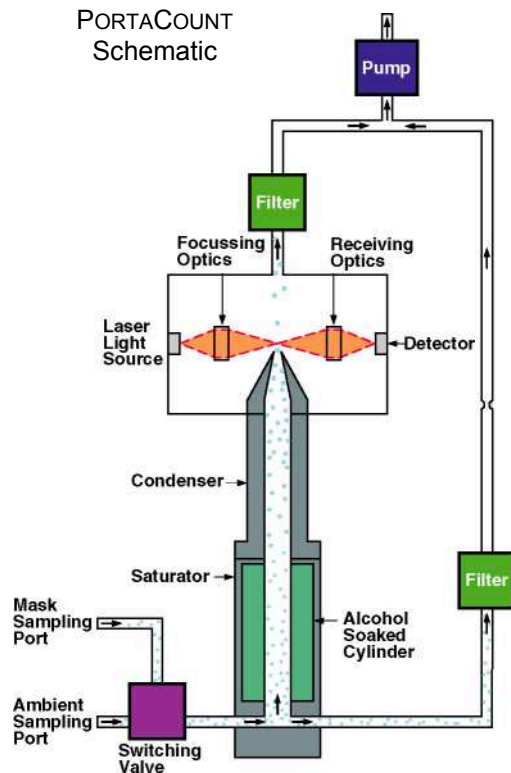
Aerosol is drawn through the instrument by a diaphragm vacuum pump operating at a flowrate of 0.7 liter per minute. The flow enters the instrument through either the ambient port or the sample port. The switching valve determines which port is used. The outlet of the switching valve leads to the saturator end cap where the flow splits. A flowrate of 0.1 liters per minute enters the saturator and passes through the condenser, nozzle, and sensing volume. The remaining flow passes through the excess airline and is recombined with the sampled flow down-stream of the sensing volume.

The PORTACOUNT Plus sensor consists of a saturator, condenser and optical elements. The saturator is lined with an alcohol-soaked wick. A thermoelectric device is mounted between the saturator and condenser which cools the condenser and heats the saturator. After passing through the saturator, the aerosol (now saturated with alcohol vapor) enters the condenser tube. The alcohol vapor condenses on the particles, causing them to grow into droplets. The droplets then pass through the nozzle and into the sensing volume as depicted in the schematic diagram below.

The focusing optics in the sensor consist of a laser diode, and a series of lenses which focus the laser light into a sensing volume just above the nozzle. Each particle passing through the sensing volume scatters light. The light is collected by the receiving optics and focussed onto a photodetector. The photodetector generates an electrical pulse from the scattered light as each droplet passes through the sensing volume. The particle count is determined by counting the number of pulses generated during a given time period. Knowing the particle count, time period and flowrate allows particle concentration to be computed.

Appendix C

CALCULATING FIT FACTOR

Fit factor is defined as the particle concentration outside the respirator divided by the particle concentration inside the respirator.

Because ambient concentration can vary over time, the PORTACOUNT Plus calculates the fit factor by taking the average of the ambient concentrations measured before and after the respirator sample and then dividing by the concentration measured in the respirator. This is why the first test cycle (exercise) is longer than additional test cycles in Fit Test Mode. It is necessary to measure the required additional ambient concentration sample before the first fit factor can be calculated.

Both the ambient and respirator concentrations are determined by integration. The integrated concentrations are determined by the total number of particles counted during the sample periods.

Fit factor is actually calculated by:

$$FF = \frac{C_B + C_A}{2C_R}$$

where: FF = fit factor
C_B = particle concentration in the ambient sample before the respirator sample
C_A = particle concentration in the ambient sample after the respirator sample
C_R = particle concentration in the respirator sample.

If no particles are counted in the respirator sample, the PORTACOUNT Plus automatically adds one particle. This prevents dividing the ambient concentration by zero. At the end of a fit test, the overall fit factor is calculated and displayed, based on the individual fit factors for each test cycle.

The following equation is used to calculate the overall fit factor in the PORTACOUNT Plus:

$$Overall\ FF = \frac{n}{\dfrac{1}{FF_1} + \dfrac{1}{FF_2} + \dfrac{1}{FF_3} + ... + \dfrac{1}{FF_{n\ 1}} + \dfrac{1}{FF_n}}$$

where: FF_x = fit factor for test cycle
n = number of test cycles (exercises).

Disclaimer: The measurement provided by the PORTACOUNT Plus is an assessment of respirator fit during a fit test only. Respirator fit at other times will vary. The fit factor value is not intended for use in calculating an individual's actual exposure to hazardous substances.

Appendix D

CALCULATING PARTICLE CONCENTRATION

Particle concentration is calculated by counting the number of particles passing through the sensor in a given period of time. Since the flow rate is known (1.67 cm³/sec), the particle concentration can be determined.

In 1-Second Count Mode the equation is:

$$Particle\ Concentration = \frac{N_1}{(1\ sec)\,1.67\ cm^3\ /\ sec}$$

where N_1 is the number of particles counted in a 1-second period

In 15-Second Count Mode the equation is:

$$Particle\ Concentration = \frac{N_{15}}{(15\ sec)\,1.67\ cm^3\ /\ sec}$$

where N_{15} is the number of particles counted in a 15-second period

Note that the total flow rate of air through the PORTACOUNT Plus is a nominal 11 cm³/sec. The reason that we use 1.67 cm³/sec. in the calculations above is because the flow path inside the PORTACOUNT Plus is divided into two branches, the sensor flow and the bypass flow. The sensor flow is set at **precisely** 1.67 cm³/sec and the bypass flow is **approximately** 9.2 cm³/sec.

Using the equations above, you can see that the minimum measurable concentration is 0.6 and 0.04 particles per cm³ in 1-Second and 15-Second Count Mode, respectively.

The equations above can also be used to determine the minimum measurable mask concentration that can be measured in Fit Test Mode given the mask sample time that is used. For example, with a 40 second mask sample (factory setting) the minimum measurable concentration is 0.015 particles per cm³.

Appendix E

INTERNAL TIMING IN FIT TEST MODE

NOTES: *Internal timing is different when the optional Model 8095 N95-Companion is in use. See the N95-Companion Operation and Service Manual for more information.*

The exercise timing outlined below occurs when the PORTACOUNT Plus is used in Stand-Alone Mode (i.e., no computer attached). When FitPlus software is in use, the software determines the exercise timing and the internal settings are ignored. FitPlus software (v2.12 or higher) can be used to permanently reprogram the internal exercise timing for Stand-Alone Mode.

Test Sequence

In Fit Test Mode, the PORTACOUNT Plus automatically samples both the ambient air and the particles inside the respirator. An internal switching valve automatically switches between the two sampling ports. In each test cycle, (exercise) both an ambient sample and a respirator sample are taken. Also, time is allowed for purging the sensor between each of the samples.

The PORTACOUNT Plus uses the ambient sample taken before and after each exercise to compute the fit factor. The two ambient particle concentrations are averaged together and then divided by the mask particle concentration to yield the fit factor for that exercise. Averaging the before and after ambient particle concentrations is done to offset any ambient particle concentration drift that may have occurred during the mask sample.

⚠	**C a u t i o n**
	Do **not** lengthen the Twin Tube Assembly more than a few inches unless the mask sample purge time has also been extended accordingly. Insufficient purging between mask and ambient samples will result in unrealistically low fit factors. Shortening the Twin Tube Assembly is never a problem.

The test starts when you press the TEST START/STOP key. The first test cycle lasts longer than subsequent test cycles since an extra ambient air sample is taken. The table below shows the test sequence for the PORTACOUNT Plus as shipped from the factory. The times used for purging, and sampling can be changed using software included with the instrument.

Test Sequence in Fit Test Mode as Shipped From Factory

Action	Time	Notes
Ambient purge	4 seconds	Test started
Ambient sample	5 seconds	
Mask purge	11 seconds	
Mask sample	40 seconds	
Ambient purge	4 seconds	
Ambient sample	5 seconds	
Display fit factor		First cycle (exercise) completed
Mask purge	11 seconds	
Mask sample	40 seconds	
Ambient purge	4 seconds	
Ambient sample	5 seconds	
Display fit factor		Second cycle (exercise) completed
Mask Purge	11 Seconds	
Mask sample	40 seconds	
Ambient purge	4 seconds	
Ambient sample	5 seconds	
Display fit factor		nth cycle (exercise) completed
Display overall fit factor		Test completed

Appendix F

USING THE TSI PORTACOUNT PLUS TO FIT TEST POSITIVE PRESSURE RESPIRATORS

On January 8, 1998 OSHA released the long-awaited revision to the Respiratory Protection Standard 29CFR1910.134. It replaces the standard with the same name and number that was released in 1971. This new revision has far reaching impact on a large number of existing OSHA standards in that it replaces certain provisions related to respirator use.

One of the new requirements is that OSHA now requires all tight-fitting respirator facepieces to be fit tested annually. This includes air-supplied and positive-pressure respirators such as Powered Air Purifying Respirators (PAPR), airline respirators, and Self Contained Breathing Apparatus (SCBA). With few exceptions, these respirator styles were previously exempted from OSHA's fit testing requirements. For detailed information regarding the new standard and to download your own copy see TSI Application Note ITI-056 Respirator Fit Testing Highlights for OSHA Respiratory Protection Standard 29CFR1910.134.

Self Contained Breathing Apparatus (SCBA) are respirators that supply breathing air from a backpack mounted tank. The most common application for SCBA is fire fighting. There are other types of positive-pressure respirators also, including air-line and recirculating respirators.

Powered Air Purifying Respirators (PAPRs) are a special class of respirator that utilizes a battery operated blower motor to pump air into the mask through an air-purifying cartridge. The blower/filter assembly is usually either belt mounted or fastened to the front of the facepiece.

The OSHA fit testing requirement is only for tight-fitting masks. Tight fitting respirators utilize a facepiece similar to the facepiece on a conventional negative-pressure air-purifying respirator with filter cartridges. In fact, many respirator manufacturers use the identical facepiece for negative and positive-pressure respirators. Tight-fitting masks form a tight seal around the wearer's face.

Loose fitting respirators usually employ a hood that fits over a person's head and loosely seals around the neck. The quality of the seal is not dependent on a close physical match with the wearer's body. Since there is no "seal" to test, there is no requirement to do a fit test. Note that some hood-type respirators are classified as tight-fitting and, therefore, require fit testing.

Respirator fit testing (testing facepiece leakage) cannot be done while the pressure inside the facepiece is maintained positive by some outside air supply. The positive-pressure will alter the seal and the measurement will not reflect how well the shape of the facepiece matches the person's face. For this reason, all fit testing of positive-pressure respirators must be done in negative-pressure mode, or in other words, without a forced air supply. Any tests done in positive pressure mode are overall performance tests, not fit tests. Hood-style respirators can be performance tested but not fit tested because there is no face seal to test.

There are two ways to accomplish fit testing positive-pressure masks in negative-pressure mode. The method preferred by many is to temporarily convert the employee's assigned mask into a negative-pressure mask. This is accomplished through the use of special fit test adapters that temporarily attach to the mask and allow the use of filter cartridges. Added benefits of this method are that an integrity test of the mask is performed simultaneously with the fit test and also, the hygienic concerns associated with sharing a test mask are greatly reduced. Fit Test Adapters are available from the respective respirator manufacturer and from TSI for many popular respirators.

When an adapter is not available, the only alternative is to use a surrogate mask or test mask. This involves purchasing a negative-pressure air-purifying mask that has the same sealing surfaces as the positive-

pressure mask that will actually be used for respiratory protection. For quantitative fit testing, the mask will need a sampling port so that a sample can be drawn from the breathing zone. Most respirator manufacturers have these available. If the mask comes in multiple sizes, you will need at least one test mask in each size. Using this technique, fit testing for positive-pressure respirators becomes identical to fit testing for negative-pressure respirators.

For those people who wish to conduct performance tests on positive-pressure respirators using a PORTACOUNT, there are a few special precautions. The primary concern is aerosol particulates in the air supply. The PORTACOUNT will measure these particles as leakage and report performance factors (fit factors) that are significantly lower than actual. Most PAPRs have a blower motor on the clean side of the filter. Most of these motors generate small particles that the PORTACOUNT can easily measure. Likewise, air from SCBA tanks, and from compressors, contain significant numbers of particles. Grade D breathing air is by no means particle free. The only way to overcome this problem is to pass the air through a HEPA filter just before it reaches the facepiece. There is no OSHA requirement to do this type of performance testing.