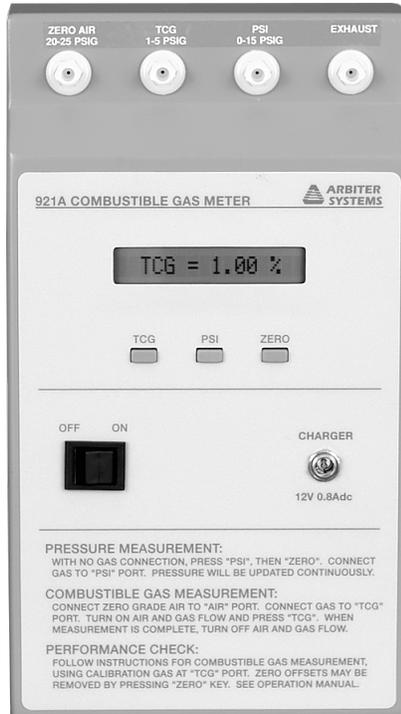


Model 921A COMBUSTIBLE GAS METER OPERATION MANUAL



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Chapter 1

Introduction

The Arbiter Systems, Inc. Model 921A Combustible Gas Meter is a portable, battery-operated instrument which measures the percentage of combustible gases, such as methane, hydrogen, acetylene, and carbon monoxide, in the nitrogen gas used to blanket oil-filled transformers common to the electric utility industry. The Model 921A also measures gas pressure in the range of 0-15 PSI, to verify proper pressure in the transformer.

1.1 Vehicle Power

The Model 921A can be charged from a 12-volt negative-ground, vehicle power system using a supplied adapter, which plugs into the vehicle's cigarette lighter outlet.

1.2 Safety Information

Observe all safety markings and instructions before operating the Model 921A. Operating safety information is found in the appropriate places throughout this manual.

1.3 General Instructions

The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific warnings

elsewhere in this manual violates safety standards for the design, manufacture, and intended use of the instrument. Arbiter Systems, Inc. assumes no liability for the user's failure to comply with these requirements.

1.3.1 Instrument Modification & Other Parts

Because of the danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modification to the instrument. Return the instrument to Arbiter Systems for service and repair to ensure that the safety features are maintained.

1.4 Regular Calibration

To reduce the possibility of an early sensor failure, it is highly recommended to run the 921A and exercise the gas sensor at least every two weeks. To exercise the 921A, simply perform a Field Calibration. Alternately, connect the Air Zero Grade and 1% METHANE cylinders to the 921A and press the TCG button. For more information, see Section 6, Trouble Shooting Guide.

1.5 Factory Service

Should your instrument need to be returned for factory service (refer to paragraph 5.3), please contact the Arbiter Systems Service Department to obtain a Return Authorization (RA) number. If your instrument is covered by warranty, see our Limited Warranty description at the end of this manual. If your instrument is not covered by warranty, we will provide a copy of our current service policy and price list. If an instrument return is authorized, forward the instrument prepaid to Arbiter Systems.

1.6 Extended Warranty

Arbiter Systems also offers an extended warranty available in one-year increments. You may purchase the extended warranty at any time before your standard one-year warranty expires. Please contact our sales department for more information about our extended warranty.

Chapter 2

Accessories

Accessories for the Model 921A are listed below with their respective part numbers and relevant information.

2.1 Transit Case

The transit case is made of impact-resistant polyethylene, and contains foam inserts with cutouts for the Model 921A and supplied accessories. See Figure 2.1.



Figure 2.1: Model 921A and Accessories

2.2 Plug-In Charger, UL/CSA

Part Number: AP0001800, Included

The standard plug-in charger is designed for charging the internal sealed, lead acid battery used to power the Model 921A Combustible Gas Meter. Specifications are listed below.

Input:	120 VAC, 60 Hz, 16 W
Output:	12 VDC, 800 mA
Output Connector:	5.5 mm Mini jack, center positive

FOR INDOOR USE ONLY
CLASS 2 TRANSFORMER

2.3 Automobile Accessory Adapter

Part Number: AP0002500, Included

The Automobile Accessory Adapter is for use with all 12-Volt auto battery systems with negative ground. The 5.5 mm output mini-jack matches that of the Plug-in Charger. Use this in the field to charge the unit when no AC power is available for use with the Plug-in Charger.

2.4 Calibration Gas Regulators

Part Number: AS0019100, Included

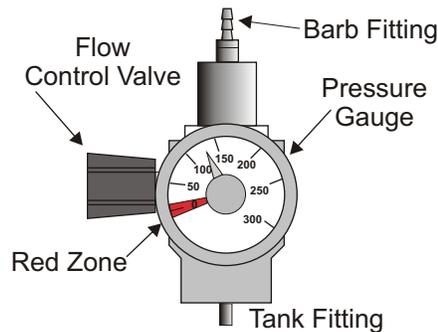


Figure 2.2: Gas Regulator

WARNING. Do not use 921A to measure TCG when any gas cylinder pressure indicates in the RED ZONE.

Two Gas Regulators are provided with the Model 921A to regulate the flow of air and one of the two calibration gases in field calibrating the Model 921A and measuring TCG. The two calibrating gases are 1% Methane In Nitrogen and Nitrogen Zero Grade.

2.5 Transformer Gas Hose Assembly

Part Number: AS0019300, Included

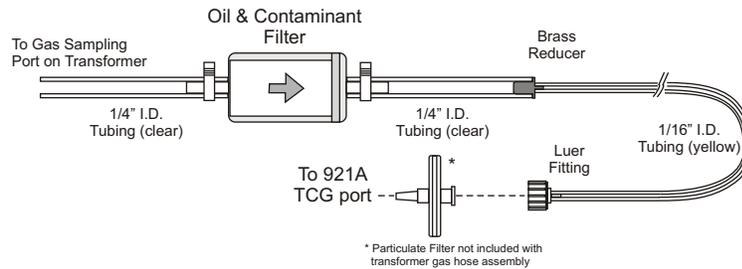


Figure 2.3: Transformer Gas Hose Assembly

The Transformer Gas Hose Assembly connects the transformer under test to the Model 921A Combustible Gas Meter. Use this assembly to direct the combustible gases in the nitrogen blanket of an oil-filled transformer to the Model 921A TCG port (place a particulate filter between the gas hose assembly and 921A port). The Transformer Gas Hose Assembly is composed of various tubes, connectors and filter shown in Figure 2.3. Always perform a Field Calibration before testing for TCG.

WARNING. Any red or pink coloration of the Oil and Contaminant Filter element (normally white) indicates contamination with oil. Replace the filter if it becomes contaminated.

For information on connecting this assembly for TCG Measurement, see Sections 3.4 and 3.5.

2.6 Red Calibration Gas Hose Assembly

Part Number: AS0019402, Included

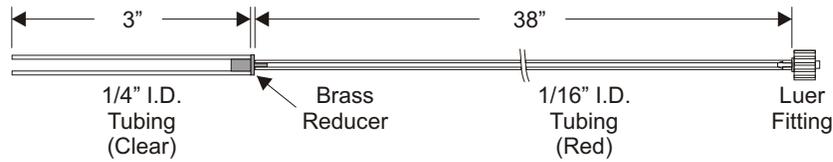


Figure 2.4: Calibration Gas Hose Assembly, Red

Used during Field Calibration only, the Red Calibration Gas Hose Assembly connects the Nitrogen Zero Grade to the TCG Port, and connects the 1% Methane in Nitrogen to the TCG port on the Model 921A in separate steps. For information on connecting this assembly for Field Calibration, see Sections 3.3.2 and 3.3.3.

2.7 Blue Calibration Gas Hose Assembly

Part Number: AS0019406, Included

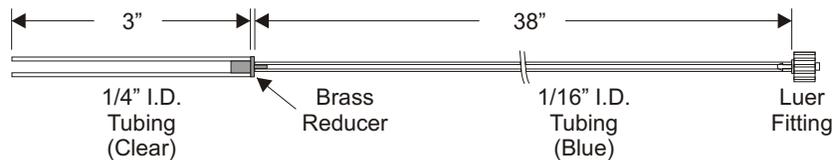


Figure 2.5: Calibration Gas Hose Assembly, Blue

Used during Field calibration and TCG tests, the Blue Calibration Gas Hose Assembly connects the Air Zero Grade to the Model 921A, ZERO-AIR port. For information on connecting this assembly for Field Calibration and TCG measurement, see Sections 3.3.2 and 3.3.3.

2.8 Transformer Hose In-Line Filter Kit

Part Number: AS0026900, Consumable, Optional accessory,
AS0026901, (Kit of 5)

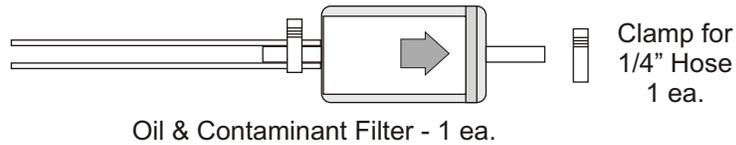


Figure 2.6: Transformer Hose In-Line Filter Kit

Used to replace the Oil & Contaminant Filter in the Transformer Gas Hose Assembly, this assembly attaches to the clear tubing connected to the Brass Reducer on the Transformer Gas Hose Assembly. Kit includes nylon clamp for attaching to hose.

WARNING. Any red or pink coloration of the Oil and Contaminant filter element (normally white) indicates contamination with oil. Replace the filter if it becomes contaminated.

2.9 Calibration Gas

Included 1 set of 3 cylinders with instrument.

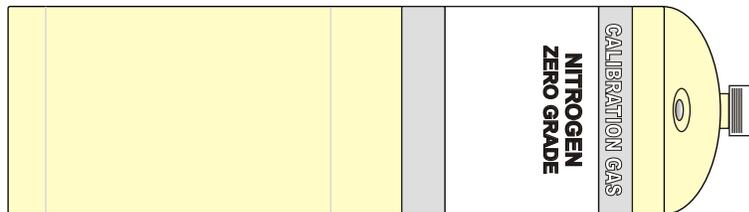


Figure 2.7: Gas Cylinder, Nitrogen

1. Air Zero Grade AS0019500, 1 each
2. Air Zero Grade - AS0019501, case of 12
3. Nitrogen Zero Grade AS0019600, 1 each
4. Nitrogen Zero Grade AS0019601, case of 12
5. 1% Methane In Nitrogen AS0019700, 1 each
6. 1% Methane In Nitrogen AS0019701, case of 12

These items are disposable supply items, separately available sold singly or in cases of each gas or mixed gas cylinders in cases.

2.10 Syringe Adapter (Kit of 5 ea.)

Part Number: AS0020500, Optional Accessory

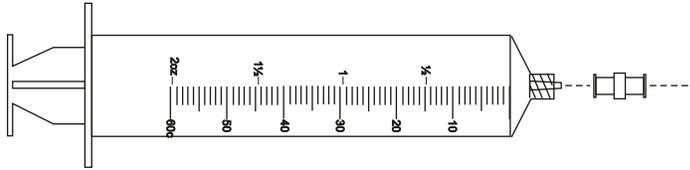


Figure 2.8: Syringe Adapter Kit

Use the Syringe Adapter to extract gas from a transformer that has a low positive pressure, or negative pressure, with respect to the atmosphere. Syringe Kit includes a Luer adapter for connection to Particulate Filter. For information on using the Syringe Kit, see Section 3.5, Measuring TCG Transformer < 1 PSI.

2.11 Annual Filter Maintenance Kit

AS0035100, Optional Accessory

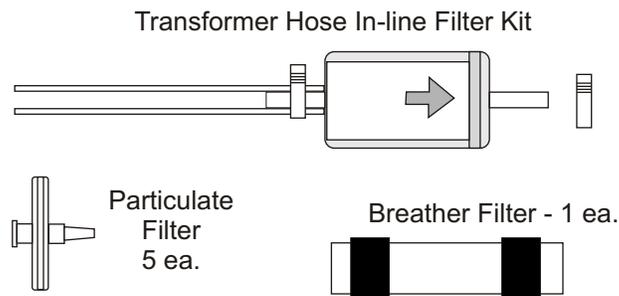


Figure 2.9: Annual Filter Kit

Kit includes five Particulate filters for internal and external use, one internal Breather Filter and Transformer Hose In-line Filter

Kit. For information on installing this kit, see Annual Filter Maintenance Kit in Section 5.2.

1. Transformer Hose Inline Filter Kit – AS0026900, 1 each
2. Particulate Filter – AS0020800, 5 each
3. Breather Filter Assembly – AS0020300, 1 each

2.12 Particulate Filter Kit

AS00208000, Set of 10 particulate filters.

2.13 Operation Manual

PD0010700, Included: Available in either printed or in pdf format.

2.14 Battery Replacement

BT0000700, 6V/4AH sealed, lead-acid battery. See Specifications, Section 4.4, for additional details.

Chapter 3

Operation

3.1 General

To use the Model 921A Combustible Gas Meter to measure pressure (PSI) or total combustible gas (TCG), first set the power switch to the ON position. At power up, the unit's microprocessor performs a self-check of its functions. If the test passes, the display will indicate Command?. If the test fails, a Fatal Error#! message will appear. Recycle power, and if error persists, contact Arbiter Systems for additional assistance.

NOTE. Prior to use, the instrument, cylinders, regulators and hoses should be inspected for any evidence of damage or contamination. If indicated any problems, they should be immediately corrected. In particular, contamination with transformer oil will preclude proper operation (refer to Section ??).

3.2 PSI Measurement

Perform a PSI Measurement prior to measuring TCG to determine the TCG measuring process. Exposure to gauge pressures above +15 PSIG can cause shifts in the instrument's pressure calibration and should be avoided if possible. Although accuracy is not specified for vacuum (pressures below 0 PSIG), the Model 921A will measure pressure down to full vacuum with typical accuracy similar to that in its specified range. This is useful to identify under-pressure transformers.

NOTE.— The Model 921A damage limits are -15 PSIG (full vacuum) to +30 PSIG

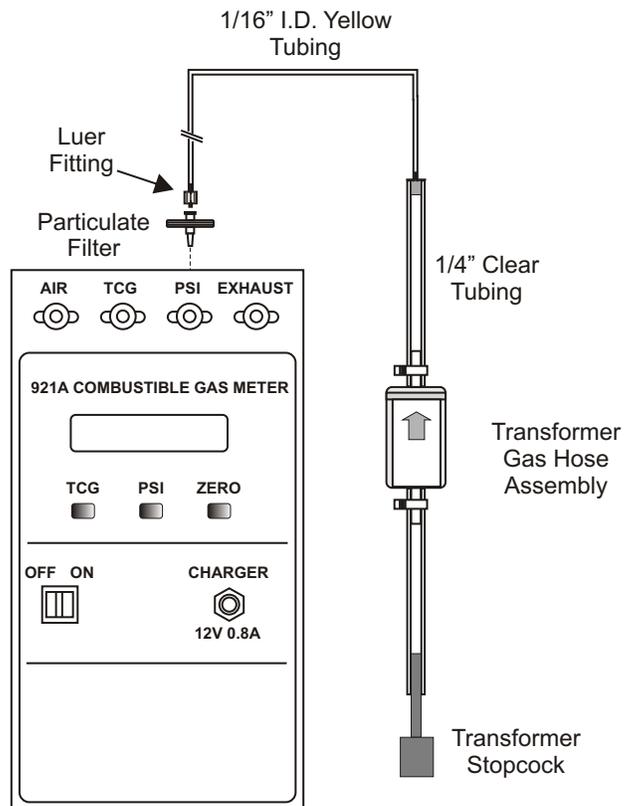


Figure 3.1: PSI Measurement

To measure PSI, see Figure 3.1 and perform the following steps:

1. Press the PSI key on the front panel (without any gas connection) and wait for a pressure indication, which should appear quickly.
2. The display should indicate approximately zero. Because of drifts and temperature variations, the value may be slightly different than zero.
3. To remove these errors, press the ZERO key. The display should now indicate PSI = 0.00.
4. Connect a source of pressure between 0 and 15 PSI to the PSI port on the Model 921A. The pressure should appear in the display.

3.3 Field Calibration

Calibrate the 921A each time the power is switched ON (or whenever improper operation is suspected) to assure that the TCG measurement is accurate to within the specifications listed in Section 4. Field calibration uses two standard gas mixtures of known percentage to align the critical measurement functions before measuring the TCG.

Numerous transformers may be tested after a single field calibration, provided that instrument power is maintained.

The Model 921A uses a catalytic-bead TCG sensor, which can be damaged by physical shock. The sensor is most sensitive to shock when at its operating temperature. To minimize power consumption and the likelihood of sensor damage due to shock while being transported, sensor power is automatically switched OFF at the completion of a measurement sequence.

3.3.1 Field Calibration Check List

A Field Calibration consists of performing the following main tests:

1. Remove dust covers on 921A ports (4 each)
2. Check pressure of each gas cylinder
3. Calibrate for 0% TCG
4. Calibrate for 1% TCG

NOTE. All sample ports on the Model 921A are tapered plastic twist-lock (Luer) fittings. Do not over tighten or use extreme downward pressure when attaching the particulate filter to the desired sampling port. Gentle pressure is all that is required to form a leak-tight seal.

3.3.2 Calibrate for 0% TCG

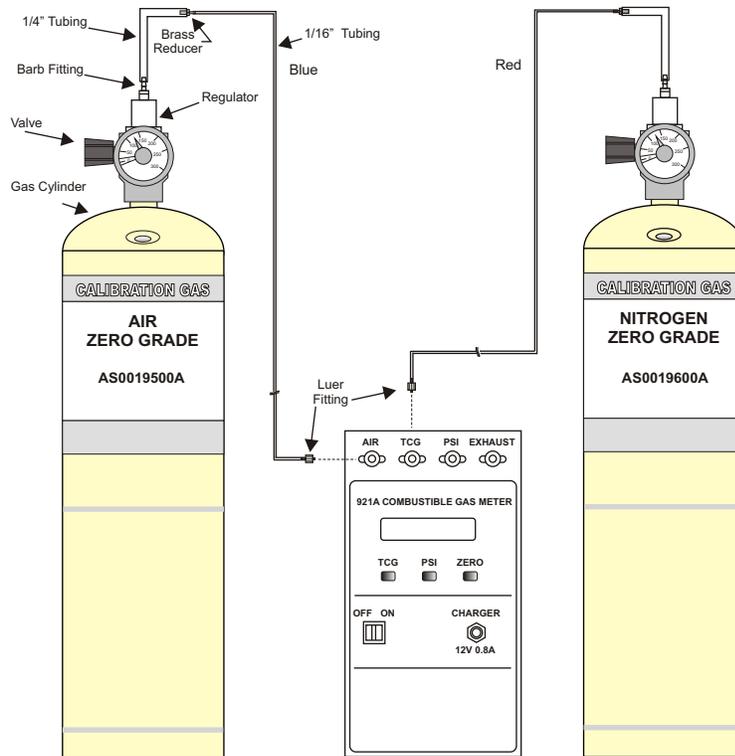


Figure 3.2: 0% TCG Calibration

1. Attach one of the calibration gas regulators to the Air Zero Grade cylinder supplied with the 921A. Do not over tighten the regulator fitting. Check for adequate gas cylinder pressure (above the red zone).
2. Attach the 1/4" clear tube of the blue calibration gas hose assembly to the regulator outlet barb fitting and the Luer fitting to the ZERO AIR port on the Model 921A.
3. Attach the other calibration gas regulator to the Nitrogen Zero Grade cylinder. Do not over tighten the regulator fitting.
4. Attach the clear tube of the red calibration gas hose assembly to the regulator outlet barb fitting, and the Luer fitting to

the TCG port on the Model 921A.

5. Make sure the 921A power is on, open both flow-control valves (approximately 1/2 turn) on the side of each regulator and press the TCG button.
6. A TCG measurement cycle will begin. At the end of the measurement cycle the display will indicate the measured TCG value, which should be approximately 0%.
7. Always press the ZERO key at the end of the measurement cycle even if the display reads 0.00. This error-correction offset is maintained for as long as the power is left on, or until the sequence is performed again.
8. To conserve gas supplies, close the flow control valves on each regulator at the conclusion of the test.

NOTE. If the value displayed during 0% TCG verification is outside of the compensation range for the instrument ($\pm 0.05\%$), the display will read ZERO/GAIN ERROR when the ZERO key is pressed. Consider returning the instrument to Arbiter Systems for repair and calibration before reaching $\pm 0.05\%$.

3.3.3 Calibrating for 1% TCG

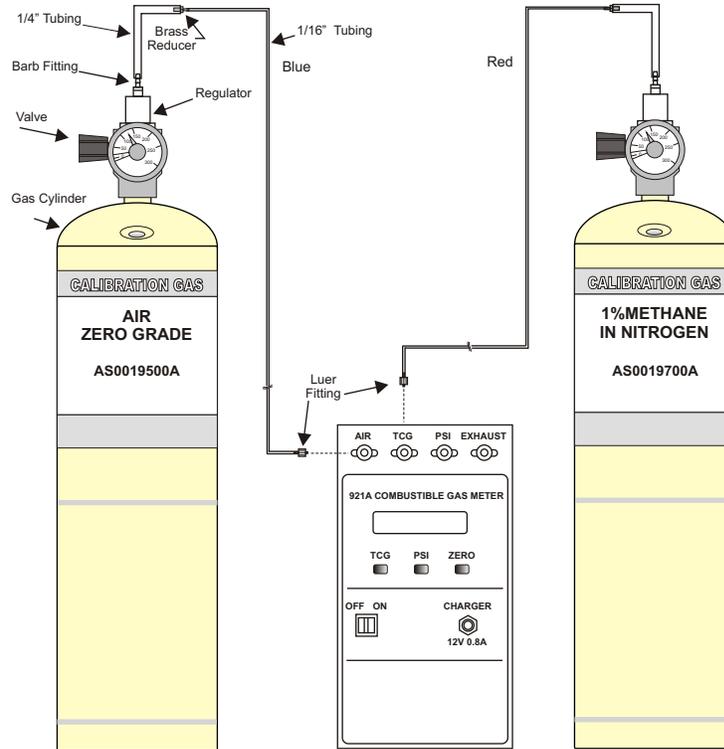


Figure 3.3: 1% TCG Calibration

9. Leave the Model 921A power ON and the Air Zero Grade cylinder attached to the ZERO AIR port.
10. Move the regulator on the 0% Nitrogen Zero Grade cylinder to the 1% Methane In Nitrogen cylinder.
11. Open the regulator valves on the Air Zero Grade and 1% Methane In Nitrogen cylinder approximately 1/2 turn each. Check the gauges for adequate pressure in each cylinder.
12. Press the TCG button.
13. A TCG measurement cycle will begin. At the end of the measurement cycle the display will indicate the measured TCG value, which should be approximately 1.00%.

14. Always press the ZERO key at the end of the measurement cycle even if the display reads “1.00”. This error-correction offset is maintained for as long as the power is left on, or until the sequence is performed again.
15. To conserve gas supplies, close the flow control valves on each regulator at the conclusion of the test.

NOTE. If the value displayed during 1% TCG verification is outside of the compensation range for the instrument (0.75% to 1.25%), the display will read ZERO/GAIN ERROR when the ZERO key is pressed. Consider returning the instrument to Arbiter Systems for repair and calibration before exceeding these compensation limits.

3.4 Measuring TCG – 1 to 5 PSI

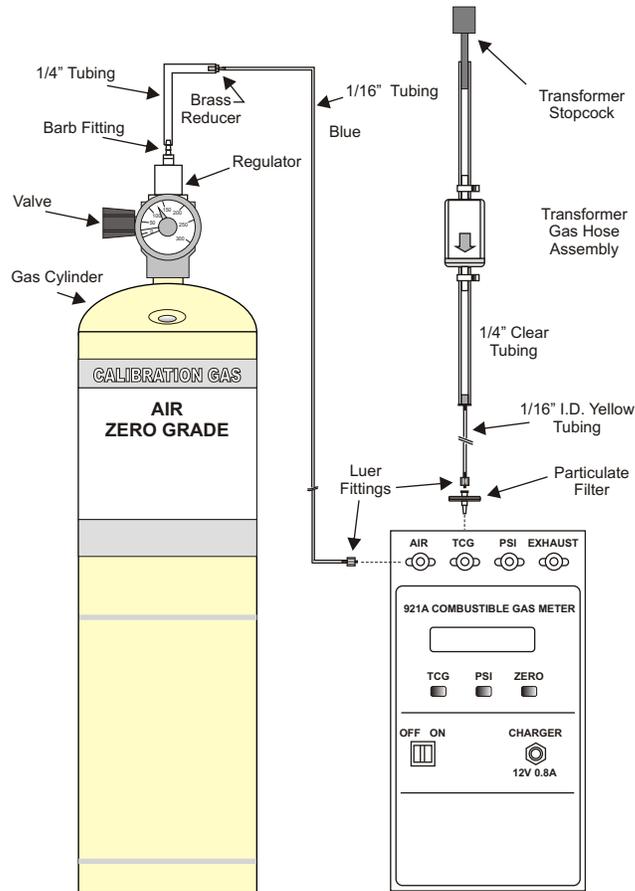


Figure 3.4: TCG Measurement, 1 to 5 PSI

WARNING. DO NOT SHOCK INSTRUMENT WHILE A TCG MEASUREMENT IS IN PROGRESS!

Use this procedure if the transformer nitrogen blanket pressure is from 1 to 5 PSI and only after field calibrating the 921A. For pressures less than 1 PSI, see the next section. The following steps describe how to perform a TCG measurement on a transformer:

1. Make sure the Air Zero Grade is connected to the ZERO-AIR port on the 921A as described in Figure 3.4.
2. Before connecting transformer gas hose assembly, open stop-cock valve on transformer to assure that no oil is present.
3. Connect Transformer Gas Hose Assembly between the sampling port on the transformer and the PSI port on the Model 921A.
4. Open the transformer gas sampling port valve and verify that the transformer internal pressure is in the range of 1 to 5 PSI required for proper operation. Close the valve on the sampling port. If it is less than 1 PSI or negative, go to Section 3.5.
5. Disconnect the Transformer Gas Hose Assembly from the 921A PSI port and connect it to the TCG port.
6. Open the two valves to permit the gases to flow.
7. Press the TCG button on the 921A to start a measurement cycle. This consists of a warm-up period followed by a drift-canceling measurement sequence. The entire process takes about 25 seconds.
8. When the measurement is complete, the result will appear in the display.
9. To conserve gas supplies, close the control valve on the Air Zero Grade regulator and the transformer sampling port upon completion of the measurement.

NOTE. If the 921A measures a high TCG (e.g. 2.5%) it will automatically start a purge cycle at the end of the regular TCG measurement cycle. During this cycle, the 921A will pass AIR alone over the sensor to cleanse it.

WARNING. Any red or pink coloration of the Oil and Contaminant Filter element (normally white) indicates contamination with oil. Replace the filter if it becomes contaminated.

3.5 Measuring TCG – < 1 PSI

To perform TCG measurements of < 1 PSI, use the Syringe Adapter Kit (P/N: AS0020500). Make sure to perform a field calibration if just powering up the 921A.

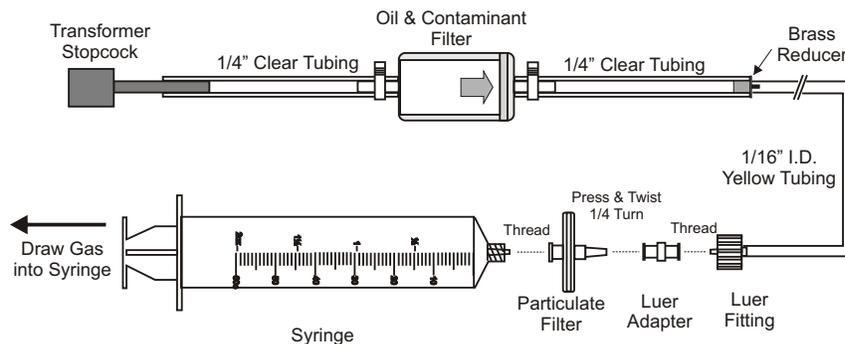


Figure 3.5: Extracting Gas from Transformer, <1 PSI

1. Connect the Transformer Gas Hose Assembly (yellow) to the transformer stopcock in the usual manner. See Figure 3.5.
2. Connect the Syringe, Particulate Filter and Luer Adapter to the Luer fitting on the Transformer Gas Hose Assembly.
3. Make sure that the Air Zero Grade is connected to the 921A and open the regulator valve 1/2 turn.
4. With the Syringe plunger fully depressed, extract a full syringe of gas. Turn off the transformer gas sampling port valve. Purge the syringe and repeat this step, extracting gas a second time to insure a good sample.
5. Disconnect the Syringe and Particulate Filter from the Transformer Gas Hose Assembly and connect it directly to the TCG port on the 921A (see Figure 3.6).
6. Press the TCG button. When the 921A pump begins to run, slowly depress the plunger, transferring the sample gas from the syringe to the 921A. Perform the gas sample transfer slowly, thereby ensuring that the gas sample will last throughout the measurement process (approximately 25 seconds). During the entire time that the pump is operating, there should be sample gas entering the Model 921A.
7. Read the TCG at the end of the measurement cycle.

8. Disconnect the syringe and close the regulator valve on the Air Zero Grade cylinder to conserve gas.

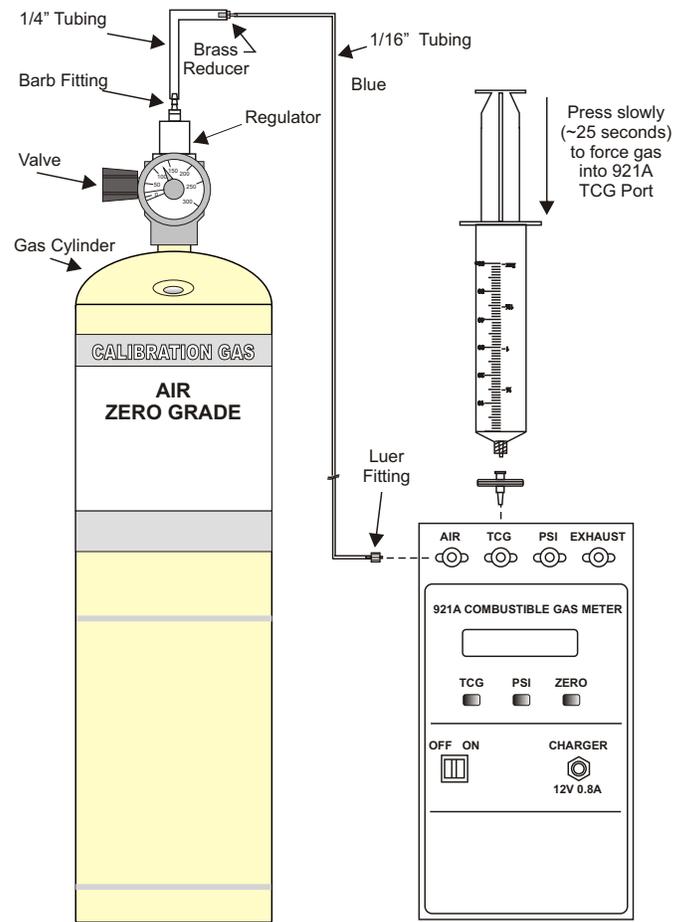


Figure 3.6: Injecting Gas with Syringe

3.6 Battery Charging

The Model 921A uses a 6V, 4.2 Amp-hour, sealed, lead-acid, storage battery. For additional information on battery usage, see Section 6, Trouble Shooting Guide. To charge the battery, plug the supplied charger or other source of +12 volts at 800 mA (minimum) into the front-panel connector labeled CHARGER. Charging time is less than 8 hours, from a fully discharged state.

The built-in charger controller being a constant-voltage, current-limited type, with float charge mode, automatically switches from fast charge to float (trickle) charge when near 100% capacity. Because the float charge level is intended for continuous operation, the unit may be left to charge continuously. Charging occurs only when the 921A power switch is in the OFF position and will disconnect the charger when power is switched ON.

3.6.1 Low Battery Indication

The Model 921A checks the battery voltage at the beginning of any sequence in which power is applied to the TCG Sensor. This occurs at the power-on function test and at the beginning of each TCG measurement. The display will indicate LOW BATTERY whenever the battery voltage drops below the recommended level for proper operation. This will not disable measurements, but is a warning to recharge before continuing testing.

3.6.2 Calibration Gas Cylinder Usage

Both calibration gas regulators supplied with the Model 921A have a red zone marked on the pressure gauge indicating the minimum cylinder pressure required for calibrated flow. The cylinders should be replaced when the indicated pressure is in the red zone see Red Zone indication in Figure 2.2. Additional cylinders of calibration gas may be purchased directly from Arbiter Systems using the part numbers identified in Section 2 of this manual.

They are available either singly or in cases of 12 (this includes mixing gas cylinder types in a case).

DO NOT ATTEMPT TO REFILL ANY OF THE GAS CYLINDERS SUPPLIED WITH THE 921A.

Under normal conditions, the Air Zero Grade cylinder supplied with the Model 921A contains sufficient gas for approximately 300 measurements. The cylinders of Nitrogen Zero Grade and 1% Methane In Nitrogen each contain enough gas for approximately 150 calibrations. To achieve this performance, close the regulator flow valves on both regulators between tests.

Chapter 4

Specifications

4.1 TCG Measurement

Range:	0% to 5%
Accuracy:	$\pm(5\% \text{ of reading} + 1 \text{ count})$
Resolution:	0.01% TCG
Inlet Pressure:	1 - 5 PSIG, nominal
Damage Limit:	Vacuum to 30 PSIG
Gas Inlet:	Female Luer Fitting
Calibration:	1% Methane = 1% TCG
Sensitivity to Various Gases:	(for 1% gas in nitrogen, typ)
Methane:	1.0
Carbon Monoxide	0.48
Hydrogen	0.86
Acetylene	$1.9 - 2.01^1$
Ethylene	1.92
Ethane	1.64
Air (100%)	-0.072^2

¹Interactions between the catalyst and acetylene cause the sensitivity to gradually increase during a sequence of acetylene measurements. This does not affect the sensitivity to other gases, and the effect is reversed on standing.

²The thermal conductivity of air, being slightly higher than that of nitrogen, will cause a negative reading by virtue of differences in thermal conductivity. While not optimized as a thermal-conductivity detector, this is an indication that transformer gas is not reaching the Model 921A.

4.2 Pressure Measurement

Range:	0 to 15 PSIG
Accuracy:	0.1 PSI
Damage Limit:	Vacuum to 30 PSIG
Gas Inlet:	Female Luer Fitting

4.3 Air Input

Purity:	Zero-Grade Instrument Air 21.00% Oxygen, Balance Nitrogen
Inlet Pressure:	20-25 PSIG or use supplied regulator
Air Inlet:	Female Luer Fitting

4.4 Battery

Type:	Sealed, lead-acid rechargeable 6V/4AH
Operating Time:	400 measurements (minimum), fully charged
Charger:	Dual-mode (CV/CC charge + float charge); plug-in external power supply 12V, 0.8 A
Charging Time:	8 hours, typical

4.5 General

Size	
Instrument:	130 × 230 × 65 mm (5 $\frac{1}{8}$ × 9 $\frac{1}{8}$ × 2 $\frac{5}{8}$) in.
Transit Case:	400 × 380 × 240 mm 16 × 15 × 9 $\frac{1}{2}$ in.

Weight:	3 kg (7 lb.), net, with accessories in transit case
Temperature:	Operating: 0°C to +50°C
Non-operating:	-40°C to +75°C
Display:	16-characters alpha-numeric supertwist LCD

4.6 Calibration Gas Cylinder Capacity

If used as directed in the Operation section, the calibration gas cylinders should provide many tests before renewing. Obviously, no one will perform the calibration and tests in the same manner. However if the regulator control valves are closed immediately after each test, the bottles should provide the approximate number of tests shown below.

Air Zero Grade	300
Nitrogen Zero Grade	150
1% Methane In Nitrogen	150

Chapter 5

Maintenance

5.1 Periodic

Prior to use, the instrument, cylinders, regulators, and hoses should be inspected for any evidence of damage or contamination. If any problems are indicated, they should be immediately corrected. In particular, contamination with transformer oil will preclude proper operation (refer to Section 5.4).

Replace internal and external filters on a yearly basis, or sooner if the filter indicates any oil contamination. Discard any hose that has been contaminated with oil. Do not try to clean them as it will damage the instrument and require returning to Arbiter Systems for repair and calibration.

An Annual Filter Maintenance Kit, P/N: AS0035100, is available. Other maintenance supplies include a single transformer Hose In-Line Filter Kit, P/N: AS0026900 (also available in a bag of 5 each, P/N AS0026901). Particulate filters are available in a bag of 10 as P/N AS0020800. See Chapter 2 for identification of various supplies.

5.2 Installing the Maintenance Kit

The Annual Filter Maintenance Kit comes with one Oil & Contaminant Filter Assembly (including nylon clamp), one Breather Filter and five Particulate Filters (see Section 5.2). Replace filters as follows:

5.2.1 Oil & Contaminant Filter

1. Remove the tube from the old Oil and Contaminant Filter body (on the 921A side).
2. Press the new Oil and Contaminant Filter into the hose that was removed in step 1.
3. Replace the old clamp with the new clamp provided in the kit.

5.2.2 Particulate Filter

1. Remove and throw away old filters, and replace with new filter during use.
2. Attach filters by gently pressing into Luer fitting and rotating $\frac{1}{2}$ turn. Remove with opposite procedure.

Order separately as P/N AS0020800: bag of ten particulate filters. See Figure 2.9 for identification.

5.2.3 Breather Filter

1. Remove the rear cover from the Model 921A (4 each M3 screws; a T10 driver). Take care of small parts needed to reassemble the 921A. See Figure 5.1.
2. Breather filter is now anchored by an adhesive-backed label. Cut tie wrap to free the breather filter.
3. Hook your finger around the $\frac{1}{16}$ " tube at B, on the right of the Breather Filter and pull the filter to the right.
4. Twist and pull the Luer fitting from the filter fitting at side B. Remove the Luer fitting that remains on the old Breather Filter at B.
5. Thread the other fitting off of the breather filter at side A.
6. Peel the tape off of the ends of the new Breather Filter and replace it in the opposite order.
7. Anchor the new breather filter with a new tie wrap.
8. Replace the rear cover to the Model 921A and the 4 screws in the cover. Be careful not to pinch any of the tubing.

Order separately as P/N AS0020300: one each breather filter. See Figure 2-9 for identification.

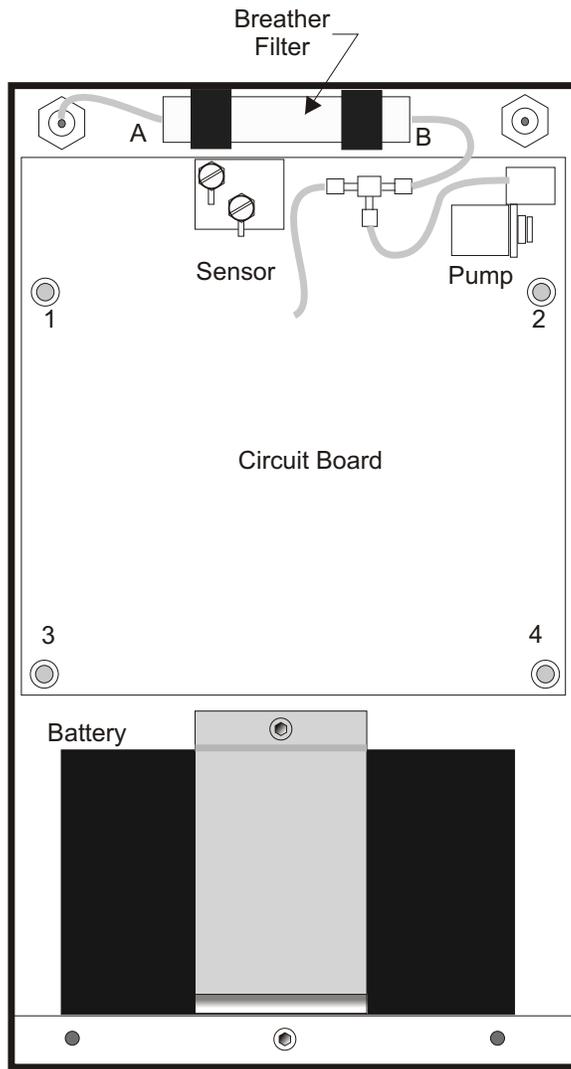


Figure 5.1: Breather Filter Location

5.3 Factory Service and Repair

NOTE. If the value displayed during the 0% Calibration (paragraph 3.2.2) is +/- 0.02% or greater, the 921A should be returned to the factory for re-calibration. Meanwhile, if error is +/-0.05% or less, the 921A may be used to continue testing if performing a Field Calibration each time the unit is powered on.

If the value displayed during 1% Field Calibration is outside of the compensation range (0.75% to 1.25%), the display will read ZERO/GAIN ERROR when the ZERO key is pressed. The instrument should then be returned to the factory for repair and calibration. For additional information see www.arbiter.com, or see the front of the manual for other contact information.

5.4 Oil Exposure

If the instrument has been exposed to transformer oil (e.g., oil has saturated and passed through the Oil and Contaminant Filter) factory maintenance is required. Even a small amount of oil entering the Model 921A degrades operation to the point where factory repair and calibration are required.

Possible indications of oil exposure are:

1. Negative readings when testing TCG
2. Difficulties in calibrating the instrument
3. Smell of oil at the exhaust port when testing TCG

If you have any questions about whether or not the Model 921A may have ingested transformer oil, please contact the factory.

Chapter 6

Trouble Shooting Guide

6.1 Zero-Gain Error during Calibration

If the value displayed during 1% TCG Calibration is outside the range in which the instrument can compensate (0.75% to 1.25%) the display will read ZERO/GAIN ERROR after pressing the ZERO key. If you encounter a ZERO/GAIN ERROR, then the instrument will probably need to be returned to the factory for repair and calibration. This error normally occurs if the gas sensor (catalytic bead) is worn out or has become desensitized.

To reduce the possibility of an early sensor failure, it is highly recommended to run the 921A and exercise the gas sensor on a weekly basis. To exercise the 921A, simply perform a Field Calibration. Alternately, connect the Air Zero Grade and 1% METHANE cylinders to the 921A and press the TCG button.

6.2 Negative Measurement Readings

Occasionally, the Model 921A will produce a negative reading (e.g. between -0.02 to -0.07 depending on the vintage of the unit). Usually this indicates that one of the gases is not present in the Model 921A during a Field Calibration or TCG test. Causes of negative readings are usually one of the following:

Causes	Correction Check List
Regulator flow	Check valves - they should be about $\frac{1}{2}$ turn
Low gas pressure	Check the individual gas cylinders, with the regulator attached, for gas pressure above the red indication. Also check the Transformer pressure (through the Transformer Gas Hose Assembly) for adequate pressure. Otherwise, if the transformer has low pressure, use the syringe to inject gas from the transformer into the 921A. See Section 3.5.
Gas Tube assemblies blocked or loose	Check for loose external and internal connections to the 921A. Check internal connections by removing the rear cover and inspecting all the pneumatic fittings. Blocked tubes are tougher to check but may be examined systematically by checking each section.
Pump not operating correctly	Listen for the normal buzzing sound of the pump when pushing the TCG button. Check for air output from the EXHAUST port – you should feel a slight air-flow against face, or place a small piece of tissue near the exhaust port.
Oil Contamination	If the unit has been contaminated by the oil ingested through the Transformer Gas Hose Assembly, then the unit will typically give a negative reading and possibly smell of oil at the exhaust port. If contaminated, the instrument must be returned to the factory for repair and calibration.

6.3 Erratic Readings

Erratic TCG readings, during calibration or testing, may be a symptom from one of several causes. Most of the causes can be remedied by simple checks, however it could indicate that something more serious is wrong. Causes may include:

Causes	Correction Check List
Low battery	Charge battery with the plug-in charger or the automobile accessory outlet. If charging does not help, see sections on batteries below.
Low gas pressure in cylinder	Check each cylinder with the regulator to verify adequate cylinder pressure – it should be above the red zone. If cylinder pressure is low, replace with new gas cylinders. Do not attempt to refill used cylinders.
Oil ingested in 921A	Sometimes a faint oil smell may be detected from the EXHAUST port when the TCG button is pressed. Instrument must be returned to factory for repair and calibration.

6.4 Low Battery Indication

Use the Plug-in Charger or the Automobile Accessory Adapter to charge the battery in the 921A. The Model 921A will operate with either of these chargers connected to the CHARGER port on the 921A, however it will not charge the battery when the 921A power is switched ON. To correctly charge the internal battery, make sure the 921A power switch is in the OFF position.

The chart below gives the battery State-of-Charge in percent against their respective open circuit voltages. This could be used to compare a fully-charged condition to an impending battery replacement. The table is for a standard 6-volt, sealed lead-acid battery.

NOTE. Use great care when checking battery voltage to guard against shorting the terminals, which could cause an explosion.

Battery OCV	State-of-Charge
6.325	100%
6.225	75%
6.120	50%
6.030	25%
5.945	0%

Table 6.1: Battery Voltage vs. State of Charge

OCV = Open Circuit Voltage (power switch in OFF position)

A new, freshly charged battery may have a higher potential than indicated in the 100% State-of-Charge above. It should settle to the value indicated in time.

6.5 Battery Health Check

Use the following procedure to help you determine the condition of your battery. After testing your 921A battery you should be able to determine if you need to replace the existing battery in order to meet full specifications.

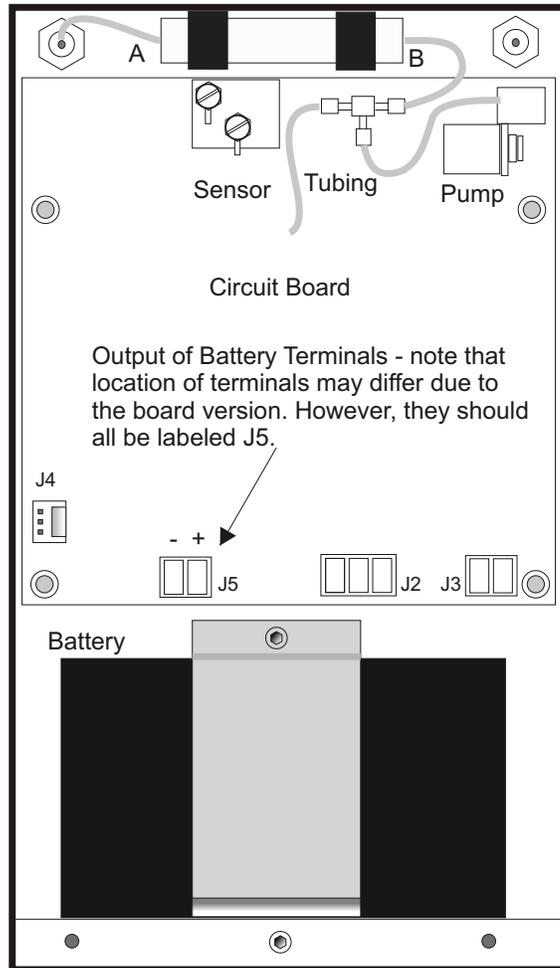


Figure 6.1: Battery Test Points

1. Make sure that the Model 921A power switch is in the OFF position.
2. Remove the rear cover to the Model 921A, check the voltage across the terminals at J5, and record the voltage. (Locate J5 on the bottom-left of the circuit board in Figure 6-1).
3. Connect the charger to the Model 921A and charge the 921A for 8 hours. Make sure that the 921A-power switch is in the OFF position while charging. After charging, let the battery sit idle for one hour without powering up the 921A.
4. Switch the 921A power ON and run the pump by pressing the TCG button. It will probably give a bad TCG reading, but will exercise the battery. Repeat this operational test a few times.
5. Switch the 921A power to OFF and let it stabilize for a half-hour.
6. Again measure the battery voltage at J5.

Compare your measured voltage to the chart above to give an indication of 100% (State-of-Charge) battery condition. If after being charged for 8 hours the voltage does not indicate a fully charged condition, the battery capacity has been reduced and will not be able to fully charge.

Replace a defective battery only with the same size and type. Contact Arbiter Systems for all supplies and replacement parts for the Model 921A. Dispose of defective batteries in a proper recycling center.

6.6 Battery Replacement

See Sections 2.14 and 4.4 for additional details on battery specifications and part number for ordering.

Chapter 7

Limited Warranty

Arbiter Systems makes no warranty, expressed or implied, on any product manufactured or sold by Arbiter Systems except for the following limited warranty against defects in materials and workmanship on products manufactured by Arbiter Systems. Products manufactured by Arbiter Systems are guaranteed against defective materials and workmanship under normal use and service for one year from date of delivery. The responsibility of Arbiter Systems under this warranty is limited to repair or replacement, at Arbiter Systems' option, of any product found to be defective. Arbiter Systems shall have no liability under this warranty unless it receives written notice of any claimed defect within the earlier of thirty days of discovery by Buyer or one year from the date of delivery. For warranty service or repair, products must be returned to a service facility designated by Arbiter Systems. Buyer shall prepay all shipping charges to Arbiter Systems and Arbiter Systems shall pay shipping charges and return the product to Buyer. However, Buyer shall pay all shipping charges, duties and taxes for products returned to Buyer in a country other than the United States of America.

THE WARRANTY SET FORTH HEREIN CONSTITUTES THE ONLY WARRANTY OBLIGATIONS OF ARBITER SYSTEMS, EXPRESSED OR IMPLIED, STATUTORY, BY OPERATION OF LAW, OR OTHERWISE. ARBITER SYSTEMS DISCLAIMS ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, AND BUYER EXPRESSLY WAIVES ALL OTHER WARRANTIES.

This limited warranty does not extend to any product which has been subject to (i) improper use or application, misuse, or abuse, or operation beyond its rated capacity, or contrary to the instructions in the operation and maintenance manuals, if any (ii) accident (iii) repair or maintenance, except in accordance with the operation and maintenance manuals, if any, and any special instructions of Arbiter Systems, or (iv) modification without the prior written authorization of Arbiter Systems (whether by the substitution of non-approved parts or otherwise).

The remedies provided herein are Buyer's sole and exclusive remedies. In no event shall Arbiter Systems be liable for direct, indirect, incidental or consequential damages (including loss of profits), whether based on contract, tort, or other legal theory. FOR THE FASTEST POSSIBLE SERVICE, SHOULD FAULT UNDER THIS WARRANTY DEVELOP, PLEASE PROCEED AS FOLLOWS:

1. Notify Arbiter Systems, Inc., specifying the instrument model number and serial number and giving full details of the difficulty. Service data or instrument return authorization will be provided upon receipt of this information.
2. If instrument return is authorized, forward prepaid to the manufacturer. If the instrument is not covered by this warranty, an estimate will be made before the repair work begins, if requested.

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