High Intensity Ultrasonic Processor

300-Watt Model
375-Watt Model
600-Watt Model
600-Watt Model Dual Output

INSTRUCTION MANUAL

WARNING

SAFETY PRECAUTIONS
READ BEFORE INSTALLING OR USING THE EQUIPMENT

This Ultrasonic Processor has been designed to assure maximum operator safety. However, no design can completely protect against improper usage. Improper usage may result in bodily injury and/or property damage. For maximum safety and equipment protection, observe the following warnings at all times, and read the instruction manual carefully before you attempt to operate the equipment.

— High voltage is present in the power supply. Never remove power supply cover unless qualified to do so.

— Disconnect electrical plug before removing cover for servicing.

— Make sure the Ultrasonic Processor is properly grounded with a 3-prong plug. Before plugging in, test electrical outlet for proper earth grounding.

— Never touch a vibrating probe.

The Ultrasonic Processor supplied with this instruction manual is constructed of the finest material and the workmanship meets the highest manufacturing standards. It has been thoroughly tested and inspected before leaving the factory and when used in accordance with the procedures outlined in this manual, will provide you with many years of safe and dependable service.

CAUTION

Never allow a microtip or an extender to vibrate in air for more than 15 seconds. When using a microtip never exceed setting "5" on output control. Ignoring these cautions will cause the microtip or extender to fracture.

METHYLENE CHLORIDE • ORGANIC SOLVENTS

The probes (solid or with a replacable tip) are tuned elements that resonate at 20kHz ± 50 Hz. If the replaceable tip is removed or isolated from the rest of the probe, the unit will not resonate at 20kHz causing the power supply to fail.

Unlike aqueous (water based) solutions which rarely cause problems, solvents and low surface tension liquids — such as Methylene Chloride, are problematical. These liquids penetrate the probe/replaceable tip interface, and force the particulates into the threaded section isolating the tip from the probe.

When working with these liquids ALWAYS use a solid probe or as an alternate an extender.

The extender screws into the probe, and takes the place of the replaceable tip. Being 5″ (13cm) long, the threaded section is above the level of the liquid, inhibiting the particulates from penetrating the threaded section.

SECTION I – INSTALLATION

INSPECTION

Prior to installing the Ultrasonic Processor, perform a visual inspection to detect any evidence of damage which might have occurred during shipment. Before disposing of any packaging material, check it carefully for small items.

It was carefully packed and thoroughly inspected before leaving our factory. Responsibility for its safe delivery was assumed by the carrier upon acceptance of the shipment. Claims for loss or damage sustained in transit must, therefore, be made upon the carrier.

Visually inspect all external controls, indicators and surfaces to detect any damage in transit. If damage has occurred contact your carrier within 48 hours of delivery date. DO NOT OPERATE DAMAGED EQUIPMENT. Retain all packing materials for future shipment.

UTILITIES REQUIRED

ELECTRICAL POWER — The Ultrasonic Processor requires a fused, single phase 3-terminal grounding type electrical outlet capable of supplying 50/60 Hz at 100 volts, 117 volts, 220 volts, or 240 volts, depending on the voltage option selected.

For power requirements, check the label on the back of the unit.

WARNING

For your personal safety, the electrical line cord is equipped with a 3-prong grounding plug. Do not, under any circumstances, defeat the grounding feature of the power cord by removing the grounding prong. The plug must be plugged into a mating 3-prong grounding type wall receptacle.

INSTALLING THE ULTRASONIC PROCESSOR

The Ultrasonic Processor should be installed in an area that is free from excessive dust, dirt, explosive and corrosive fumes, and extremes of temperature and humidity.

The power supply is air cooled. Sufficient space should be allocated around the unit so that the air flow through the cabinet is unrestricted. If air circulation is impaired, the ambient temperature within the power supply may become excessive, causing a safety thermal cut-out device to switch the power off. Although the power will be automatically reinstated when the temperature reaches an acceptable level, it is advisable that when this happens, the cause be investigated.

Periodically clean the air intake grille.

SECTION II — OPERATION

PRINCIPLES OF ULTRASONIC DISRUPTION

The ultrasonic power supply (generator) converts 50/60 Hz line voltage to high frequency 20 kHz (20,000 cycles per second) electrical energy. This high frequency electrical energy is transmitted to the piezoelectric transducer within the converter, where it is changed to mechanical vibrations. The vibrations from the converter are intensified by the probe, creating pressure waves in the liquid. This action forms millions of microscopic bubbles (cavities) which expand during the negative pressure excursion, and implode violently during the positive excursion. It is this phenomenon, referred to as cavitation, which produces the powerful shearing action at the horn tip, and causes the molecules in the liquid to become intensely agitated.

The larger the tip of the probe, the larger the volume that can be processed but at lesser intensity. For information regarding processing capability of each probe, consult the tables below.

	TAPERED MICROTIPS			STEPPED MICROTIP
TIP DIAMETER	1/8" (3 mm)	3/16" (5 mm)	1/4" (6.5 mm)	1/8" (3 mm)
INTENSITY	Very High	Very High	High	Ultra High
VOLUME (batch)	1-10 ml	3-15 ml	5-25 ml	1/4-10 ml

	STANDARD HORNS			
TIP DIAMETER	3/8" (9.5 mm)	1/2" (13 mm)	3/4" (19 mm)	1" (25.4 mm)
INTENSITY	Very High	High	Medium	Low
VOLUME (batch)	5-100 ml	10-250 ml	25-500 ml	50-1000 ml

	HIGH GAIN "Q" HORNS	
TIP DIAMETER	3/4" (19 mm)	1" (25.4 mm)
INTENSITY	High	Medium
VOLUME (batch)	25-500 ml	50-1000 ml

FUNCTIONS OF CONTROLS, INDICATORS, AND CONNECTORS

FRONT PANEL	
POWER MONITOR (METER)	Indicates the percentage of maximum available ultrasonic power delivered to the probe. 300 watt unit: 100% = 300 watts, 50% = 150 watts. 375 watt unit: 100% = 375 watts, 50% = 187.5 watts. 600 watt unit*: 100% = 600 watts, 50% = 300 watts. *When using two probes with the dual output unit, the power delivered to each probe is half that displayed on the power monitor.
POWER SWITCH	ON position — energizes the power supply. OFF position — de-energizes the power supply. Illuminates when the power supply is energized.
TUNE SWITCH	When depressed, allows the power supply to be tuned.
TIMER	Sets the duration of ultrasonic application from .1 second to 999 hours. The right hand push button selects the timing option as follows: .S=tenth of seconds, S=seconds, .M=tenth of minutes, M=minutes .H=tenth of hours, H=hours. The other three push buttons select the timing increments.
START BUTTON	When depressed, energizes the ultrasonics.
RESET BUTTON	When depressed, de-energizes the ultrasonics and resets the timer.

FUNCTIONS OF CONTROLS, INDICATORS, AND CONNECTORS (CONT.)

TUNER	Optimizes power supply performance by tuning the power supply to the converter/probe assembly.
FOOTSWITCH CONNECTOR	Connects to footswitch cable.
PULSER	Applies the ultrasonic energy on a pulsed mode. In the OFF position the ultrasonics is continuous. In the ON position the ultrasonics is intermittent. The % DUTY CYCLE SELECTOR sets the pulse rate. Intermittent operation inhibits heat build-up in the liquid and provides more efficient processing by allowing the material to settle back under the probe tip after each burst.
OUTPUT CONTROL	Controls the amplitude of vibrations at the probe tip. ***CAUTION:*** *When using a microtip, never allow the output control setting to exceed MICROTIP LIMIT "5".*

REAR PANEL	
3 PIN CONNECTOR (S)	Connect to the converter cable(s).
FUSE(S)	Protects against electrical overload.
ELECTRICAL LINE CORD	Connects the power supply to the electrical outlet.

PREPARATION FOR USE

CAUTION

If the Ultrasonic Processor has been left in a very cold or hot environment for a prolonged period of time, do not operate until it has reached room temperature.
To safeguard the fuse against failure, always switch the power supply off before connecting or disconnecting the footswitch plug.

1. Ensure that the POWER SWITCH is set to OFF.
2. Plug the electrical line cord into the electrical outlet.
3. If a footswitch is used, plug into the FOOTSWITCH CONNECTOR. Make sure that the plug is inserted forcefully all the way in.
4. If the converter, and accessories are not already assembled, observe steps 5, 6, and 7.
5. Clean the mating surfaces of the converter and probe or stepped microtip, as well as the threaded stud and hole. Check that the stud is tight.

CAUTION

Never assemble or disassemble a probe by holding the converter in a vise.
Never place a washer between the probe and the converter.
Never apply grease to the mating surfaces or threads of the converter, probe, replaceable tip or microtip.

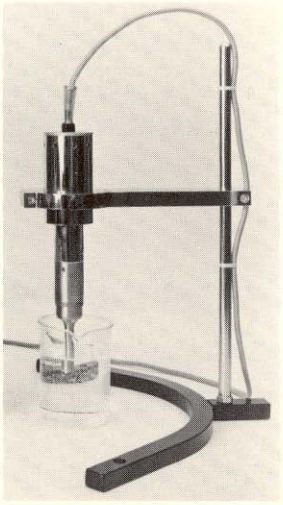
6. Hand assemble the probe or stepped microtip assembly (consisting of coupler and stepped tip) to the converter, and using wrenches provided, tighten securely. See Page 9.
7. To secure a replaceable tip, extender, or tapered microtip to a probe, use a spanner wrench and an open wrench. See page 9.

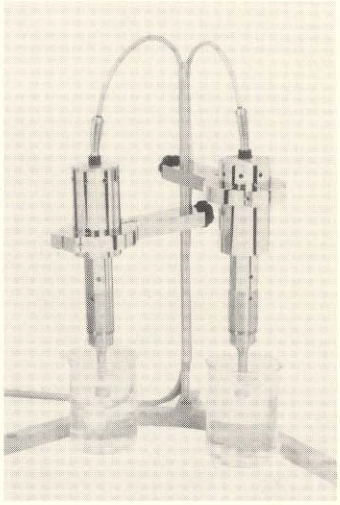
NOTE

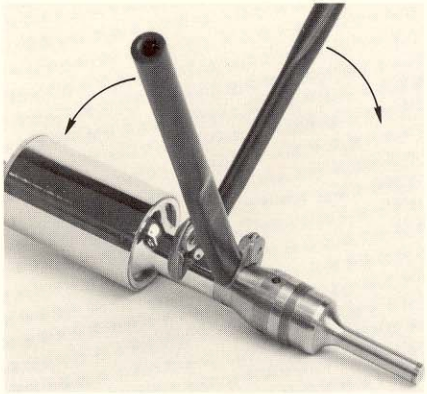
Should it become necessary to remove a probe, use the spanner wrenches supplied. If the probe has been on the converter for a long time, it might be necessary to use a vise. Be sure the vise has soft jaws or other means to prevent scratching. Secure the wide diameter portion of the probe in the jaws of the vise. Never grip the converter in the vise. Using a spanner wrench, twist the converter off the probe. A tap of a hammer may be applied to the end of the spanner wrench. Never attempt to twist the converter housing as this may damage the crystal or the electrical connections within the housing.

8. Connect the converter cable to the bottom connector. With a dual output 600 watt Ultrasonic Processor, if two converters are going to be used simultaneously, **do not** connect the second converter at this time.

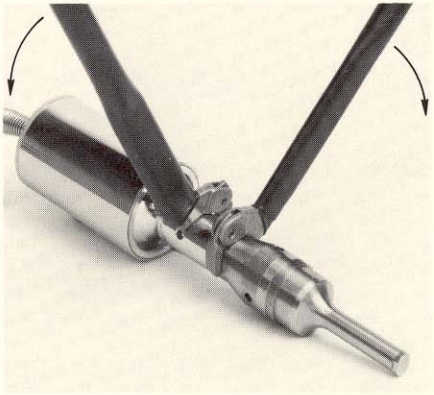
9. Mount the converter/probe assembly(ies) in a laboratory stand. Secure the clamp(s) to the 2½″ (63.5 mm) diameter converter housing only. Do not secure the clamp(s) to any other portion of the converter/probe assembly(ies). Never allow the probe to touch the workbench or other surfaces.



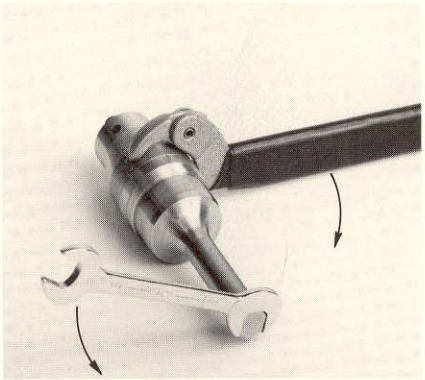




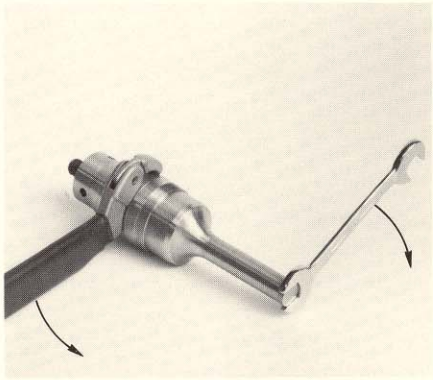
HORN REMOVAL



HORN TIGHTENING

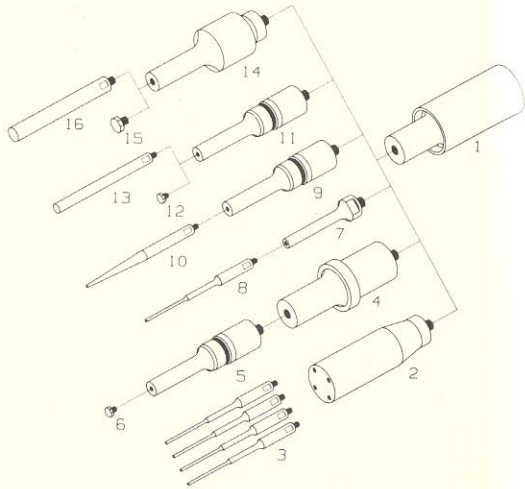


TIP REMOVAL



TIP TIGHTENING

No.	DESCRIPTION	Order Number
1	Converter Model CV17	CV00017
2	Four element coupler	630-0425
3	Stepped tip(s) 1/8" (3 mm)	630-0422
4	Booster	BHNVCGD
5	Standard horn 1/2" (13 mm) solid	630-0201
	Standard horn 1/2" (13 mm) with threaded end and replaceable tip	630-0200
	Standard horn 3/4" (19 mm) solid	630-0208
	Standard horn 3/4" (19 mm) with threaded end and replaceable tip	630-0207
	Standard horn 1" (25 mm) solid	630-0209
	Standard horn 1" (25 mm) with threaded end and replaceable tip	630-0210
6	Replaceable tip 1/2" (13 mm)	630-0406
	Replaceable tip 3/4" (19 mm)	630-0407
	Replaceable tip 1" (25 mm)	630-0408
7	Coupler	630-0421
8	Stepped tip 1/8" (3 mm)	630-0422
9	Standard horn 1/2" (13 mm) with threaded end and replaceable tip	630-0200
10	Tapered microtip 1/8" (3 mm)	630-0418
	Tapered microtip 3/16" (5 mm)	630-0419
	Tapered microtip 1/4" (6 mm)	630-0420
11	Standard horn - solid or with threaded end and replaceable tip – same as 5	
12	Replaceable tip – same as 6	
13	Extender 1/2" (13 mm)	630-0410
	Extender 3/4" (19 mm)	630-0409
	Extender 1" (25 mm)	630-0444
14	High gain Q horn 3/4" (19 mm) solid	630-0306
	High gain Q horn 3/4" (19 mm) with threaded end and replaceable tip	630-0305
	High gain Q horn 1" (25 mm) solid	630-0310
	High gain Q horn 1" (25 mm) with threaded end and replaceable tip	630-0311
15	Replaceable tip 3/4" (19 mm) or 1" (25 mm) – same as 6	
16	Extender 3/4" (19 mm) or 1" (25 mm) – same as 13	



CAUTION

Do not use tapered microtip with coupler.

Do not use stepped tip without coupler.

TUNING

Tune the power supply in accordance with the following procedure each time a new converter, probe, cup horn, tip, microtip, extender, or accessory is used.

> **CAUTION**
>
> *The power supply should be tuned after the probe has reached operating temperature. When working with low or high temperature liquids, immerse the probe in the liquid for a few minutes, withdraw the probe out of the liquid,* **then**, *tune the power supply.*
>
> *When using the optional cup horn or continuous flow cell, remove all the water from the cup horn, and liquid from the continuous flow cell, before tuning the power supply.*

1. Ensure that the probe or microtip is not immersed in the liquid and that it does not come in contact with anything. If a cup horn or flow through cell is used, make sure that it does not contain any liquid.

2. Set PULSER to OFF.

3. Set OUTPUT CONTROL to "10" (to "5" when using a microtip).

CAUTION

When using a microtip or extender, never allow the tip to vibrate in air for more than 15 seconds and do not set the OUTPUT CONTROL above "5". Ignoring these instructions will cause the microtip or extender to fracture.

4. Set POWER SWITCH to ON. The switch will illuminate.
5. **Momentarily** depress TUNE SWITCH and rotate the tuner clockwise or counterclockwise until a **minimum** (not maximum) reading (usually less than 20) is obtained on the POWER MONITOR. If a minimum reading cannot be obtained, the probe, cup horn, tip, microtip, extender, or accessory is loose or out of resonance, or the power supply or converter require servicing. A loose probe will usually generate a loud piercing sound.

NOTE

The probe is tuned to vibrate at a specific frequency. If the resonant frequency of the probe has changed, due to cavitation erosion or fracturing, minimum reading will not be obtained. If minimum reading cannot be obtained, check the unit without the probe. If proper tuning is obtained without the probe, then the probe should be changed.

6. Set OUTPUT CONTROL to "4".
7. Set POWER SWITCH to OFF.
8. With a dual output 600 watt Ultrasonic Processor, if two converters are going to be used simultaneously, connect at this time the second converter cable to the top connector.

USING THE ULTRASONIC PROCESSOR

CAUTION

- *Do not operate the power supply unless it is connected to the converter(s).*
- *High voltage is present in the power supply — Do not operate with the cover off.*
- *Never allow liquid to spill into the converter. Do not use the cup horn without a splash shield.*
- *Do not allow a microtip or extender to vibrate in air for more than 15 seconds.*
- *When using a microtip, never exceed MICROTIP LIMIT "5" on OUTPUT CONTROL.*
- *Do not allow the vibrating microtip to come in contact with anything but the liquid.*
- *Do not operate the converter in an explosive, humid, or caustic atmosphere.*

1. Ensure that the power supply is properly tuned (see Pages 11 and 12).
2. If a standard probe is used, immerse the probe 1 to 1½ inches (3 cm) into the liquid. If a microtip is used, immerse the microtip ½ inch (1 cm) into the liquid.
3. Set TIMER as required. If the footswitch is used, set TIMER to 999 HOURS. Depressing the footswitch will not energize the power supply, unless the TIMER is activated.
4. Set PULSER as required. If the pulsing mode is not required, set PULSER to OFF.
5. Set POWER SWITCH to ON. The switch will illuminate.
6. Activate the timer by depressing the START button.
7. If the footswitch is used, depress footswitch.
8. Using OUTPUT CONTROL increase or decrease intensity as required.

IMPORTANT

As the volume or viscosity increases, so does the need for higher power output. A sensing network continuously monitors the output requirements, and automatically adjusts the power output in order to satisfy the needs of the application. The actual power delivered will only be that required by the application. The greater the resistance to the movement of the probe, because of higher viscosity, larger volume or deeper immersion of the probe into the liquid, the greater the deflection on the POWER MONITOR.

With the 300 watt unit, full meter deflection will only take place when the unit is called upon to deliver 300 watts. With the 375 watt unit, full meter deflection will only take place when the unit is called upon to deliver 375 watts. With the 600 watt unit, full meter deflection will only take place when the unit is called upon to deliver 600 watts.

The VC 600-dual can energize one converter at 600 watts or two converters at 300 watts each. When processing two identical samples with two identical probes, the power delivered to each probe will be half that indicated on the power monitor.

To demonstrate the above statement, perform the following: With a ½" (13mm), ¾" (19mm) or 1" (25mm) probe, set OUTPUT CONTROL to maximum (to halfway point with a microtip). Depress the probe down against a piece of wood. The greater the down pressure, and consequent greater resistance, the greater the deflection on the POWER MONITOR.

OPERATING SUGGESTIONS AND TECHNIQUES

Cavitation induced by ultrasound has many advantages for cell disruption as compared with other methods, the main advantage being that resistant organisms such as bacteria and yeasts, which have tough and resilient cell walls, are broken relatively quickly. It has been established that micro-organisms differ greatly in their sensitivity to ultrasonic disintegration. The most readily disintegrated for example are the rod-like forms (bacilli) while the spherical organisms (cocci) are much more resistant. The group Mycobacteria, to which the tuberculosis organism

belongs, is particularly difficult to disrupt. Generally, animal cells are more easily disintegrated than plant cells, and red blood cells are more readily disintegrated than muscle cells because they lack a protective cell wall.

Before each experiment, place the probe tip in water or alcohol and energize the power supply for a few seconds to remove any residue.

The probe must never be allowed to come in contact with anything but the liquid. When using a microtip, the stress resulting at the point of contact with the vessel could cause the microtip to fracture. Standard probes will not fracture if they contact the treatment vessel, but they can damage the vessel.

Insert the probe deep enough below the surface of the liquid to inhibit aerosoling or foaming. Foaming substantially reduces cavitation. Processing at a lower power setting without foam is more efficient than processing at a higher power setting with foam. Decreasing the power, increasing processing time, using a narrower vessel, and lowering the temperature of the liquid will usually prevent aerosoling and foaming. Do not add anti-foaming agents or any materials that might lower surface tension. Reducing surface tension, such as by adding a surfacant, will lower the power required but will decrease intensity. Use a conical shaped tube such as a reaction vial whenever possible.

Allowing the probe to come in contact with the vessel will decrease the power output, and cause tiny glass particles to migrate into the liquid. Although these glass particles will not adversely affect the chemical composition, they will form a thin grey layer on centrifuging.

In ultrasonic processing the molecular motion in the liquid causes temperature elevation — especially with small volumes. Since high temperature reduces cavitation, the liquid should be kept as cold as possible. This can be accomplished by immersing the sample vessel in an ice-salt-water-alcohol bath, or by using a water-jacketed processing vessel through which very cold water or alcohol is circulated.

Since the greatest concentration of energy is immediately below the probe, it is imperative that the sample be kept as close to the tip as possible. Liquids are easily processed because the free moving cells circulate repeatedly below the probe. Solid materials, however, have a tendency to be repelled by the ultrasonics. To alleviate this problem, the vessel should be large enough to accommodate the probe, yet small enough to restrict sample movement.

If the probe has to come in contact with a solid sample, use a standard ¾″ (20 mm) diameter stainless steel centrifuge tube cut to 3″ (70 mm) length. *Do not use a glass tube.*

When processing difficult cells, the usage of enzymes might be considered. Glusulase can be used with yeast, lysostaphin can be used with staphylococcus, collagenase can be used with skin and cartilage, and trypsin hyaluronidase can be used with liver and kidney.

Glass beads in the 50 micron size range can also be added to the liquid to expedite processing. When using glass beads, a good ratio is 1/3 beads, 2/3 liquid. Glass beads concentrate the energy released by the implosion and facilitate the crushing of cell walls. After processing, the glass will sink to the bottom of the vessel or can be centrifuged or filtered out.

Whenever possible, the tissues should be diced very small to permit movement within the liquid. Freezing followed by powdering could also be resorted to, if this procedure is not detrimental to the experiment.

Large samples should first be liquified in a high speed mechanical blender for about 10 seconds. If sub-cellular particles are desired intact, the amplitude control should be set low and the processing time increased.

Ultrasonic outgassing or deaeration of liquids is best done at low pressure or under vacuum.

Proper care of the probe is essential for dependable service. The intense cavitation will, after a prolonged period, cause the tip to erode, and the power output to decrease without showing up on the power monitor. The smoother and shinier the tip, the more power will be transmitted into the liquid. Any erosion of the probe tip will increase the rate of future erosion. For that reason, it is recommended that after every 5 or 6 hours of use the tip be examined, and if necessary, polished with a fine emery cloth. Since the probe and tip are tuned to vibrate at a specific frequency, it is most important that only the contaminated surface be removed. If tip wear is excessive, replace the tip.

High viscosity and concentration are problematical. 8,000 cP and 15% concentration by weight are maximum limits. If the liquid is so thick that it will not pour or circulate easily, it is too thick.

During cavitation free radicals are formed which, if they are allowed to accumulate, can greatly affect the biological integrity of the sample. Although during short periods of processing their formation is not normally considered a problem; for prolonged processing, the addition of free radical scavengers such as cysteine or glutahione might be considered. Saturating the liquid with hydrogen or carbon dioxide will often eliminate free radical formation. A small pellet of dry ice dropped in the liquid will often resolve the problem.

If aerosoling presents difficulties, use the Sealed Atmosphere Treatment Chamber.

The problem of oxidation is a serious one particularly where the study of sulfhydril enzymes is concerned. This may be partially controlled by the use of free radical traps such as cysteine, reduced gluthathione or comparable substances or by insonating in the presence of an inert atmosphere. Whereas it is true that gas is required for effective cellular disruption, it is not necessary that the vapor phase be oxygen or air since any gas except carbon dioxide has essentially the same efficiency for cellular disruption. A Sealed Atmosphere Treatment Chamber permits extraction to be made in presence of helium or nitrogen. Forcing inert gas through the liquid will also reduce aerobic oxidation.

The probe tip may be autoclaved, or sterilized either by immersing in boiling water or in a detergent bactericide such as Staphene and a disinfectant.

Use the Sealed Atmosphere Treatment Chamber for processing pathogenic and biohazardous materials.

Use the Continuous Flow Cell for processing large volumes. If it is necessary to keep the flow cell cold, immerse the coiled copper tubing carrying the water to the water jacket in a salted ice bath.

Use the Cup Horn for processing pathogenic, radioactive and biohazardous materials in complete isolation. Because plastic tubes have a tendency to absorb vibrations, it is advisable to use stainless steel tubes or glass tubes when working with a cup horn. To expedite processing, add glass beads to the liquid.

If concerned with sample loss in test tube due to sticking, siliconize the test tube in accordance with the following procedure. Wash and dry the tube thoroughly, coat with silicone, then air-dry. "Sigmacote" manufactured by

Sigma Chemical Co., 3050 Spruce St., St. Louis, Missouri 63103. Phone (314) 771-5765, is ideally suited for that purpose.

Glass Bead can be acquired from Catatphote, Inc., P.O. Box 2369, Jackson, Mississippi 39225-2369 USA. Phone (601) 939-4631 or (800) 221-2574.

Always use an extender or a solid probe (without replaceable tip) when working with solvents or low surface tension liquids such as methylene chloride.

SECTION III — MAINTENANCE

GENERAL

It is suggested that an Ultrasonic Processor in needs of repair be sent back to the factory.

In order to receive prompt service, always contact the factory before returning any instrument. Include date of purchase, model number and serial number. For units not covered by the warranty, a purchase order should be forwarded to avoid unnecessary delay. Care should be exercised to provide adequate packing to insure against possible damage in shipment. The Ultrasonic Processor should be sent to the "Service Department" with all transportation charges prepaid and return method of shipment indicated.

BY RETURNING ANY MATERIAL, THE CUSTOMER OR THE CUSTOMER'S AGENT THUS CERTIFIES THAT ANY AND ALL MATERIALS SO RETURNED ARE, OR HAVE BEEN RENDERED, FREE OF ANY HAZARDOUS OR NOXIOUS MATTER OR RADIOACTIVE CONTAMINATION AND ARE SAFE FOR HANDLING UNDER NORMAL REPAIR SHOP CONDITIONS. Do not return any material for which such certification can not be made.