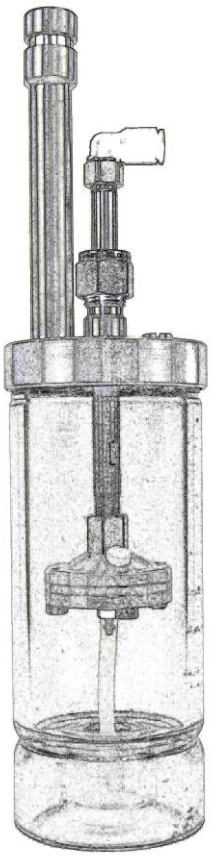
Blaustein Atomizer (BLAM)
Multi-jet Model



User's Manual

CH TECHNOLOGIES (USA)

CONTENTS

1. GENERAL DESCRIPTION AND SPECIFICATIONS

1.1. Introduction

The Blaustein Atomizer (BLAM) is a high output atomizer that uses the jet nebulization principle of the Collison Nebulizer, which has long been the recognized as the technique for the efficient aerosolization of various liquids. However, the BLAM relies on a new, patent pending design, which allows for a more efficient generation of aerosol than the Collison or other existing devices, in both its single pass and recirculating configurations. This innovative design allows users to produce liquid aerosol at high particle concentrations and very narrow particle size distribution.

The BLAM is superbly suited to handle various liquid media, such as water based drug solutions, solvent based mixtures such as pesticides, oils and other viscous liquid suspensions and biological test articles such as bacterial/viral suspensions. The multi-jet BLAM is able to efficiently aerosolize and deliver high aerosol outputs of viscous liquid media, which is particularly of great importance in meeting the OECD requirements for pesticide testing. Also, it provides bioaerosols with enhanced viability of pathogenic microorganisms for aerobiology research.

The particle size distribution of the aerosolized mist will depend on the nature of the liquid test article. However, for most solutions and suspensions, the BLAM will deliver a narrowly distributed mist that falls well within the respirable cutoff.

The multi-jet BLAM can be used in Single Pass Atomization (SPA) mode, with the liquid feed being injected externally by a metering device, or Multi Pass Atomization (MPA) mode where the atomizer jar is pre-filled with the liquid test article and the medium is cyclically re-circulated (atomized) to the four or eight sonic velocity air jets until is exhausted.

The BLAM as a retrofit can be exchanged for existing Collison-type nebulizing nozzles and used as an atomizer by simply mounting it in a suitable inhalation exposure system using standard tube and pipe fittings. The retrofit kit is packaged as a direct nozzle replacement for many USA Collison nebulizers.

The BLAM is equipped with a vapor polished polycarbonate jar that is highly resistant to heat and mechanical stress, but at the same time allows a clear visual of the atomization process inside the device. As all other CH Technologies nebulizers, the BLAM outlet is equipped with a vertical or horizontal Jaeger joint connector that is the standard connector of our inhalation systems. Other custom-designed connectors are available upon request.

The complete CHT BLAM is best used as an atomizer that interfaces directly to CH Technologies systems and equipment but with suitable modifications also adapts to other non-CHT equipment

1.2. Specifications

- Particle diameter: Approximately 0.7-2.5 μm
- Models available: 4- and 8-jet
- Air flow rate: 4-30 L/min
- Liquid Feed Rate: 0.1 – 60 ml/min
- Discharge: Vertical or Horizontal
- Material: Stainless Steel 316 (stem & plates) and Ploycarbonate (jar & head)

1.3. Mechanism of Operation

Knowledge of the mechanism of aerosol formation by the BLAM will help you in determining the aerosol characteristics as well as being useful for maintenance. The atomizing head at the end of the air supply stem is the key to aerosol formation. It is composed of three main parts: Nozzle Body, Jet Plate and Expansion Plate (Figure 1).

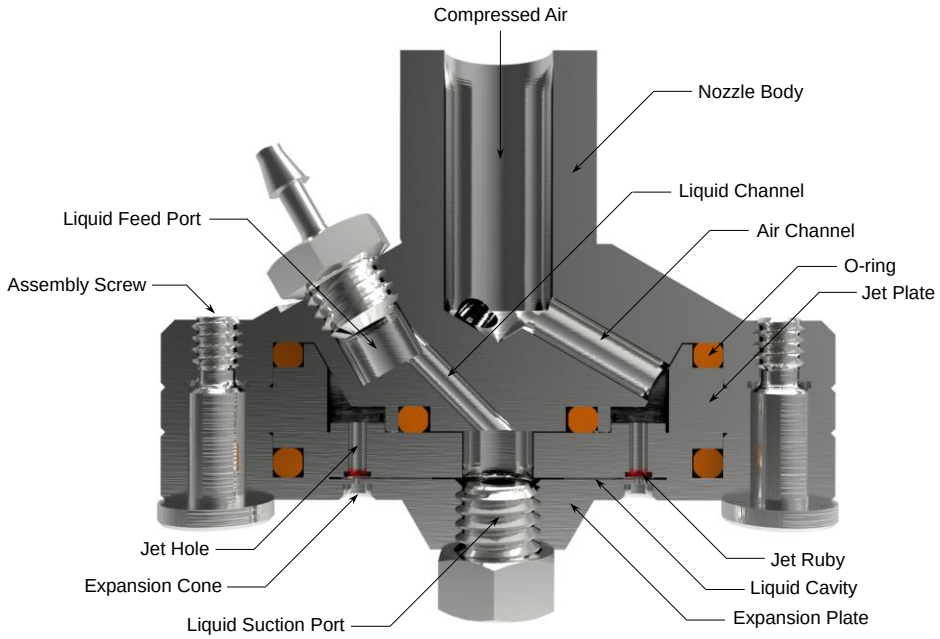


Figure 1. Components of BLAM's Atomizing Nozzle

The atomization occurs when the pressurized air coming from the stem pushes through the jets on the Jet Plate at sonic velocity. The jets are very small orifices through which pressurized air flows at a constant velocity. This process creates a powerful vacuum effect in the cavity (only 0.002" deep) between the Jet Plate and Expansion Plate which drives the liquid from the liquid chamber to the jets. The liquid then reaches the wells around the jets where is aspirated in and sheared into tiny droplets as the air expands after

the jet. In multi-pass mode, the liquid is driven into the liquid chamber through the suction tube at the center of the Expansion Plate simply by the vacuum created by the air jets. On the other hand, in single pass mode the suction port on the Expansion Plate is plugged and the liquid is pumped in through the liquid feed port located on the Body.

The aerosol generated by the atomization process is sprayed downwards and, after impacting the surface of the liquid inside the jar, it makes a 180° turn and it is forced up the outlet tube on top of the BLAM lid. During this process, larger droplets are collected on the liquid surface due to impaction as they cannot make the U-turn. The end result is a very fine mist, well within the respirable range and with narrow size distribution.

The properties of the aerosol generated by the multi-jet BLAM are a function of the jet hole size and expansion cone size. The BLAM jets are equipped with 0.010" diameter laser cut rubies which guarantee long lasting precision in the atomization process. For specific applications, the BLAM can be fitted with other non-standard jet hole sizes and expansion plates.

The multi-jet BLAM is equipped with a precious fluids jar which has a small well at the bottom. In MPA mode, the thin silicone tube attached to the liquid aspiration port on the Expansion Plate extends all the way to the bottom of the well. This allows the atomizer to essentially use every last drop of the test fluid. See Appendices 1 and 2 for an overview of parts of an assembled multi-jet BLAM in both SPA and MPA mode.

2. BLAM OPERATION

2.1. Unpacking the BLAM

When you receive your BLAM, you should unpack it carefully and check to make certain that the following parts are all present and in undamaged condition:

- The BLAM assembly as seen in Appendix 1 or 2

- Package of accessories containing:
  - 2 spare 10-32 barb fittings
  - 2 spare 10-32 plugs
  - 2 spare O-ring sets
  - Spare silicon tubing for liquid feed
  - Allen wrench for the nozzle screws

- Carrying Case

Your BLAM may vary slightly in appearance depending upon the specific model that you ordered (4-jet vs. 8-jet), type of discharge (vertical vs. horizontal) and fittings you requested. Appendix 4 shows photographs of multi-jet BLAMs with vertical and horizontal discharge. An overview of parts and accessories of the BLAM's complete kit is given in Appendix 5.
Any changes from the standard pieces listed above will be noted on your shipping memo. PLEASE KEEP YOUR SHIPPING MEMO FOR FUTURE REFERENCE. If you find that anything has been damaged in transit, contact the carrier of the shipment immediately in addition to CH Technologies.

2.2. Initial Testing

After unpacking, you should immediately check the operation of the device. Your BLAM comes fully assembled so it ready to be used for a performance check. Follow the steps outlined in Section 2.3.1. to set up and operate the device. Use ONLY distilled water for initial testing.

When the air source is turned on, mist should appear at the aerosol outlet as shown in Figure 2. If mist does not appear, recheck all your fittings and make sure that jar is screwed in tight. The operation of the BLAM depends upon it being a completely sealed unit.

Perform a visual inspection of the jet operation and make sure that none of them appears to be aerosolizing less than others or not at all. All the jets are identical and should perform exactly the same.

2.3. BLAM Operation Procedures

2.3.1. Operating the BLAM in MPA Mode

Your BLAM comes set up for MPA mode operation. In this mode, the liquid feed hole on the lid as well as liquid feed port on the nozzle body are plugged. A barb fitting with a short piece of silicon tube is assembled into the liquid aspiration port on the jet plate. See Appendix 1 for a representation of the BLAM in MPA mode.

Follow these steps to operate the BLAM in MPA mode:

1. Remove the jar and fill it with about 100 ml of the test solution or suspension.

   ATTENTION! The amount of liquid can alternatively be greater (if the device is operated at high outputs and/or for long aerosolization sessions) or smaller (if you are using precious fluids)

2. Reassemble the jar into the lid and make sure that it's tight

3. Release the compression nut that holds the air stem and adjust the height of the nozzle at about 1" from the surface of the liquid. Make sure that liquid aspiration tube connected to the nozzle is long enough to reach to the bottom of the precious fluid well. Tighten the nut when you are done.

   ATTENTION! DO NOT use tools to tighten the air stem compression nut!

4. Using a ¼" OD tube, connect a compressed air line to the air inlet of the BLAM. Use polyurethane tubing or one that that can withstand the pressure used. BLAM's air inlet is equipped with a ¼" push-to-connect fitting so the air line can be connected by simply pushing the tubing in. If you BLAM comes with non-standard fittings, use appropriate couplers to connect the air line to the atomizer. If you are not using any of CH Technologies system control units, make sure that the compressed air line is equipped with appropriate pressure and flow controllers. An illustration of a standard setup of the BLAM in MPA mode is given in Figure 2.

5. Connect the BLAM outlet to your system or application using appropriate fittings. Make allowance for dilution of the aerosol outflow if desired.

6. Start atomization by turning on air

7. Using your flow controller, adjust the air flow at about 2 L/min per jet (~8 L/min for the 4-jet BLAM; ~16 L/min for the 8-jet BLAM). If you need more output, increase first the upstream pressure of the compressed air line and then increase air flow rate to the atomizer.

   ATTENTION! DO NOT exceed 90 psi upstream pressure!

8. Turn off atomization at any time by shutting down compressed air supply to the atomizer

9. Remove the compressed air line from the BLAM's air inlet

10. Take the atomizer for cleaning/decontamination

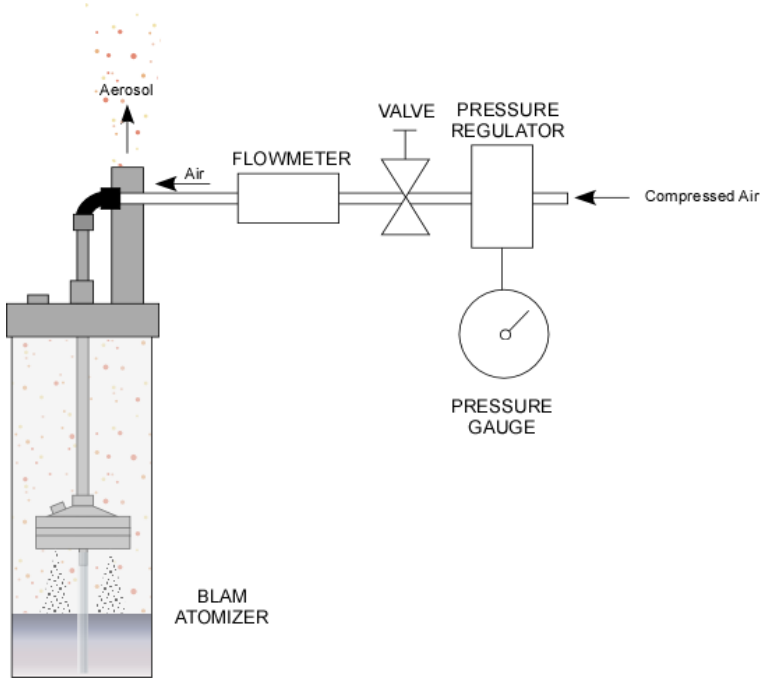


Figure 2. Schematic of BLAM's Setup in MPA Mode

2.3.2. Operating the BLAM in MPA Mode with External Refill

If your experiment requires running the BLAM at high output for long periods of time it is recommended that the device be operated with the external refill option. This allows the user to refill the BLAM with the test liquid without interrupting atomization.

Follow these steps to run the BLAM in MPA mode with external refill option:

1. Remove the liquid feed port plug on the lid

2. Install the provided liquid feed barb and tighten it up

3. If you will use a syringe pump for the refill, fill the syringe with about 100 ml of test article and place it in the pump

4. If you are using a low flow peristaltic pump instead, fill a glass beaker with about 100 ml of liquid and dip the inlet end of the pump's tube in it

5. Using a piece of thin silicon tube, connect the outlet of a syringe or low flow peristaltic pump to the BLAM's liquid feed port (refer to Figure 3).

6. Next, follow steps 1 through 7 in Section 2.3.1 to operate the atomizer

7. When the liquid in the jar is almost exhausted, turn on the external refill pump. When the jar is refilled with the predetermined amount of liquid, turn the pump off.

ATTENTION! Make sure that all the connections between the external refill pump and the BLAM are air tight.

8. Repeat the refill procedure as often as needed during the atomization process

9. Shut down compressed air supply to the atomizer when you are done with the atomization process

10. Remove the refill tube from the liquid feed port on the lid

11. Remove the compressed air line from the BLAM's air inlet

12. Disconnect the atomizer from the external refill pump and take it for cleaning/decontamination

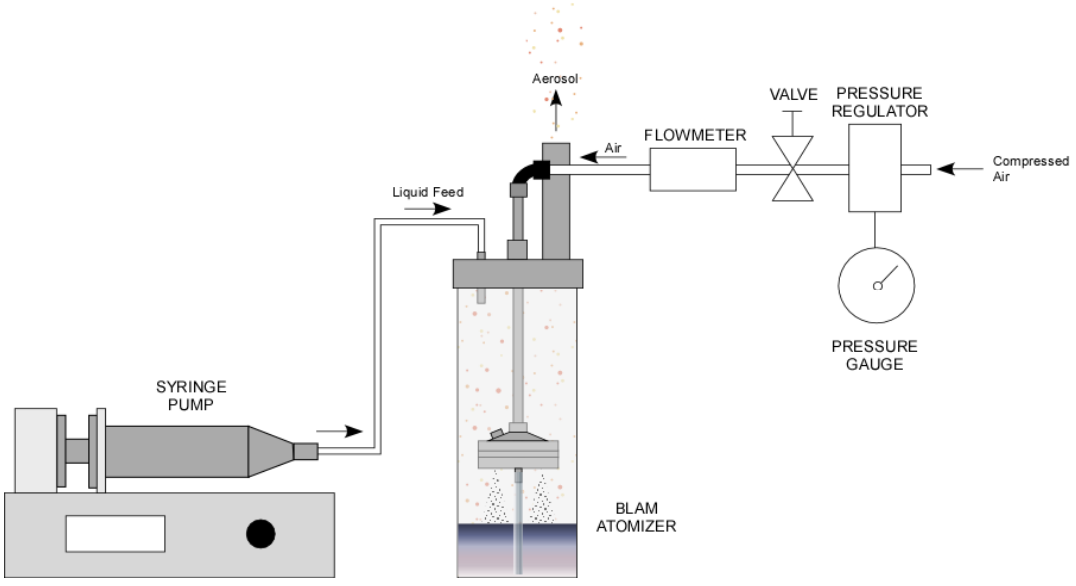


Figure 3. Schematic of BLAM's Setup in MPA Mode with External Refill

2.3.3. Operating the BLAM in SPA Mode

When you are using your BLAM with live pathogen suspensions, it is recommended that the device be operated in SPA mode. In this mode, the test article passes only once through the atomization process which results in preservation at a large extent of the viability of the microorganisms in the aerosol. The SPA mode is also recommended for proteinic solutions because prevents foaming during atomization.

Follow these steps to convert the BLAM and run it in SPA mode:

1. Remove the BLAM jar

2. Remove the liquid feed port plug on the lid

3. Install the provided liquid feed barb instead of it and tighten it up

4. Switch places of the liquid aspiration port barb fitting (center of the jet plate) with the liquid feed port plug (on the nozzle body)

5. Using a piece of the supplied silicon tube, connect the liquid feed port on the lid with the liquid feed port on the nozzle body

6. Fill the jar with about 20-30 ml of test solution and reassemble it into the lid. Make sure that the assembly is air tight.

   ATTENTION! DO NOT fill the jar excessively. The solution in it serves only the purpose of a soft impaction surface for the aerosol and it will not be used for atomization.

7. If you will use a syringe pump for feeding the BLAM, fill the syringe with the predetermined amount of test article and place it in the pump. Use a syringe large enough so that the BLAM does not run out of liquid before the atomization session is up.

8. If you are using a low flow peristaltic pump instead, fill a glass beaker or another appropriate container with the predetermined amount of liquid and dip the inlet end of the pump's tube in it. If your test article is a solution containing pathogens, make sure that the container is properly sealed (with a ventilation hole on the lid).

9. Using a piece of thin silicon tube, connect the outlet of the syringe or low flow peristaltic pump to the BLAM's liquid feed port

ATTENTION! Make sure that all the connections between the liquid feed pump and the BLAM are air tight.

10. Turn ON the liquid feed pump and adjust the feed rate as desired

11. When the liquid reaches the liquid feed port of the BLAM, turn ON compressed air supply to the device.

12. Next, follow steps 1 through 7 in Section 2.3.1 to operate the atomizer

13. When the atomization process is up, turn OFF the liquid feed pump and, in quick sequence shut down compressed air supply to the atomizer

14. Remove the liquid feed tube from the liquid feed port on the lid

15. Remove the compressed air line from the BLAM's air inlet

16. Take the atomizer for cleaning/decontamination

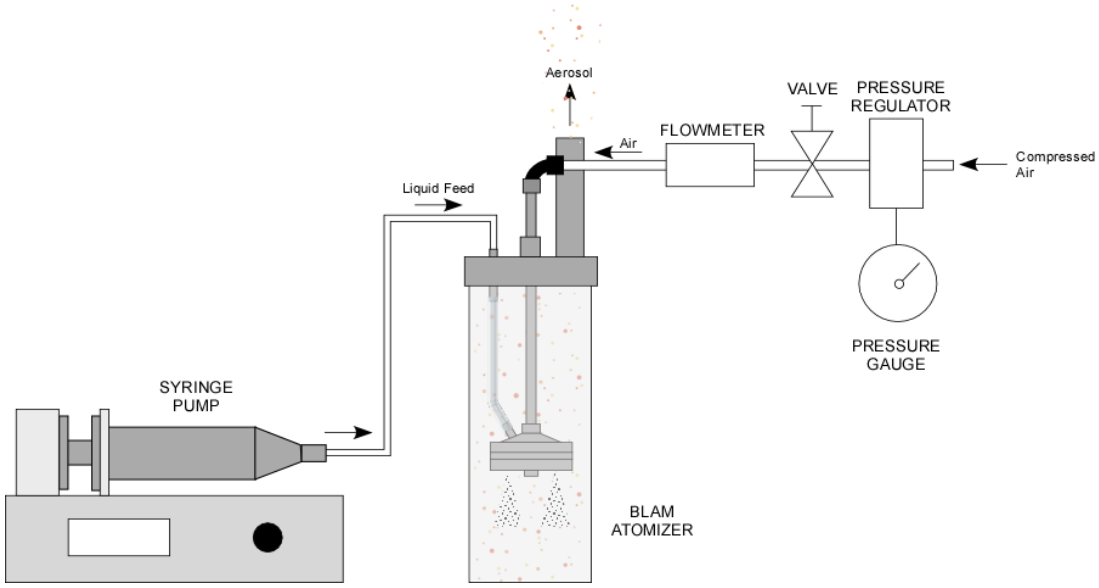


Figure 4. Schematic of BLAM's Setup in SPA Mode

2.4. Cleaning/Decontaminating Procedures

Your BLAM should perform indefinitely if it is cleaned and maintained properly. The device should be cleaned after each use.

If you are using your BLAM with any aqueous solutions that contain no pathogens, cleaning with a mild soap solution in warm water is generally adequate. Depending on the test article used, special solvents may be used in certain cases. Be sure that the O-rings are compatible with any solvents used. Special chemical resistant O-rings are available from CH Technologies if needed. Distilled water is a good choice for the final rinse; warm tap water may work also. You must judge the success of your cleaning/rinsing with your own QA/QC wipe tests or similar assessments. The cleaned BLAM parts should be allowed to air dry or they may be dried with warm forced air.

If your tests involve atomization of viscous suspensions or you are switching from one test article to another, an additional step is needed to make sure that the jets are freed from any occlusion from solids that may dry inside the nozzle and/or the nozzle is free from any residuals that may cause cross contamination. To do this, after cleaning the parts externally, feel the jar with few milliliters of water and run the BLAM for a few minutes in MPA mode. As clean water is atomized, it washes the cavities inside the nozzle and the jet holes.

WARNING! Whether you are using the BLAM in SPA or MPA mode, always replace the internal liquid aspiration/feeding tube during the cleaning/decontamination process when you switch from one test article to another to avoid potential cross-contamination.

Autoclaving can be used to decontaminate the BLAM parts if the device is used with pathogenic test articles. If you opt for autoclaving, you should first contact CH Technologies in order to establish appropriate guidelines for cleaning under high temperature and pressure.

WARNING! If autoclaving or decontamination with corrosive chemicals is not carried out properly, it may cause mechanical damage and/or chemical corrosion to various BLAM parts.

The O-ring in the BLAM's lid should be inspected during each cleaning. The slightest tear or cut on the O-ring will result in an inappropriate sealing of the device and may result in leaking of the test article into the air. The O-ring should be changed at frequent intervals because it may deteriorate with time.

2.5. Nozzle Maintenance and Adjustment

To make sure that the BLAM performs consistently over long periods of time, the nozzle should be serviced periodically. The frequency of the service will depend on the usage intensity and type of test articles utilized. The maintenance procedure of the nozzle is the following:

1. Remove the nozzle from the air stem using appropriate wrenches

2. Remove the barb and plug fittings from the liquid feed/aspiration ports

3. Use the provided allen wrench to remove the four screws that hold together the nozzle plates

4. Split the plates and lay them down on a clean work surface

5. Remove and carefully inspect the O-rings that seal the plates against each-other (refer to Figure 1 for details). If they show signs of damage, replace them with O-rings from the spare set supplied with the BLAM.

6. Visually inspect the jet holes against a light source and observe if there is any visible occlusion present in any of them. If any of the jets is clogged, place the jet plate in an ultrasonic bath with distilled water for about 30 minutes.

7. Wash the plates with a mild soap solutions and rinse them well with tap or distilled water

8. After the plates have dried, place the O-rings on the plates and reassemble the nozzle

9. Apply some Teflon tape on the threads of the air stem and thread the nozzle using appropriate wrenches

WARNING! If the BLAM has been used with pathogenic test articles, any servicing of the nozzle should take place after the device has been properly decontaminated or autoclaved.

3. DISCLAIMER

The BLAM Atomizer is subject to all the terms of CH Technologies (USA) standard limited warranty. The BLAM is a specialized article of research equipment intended for use by trained professionals. No liability is accepted by CH Technologies (USA) on account of misuse, misapplication or mishandling. CH Technologies (USA) specifically does not condone nor endorse any application or use which involves restricting emissions from the device and thus causing pressurizing of the jar. Further, CH Technologies (USA) accepts no liability for exposure to toxic, infectious or harmful substances resulting from the use of this apparatus.

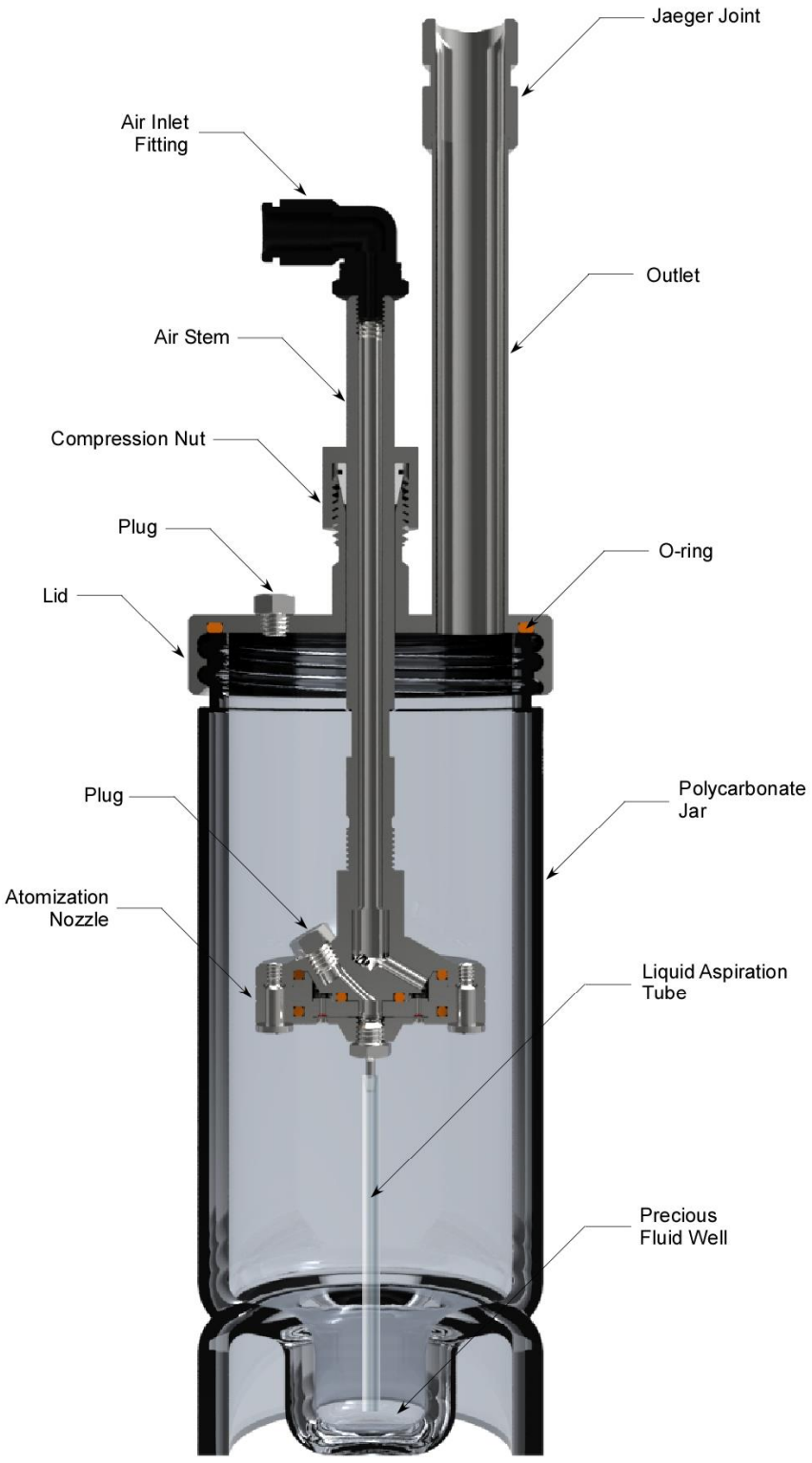
4. LIMITED WARRANTY

CH Technologies (USA) warrants equipment of its manufacture to be free from defects in workmanship and material. We make no warranty, express or implied, except as set forth herein.
CH Technologies (USA)'s liability under this warranty extends for a period of one (1) year from the date of shipment. It is expressly limited to repairing or replacing at the factory during this period and at CH Technologies (USA)'s option, any device or part which shall within one year of delivery to the original purchaser, be returned to the factory, transportation prepaid and which on examination shall in fact be proved defecting. CH Technologies (USA) assumes no liability for consequential damages of any kind. The purchaser, by acceptance of this equipment, shall assume all liability for consequences of its misuse by the purchaser, his employees or others. This warranty will be void if the equipment is not handled, installed, or operated in accordance with our instructions. If damage occurs during transportation to the purchaser, CH Technologies (USA) must be notified immediately upon arrival of the equipment.

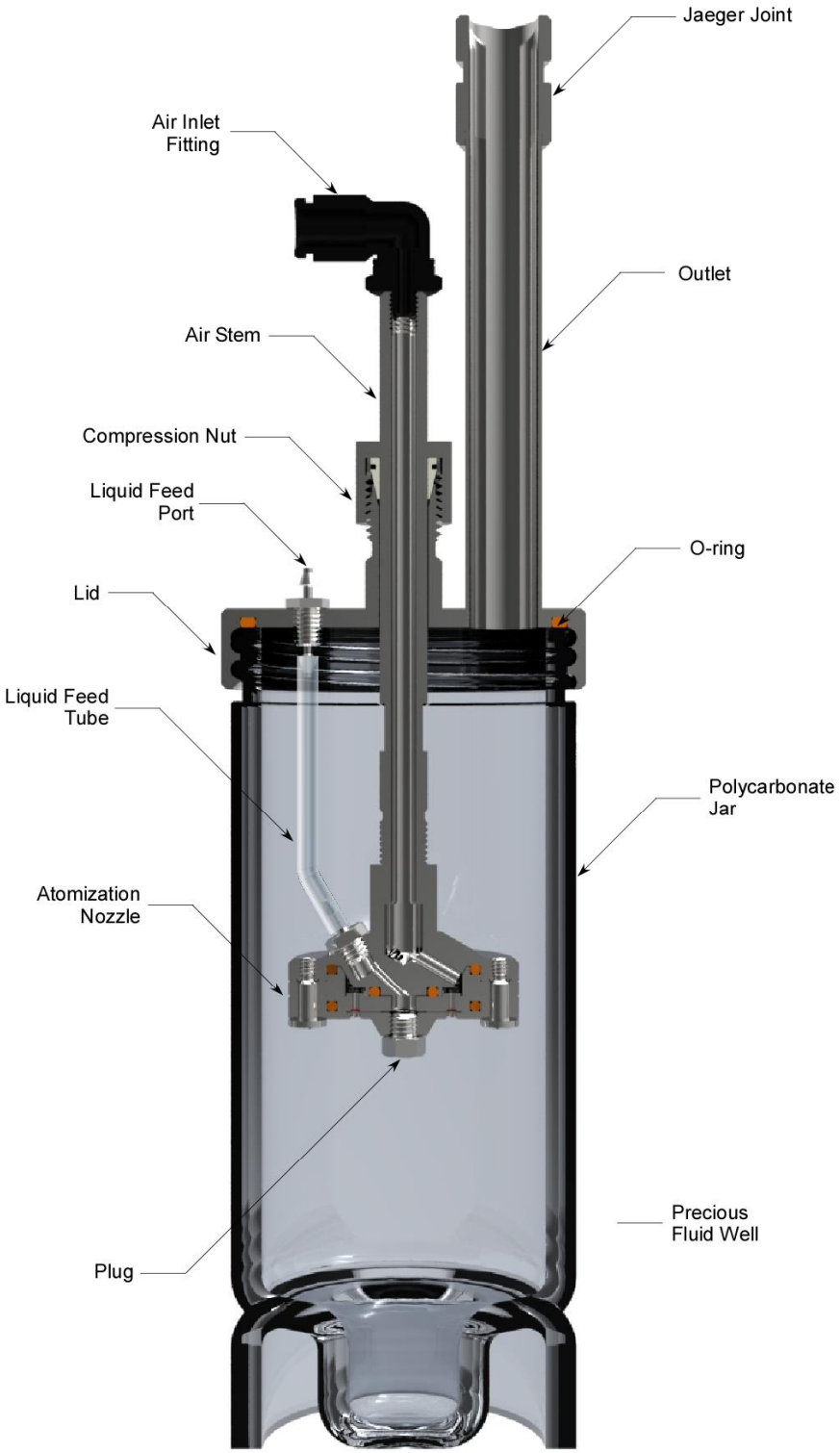
A defective part in the meaning of this warranty shall not, when such part is capable of being repaired or replaced, constitute a reason for considering the complete equipment defective. Acknowledgment and approval must be received from CH Technologies (USA) prior to returning parts or equipment for credit.

No representative of ours has authority to change or modify this warranty in any respect.

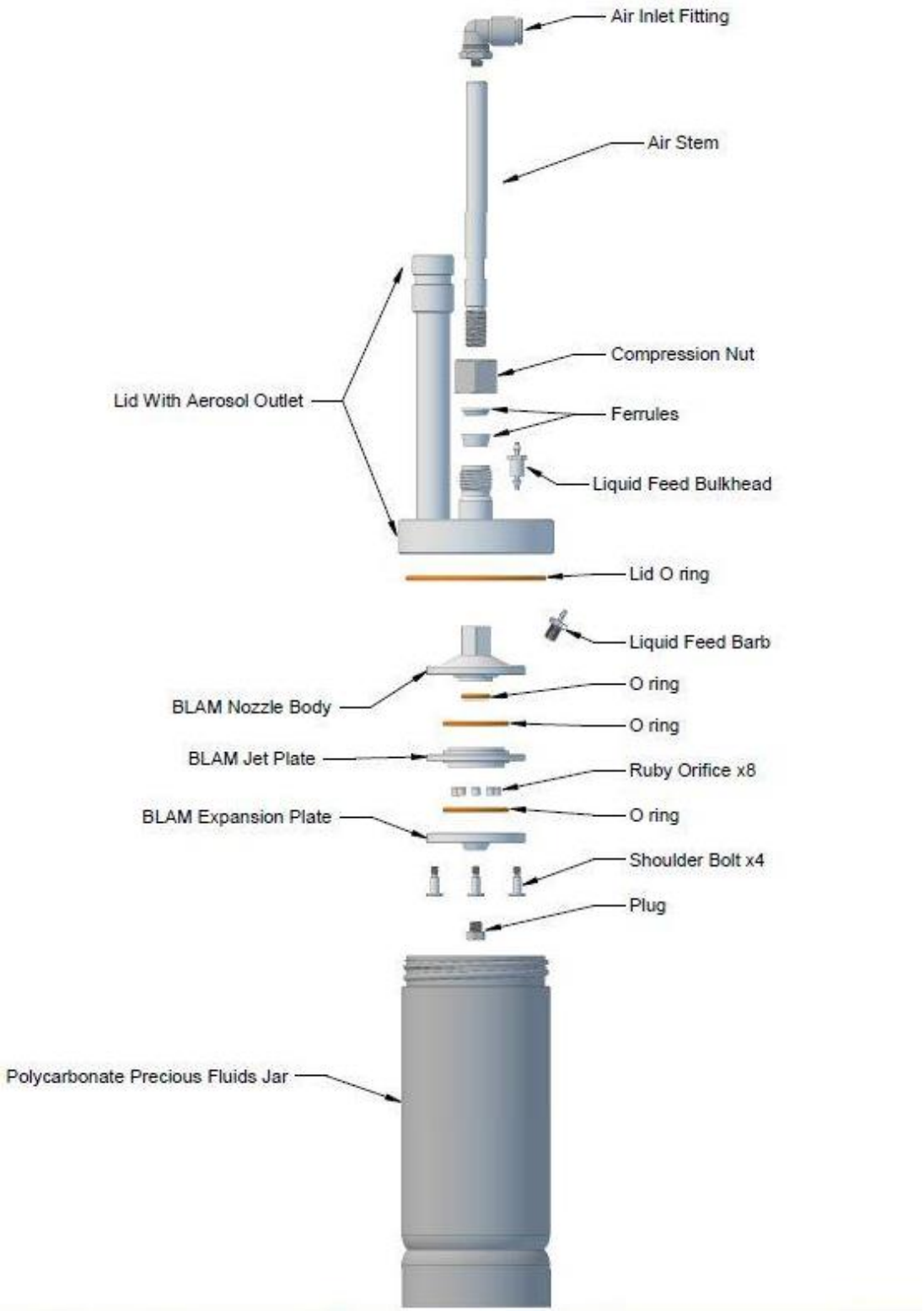
Appendix 1. Overview of Multi-jet BLAM Assembly in MPA Mode



Appendix 2. Overview of Multi-jet BLAM Assembly in SPA Mode



Appendix 3. BLAM Exploded Diagram



Appendix 4. View of Multi-jet BLAM

Vertical Discharge BLAM

Horizontal Discharge BLAM

Appendix 5. View of the Complete Multi-Jet BLAM Kit