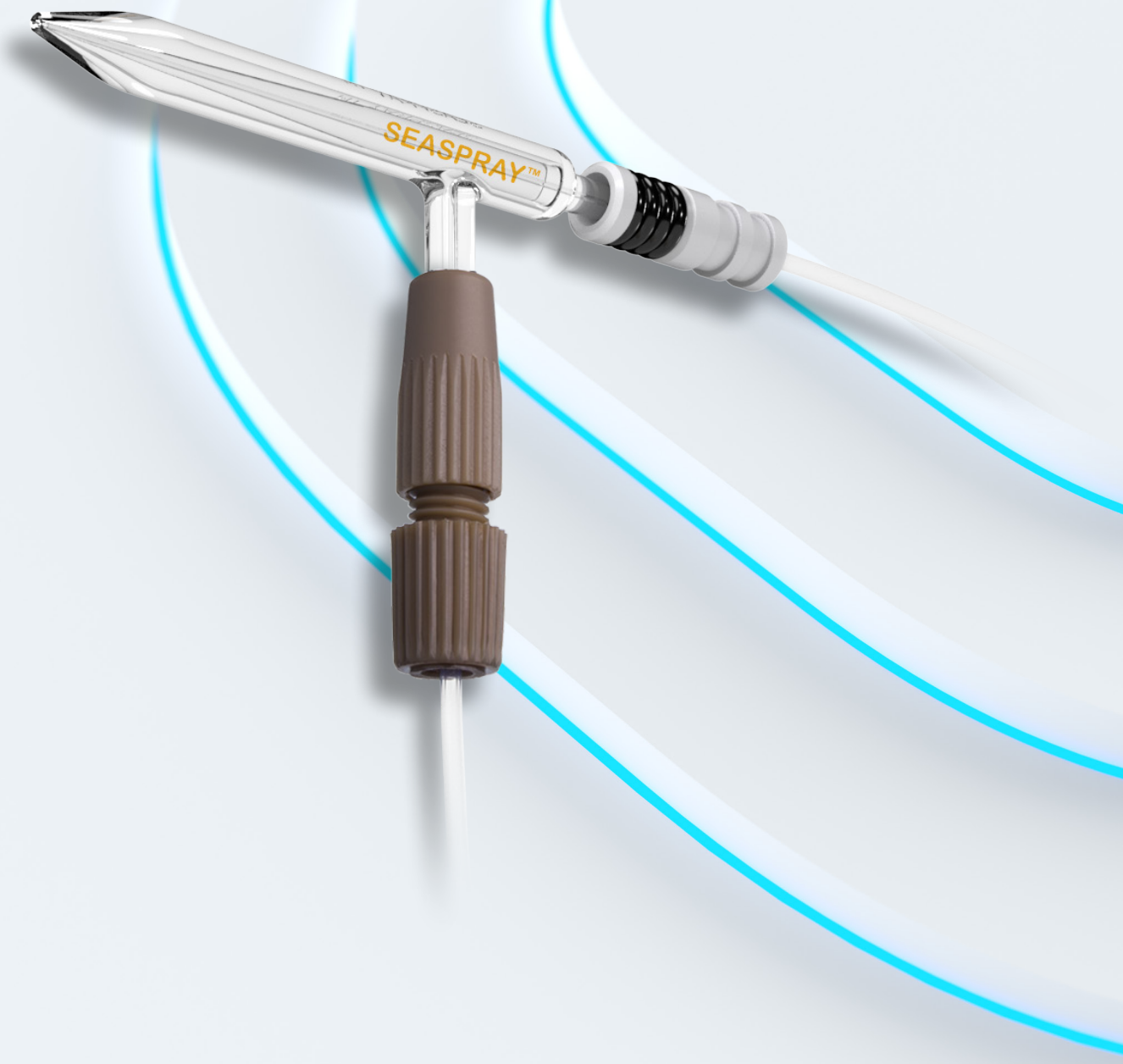
GLASS EXPANSION
Quality By Design

SeaSpray™ DC Nebulizer

Educational Tutorial & Best Practices Guide



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1 SeaSpray™ DC Nebulizer Educational Tutorial & Best Practices Guide

Maximizing Performance with Outstanding Efficiency and Tolerance to Dissolved Solids

1.1 Introduction to the SeaSpray™ DC Nebulizer

The Glass Expansion SeaSpray™ Direct Connection (DC) Nebulizer represents the pinnacle of concentric glass nebulizer technology, offering the highest sensitivity of any concentric glass nebulizer on the market. Independent peer-reviewed research has consistently demonstrated the SeaSpray's superior analytical performance, with comparative studies showing it achieves the best short-term precision and highest signal-to-root background ratios among tested concentric nebulizers.

This educational tutorial will guide you through understanding, optimizing, and utilizing the unique advantages of the SeaSpray DC nebulizer for various analytical applications, with specific focus on EPA and ASTM standard testing methods.

1.1.1 Key Performance Characteristics

- Outstanding sensitivity and precision for trace-level analyses
- Exceptional tolerance to dissolved solids up to 20% TDS (Total Dissolved Solids)
- Superior nebulization efficiency with minimal dead volume (4.0 µL)
- Fastest washout characteristics due to uniform sample channel design
- Direct connection capability with UniFit sample connector system

1.1.2 Industry Leaders

No other manufacturer can match the precision and reproducibility of the **VitriCone™ construction**, making it the most robust and dimensionally reproducible concentric nebulizer available.

The Global Standard in Nebulizer Innovation

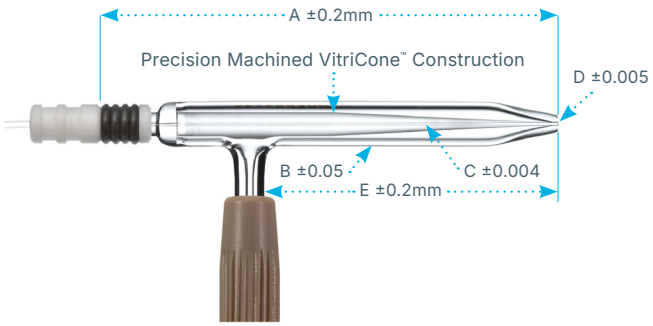
Manufacturing Tolerance

All Glass Expansion concentric nebulizers use the unique VitriCone™ construction delivering the best possible precision. Other manufacturers heat and draw a thin fragile capillary from glass tubing to create the internal capillary. This process is prone to a number of problems including inconsistent diameters, an increase in the porosity of the glass, and harmonic vibrations from the flow of argon, all of which can degrade performance and lifetime.

Glass Expansion is the only manufacturer that takes thick-walled precision-bore tubing and machines the outside to a uniform aerodynamic shape. This guarantees a uniform sample channel, assuring tolerance to nasty samples and excellent reproducibility.

The VitriCone design features:

A. **Controlled overall length precision:** ±0.2mm
B. **Shell Diameter:** ±0.05mm
C. **Full length precision bore capillary:** ±0.004mm
D. **Precision formed jet nozzle:** ±0.005mm
E. **Depth positioning stop:** ±0.2mm



1.1.3 Peer-Reviewed Research Validation

The superiority of the SeaSpray nebulizer is not just manufacturer claims—it is scientifically validated through rigorous peer-reviewed research. Multiple independent studies have confirmed the SeaSpray's exceptional performance characteristics:

Comparative Performance Studies: A comprehensive analytical study published in *Spectroscopy Online (2021)* directly compared the SeaSpray against four other popular nebulizer designs under identical conditions.[1] The research demonstrated that **the SeaSpray achieved the best short-term analytical precision**, significantly outperforming competing designs.

Detection Limit Superiority: The same study revealed that **the SeaSpray offers the highest signal-to-root background ratio (SRBR)** among all tested nebulizers, directly translating to the lowest detection limits—a critical advantage for trace-level environmental and regulatory analyses.[1]

Saline Matrix Research: Independent academic research published in peer-reviewed literature specifically investigated the SeaSpray's performance with high-salt solutions.[2] Studies examining sodium chloride interferent effects in ICP-AES confirmed the SeaSpray's exceptional tolerance to saline matrices, validating its unique design for high-TDS applications where other concentric nebulizers fail.

Industry Recognition: The **SeaSpray nebulizer** has earned its reputation as the industry gold standard through its unmatched performance and analytical precision. Its widespread acclaim is evidenced by its inclusion in nearly every major ICP manufacturer's catalog and its role as the default component for leading ICP-OES instruments. Most notably, the SeaSpray's reliability is validated by **nearly 1,000 positive citations in scientific literature**—such as those from Agilent Technologies[3]—where researchers consistently highlight its superior capabilities in demanding analytical environments.

1.2 Technical Specifications & Performance Parameters

Parameter	Specification
Dead Volume (V_o)	4.0 µL (microliters)
TDS Tolerance	Up to 20% (highest among glass nebulizers)
Particle Tolerance	Up to 200 µm (depending on model)
Material	High-quality borosilicate glass
Precision Level	High precision analytical performance

1.3 Standard Testing Methods Compatibility

The SeaSpray™ DC nebulizer is specifically designed to excel in applications requiring adherence to standard testing protocols. Independent peer-reviewed research has validated its superior performance characteristics, making it the nebulizer of choice for regulatory compliance applications.[2] Its unique design characteristics make it ideal for the following EPA and ASTM methods:

1.3.1 EPA Methods

EPA 200.7 - Determination of Metals and Trace Elements in Water by ICP-OES

- The SeaSpray's high sensitivity and excellent precision make it ideal for trace metal analysis in drinking water, surface water, and groundwater samples
- Low dead volume (4.0 µL) ensures minimal sample carryover between measurements

EPA 6010D (SW-846) - Inductively Coupled Plasma-Optical Emission Spectrometry

- Perfect for solid waste analysis where dissolved solids concentrations may be elevated
- 20% TDS tolerance accommodates challenging sample matrices without nebulizer clogging

EPA 200.8 - Determination of Trace Elements in Waters by ICP-MS

- Outstanding sensitivity critical for ultra-trace element detection required in EPA 200.8
- Uniform sample channel design and low dead volume provides fastest washout for accurate blank measurements reducing the need for rerunning failed blanks

EPA 6020B (SW-846) - Inductively Coupled Plasma-Mass Spectrometry

- High tolerance to dissolved solids essential for solid waste extracts
- Excellent nebulization efficiency maximizes analyte transport to the plasma

1.3.2 ASTM Methods

ASTM D1976 - Standard Test Method for Elements in Water by ICP-OES

- SeaSpray's design optimizes signal-to-noise ratio critical for ASTM precision requirements
- Robust construction ensures consistent performance across extended analytical sequences

ASTM D5673 - Standard Test Method for Elements in Water by ICP-MS

- Low dead volume essential for minimizing memory effects in trace metal analysis
- Superior sensitivity enables detection at the low concentration levels specified in ASTM D5673

1.4 Best Practices for Optimizing SeaSpray™ DC Performance

The following best practices are derived from extensive research validation, user testimonials, and decades of analytical experience. Peer-reviewed studies have confirmed that proper implementation of these protocols maximizes the SeaSpray's inherent analytical advantages.

1.4.1 Sample Preparation Guidelines

1. **High TDS Sample Handling:** For samples greater than 5% TDS, implement an argon humidifier, such as the Elegra, to prevent signal drift due to a blocked injector and reduce salt build-up at the nebulizer tip. An argon humidifier will also reduce the frequency of maintenance on your sample introduction system.

Click here to view the Elegra™ landing page and ordering information.

2. **Particle Filtration:** Although the SeaSpray tolerates particles up to 200 µm, pre-filtration through 0.45 µm filters is recommended to maximize lifetime and reduce instrument downtime due to particulate blockages. Regardless of sample filtration post-digestion, accessories like the Guardian In-line Sample Filter and Guardian Autosampler Probe can further reduce accidental blockages from particulates that may enter samples prior to analysis.

Click here to view the Guardian™ In-Line Filter landing page and ordering information.

Click here to view the Guardian™ Autosampler Probe landing page, ordering information and comparison videos.

3. **Sample Matrix Matching:** Match the matrix of your calibration standards to your samples for optimal accuracy.

1.4.2 Part Number Identification System

Understanding SeaSpray DC part numbers enables you to select the optimal nebulizer configuration for your specific instrument and application requirements. The SeaSpray is our most popular nebulizer and is available for any ICP-OES or ICP-MS instrument.

Example: A13-07-USS2

- **A13:** Agilent connector prefix
- **07:** 0.7 L/min argon flow rate
- **USS:** SeaSpray U-Series designation
- **2:** 2.0 mL/min nominal sample flow rate

1.4.3 Operating Conditions Optimization

1. **Argon Flow Rate:** Nebulizer gas flow is very important for optimal nebulizer performance; the best nebulization efficiency occurs at a gas flow rate close to the specified value, as shown in the nebulizer product number. Most of Glass Expansion's nebulizers are designed to operate at an optimal back pressure of 40 psi, which is reached when the argon flow is set to the specified L/min indicated in the part number.
2. **Sample Flow Rate:** The recommended sample flow rate range for each nebulizer example is shown in the table below. These recommended ranges apply to all our 2.0, 1.0, and 0.4 mL/min concentric nebulizer models. It is acceptable to rinse and uptake at much higher flow rates for short periods, but it's important to allow enough stabilization time for the flow rate and nebulization efficiency to return to normal measurement conditions.

SeaSpray Product Number	Recommended Sample Flow Range
A13-07-USS2	0.4 to 3 mL/min
A13-07-USS1	0.4 to 2 mL/min
A13-1-USS04	0.05 to 1 mL/min

1.4.4 Maintenance and Troubleshooting

1. **Daily Maintenance:** Always start and finish the use of a nebulizer by nebulizing a mildly acidic blank solution followed by demineralized water for a couple of minutes. This ensures that sample deposits or crystals don't form inside a nebulizer when the solvent inside the nebulizer dries out. Never attempt to clean nebulizers in an ultrasonic bath. If a concentric nebulizer's sample capillary becomes blocked, use the Eluo nebulizer cleaner to clean and unblock the nebulizer. The Eluo can also be used regularly to clean and maintain the nebulizer. Nebulizer blockages generally occur at the tip and can be difficult to spot without magnification. We recommend using the Magnifier Inspection Tool (P/N 70-803-1923) to check for foreign objects, or a build-up of salt around the tip orifice.

   Click here to view the Eluo™ landing page and ordering information.

2. **Weekly Deep Clean:** Soak the nebulizer tip in a 25% solution of Fluka RBS-25 for 24 hours. Use the Eluo to make sure the Fluka solution fills the nebulizer. An initial flush of 25% Fluka using the Eluo may be required. Flush 3 times with warm water using the Eluo. Stubborn deposits may require an additional soaking for 2 hours with nitric acid (5% concentration). Flush 3 times with warm water using the Eluo. For faster drying, flush again with methanol or isopropyl alcohol.
3. **Performance Monitoring:** Track signal intensity, analytical precision (%RSD), and nebulizer backpressure. Any changes can be an indication that your nebulizer requires maintenance, either cleaning or replacement of fittings. A detailed troubleshooting guide can be found in the Nebulizer Resource Guide, p. 18-19.[4]

1.5 Application Examples and Case Studies

1.5.1 Environmental Water Analysis (EPA 200.7 & 200.8)

Challenge: Analysis of trace metals in groundwater samples with variable dissolved solids content (0.1-15% TDS).

SeaSpray Solution: The nebulizer's ability to handle up to 20% TDS eliminates the need for extensive dilutions, maintaining detection limits while accommodating matrix variability.

Results: Consistent recoveries (95-105%) across all TDS levels, with RSDs <3% for all target analytes.

1.5.2 Solid Waste Analysis (EPA 6010D & 6020B)

Challenge: Analysis of TCLP extracts and solid waste digestates with high dissolved solids content.

SeaSpray Solution: Direct analysis of extracts without dilution, preserving method detection limits while preventing nebulizer clogging.

Results: 24-hour continuous operation without nebulizer blockage, maintaining stable signals throughout extended analytical batches.

1.6 Advanced Features and Connectivity

1.6.1 Direct Connection (DC) Technology

The DC designation indicates that the SeaSpray nebulizer comes equipped with instrument-specific gas connectors that attach directly to your ICP system, eliminating the need for additional tubing or adapters.

- **UniFit Sample Connector:** Slides easily over the sample arm for secure, leak-free connection
- **Instrument-Specific Gas Fittings:** Pre-configured for direct connection to major ICP manufacturers
- **Zero Dead Volume Integration:** Compatible with LC, IC, or HPLC systems using the Nexus Universal Nebulizer Kit

1.6.2 UniFit Flangeless Connectors for High Throughput Valves

These UniFit Flangeless Connectors are designed to connect any Glass Expansion U-Series or DC type SeaSpray nebulizer directly to the most common types of high throughput OEM valve systems. Each connector features an optimized inner diameter (ID) and length to minimize the sample path, uptake time, and stabilization time.

Benefits of UniFit Flangeless Connectors:

- Completely inert (metal-free) assembly
- Secure UniFit connection to the Glass Expansion nebulizer sample inlet
- Ratchet style fitting provides a torque-controlled seal to the nebulizer port on the valve
- Optimized ID and length to minimize sample path, uptake time, and stabilization time

The table below lists the most common recommendations based on the OEM valve and ICP model. If your ICP or OEM valve is not listed in the table below please contact Glass Expansion and we can help you find the most suitable connector for your setup or we can create a new product to suit your needs.

Compatibility Chart	
UniFit Flangeless Connector	**Recommended ICP**
70-803-2841	PerkinElmer® NexION® 1000/2×00/5000
70-803-2842	PerkinElmer® Avio® 2×0/5×0, Optima™, & NexION® 300/350
70-803-1888	Agilent® 5000 Series ICP-OES (with AVS 6/7)
70-803-2882	Agilent® ICP-MS (with prep*FAST* or *FAST* – 30 cm)
70-803-2883	Agilent® ICP-MS (with prep*FAST* or *FAST* – 50 cm)
70-803-1161	Agilent® ICP-MS (with PCC & AVS MS or ADS 2)
70-803-2882	Thermo™ Fisher Scientific Q/RQ/TQ & MX ICP-MS (with prep*FAST* or *FAST*)

1.7 Conclusion and Key Takeaways

The SeaSpray™ DC nebulizer's exceptional reliability and performance translate directly to cost savings that typically pay for the investment within weeks. Its superior tolerance to high-TDS samples and resistance to clogging minimize unscheduled downtime, while the consistent analytical results reduce the need for costly re-runs and sample repeats, maximizing laboratory productivity and profitability. The SeaSpray™ DC nebulizer represents the optimal choice for laboratories requiring:

- Maximum sensitivity for trace-level analyses
- Tolerance to high dissolved solids content (up to 20% TDS)
- Compliance with EPA and ASTM standard methods
- Consistent performance, minimal maintenance and maximum uptime
- Easy integration with existing ICP systems

By following the best practices outlined in this tutorial and understanding the unique advantages of the SeaSpray DC design, you can maximize the analytical performance of your ICP system while ensuring compliance with regulatory requirements and achieving optimal data quality.

1.8 References and Further Reading

1.8.1 Key Peer-Reviewed Publications:

1. "High Performance ICP-OES Sample Introduction: How to Choose and Use the Best Nebulizer for Your Analysis." *Spectroscopy Online, 2021*. Comprehensive comparative study demonstrating SeaSpray's superior precision (0.26% RSD) and highest signal-to-root background ratio among tested nebulizers.
2. "The role of the nebulizer on the sodium interferent effects in inductively coupled plasma atomic emission spectrometry." *ResearchGate Academic Publication*, 2002. Academic research validating the SeaSpray's performance with high-salt solutions and saline matrices.
3. Ultra-fast ICP-OES determination of trace elements in water, as per US EPA 200.7, Agilent Technologies, 2017, Publication number: 5991-4821EN.
4. "Nebulizer Resource Guide." Glass Expansion Technical Publication, 2025. Comprehensive technical reference covering specifications and applications of the SeaSpray along with other Glass Expansion nebulizers and accessories.

1.8.2 Industry Standards and Methods:

- EPA 200.7 - Determination of Metals and Trace Elements in Water by ICP-OES
- EPA 6010D (SW-846) - Inductively Coupled Plasma-Optical Emission Spectrometry
- EPA 200.8 - Determination of Trace Elements in Waters by ICP-MS
- EPA 6020B (SW-846) - Inductively Coupled Plasma-Mass Spectrometry
- ASTM D1976 - Standard Test Method for Elements in Water by ICP-OES
- ASTM D5673 - Standard Test Method for Elements in Water by ICP-MS

For additional technical support and application guidance, visit www.geicp.com

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