HAMILTON

BiOS®

Automated Sample Storage System

About Hamilton BiOS

A Solution for Biological Sample Management

Hamilton BiOS is an automated storage system specifically designed to store sensitive biological samples at -80°C. BiOS keeps samples close to -80°C throughout their entire life inside the system—while introducing and sorting samples, managing the inventory, processing and delivering orders, and controlling sample access rights. In addition, BiOS records a full audit trail and temperature log for all samples managed in the system.

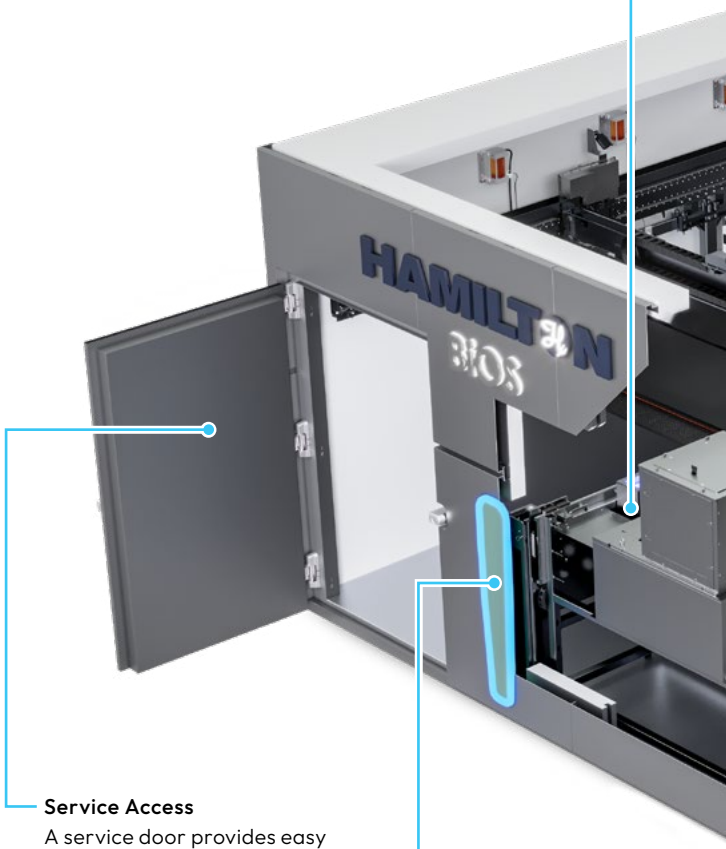
Its modular and scalable design allows storage of 100,000 to over 20 million samples in a wide variety of different types of labware. It seamlessly interfaces with your IT infrastructure and laboratory information management system (LIMS) by providing the BiOS Application Programming Interface (API) and remote monitoring options.

BiOS is Designed to Provide:

- **Sample Integrity:**
  Guarantees sample integrity throughout the lifetime of the samples
- **Flexibility:**
  Easily integrates into your applications
- **Reliability:**
  Keeps operations at peak performance

BiOS XL
For very large biological sample collections, the BiOS XL is designed with a moving sample processing gantry to increase process efficiency, and minimize sample transit between storage and processing.

ID and Frost Removal Stations
The ID station utilizes a camera and mirror system to simultaneously image 2D barcodes on the bottoms of tubes and racks, as well as 1D and 2D barcodes on the sides of racks. In the event of an error in scanning a barcode, the Frost Removal Station may be utilized to remove frost with brushing before re-imaging barcodes.

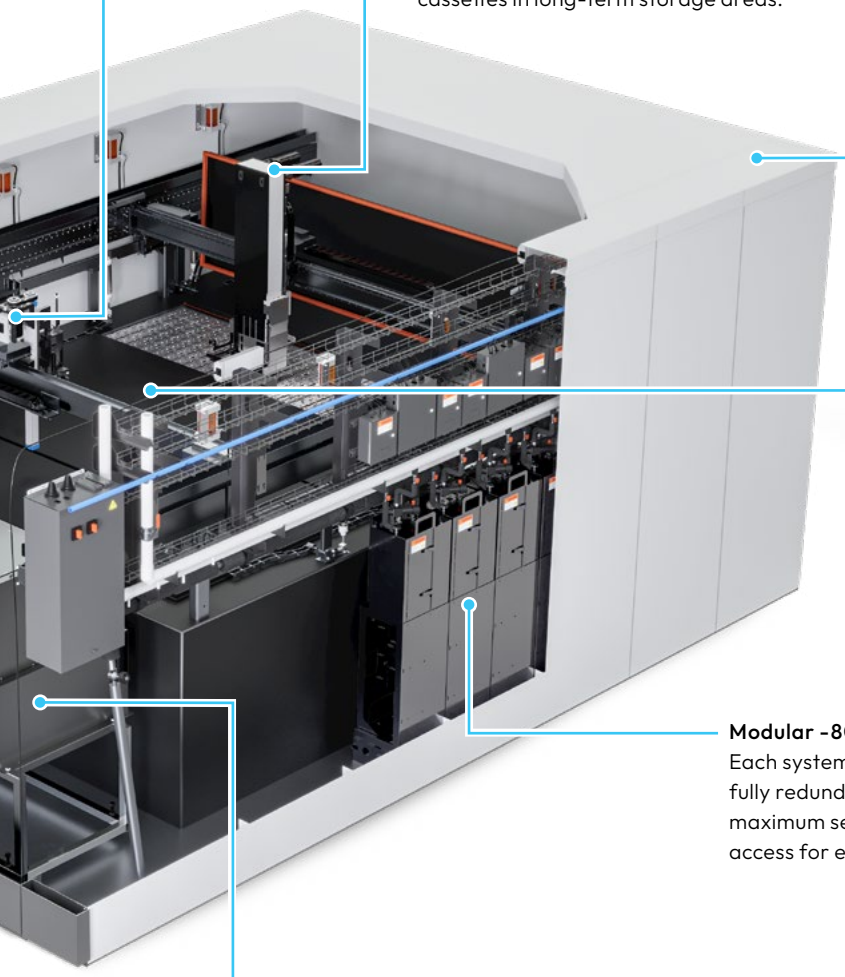


Service Access
A service door provides easy access into the system for maintenance and repairs.

User Access
Introduce and retrieve samples simply using the multifunctional Input/Output (I/O) module. This frees up time to work on more important tasks, such as your research.

Rack Robot
The Rack Robot transports sample racks and plates between the Cassette Puller, the -80°C Tube Picker, and the ID and Frost Removal Stations.

Cassette Puller
The Cassette Puller transports cassette shelving units to/from the I/O module for loading and unloading samples. The Cassette Puller also places/ejects labware from cassettes in long-term storage areas.



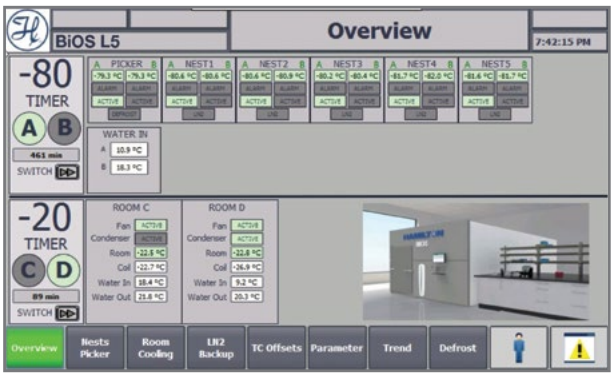
Insulated Cold Room Enclosure
Environmentally-controlled enclosure provides optimal conditions for storing and processing samples at -80°C.

Storage Compartments
Samples are safely stored in high-capacity -80°C lid-covered chest freezers.

Modular -80°C Refrigeration Systems
Each system has multiple independent and fully redundant refrigeration systems for maximum security, and external service access for ease of maintenance.

-80°C Tube Picker Automation
Samples are picked and placed in Hamilton's unique -80°C tube picker to minimize sample warming events during processing and defragmentation.

Intelligent Control
BiOS M/L Refrigeration HMI monitor and control screen.



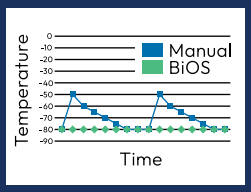
Sample Integrity

Maintain the Value of Samples

Temperature stability is key to maintaining the value of samples. By taking special measures to prevent any significant temperature rises, temperature fluctuations are limited and potential sample degradation is prevented.
A few of our unique design aspects to ensure maximum temperature stability in the system are:

- -80°C tube picking to maintain constant sample temperature
- -80°C chest freezers for maximum temperature uniformity
- Two independent layers of insulation between -80°C and -20°C for maximum sample safety
- Picked samples ready for retrieval are cached at -80°C to maintain temperature until recalled

-80°C Chest Freezers
Lid-covered -80°C chest freezers for maximum temperature uniformity.



Temperature Stability
Storage temperature remains stable in BiOS (green) to prevent sample degradation, unlike a manual freezer (blue) which can have dramatic temperature increases during access, followed by extended recovery times.

Eliminate the Unknowns

Knowledge about your samples and what happened to them during storage is one of the keys to conducting validated top-level research. BiOS eliminates many of the unknowns by tracking the temperature of each sample at all times, recording each move within the system, and verifying the entire chain of custody, providing you with a temperature profile for each sample moving throughout the system.

Always Keep Your Samples Cold

BiOS has multiple levels of redundancy to ensure samples will remain at -80°C during all scenarios.

Flexibility

Use the Labware of Your Choice

A mixture of labware, including a wide variety of microtubes, cryovials, and blood tubes can be stored and sorted in the same tube picking module. This allows different labware formats from multiple sources to be easily stored and sorted in one system.

Mixture of Labware
A wide variety of labware can be stored in the same system.

Scale the System

The capacity of BiOS can be scaled to fit your specific storage needs, whether it is 100,000 or greater than 20 million samples.

- BiOS M is designed for existing labs with limited accessibility that need a compact storage system.
- BiOS L is designed in a compact footprint for labs that have large storage needs.
- BiOS XL is designed for the largest studies to store millions of samples in dedicated facilities.

Grow the System with Your Needs

BiOS can provide a cost-effective expansion in the field to satisfy your growing needs after the initial installation. Capacity can be increased by adding storage compartments and extending the system enclosure. There is no need to multiply the internal robotics. Furthermore, this expansion can be made without removing the existing samples, keeping them safe at -80°C.

Reliability

Maximize Productivity

System reliability is key to driving productivity. Hamilton realizes this by keeping all automation in the -20°C environment to increase reliability and minimize downtime.

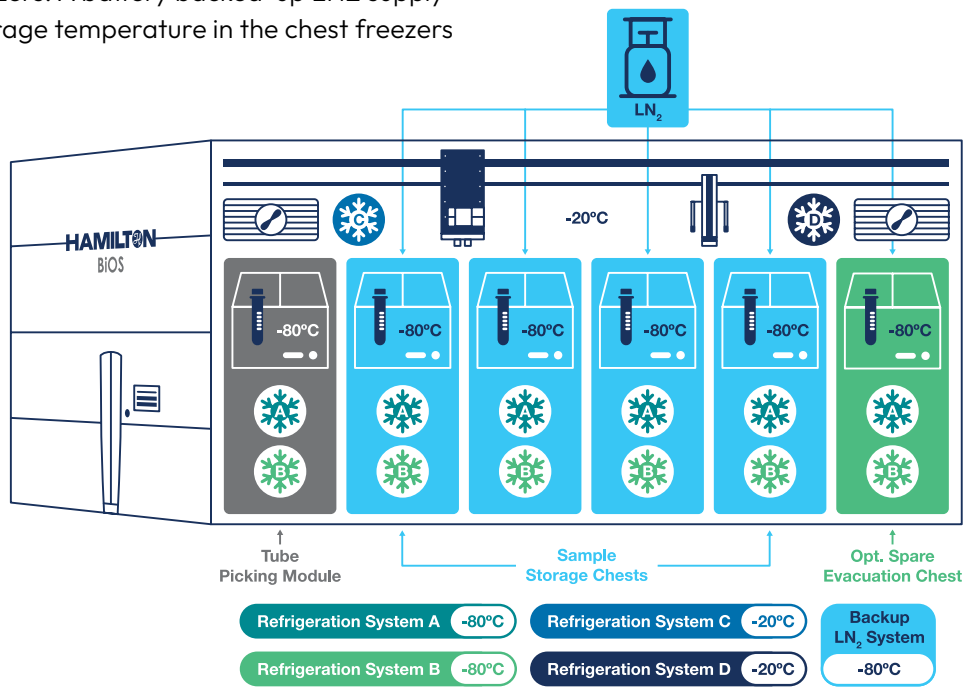
Enhanced Serviceability

Redundant refrigeration system components are housed separately from the sample storage compartments. This allows for set temperatures to be maintained even during refrigeration service. The BiOS -80°C refrigeration modules are designed to be easily swapped from local spare units to minimize downtime. Many components, such as redundant temperature sensors and the local controller boxes, can be replaced in as little as 30 minutes.

Solving the “what ifs”

Part of building a reliable automated storage system means considering the “what ifs” and designing those scenarios into the system.
Some of these include:

- Frost prevention—BiOS has extensive frost prevention technologies. However, Hamilton acknowledges that frost may still build up over time in any ultra-low temperature system. An optional spare freezer chest makes sample evacuation and chest freezer defrost possible without ever having to remove samples from the BiOS system.
- Power outage measures—In the event of a power loss, samples are safely returned to the -80°C chest freezers. A battery backed-up LN2 supply system will maintain a -80°C storage temperature in the chest freezers for 48 hours.



Advantages of Working with BiOS

One of the benefits of BiOS is that it relieves your staff from time consuming and labor intensive work, such as tube sorting and defragmentation of the sample collection. From introducing your samples to retrieving them, BiOS is easy to use and offers many advantages:

Loading your samples

- Effortlessly load individual tube racks or plates, or large quantities in bulk
- Unique sample integrity mode to load samples arriving on dry ice
- Allows for continuous introduction

Ordering your samples

- Integrate your IT infrastructure to order directly from your LIMS system
- Receive an email notification when the order is ready for pickup
- Prioritize and schedule your orders with a job queue manager

Tracking your samples

- Track each individual sample to maintain a complete audit trail of all the samples, including their temperature and location at all times

Monitoring your samples

- Monitor BiOS operations and storage temperature from the user interface or remotely from your desktop

Securing your samples

- Assign user access rights to provide sample access only to approved users

Processing your samples

- BiOS can process orders at all times—day or night—to maximize productivity
- Orders can be placed in advance and held until retrieval is needed

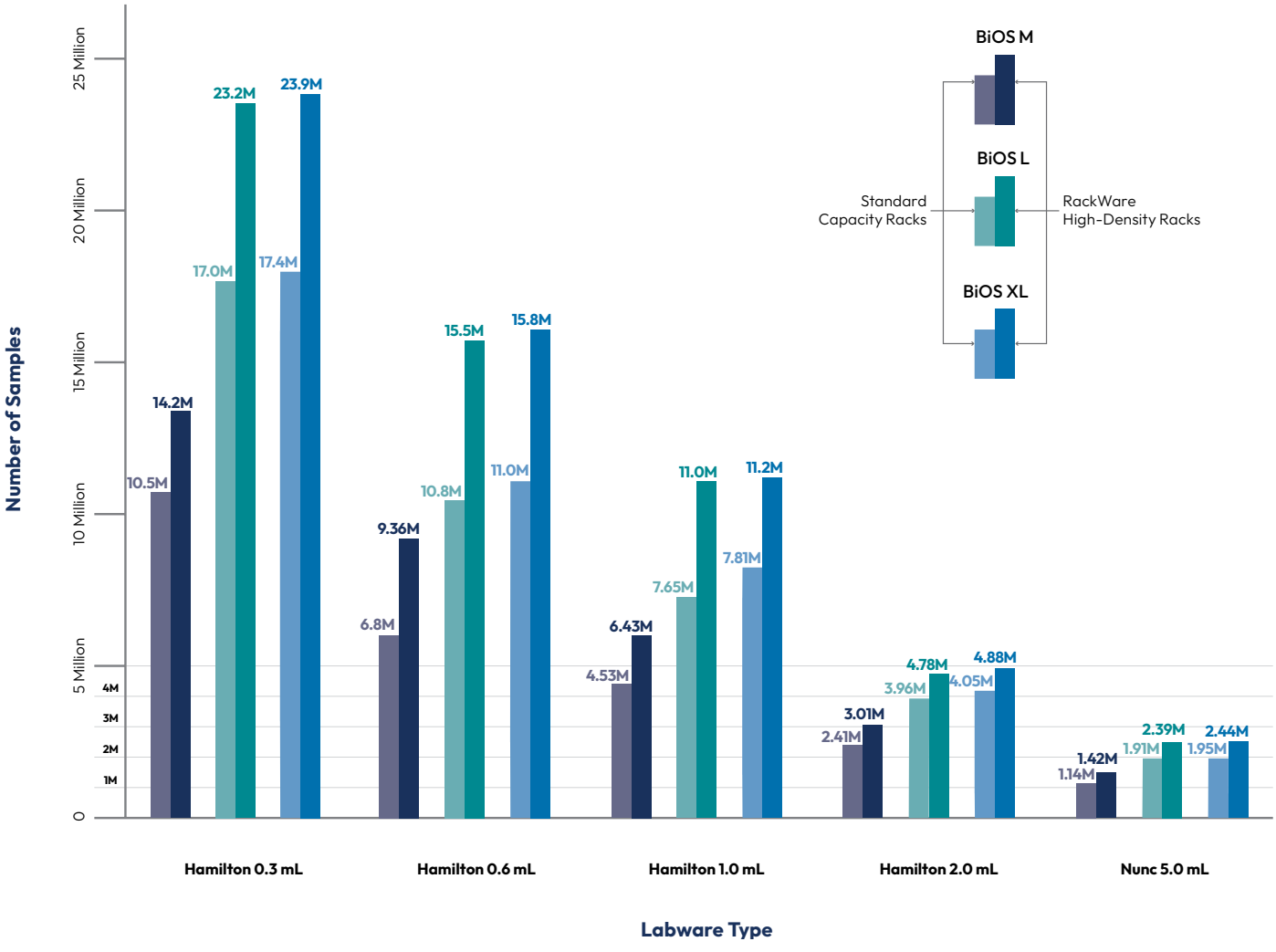
Supported Labware

BiOS supports a wide range of labware in SBS-format standard racks or plates up to a height of 110 mm. Manufacturers of supported labware include Hamilton, Matrix™, Micronic, LVL, Greiner, Nunc™, FluidX, Sarstedt, Eppendorf, and Corning.*

*This is not a complete list. Please contact Hamilton for verification of any specific or additional type of labware.

Labware Capacities

The capacity ranges for selected tube types are listed in the chart below. Actual capacities will vary based on the specific manufacturer, tube size, and number of storage freezers in the system. Hamilton Storage offers RackWare® high-density racks to increase the number of tubes that can be placed in a rack. The HDR-30 supports popular 24-format labware and increases storage capacity from 24 to 30 tubes. The HDR-60 supports popular 48-format labware and increases storage capacity from 48 to 60 tubes. The HDR-138 supports most major 96-format labware and increases storage capacity from 96 to 138 tubes. Both standard rack and high-density rack capacities are provided in the chart below.



Configurations

BiOS is offered in three configurations: BiOS M, BiOS L, and BiOS XL. Example configurations are shown below. The height and width of each system is fixed, but the length varies as it is scaled to fit the customer's capacity requirements.

BiOS M BiOS L BiOS XL

Dimensions			
	BiOS M	**BiOS L**	**BiOS XL**
Height	2.93 m (9 ft, 7 in)	4.23 m (13 ft, 11 in)	4.88 m (16 ft)
Width	4.34 m (14 ft, 3 in)	4.34 m (14 ft, 3 in)	5.03 m (16 ft, 6 in)
Length	3.9 m (12 ft, 10 in)— 22.5 m (73 ft, 10 in)	3.9 m (12 ft, 10 in)— 22.5 m (73 ft, 10 in)	7.1 m (23 ft, 4 in)— 22.5 m (73 ft, 10 in)

* Please contact Hamilton for required installation space including service access clearances.

Example Capacities						
	BiOS M		**BiOS L**		**BiOS XL**	
	Standard Racks	RackWare HD Racks	Standard Racks	RackWare HD Racks	Standard Racks	RackWare HD Racks
Hamilton 0.3 mL	906K - 10.5M	1.33M - 14.2M	1.47M - 17.0M	2.16M - 23.2M	3.26M - 17.4M	4.46M - 23.9M
Micronic 0.5 mL	661K - 7.65M	1.02M - 11.0M	1.16M - 12.5M	1.67M -17.9M	2.40M - 12.7M	3.44M - 18.3M
Hamilton 0.6 mL	634K - 6.80M	873K - 9.36M	1.00M - 10.8M	1.44M - 15.5M	2.07M - 11.0M	2.97M - 15.8M
Hamilton 1.0 mL	392K - 4.53M	563K -6.43M	661K - 7.65M	1.02M - 11.0M	1.47M - 7.81M	2.19M - 11.2M
Hamilton 2.0 mL	208K - 2.41M	260K - 3.01M	343K - 3.96M	413K - 4.78M	762K - 4.05M	919K - 4.88M
Nunc 5.0 mL	104K - 1.14M	122K - 1.42M	166K - 1.91M	207K - 2.39M	367K - 1.95M	459K - 2.44M

* Please contact Hamilton for exact capacities.

Real-World Example

Space and Energy Savings

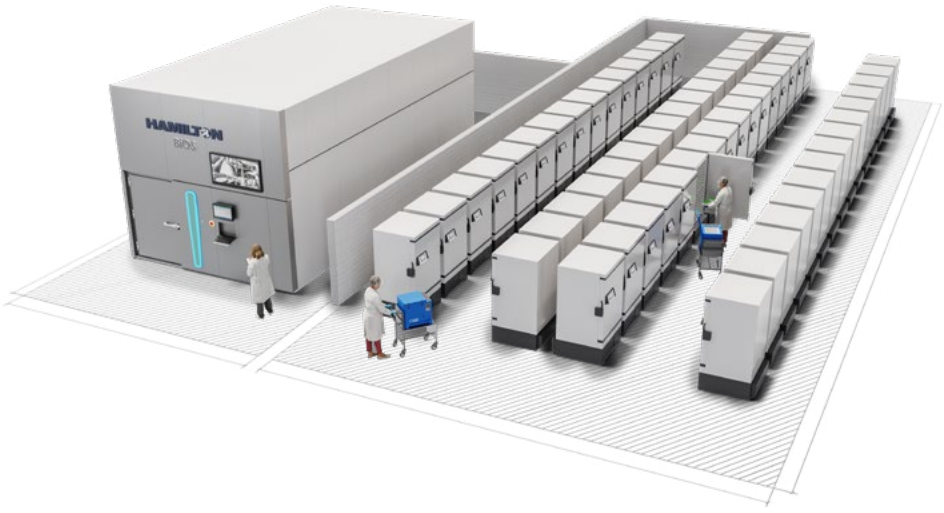
Below is one example of a midsized BiOS system compared to a manual freezer farm. With BiOS, power consumption per sample decreases and valuable lab space is optimized.

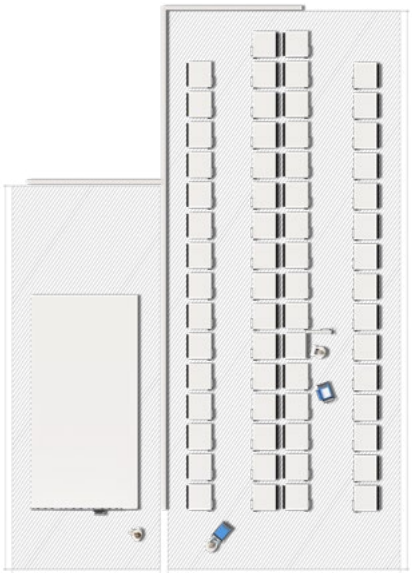
BiOS L5 System vs. Manual Freezer Farm		
	BiOS L5	**Manual ULTs (assumes 75% fill density)**
Storage Capacity	2.6 million 1 mL samples	62 upright 740 L capacity manual freezers
Footprint	BiOS L5 occupies 42 m^2 [452 ft^2]	62 manual freezers occupy 188 m^2 [2,022 ft^2]
Power Consumption	225 kW/day	806-1,302 kW/day, depending on model, maintenance history, and age
Annual Equivalent CO_2 Emissions*	35.6 metric tons	75.5-187 metric tons
Servicing and Maintenance	Redundant refrigeration systems ensure samples do not need to be evacuated during service. Design features in BiOS prevent frost accumulation and the system does not require regular defrost of storage chests.	Evacuation to additional backup freezers is required during emergency and for annual defrosting and other maintenance tasks.
Heat Load Impact to HVAC Systems	None; BiOS refrigeration systems utilize chilled water.	663 W [104,000 BTUs]/hr

*EPA (2021). eGRID. U.S. annual national emission factor, year 2019 data. U.S. Environmental Protection Agency, Washington, D.C. (https://www.epa.gov/egrid)

2.6 million x 1 mL Samples Comparison

- BiOS L5: 42 m^2 [452 ft^2]
- 62 Manual Freezers: 188 m^2 [2,022 ft^2]





Bird's-eye view

About Hamilton

Innovation for a Better World

Hamilton Company specializes in the development, manufacturing, and customization of precision measurement devices, automated liquid handling workstations, and sample management systems.

Hamilton's processes are optimized for quality and flexibility. Whether it's a custom needle with a quick delivery timeframe, a special length pH sensor, or a comprehensive solution to fully automate your assay workflow, trust that Hamilton's products will always meet your needs.

Lab Products

Hamilton Laboratory Products manufactures Microliter™ and Gastight® syringes that set the standard for analytical fluid measurement. Other products include custom needles, semi-automated diluters and dispensers, polymeric HPLC columns, pH electrodes, pipettes, and more.

Robotics

Hamilton Robotics provides automated liquid handling workstations and laboratory automation technology for the scientific community. With a focus on innovative design, our products incorporate Hamilton's patented liquid handling technologies for fully automated solutions. In addition to liquid handling platforms, we also offer application-specific solutions, small devices, and consumables.

Storage

Hamilton Storage offers ultra-low temperature automated sample management systems for storage of a variety of labware. Hamilton's line of biobanking and compound management systems, benchtop devices, and consumables are designed for sample integrity, flexibility, and reliability.

Process Analytics

Hamilton Process Analytics includes innovative solutions for the online measurement of pH, dissolved oxygen, conductivity, ORP, viable cell density, and total cell density. Hamilton's proprietary Arc® intelligent sensor technology eliminates the need for transmitters and moves the functionality to your smartphone or tablet.

OEM Solutions

Many of the world's top manufacturers utilize Hamilton products and expertise to get their innovations to market faster with lower development and manufacturing costs. As an OEM partner, we offer the ability to integrate our proven syringe pumps or pipetting channels, customize our proven liquid handling platforms, or design a complete system to automate your novel chemistry.

Hamilton Company has been a leading global manufacturer for more than 75 years, with headquarters in Reno, Nevada; Franklin, Massachusetts; Timișoara, Romania; and Bonaduz, Switzerland; and subsidiary offices throughout the world.

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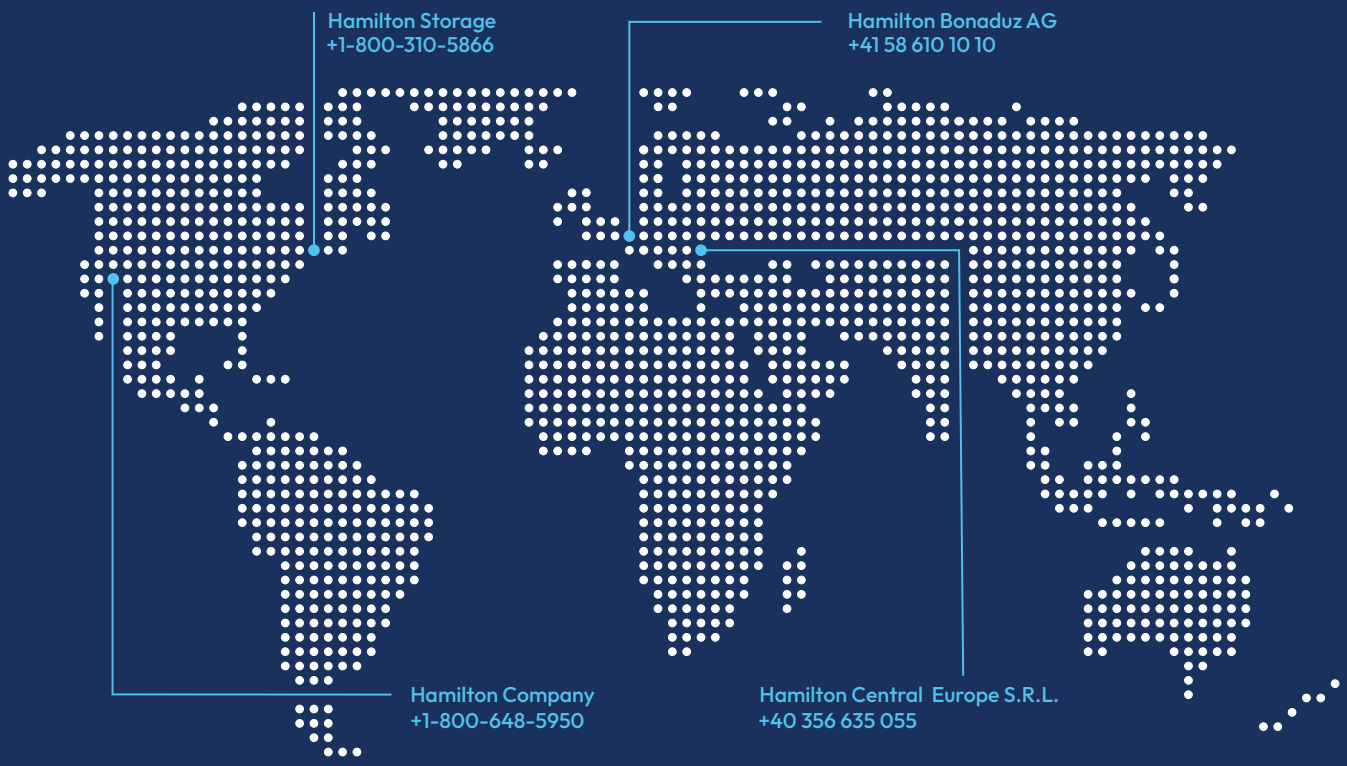

Years of Experience
75+

Locations Worldwide
22+

Employees Internationally
3,000+

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