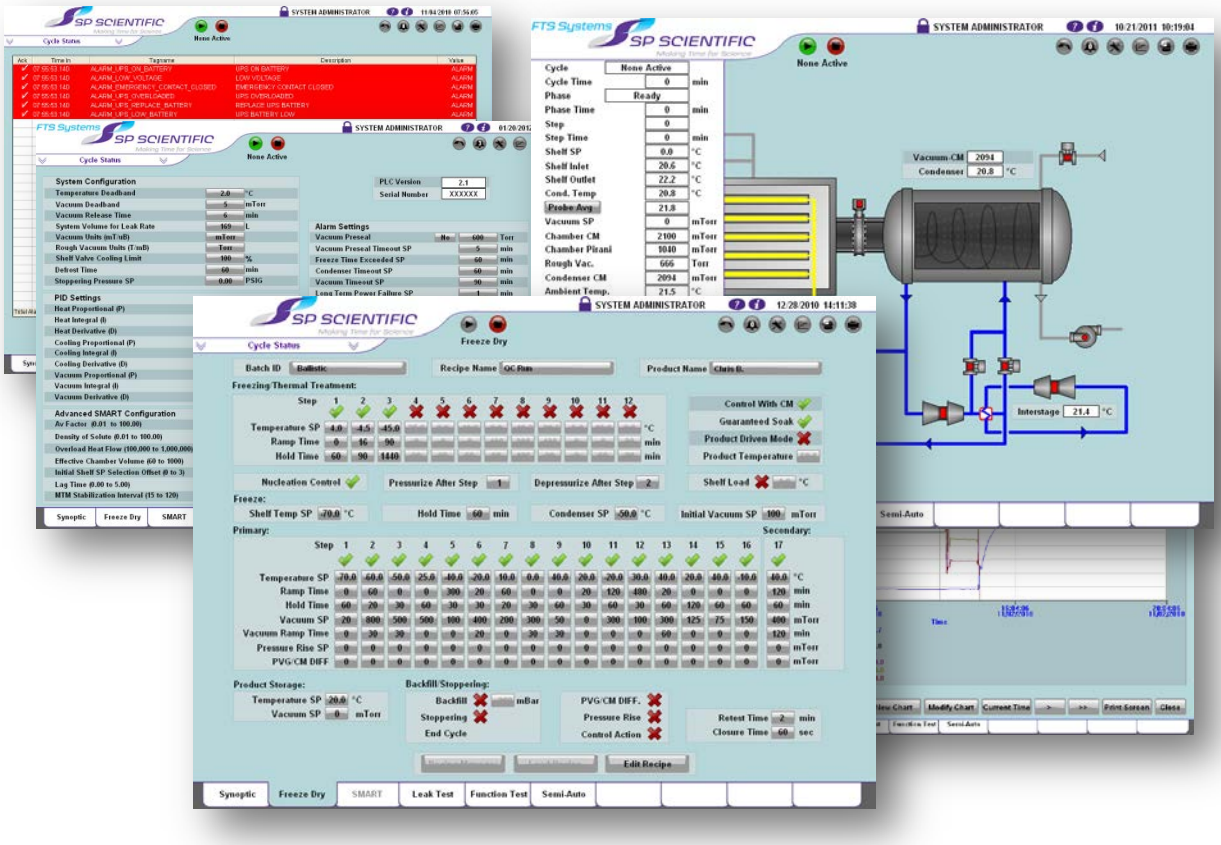
CONTROL SYSTEM OPERATOR'S MANUAL



LYOS™

BUILT WITH GE PROFICY® HMI/SCADA IFIX

FTS Systems Genevac Hull National-Hotpack VirTis

Part Number 100004447

Rev 012, 07/15

Original Instructions

The U.S. English version of this document is the original instructions.
All other languages are a translation of the original instructions.

SP Scientific	3538 Main Street Stone Ridge, NY 12484 USA	935 Mearns Road Warminster, PA 18974 USA	815 State Route 208 Gardiner, NY 12525 USA
	(800) 251-1531 (845) 687-0071	(800) 523-2327 (215) 672-7800	(800) 431-8232 (845) 255-5000

SP Service **(877) 548-4666**
SP Service Fax **(845) 687-0024**

Website http://www.spscientific.com/

Important Symbols

WARNING! INJURY OR EVEN DEATH MAY RESULT IF A RECOMMENDATION MARKED WITH THIS SYMBOL IS NOT HEEDED.

CRUSH HAZARD. KEEP HANDS CLEAR WHEN OPERATING DOOR.

ELECTRIC SHOCK DANGER! USE APPROPRIATE CAUTION TO AVOID INJURY OR DEATH.

CORROSIVE CHEMICAL. WEAR SUITABLE GLOVES, SAFETY GLASSES, AND PROTECTIVE CLOTHING.

BURN DANGER! POTENTIALLY HOT SURFACE. USE APPROPRIATE CAUTION.

PROPERTY CAUTION! TO PREVENT DAMAGE TO CHAMBER EQUIP-MENT AND/OR LOAD, ADHERE TO PROCEDURES MARKED BY THIS SYMBOL.

DO NOT STORE FLAMMABLE MATERIALS IN CHAMBER.

PRACTICAL OPERATING TIP. THESE RECOMMENDATIONS STREAMLINE UNIT OPERATION AND PREVENT COMMON OPERATOR ERRORS.

ALWAYS WEAR CERTIFIED PERSONAL PROTECTIVE EQUIPMENT (PPE) SUITED FOR THE TASK YOU ARE PERFORMING.

EXPLOSIVE MATERIALS HAZARD! KEEP OBJECTS AWAY FROM HEAT.

Safety Warnings

- ✓ *Always transport the unit with care.*
- ✓ *Always observe all warning labels.*
- ✓ *Never remove warning labels.*
- ✓ *Always turn off the unit and disconnect the line cord from the available power source prior to performing any service or maintenance procedures.*
- ✓ *Always turn off the unit and disconnect the line cord from the available power source prior to moving the unit.*
- ✓ *Never operate equipment with damaged line cords.*

Software License Information

LyoS™ is a trademark of SP Scientific. LyoS™ is owned exclusively by SP Scientific (Licensor). Details of the specific software options purchased are identified on the Customer's invoice.

GENERAL

This software license agreement (the "Agreement") is an agreement between you (on behalf of yourself or as an authorized representative on behalf of an entity) as the "Licensee" and SP Scientific ("Licensor") for the use of the LyoS™ Control System software ("Software") installed and/or included with related freeze drying equipment ("Equipment") purchased from the Licensor. By using the Software or the related Equipment in any capacity, the Licensee agrees to all the terms of this Software License Agreement ("Agreement") with the Licensor regarding the use of the Software. If the Licensee does not agree with all of these terms, the Licensee shall not install, copy or otherwise use the software. All title and intellectual rights in and to the Software are owned by the Licensor and all rights not expressly granted under this Agreement are hereby reserved.

If any provision of this Agreement is prohibited by law or held to be invalid, illegal, or unenforceable, the remaining provisions shall not be affected, and this Agreement shall continue in full force and effect as if such prohibited, illegal or invalid provision had never constituted a part hereof, with this Agreement being enforced to the fullest extent possible. The failure by any party to exercise any right provided for herein shall not be deemed a waiver of any right hereunder. This Agreement sets forth the entire understanding of the parties as to the Software and may not be modified except in writing executed by both parties.

GRANT TO SOFTWARE

Subject to the terms of this Agreement and full payment of the purchase price for the Software and/or Equipment, the Licensor hereby grants the Licensee a limited, non-exclusive, non-sublicensable, non-transferable and perpetual license to use the Software for its intended purpose. For purposes of this Agreement, the Software is intended to be used only in conjunction with the Equipment.

PERMITTED USE

The Licensee may use one (1) copy of the Software only with the intended Equipment and shall not transfer or attempt to transfer the Software to any other equipment or machine, directly or indirectly.

RESTRICTIONS

Except as explicitly set forth in this Agreement, the Licensee shall not, and shall not permit any third party to: (a) permit other persons or entities to use the Software; (b) reproduce the Software (except for one back-up or archival copy, in which event Licensee shall also reproduce the proprietary notices as they appear on the original version); (c) modify, translate, adapt or create derivative works from the Software; (d) reverse engineer, decompile, disassemble (except to the extent applicable laws specifically prohibit such restriction) or attempt to extract source code from the Software; (e) lend, lease, distribute or otherwise transfer the Software; or (f) remove or alter any proprietary notices or labels on the Software.

TRANSFER

The Licensee may not rent, lease, lend, redistribute or sublicense the Software. The Licensee may, however, make a one-time permanent transfer of all of your license rights to the Software (in its original form as provided by the Licensor) to another party, provided that: (a) the transfer must include all of the Licensor's Software, including all of its component parts, original media, printed materials and this Agreement; (b) the Licensee does not retain any copies of the Software, full or partial, including copies stored on a computer or other storage device; and (c) the party receiving the Software reads and agrees to accept the terms and conditions of this Agreement.

TERM/TERMINATION

This Agreement shall commence on the Effective Date and continue until otherwise terminated. Your rights under this Agreement will terminate automatically without notice from the Licensor if the Licensee fails to comply with any term(s) of this Agreement. Upon the termination of this Agreement, the Licensee shall cease all use of the Software and destroy all copies, full or partial, of the Software.

ACCEPTANCE

The Software shall be deemed accepted upon Licensee's initial startup and use of the same.

SOURCE CODE

This Agreement does not, under any circumstances, grant the Licensee the right to review, obtain or access to the Software source code. Licensee may only access or review the source code with the prior written consent of the Licensor.

COPYRIGHT/PROPRIETARY RIGHTS

The Software is copyrighted and protected by the United States and international copyright laws. Except for the limited license granted to the Licensee, the Licensor reserves all rights, titles and interest to the Software, as well as all associated icons, graphics and trademarks. Title to and ownership of the Software and all related intellectual property shall remain the exclusive property of Licensor. Licensee shall not take any action to jeopardize, limit or interfere with Licensor's ownership of and rights with respect to the Software. Licensee acknowledges that any unauthorized copying or use of the Software or any related intellectual property right is a breach of this Agreement.

LIMITED WARRANTY

The Software is provided "as is" and, except for expressly provided herein, there are no expressed or implied warranties with respect to the Software. Licensor does not warrant that the function of the Software will be uninterrupted or error free. Licensor warrants that the Software shall be free from programming errors and from defects in workmanship and materials under normal use for the same warranty period that is applicable for the related Equipment (the "Warranty Period"). This warranty is limited to the Licensee and is not transferable. If at any time during the Warranty Period the Licensee shall discover a defect or error in the Software that fails to conform to the provisions of this Agreement, the Licensor shall correct such defect, error or non-conformity. This limited warranty is the Licensee's exclusive remedy. The foregoing limitations and exclusions are an essential part of this Agreement and have formed the basis for determining the price charged for the Software and/or related Equipment. THE LICENSOR DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO, IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, FOR THE SOFTWARE. This limited warranty grants the Licensee specific rights. In addition to these rights, the Licensee may have others, which vary depending on jurisdiction.

CONFIDENTIALITY

In connection with the performance of this Agreement, both parties recognize that they may be a recipient ("Recipient") of information that the other party regards as sensitive, proprietary or otherwise confidential ("Confidential Information"). For example, the Software and Equipment pricing and the Software source code are Confidential Information. The Recipient shall not disclose Confidential Information to any third party without the prior written consent of the other party. Furthermore, the Recipient shall limit its use of Confidential Information to the performance of this Agreement and shall use at least the same degree of care in protecting the Confidential Information as it employs with respect to its own comparable confidential information. If the Recipient is uncertain whether any information is deemed Confidential Information for purposes of this Agreement, Recipient shall treat such information as Confidential unless and until the Recipient secures written confirmation from the other party that such information is not Confidential. The Licensee shall not disclose the existence of this Agreement to third parties without the prior written consent of Licensor.

INDEMNITY/ LIABILITY LIMITATION

The Licensee hereby agrees to indemnify and hold harmless the Licensor from any form of action, lawsuit or claim arising out of or related to the negligent or improper use of the Equipment or Software by its employees, agents or representatives. IN NO EVENT SHALL THE LICENSOR BE LIABLE FOR ANY INDIRECT DAMAGES WHATSOEVER (INCLUDING WITHOUT LIMITATION, CONSEQUENTIAL DAMAGES, DAMAGES FOR LOSS OF BUSINESS PROFITS, BUSINESS INTERRUPTION, LOSS OF BUSINESS INFORMATION, OR OTHER PECUNIARY LOSS) ARISING OUT OF THE USE OR INABILITY TO USE THE EQUIPMENT OR SOFTWARE, EVEN IF ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. Because some jurisdictions do not allow an exclusion or limitation of liability for consequential damages, the above limitation may not apply.

Warranty Information

The LyoS™ is warranted by SP Scientific to be free of defects in material and workmanship when operated under normal conditions as specified in the instructions provided in this manual.

Limited Warranty

SP Scientific (the “Company”) warrants each of its products against any defects in material or workmanship, provided that the product is used in a reasonable manner under appropriate conditions and consistent with the applicable operating instructions, for a period of 12 months from the date of installation or 15 months from the date of shipment (whichever comes first).

The obligation of the Company shall be, at its option, to repair or replace, without charge any parts that prove to be defective within the warranty period, if the purchaser notifies the Company promptly in writing of such defect. The Company shall not be responsible for labor charges payable with respect to persons other than Company employees. Replacement or repair of parts pursuant to this warranty shall not in any way extend the original warranty period. The Company will not be responsible for any unauthorized repairs, replacements or product modifications, nor will it be responsible for any product failures resulting from such unauthorized repairs, replacements or product modifications negligently or otherwise made by persons other than Company employees or authorized representatives of the Company.

THE COMPANY DOES NOT MAKE AND EXPRESSLY DISCLAIMS ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR ANY OTHER WARRANTY, EXPRESSED OR IMPLIED, WITH RESPECT TO THE SALE, INSTALLATION, DESIGN OR USE OF ITS PRODUCTS. ADDITIONALLY, THE COMPANY SHALL NOT BE LIABLE FOR ANY CONSEQUENTIAL DAMAGES RESULTING FROM THE USE OF OR ANY DEFECTS IN ITS PRODUCTS.

The Company’s employees are available to provide general advice to customers concerning the use of the Company’s products; however, oral representations are not warranties with respect to particular products or their uses and may not be relied upon if they are inconsistent with the relevant product specifications for the items set forth herein.

Notwithstanding the above, the terms and conditions set forth in the Company’s formal sales contracts shall be controlling and supersede any inconsistent terms contained herein, and any changes to such contracts must be made in writing and signed by an authorized executive of the Company.

Contents

FTS Systems SP SCIENTIFIC Making Time for Science

Chapter 1

Introduction

SP SCIENTIFIC HIGHLY RECOMMENDS THAT YOU READ THIS MANUAL IN ITS ENTIRETY, ALONG WITH THE OPERATOR'S MANUAL FOR YOUR LYOPHILIZER, BEFORE OPERATING YOUR EQUIPMENT FOR THE FIRST TIME.

The LyoS™ Control System

SP Scientific's LyoS™ \'lī-ˌōs\ control system was developed to meet the lyophilization requirements of today's pharmaceutical and biotechnology applications.

Building on the proven experience of SP Scientific's engineering team, and contributions from renowned industry experts, the LyoS™ control system packs the highest level of process-control and flexibility into a software package that is as easy to use as it is multi-functional.

Installed on a Windows®-based platform, LyoS™ leverages the GE Proficy® HMI/SCADA iFIX solution to deliver superior functionality, as well as faster, more intelligent control of the freeze-drying process and related functions. The GE Proficy® operator interface is designed for ease of use as a Human-Machine Interface (HMI), while the iFIX SCADA engine is ideally suited for process-driven applications that require reliable performance and known response times.

The HMI/SCADA provides visualization, data acquisition and supervisory capabilities directly to an Allen-Bradley CompactLogix™ programmable logic controller (PLC). The PLC runs a ladder-logic computer program that is configured from a master set of code for each system based on purchased options.

Standard Features

The LyoS™ control system software comes standard with features designed to help your process needs. These features include Batch Reports, Barometric Endpoint Testing (also referred to as pressure rise testing) and Pirani vs. Capacitance Manometer differential testing (PRCM).

Configurable Options

Your LyoS™ control system software may be configured with options to help meet your specific process requirements. These options include 21 CFR Part 11 compliance capability (SEC3), FTS Systems' SMART Freeze Dryer™ Technology and/or Praxair's ControLyo™ Nucleation On-Demand Technology.

Note: *Contact SP Scientific for more information. Additional options may be available to help meet your specific process requirements.*

Fully Validatable

The LyoS™ control system software is both fully configurable and fully validatable for .regulated pharmaceutical and biotechnology applications. SP Scientific offers testing protocols intended to support the processes that will be performed by the purchaser and/or end user, as well as onsite control system IQ/OQ validation support and a comprehensive factory-initiated software validation.

Note: *"Testing carried out by the manufacturer can form part of the IQ/OQ evidence if adequately controlled and documented. This can help reduce the amount of testing needed later, particularly in software OQ." - International Society for Pharmaceutical Engineering's (ISPE) GAMP Guide for Validation of Automated Systems.*

System Documentation and Support

All original software is provided with your LyoS™ control system. Some software may include additional information in the form of electronic documents, which may enhance and support various sections of this manual. A backup copy of the LyoS™ control system is also provided.

Please note that the GE Proficy® HMI/SCADA iFIX software license key provided with the LyoS™ control system allows "run-time" use only and cannot be used as a software development package. The software developer's functions are not supported.

Chapter 2

Getting Started

Overview

The LyoS™ control system workstation shall consist of the following components, as a minimum:

- Windows®-based PC.
- Monitor.
- Keyboard.
- Mouse.
- Printer.
- Communication Cable (*i.e.,* RS-232 or Ethernet).

Note: *Refer to your purchase order and/or sales order, and your Bill of Materials for additional control system items not included in the list above.*

Initial Inspection

Your control system workstation is carefully packed and thoroughly inspected before leaving the factory. In the unlikely event that shipping damage has occurred, retain all packing material and contact your freight carrier immediately.

DO NOT ACCEPT DAMAGED SHIPMENTS FROM A CARRIER WITHOUT A SIGNED NOTIFICATION OF DAMAGES.

Upon receiving your shipment, inspect all contents of your equipment for damage. Check packing material for small accessory items. Remove all packing material carefully and inspect for concealed shipping damage. If concealed damage or loss is discovered, contact the freight carrier immediately.[1] Keep all contents, packing material and related paperwork intact until a written report is obtained.

Note: *SP Scientific will cooperate in the matter of collecting your claim, but is not responsible for the collection or free replacement of the material. When possible, replacement parts will be shipped and invoiced to you, making them a part of your claim.*

[1] "Concealed damage or loss" refers to damage or loss that does not become apparent until the merchandise has been unpacked and inspected. Should damage or loss be discovered, you may make a written request for inspection by the carrier's agent within 15 days of the delivery date. You may then file a claim with the freight carrier or SP Scientific, depending on the terms of your shipment. If your shipment was "FOB Destination" file your claim with SP Scientific and include the inspection report and any other supporting documents. If your shipment was "FOB Shipping Point" file your claim with the freight carrier and include the inspection report and any other supporting documents.

Setup Procedure

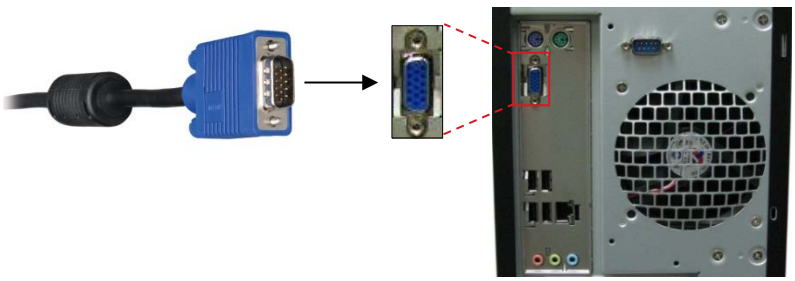
The LyoS™ control system workstation is intended for use with a specially designed lyophilizer. The following procedure will guide you with the setup of your LyoS™ control system workstation.

1. Remove the workstation and all related peripherals (*e.g.,* printer) from packaging.

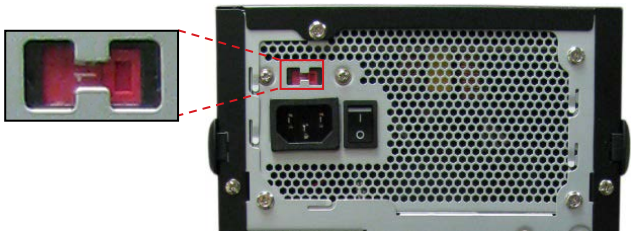
   Note: *The control system workstation is typically packaged separately from the lyophilizer.*

2. Inspect all items for visible damage.
3. Select a location for setup. The workstation and peripherals should be setup in a location that is convenient for both operation and service.
4. Attach the mouse and keyboard connectors (1), as well as the GE Proficy® Key (2) to the available USB ports on the rear of the PC (3).

5. Connect any additional workstation peripherals (*e.g.*, printer) to any unused USB port on the front or rear of the workstation tower.
6. Connect the monitor to the workstation by connecting the male end of the blue-tipped VGA cable to the VGA port on the rear of the workstation.



7. Connect the supplied data communications cable(s) between the lyophilizer and the workstation (*i.e.*, RS-232 or Ethernet).
8. Verify that the red voltage-selecting switch is appropriately configured for your input power (115 VAC or 230 VAC).



9. Using the supplied power cables, connect the monitor, PC and peripherals (*e.g.*, printer) to the available power supply (*e.g.*, wall outlet, surge protector, etc.).

   Connect the power cables of the monitor, PC and peripherals to open electrical sockets on the Uninterruptible Power Supply (UPS). Plug the UPS into the available power supply and enable power.

   Note: *Ensure that your workstation voltage aligns with the available supply on the UPS. For example, if your workstation is configured for 115 VAC, the nominal output voltage on the UPS should be available UPS 120 VAC. If your workstation is configured for 230 VAC, the nominal output voltage on the UPS should be available UPS 220 VAC.*

10. Turn on the monitor, PC and peripherals.

CAUTION! TO AVOID STATIC ELECTRICITY DAMAGE, MAKE ALL CONNECTIONS BEFORE APPLYING LINE POWER TO THE FREEZE DRYER, PC, MONITOR OR PRINTER.

WARNING! THE LYOS™ WORKSTATION SHOULD BE DEDICATED TO THE CONTROL OF YOUR LYOPHILIZER ONLY. INSTALLATION OF ANY ADDITIONAL SOFTWARE WITHOUT PRIOR AUTHORIZATION OR INSTRUCTION FROM FACTORY AUTHORIZED PERSONNEL MAY VOID THE ORIGINAL WARRANTY.

Startup

Your LyoS™ control system was developed using Windows®-based GE Proficy® HMI/SCADA iFIX software. This software interfaces with the Allen-Bradley CompactLogix™ PLC, which contains the ladder logic required for program execution.

The computer workstation has been pre-configured at SP Scientific's factory so that when power is applied, the LyoS™ control system and all required auxiliary software programs will start automatically. In the event of a power loss, the system will reboot and re-establish communications with the PLC without user input. Data loss shall only occur if the duration of the power failure is greater than the battery life of the Uninterruptible Power Supply (UPS) (*i.e.,* approximately 30 minutes).

Shutdown

The following steps shall guide you through the proper shutdown of your LyoS™ control system workstation. While the LyoS™ workstation does not require regular shutdowns, to protect system hardware and data integrity, SP Scientific highly recommends following this procedure whenever a shutdown is deemed necessary.

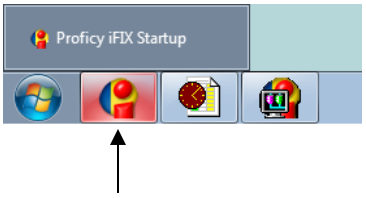
Note: *You must be logged in to the LyoS™ control system with sufficient access to complete this task (i.e., Supervisor access or above).*

To shut down the LyoS™ control system workstation:

1. Press the Windows® key on your keyboard to display the Windows® Start menu and taskbar.

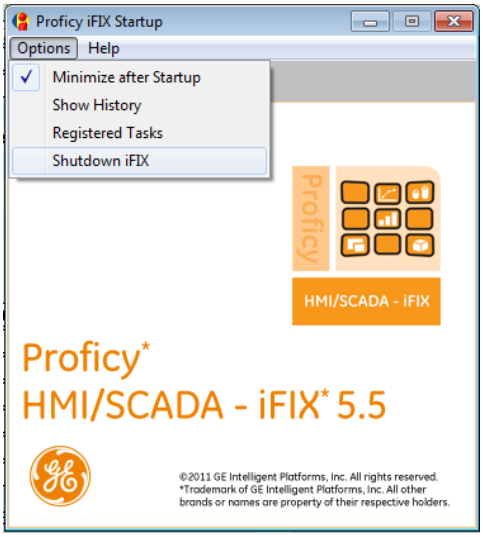
Windows® Key

2. Click the Proficy® iFIX Startup tab on the taskbar to maximize the Proficy® iFIX Startup application.



Proficy® iFIX Startup tab

3. Click Options then click Shutdown iFIX from the dropdown menu. Once clicked, wait for the application to close.



4. From the Windows® Start menu, click Shut Down.
5. Follow the Windows® prompts for proper shutdown.

Chapter 3

Basic Operation

Overview

Basic operation of the LyoS™ control system is accomplished by clicking navigation tabs, circular icons / buttons and fields.

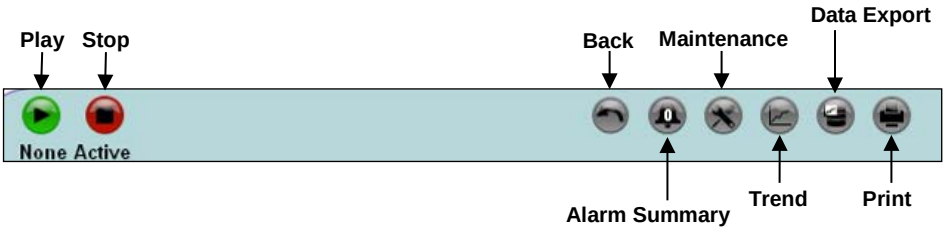
Navigation Tabs

Navigation tabs are located along the bottom of the LyoS™ control system. Click on a tab to navigate to that page.

Notes: *Your navigation tabs may differ from those shown above depending on your software configuration and purchased options. For more information, refer to Chapter 4: Basic Navigation.*

Circular Icons / Buttons

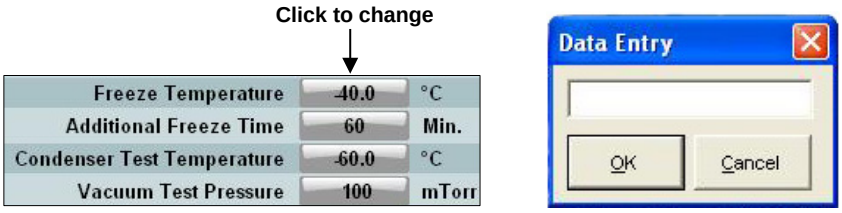
Circular icons / buttons are located on the top of the control system screen and provide access to additional pages and functions. Click on an icon / button to navigate to a page or access a function.



Note: *For more information, refer to the Circular Icon / Buttons section of Chapter 4: Basic Navigation.*

Fields

Fields are located throughout the LyoS™ control system and allow users to change the values of various parameters. To change a value, click a specific parameter and enter the desired value into the data entry box when it appears. Click the OK button to accept the change or click Cancel to keep the value the same.



Enable / Disable

The LyoS™ control system utilizes green checkmarks and red X icons to specify the state of a feature or step. A green checkmark indicates when a feature or step is enabled, while a red X indicates when a feature or step is disabled.

A green checkmark above a Drying step column signifies that the step will be used as part of the freeze-dry cycle. Steps marked with a red X will be skipped during the cycle. Disabling an active step while it is in progress will allow the freeze-dry cycle to immediately transition to the next active step.

To enable, click on a red X. A feature or step has been enabled successfully when it changes to a green checkmark.

To disable, click on a green checkmark. A feature or step has been disabled successfully when it changes to a red X.

Basic Navigation

Overview

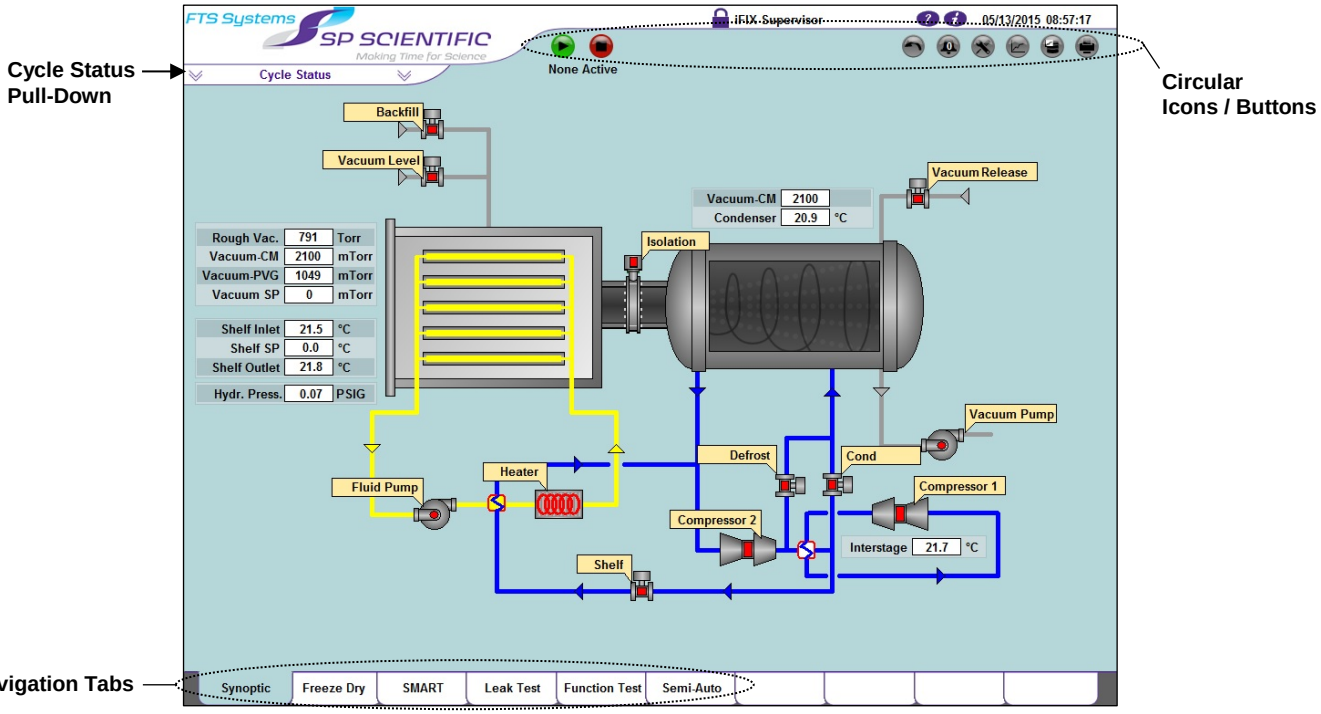
The LyoS™ control system layout resembles a workbook with tabbed pages. When powered up, the control system opens to the Synoptic page. From left to right, the top of the page includes the SP Scientific Logo, the current security access level (*e.g.*, Guest, Operator, Supervisor), the Question Mark icon, the Information icon and the current date and time.

Note: *System Administrator security access level is used at the factory for system configuration and internal testing of the control system.*

Navigation of the LyoS™ control system may be accomplished via the navigation tabs (*i.e.* located on the bottom of the page) and the circular icons / buttons (*i.e.,* located on the top middle and top right of the page). Some circular icons provide specific functions (*e.g.,* print). The status of the LyoS™ automatic cycles is displayed under the Play and Stop buttons.

The Cycle Status pull-down is accessible from the top left corner of the LyoS™ page. This pull-down displays the status of critical system parameters including, when applicable, automatic cycle and phase information, temperature and vacuum sensor readings and voltage.

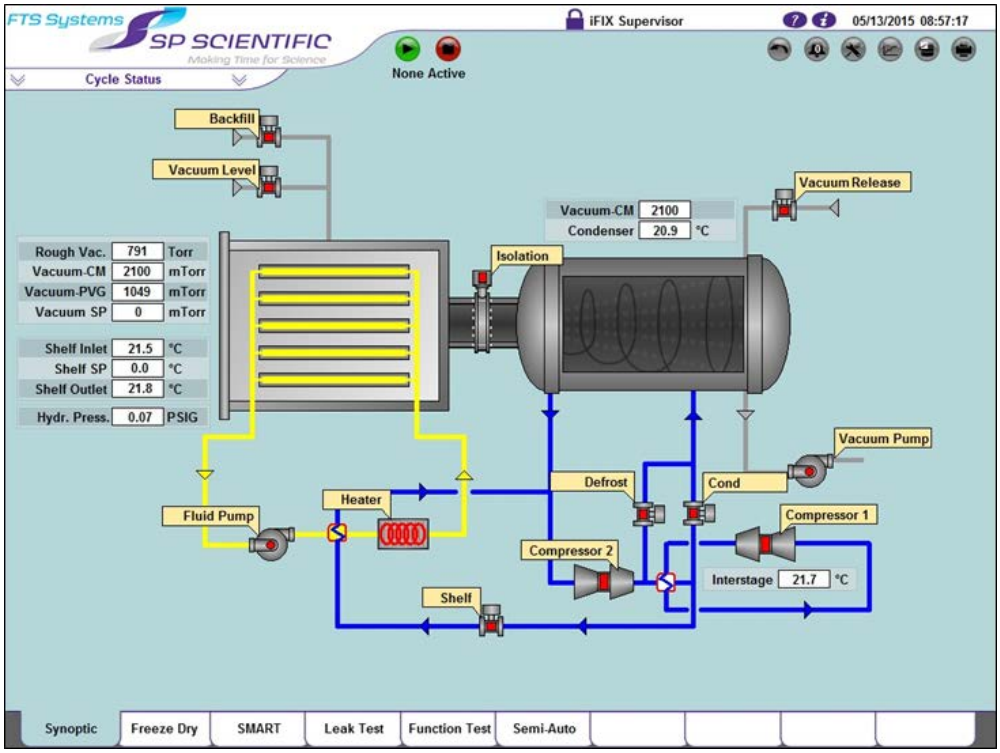
THE PARAMETERS INCLUDED IN THE FOLLOWING IMAGES ARE FOR ILLUSTRATIVE PURPOSES ONLY. THESE PARAMETERS ARE NOT INTENDED TO BE USED AS A GUIDE FOR RUNNING A FREEZE-DRYING CYCLE.



Synoptic

The Synoptic page provides a process flow diagram of the complete lyophilization system. Individual components may be monitored and/or controlled from this page. Critical system parameters are displayed.

Note: *Systems configured with Praxair's ControLyo™ Nucleation On-Demand Technology will include additional process flow items.*



Synoptic Page

Component Mode

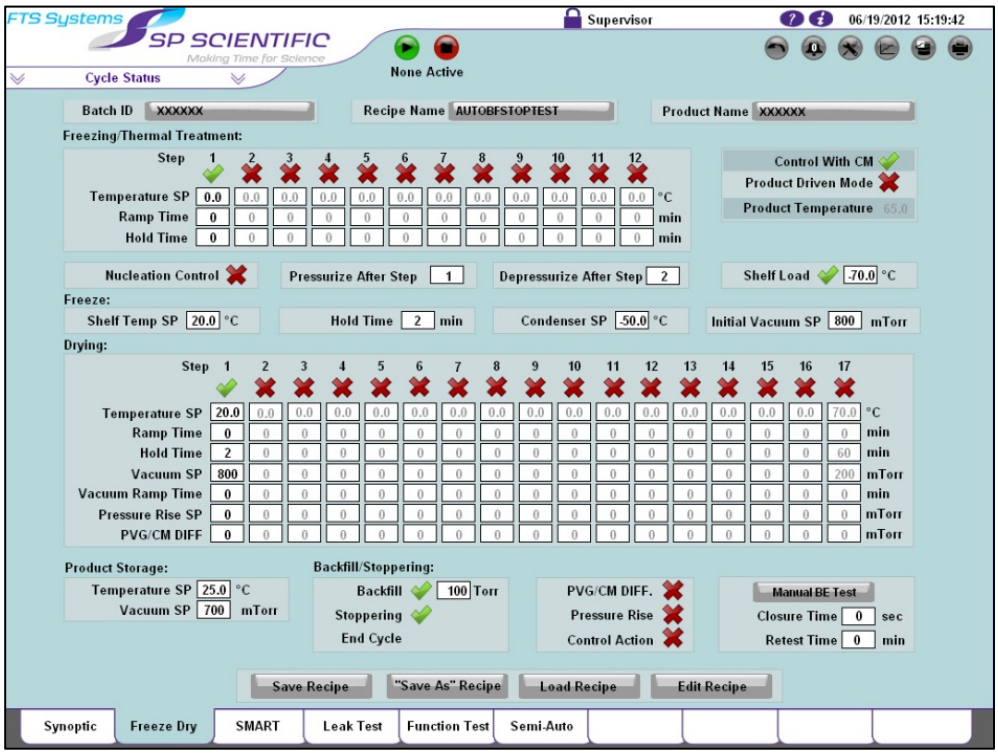
When active, you may operate the Synoptic page in component mode and activate or deactivate individual components by clicking on them.

Notes: *To activate or deactivate components from the Synoptic page, Component Mode must be enabled from the Maintenance menu pop-up.*

For more information, refer to the Component Mode section of Chapter 10: Maintenance Menu.

Freeze Dry

The Freeze Dry tab opens the automatic Freeze-Dry Recipe page. This page allows you to view and edit current recipe parameters and load a previously saved recipe. This page also provides access to the Recipe Manager function, which allows you to create and save recipes.



Freeze-Dry Recipe Page

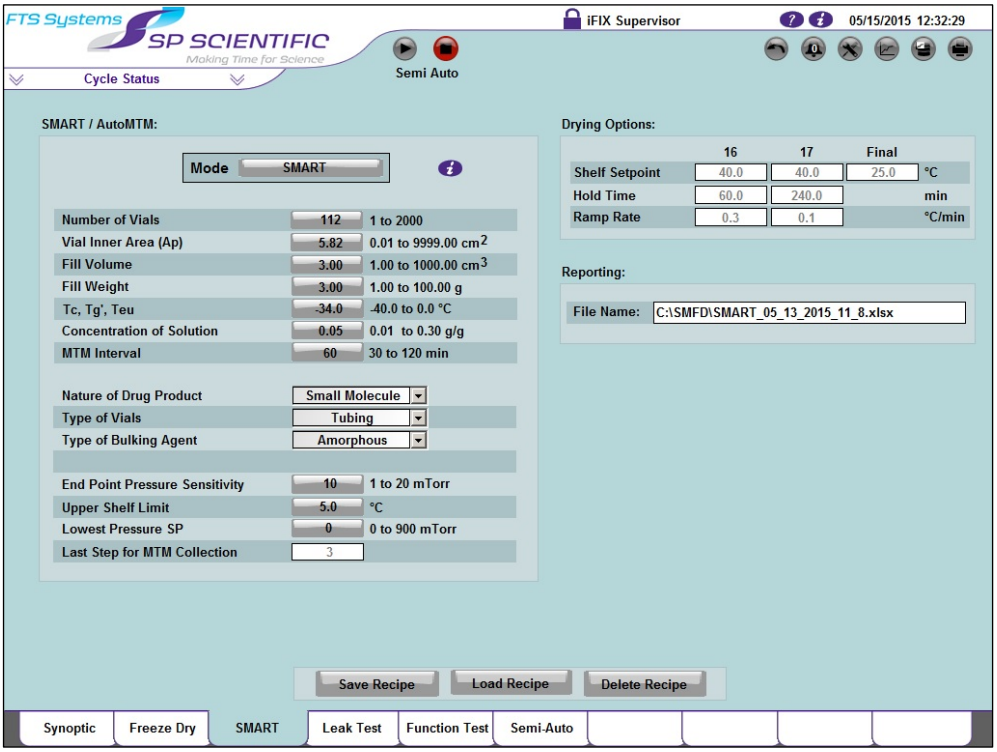
Notes: *Your Freeze-Dry Recipe page may differ from the one shown above depending on your software configuration and purchased options.*

For more information, refer to Chapter 5: The Freeze-Dry Recipe.

SMART Freeze Dryer™ Technology

The SMART tab opens the SMART Freeze Dryer™ cycle application, which is based on FTS Systems' SMART Freeze Dryer™ Technology. This patented technology is the result of extensive collaboration with freeze-drying industry experts around the world. The principle behind SMART Freeze Dryer™ technology is the use of manometric temperature measurement (MTM).

SMART Freeze Dryer™ technology analyzes user inputs and then selects an initial freezing program and Drying step for use with your product. Following automated measurements, product temperature at the sublimation interface is calculated and the application determines the ideal parameters for preventing product collapse or meltback during Drying.



SMART Freeze Dryer™ Technology Page

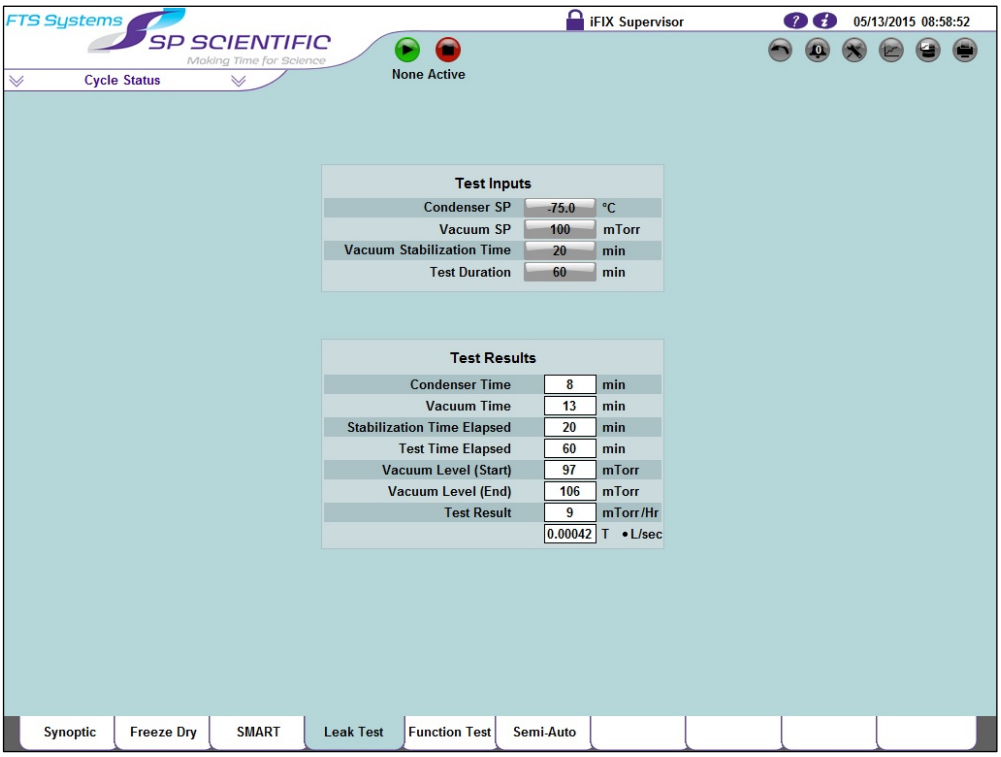
Notes: *Only systems configured with SMART Freeze Dryer™ Technology will permit access to the SMART Freeze Dryer™ Cycle application. Your SMART page may differ from the one shown below depending on your software configuration and purchased options. If SMART Freeze Dryer™ Technology is not configured on your control system, the tab will be grayed out and inaccessible to the user.*

SMART Freeze Dryer™ Technology is available as a field retrofit.

For more information, refer to Chapter 12: SMART Freeze Dryer™ Technology.

Leak Test

The Leak Test tab opens the Leak Test page, which is intended to be used when verifying the vacuum integrity of the system. With sufficient access, you may set and modify the Leak Test parameters and initiate a test cycle.

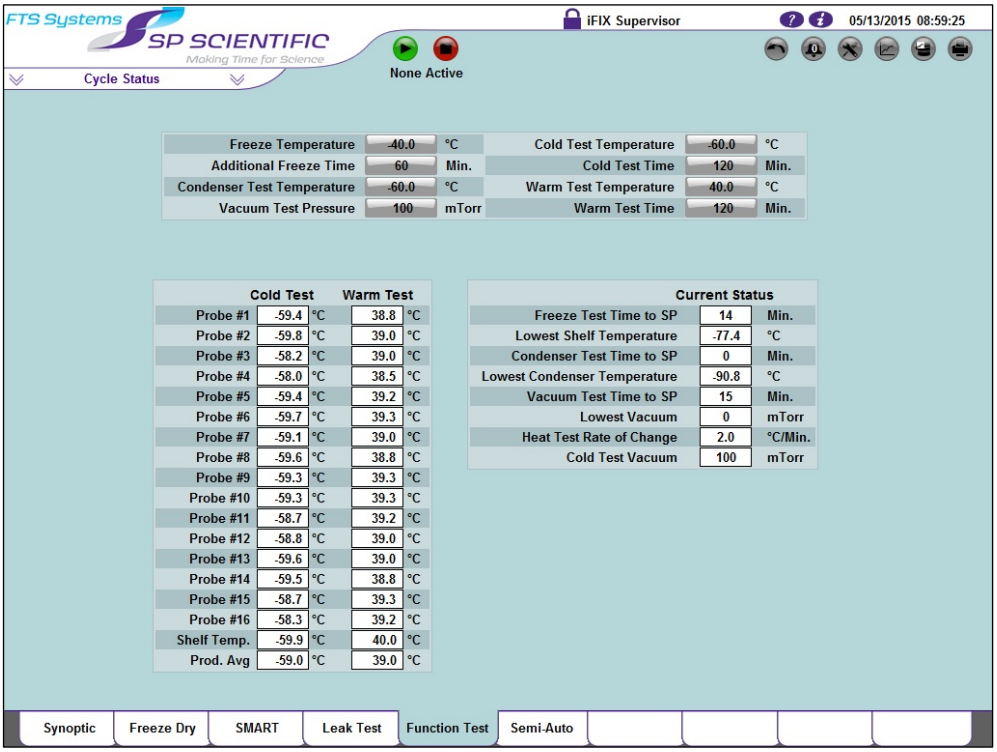


Leak Test Page

Note: *For more information, refer to Chapter 6: Leak Test.*

Function Test

The Function Test tab opens the Function Test page, which may be used periodically to verify the system's performance against the original functional specifications. With sufficient access, you may set and modify the Function Test parameters and initiate a test cycle from this page.



Function Test Page

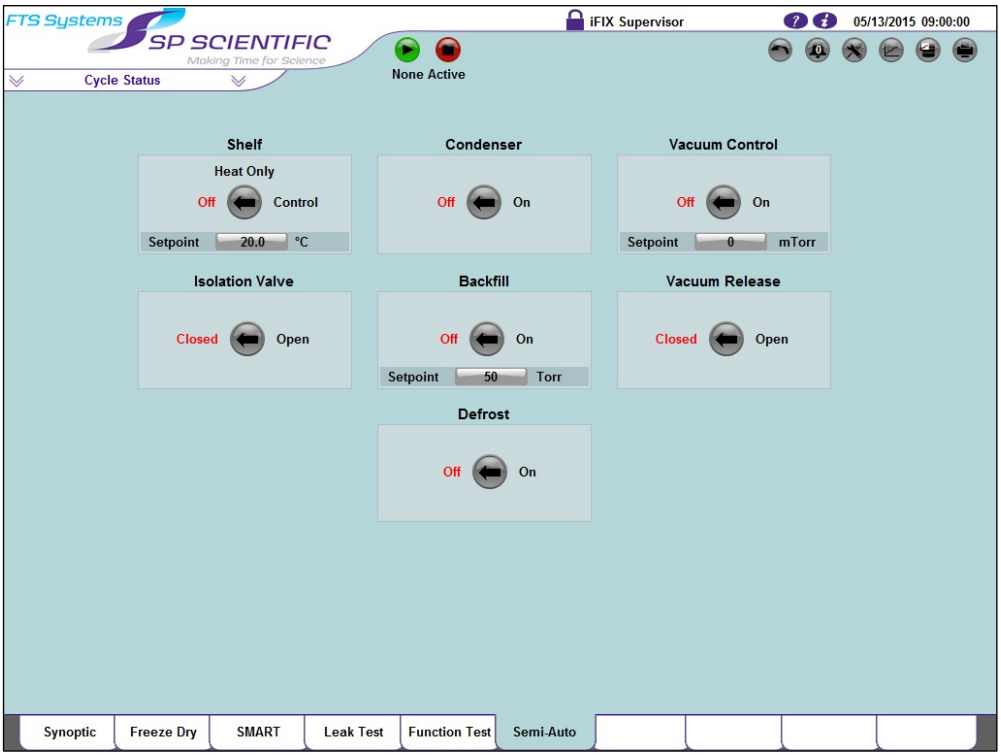
Note: *For more information, refer to Chapter 7: Function Test.*

Semi-Auto

The Semi-Auto tab opens the Semi-Auto page to activate or deactivate the semi-automatic functions. The semi-automatic functions include; Shelf (Shelf Control to setpoint or Heat Only to setpoint), Condenser, Vacuum Control to setpoint, Isolation Valve, Backfill to Setpoint, Vacuum Release and Defrost.

Notes: *The Semi-Auto tab is only accessible when no cycle is active.*

Systems configured with Praxair's ControLyo™ nucleation technology will include additional semi-auto functions for Pressurize and Depressurize.



Semi-Auto Page

Note: *For more information, refer to Chapter 8: Semi-Auto.*

Circular Icons / Buttons

The circular icons / buttons, located at the top of the LyoS™ control system screen, provide access to additional pages and functions.

Play

The Play button is located at the top of the screen. It is used to start or continue an automatic cycle such as a Leak Test, Function Test, Freeze-Dry cycle, SMART Freeze Dryer™ cycle or Auto MTM cycle. The Play button may only be activated when no other cycle is active and an automatic cycle page is displayed.

Note: *SMART Freeze Dryer™ and Auto MTM cycles are only available on systems equipped with the SMART Freeze Dryer™ Technology option.*

When the system is in a "ready" state, (*i.e.,* no automatic cycles are active), the words None Active appear under the Play and Stop buttons. When an automatic cycle is active, the name of the active cycle (*i.e.*, Leak Test, Function Test, Freeze-Dry cycle, Semi-Auto, Auto MTM or SMART) appear under the Play and Stop buttons.

Stop

The Stop button is located at the top of the screen to the right of the Play button. It is primarily used to terminate an automatic cycle such as Leak Test, Function Test, Freeze-Dry cycle, SMART Freeze Dryer™ cycle or Auto MTM cycle. Once a cycle is cancelled using the Stop button, the Cancel Current Cycle pop-up window will appear asking you to confirm your selection. Once cancellation is confirmed, you will be unable to continue from where you left off and must restart the cycle.

The Stop button may also be used to terminate active semi-automatic functions. If multiple semi-automatic functions are active, the Stop button will serve as an emergency off button, stopping all energized components at once.

When the system is in a "ready" state, (*i.e.,* no automatic cycles are active), the words None Active appear under the Play and Stop buttons. When an automatic cycle is active, the name of the active cycle (*i.e.*, Leak Test, Function Test, Freeze-Dry cycle, Semi-Auto, Auto MTM or SMART) appear under the Play and Stop buttons.

Back

The Back button is located on the top right corner of the screen. It allows you to return to the previous page when navigating.

Alarm Summary

THE FOLLOWING INFORMATION APPLIES TO ALL NON-21 CFR PART 11 COMPLIANT–READY SYSTEMS (*I.E.,* SYSTEMS NOT CONFIGURED WITH THE SEC 3 OPTION). ALARM AND EVENT DATA IS CAPTURED DIFFERENTLY ON SEC 3-CONFIGURED SYSTEMS.

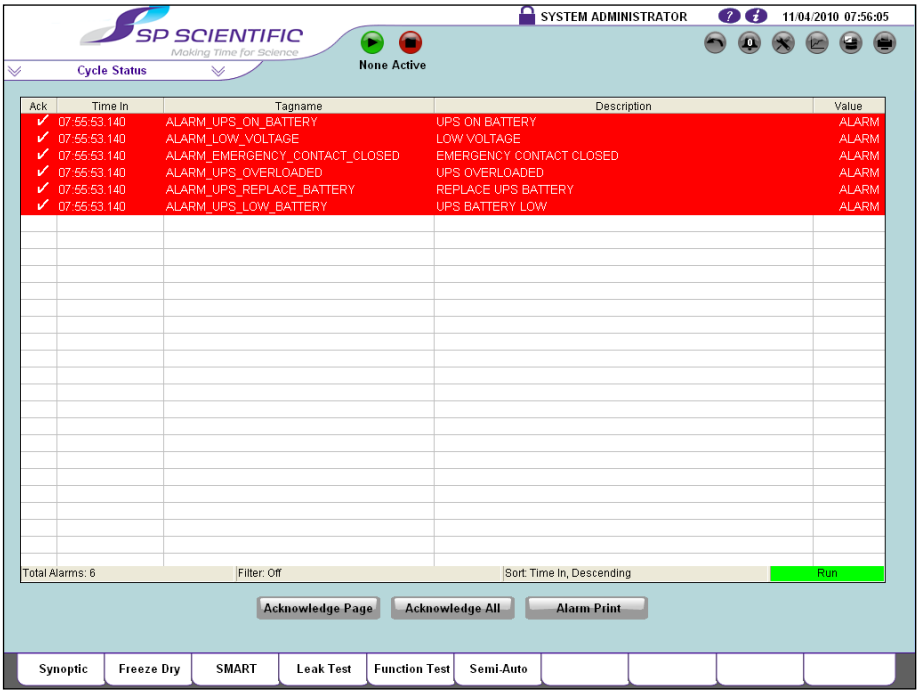
Note: *Alarm summary and maintenance are handled differently on 21 CFR Part 11 compliant capable systems. For more information, refer to the Alarm Summary section of Chapter 14: SEC 3 Security Option (21 CFR Part 11 Compliant-Capable).*

The Alarm Summary button provides access to the Alarm Summary page, which provides a detailed list of all active alarms and events. The button also displays the current number of unacknowledged alarms (*i.e.*, the number over the Alarm Summary button will change accordingly and flash red when an alarm is active).

Note: *If the Alarm Summary button displays a zero (0), this does not necessarily mean that the system did not trigger any alarms. It means that if alarms were triggered, they may have already been "acknowledged." You may visit the Alarm Summary page at any time for a list of current alarms.*

The column headings of the Alarm Summary page are defined as follows:

1. **Ack.** Indicates whether the alarm has been acknowledged by the operator. A checkmark indicates that the alarm has been acknowledged.
2. **Time In.** Displays the time that the alarm was logged in the system.
3. **Tagname.** Displays the alarm name as used by the system program.
4. **Description.** Identifies the alarm condition.
5. **Value.** Displays the type and or status of the Alarm message (*e.g.,* Alarm, OK, etc.*)*.



Acknowledge Page and Acknowledge All

Active alarms may be acknowledged using the Acknowledge Page and Acknowledge All buttons. A check mark is placed to the left of active alarms that have been acknowledged, but not cleared. Once an alarm is acknowledged, the PC horn will also silence. In order for an alarm to be removed from the page, the condition causing the alarm must be corrected.

Notes: *If the Alarm Summary page is filled with active, unacknowledged alarms, the Acknowledge All button may need to be clicked several times to acknowledge all alarms.*

For more information, refer to Chapter 16: Alarms.

Alarm and Event Data

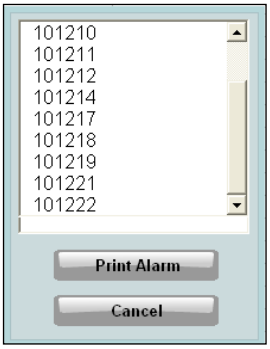
The LyoS™ control system stores daily alarm and event data files for the last 365 days. Files older than 365 days are automatically purged to preserve disk space.

Alarm Print

To print Alarm files:

1. Click the Alarm Print button on the Alarm Summary page.

2. The Alarm Print dialog appears with a list of Alarm files by date. The dates are formatted as yy/mm/dd (*e.g.,* 101210).



3. Select the date of the Alarm file you wish to print.
4. Click the Print Alarm button. The alarm will print and the Alarm Print dialog will close.

   Note: *To close the Alarm Print dialog at any time, click Cancel.*

Reading Alarm Files

Alarm file data entries include the date, time, node name (*e.g.,* application host name, such as “SPLYO”), tag name, alarm type acronym (*e.g.,* if applicable, such as CFN for Change from Normal), value, unit and description.

For example:

03/05/2012 12:46:40.1 [SPLYO] ALARM_ISOVALVE_CLOSE_FAILURE CFN ALARM ISLOATION VALVE FAILED TO CLOSE

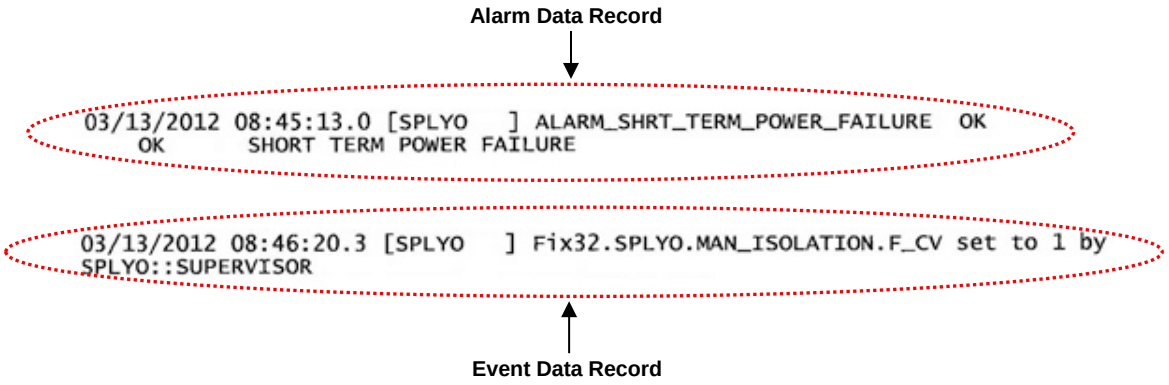
Event data entries include the date, time, node name, tag name, new value and the name of the user who executed the change.

For example:

03/05/2012 12:47:09.3 [SPLYO] Fix32.SPLYO.ACK_CONTACT.F_CV set to 1 by SPLYO::SYSTEM ADMINISTRATOR

Note: *F_CV = Float Current Value (i.e., number tags); A_CV = ASCII Current Value (i.e., text tags).*

The following is an example of an Alarm file printout:



Accessing Alarm Files for Backup

Alarm and event data files are stored on the system’s hard drive in the **c:\LyoS\ALM** directory. Alarm and event files are formatted as .alm files. Each file has a unique date and time assigned as part of its file name structure. Dates are formatted as yy/mm/dd (*e.g.,* 101210).

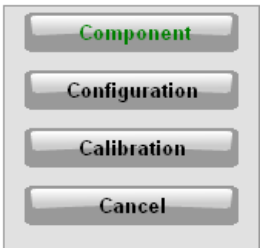
To back up alarm and event data files, copy the .alm formatted files to another medium (*e.g.,* CD or removable flash storage drive).

When opening an .alm file for the first time outside of the LyoS™ control system, the system may prompt you to select a program to view the file. SP Scientific recommends selecting Notepad to view .alm files. You may check the box that says, “Always use the selected program to open this kind of file.”

Note: *To prevent data loss, SP Scientific recommends copying alarm files from one computer to another before opening them. Alarm data files are populated daily (i.e., at midnight). This prohibits users from editing or viewing alarm data for the current day.*

Maintenance

The Maintenance button opens the Maintenance menu pop-up, from which you may activate Component Mode for the Synoptic page, or open the Configuration and Calibration pages. To close the Maintenance menu pop-up, click the Cancel button.



Maintenance Menu Pop-up

Note: *For more information, refer to Chapter 10: Maintenance Menu.*

Component Mode

Component Mode allows you to manually control system components listed on the Synoptic page such as the heater, fluid pump, vacuum pump, compressors and associated valves.

Note: *To activate or deactivate components from the Synoptic page, Component Mode must be enabled from the Maintenance menu pop-up.*

To enable Component Mode, click the Component button on the Maintenance menu pop-up. The Synoptic page will open.

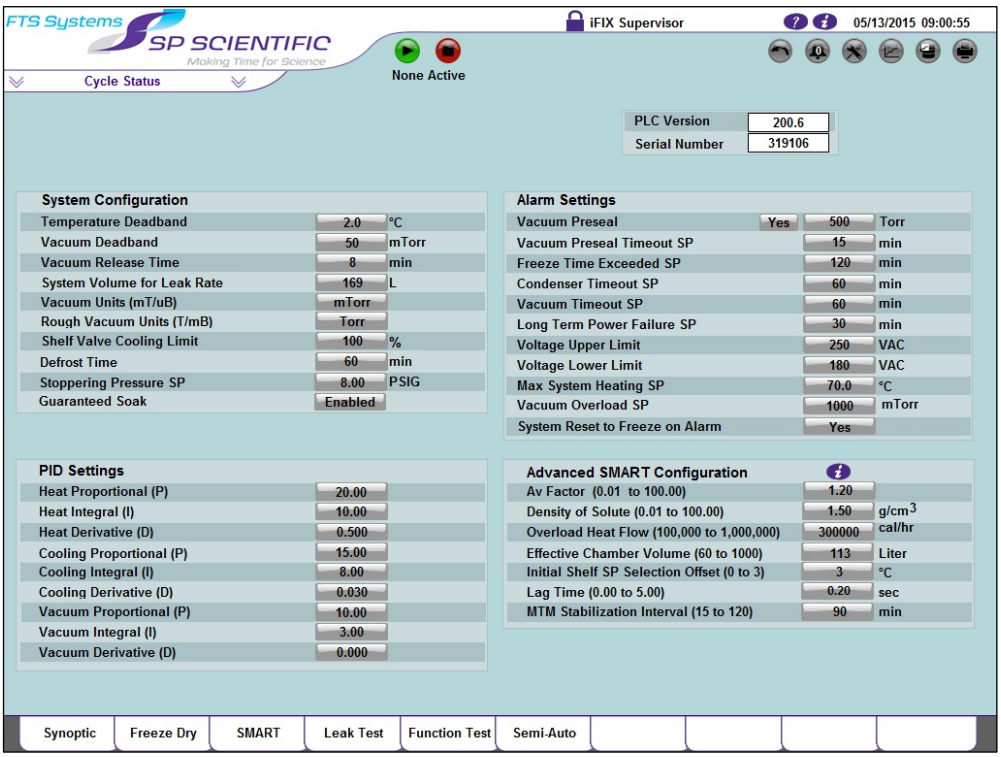
Notes: *When Component Mode is enabled, the word Component on the Maintenance menu pop-up will appear in green.*

For more information, refer to the Component Mode section of Chapter 10: Maintenance Menu.

To activate or deactivate components, click a component. A component displaying red signifies that it is inactive, or in its default state. A component displaying green signifies that the component is active.

Configuration

Selecting the Configuration button of the Maintenance menu pop-up opens the Configuration page. This page allows you to configure settings that are used by the system software to determine how your lyophilizer will operate, as well as how it will react to certain conditions. The PLC version and system serial number are displayed at the top of the page and may not be edited.



Configuration Page

Note: *The configuration page on your lyophilizer may appear different than the one shown based upon the options ordered with your unit.*

For more information, refer to the Configuration section of Chapter 10: Maintenance Menu.

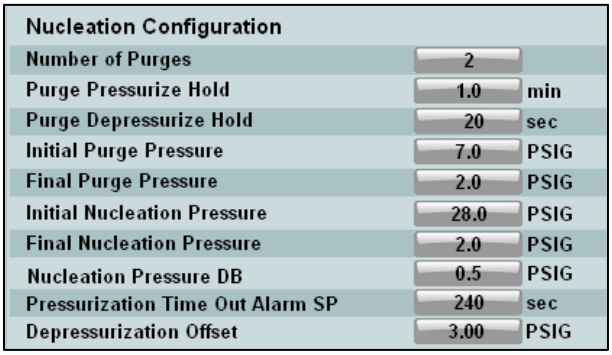
WARNING! THE SYSTEM VOLUME PARAMETER IS CALCULATED AT THE FACTORY AND SHOULD NOT BE EDITED. CHANGING THE SYSTEM VOLUME PARAMETER COULD CAUSE SYSTEM TESTS (SUCH AS THE LEAK RATE TEST) TO YIELD INACCURATE RESULTS.

The Configuration page consists of several editable regions – System Configuration, PID Settings and Alarm Settings. Units equipped with additional options such as Praxair's ControLyo™ Nucleation On-Demand Technology and/or SMART Freeze Dryer™ Technology will have up to five editable regions on the configuration page.

Configuration for Praxair's ControLyo™ Nucleation On-Demand Technology

Systems configured with Praxair's ControLyo™ Nucleation On-Demand Technology will include additional settings in the lower right region of the page titled Nucleation Configuration.

Note: *For more information, refer to the Nucleation Configuration Settings section of Chapter 10: Maintenance Menu.*

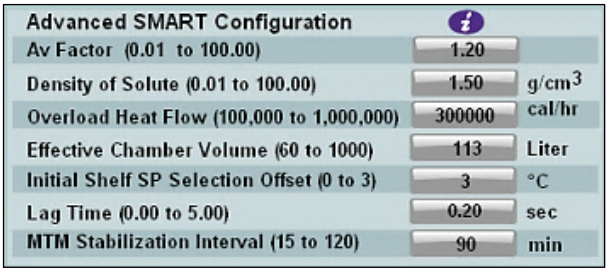


Nucleation Configuration Settings for systems with Praxair's ControLyo™ Nucleation On-Demand Technology Option.

Configuration for SMART Freeze Dryer™ Technology

Systems configured with SMART Freeze Dryer™ Technology will include additional settings in the lower left region of the page titled Advanced SMART Configuration.

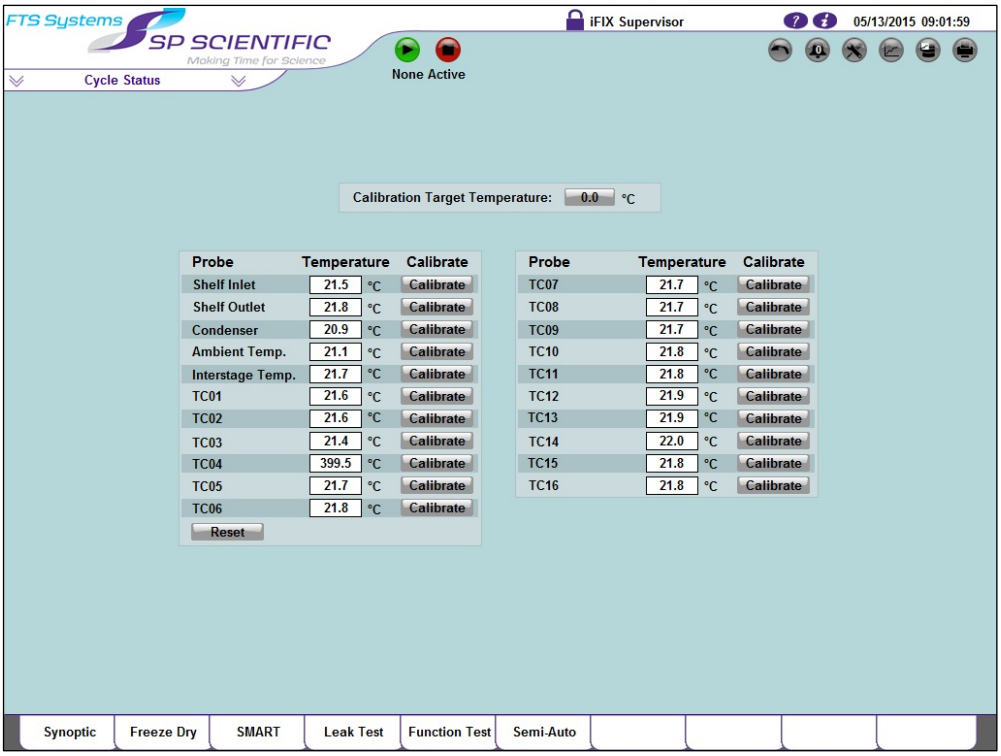
Note: *For more information, refer to the Advanced SMART Freeze Dryer™ Configuration section of Chapter 12: Smart Freeze Dryer™ Technology.*



Advanced Configuration Settings for systems with SMART Freeze Dryer™ Technology Option.

Calibration

Selecting the Calibration button of the Maintenance menu pop-up opens the Calibration page. From this page, you may calibrate the lyophilizer's temperature sensors (*e.g.*, shelf, condenser, ambient, interstage and product probes).



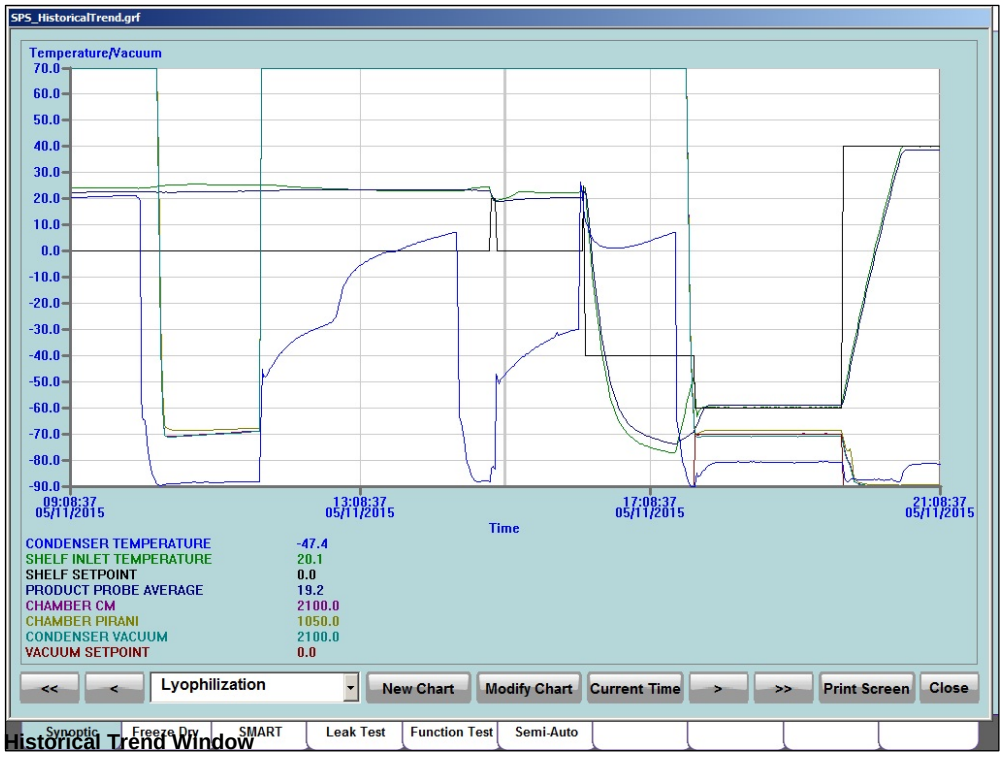
Calibration Page

Notes: *The Calibration page on your lyophilizer may differ from the one shown above depending on your software configuration and purchased options.*

For more information, refer to the Calibration section of Chapter 10: Maintenance Menu.

Trend

The LyoS™ control system includes a trend function, which allows the monitoring of both real-time and historical cycle data. Selecting the Trend button launches the Historical Trend window, which opens over the LyoS™ control system's main layout.

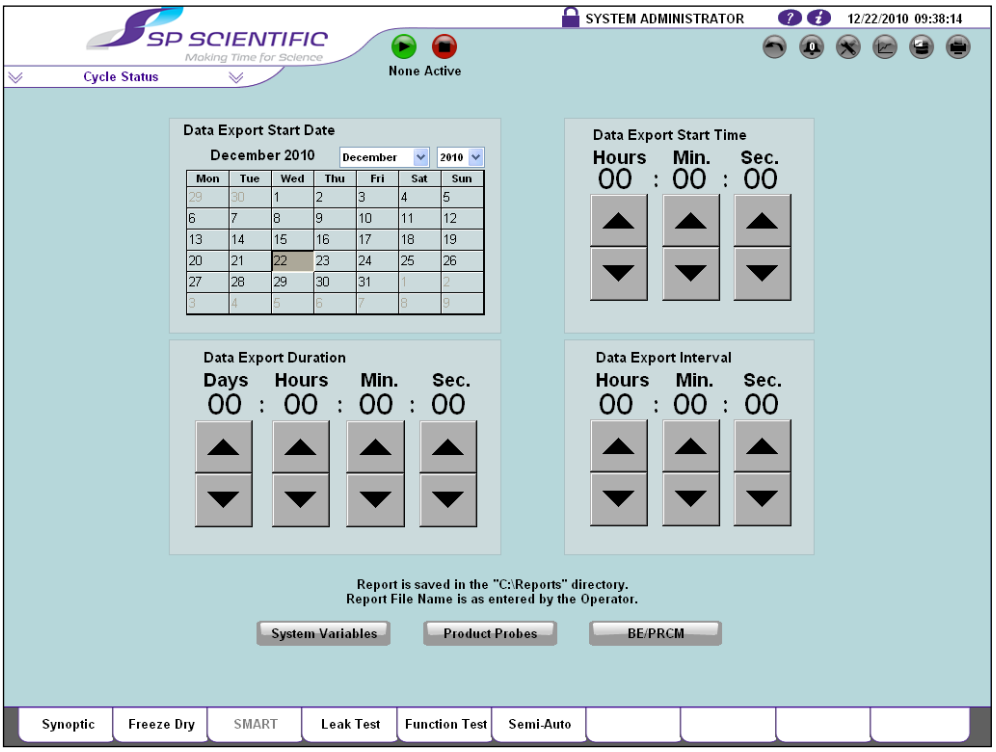


Historical Trend Window

Note: *For more information, refer to Chapter 9: Historical Data.*

Data Export

Selecting the Data Export button opens the Historical Data Export page. The Historical Data Export page allows you to export the LyoS™ historical data into a comma-separated value (.CSV) file that can be viewed with any spreadsheet application.



Data Export Page

Note: *For more information, refer to the Exporting Historical Data section of Chapter 9: Historical Data*.

Print

Selecting the Print button prints the current full-screen view to the available printer.

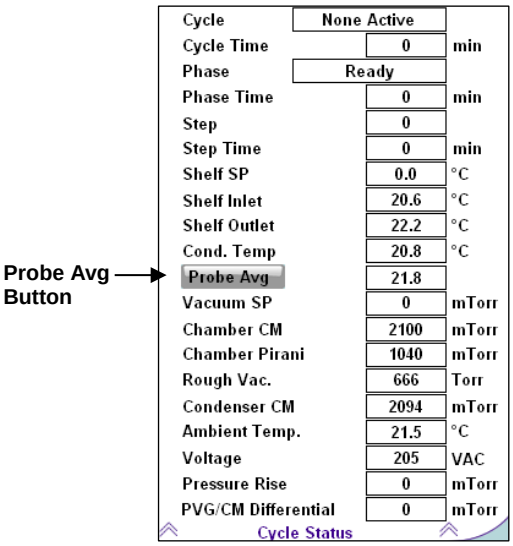
Cycle Status

The Cycle Status pull-down is accessible from the top left corner of the LyoS™ control system screen. This pull-down displays the real-time status of critical system parameters including, automatic cycle and phase information, temperature and vacuum sensor readings and voltage (i.e., when applicable).

The useable ranges of the critical system parameters listed on the pull-down are as follows:

- Temperature: -270 to 400 °C.
- Vacuum, Product Chamber: 0 to 2000 millitorr (MKS Capacitance Manometer).
- Vacuum, Product Chamber: 0 to 1000 millitorr (Pirani Vacuum Transducer).
- Pressure, Product Chamber: 0 to 1013 mbar (Pirani Vacuum Transducer).
- Vacuum, Condenser Chamber: 0 to 2000 millitorr (MKS Capacitance Manometer).

Note: *Any displayed value larger than the useable range is out of range.*

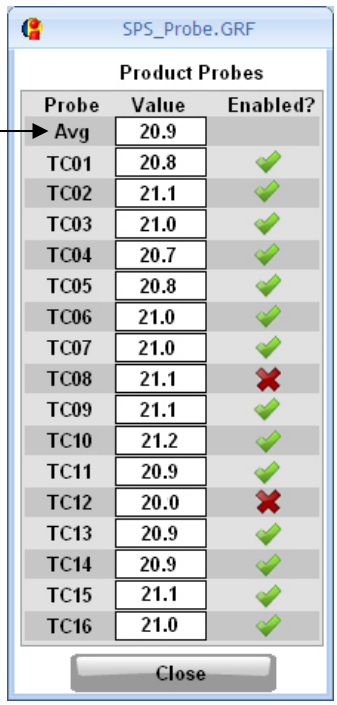


Cycle Status Pull-Down

Note: *Click the Probe Avg button to open the Product Probes pop-up.*

Probe Average (Probe Avg Button)

You may view individual product probe temperatures at any time by selecting the Probe Avg button from the Cycle Status pull-down. Once selected the Product Probes pop-up window will appear. Enabled product probes are indicated by a green checkmark. Only enabled probes are used to calculate the Probe Avg temperature, which is displayed on the Cycle Status pull-down.



Product Probes Pop-Up

Additional Layout Items

From left to right, the top of the page includes the SP Scientific Logo, the current security access level (*e.g.*, Guest, Operator, and Supervisor), the Question Mark icon, the Information icon and the date and time.

SP Scientific Logo

The SP Scientific Logo is displayed in the top left corner of the LyoS™ control system layout. The licensed brand name of the equipment utilizing the LyoS™ control system may also be displayed here.

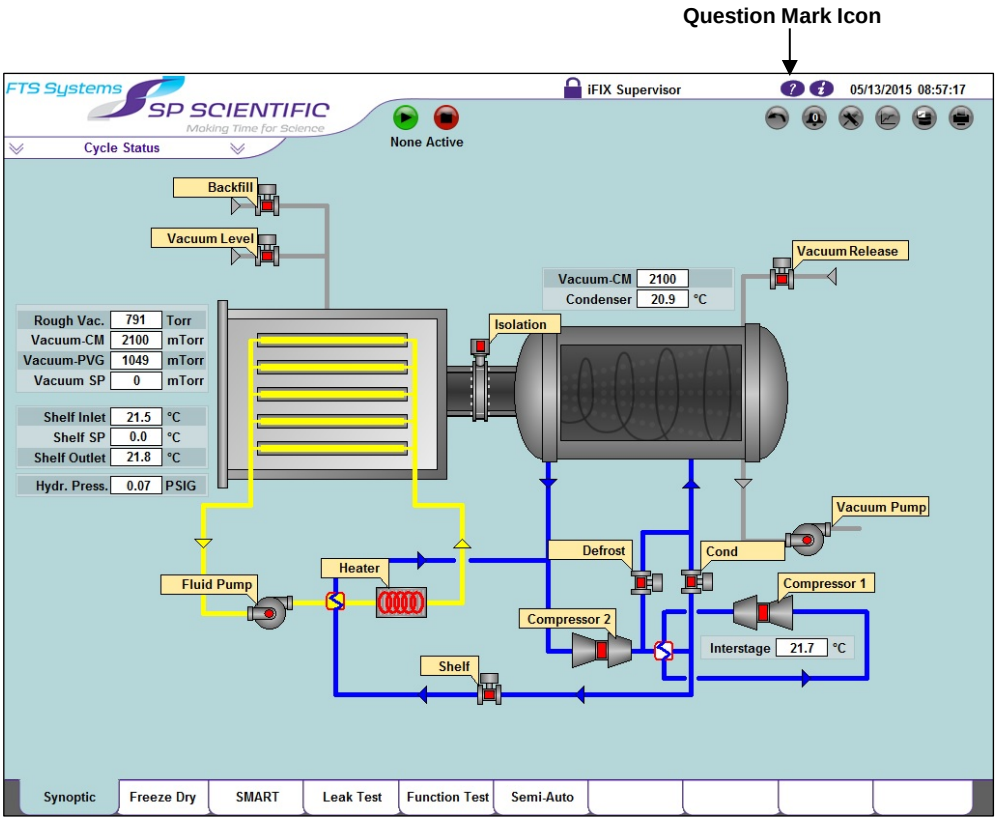
Security Access Level

The LyoS™ control system contains a multi-level, password-protected security system that permits complete access and functionality to users with the maximum-security level and limited viewing and functionality to those with lesser security levels. The standard security access levels are identified as Guest, Operator and Supervisor, with Supervisor having the highest level of security privileges.

Note: *For more information, refer to Chapter 13: SEC1 Standard Security or Chapter 14: SEC 3 Security Option (21 CFR Part 11 Compliant-Capable).*

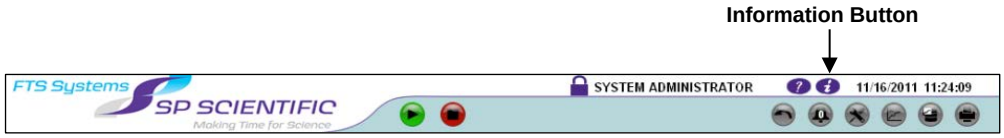
Question Mark Icon

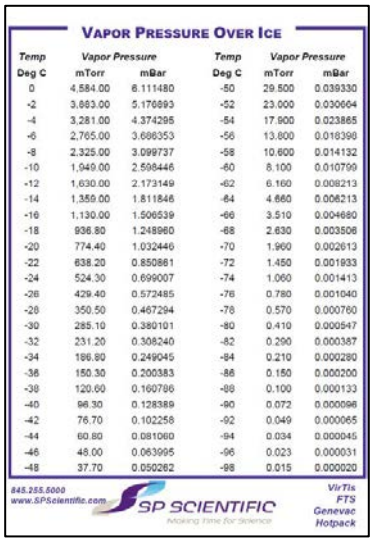
The Question Mark icon indicates a Help entry point. When selected with the Synoptic page active, illustrated components are tagged with descriptive callouts. This feature may be particularly useful when operating your lyophilizer in Component Mode.



Information Button

An Information button is located on the top of LyoS™ control system layout. When clicked from any screen, this button shall open a Vapor Pressure Over Ice table.



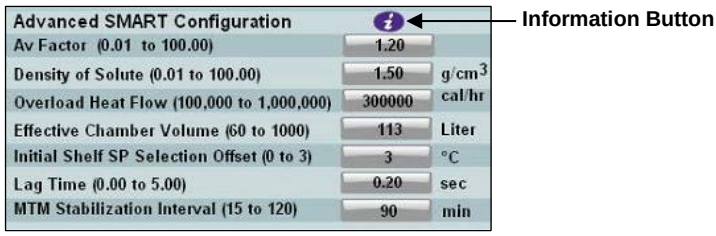


VAPOR PRESSURE OVER ICE

Temp	Vapor Pressure		Temp	Vapor Pressure	
Deg C	mTorr	mBar	Deg C	mTorr	mBar
0	4,584.00	6.111480	-50	29.500	0.039330
-2	3,883.00	5.176893	-52	23.000	0.030664
-4	3,281.00	4.374295	-54	17.900	0.023865
-6	2,765.00	3.686353	-56	13.800	0.018398
-8	2,325.00	3.099737	-58	10.600	0.014132
-10	1,949.00	2.598446	-60	8.100	0.010799
-12	1,630.00	2.173149	-62	6.160	0.008213
-14	1,359.00	1.811846	-64	4.660	0.006213
-16	1,130.00	1.506539	-66	3.510	0.004680
-18	936.80	1.248960	-68	2.630	0.003506
-20	774.40	1.032446	-70	1.960	0.002613
-22	638.20	0.850861	-72	1.450	0.001933
-24	524.30	0.699007	-74	1.060	0.001413
-26	429.40	0.572485	-76	0.780	0.001040
-28	350.50	0.467294	-78	0.570	0.000760
-30	285.10	0.380101	-80	0.410	0.000547
-32	231.20	0.308240	-82	0.290	0.000387
-34	186.80	0.249045	-84	0.210	0.000280
-36	150.30	0.200383	-86	0.150	0.000200
-38	120.60	0.160796	-88	0.100	0.000133
-40	96.30	0.128389	-90	0.072	0.000096
-42	76.70	0.102258	-92	0.049	0.000065
-44	60.80	0.081060	-94	0.034	0.000045
-46	48.00	0.063995	-96	0.023	0.000031
-48	37.70	0.050262	-98	0.015	0.000020

845.255.5000
www.SPScientific.com
SP SCIENTIFIC
Making Time for Science
VirTis
FTS
Genevac
Hotpack

If your control system is configured with SMART Freeze Dryer™ Technology, Information buttons also appear on the SMART page and the Configuration screen. These buttons display information specific to the area they appear in (*e.g.,* if the Information button is clicked from the AdVanced SMART section of the Configuration screen, definitions of the configurable parameters will appear).



Advanced SMART/AutoMTM Variable Definitions

Av Factor	Outer cross sectional area of the vial. Allows an operator to redefine this factor based on custom or vial vendor specifications. Default setting is Av=1.2*Ap.
Density of the Solute	The default value is 1.50 g/cc. This value is used only to make an initial estimate of primary drying time and to determine a safety margin below the critical product temperature which will be termed the target product temperature. If the estimate of primary drying is: < 8 hours: the safety margin will be 5 °C Between 8 and 48 hours, the safety margin will be 3 °C >48 hours, the safety margin will be 2 °C
Overload Heat Flow	A default value that can be used to limit the drying rate so that it will not exceed the maximum heat removal capacity (cal/hr) of the commercial freeze-dryer to which the process will be scaled-up.
Effective Chamber Volume	A default value in liters which will not normally need to be changed. This value is used in the MTM equation.

Date and Time

The current date and time, according to the Windows® operating system clock, is displayed at the top right corner of the LyoS™ control system layout.

To modify the clock's time, time zone and/or date; shutdown the LyoS™ control system software then refer to your Windows® operating system instructions.

Note: *If the Windows® clock's information was moved forward (e.g., the time was changed from 10:00 a.m. to 11:00 a.m.) the LyoS™ control system software may be restarted immediately after the change.*

If the Windows® clock's information was moved back, the LyoS™ control system software must be shut down for the duration of the time change (e.g., if the time was changed from 11:00 a.m. to 10:00 a.m., the LyoS™ control system software must be shut down for one (1) hour). Once the LyoS™ control system has been shut down for the needed time, it may then be restarted.

Chapter

5

The Freeze-Dry Recipe

Overview

The recipe is both the foundation and the framework of a freeze-dry cycle, providing you with complete control over the entire freeze-dry process (*i.e.*, from temperature and time setpoints to product storage conditions). While alarms and interlocks are integrated into the LyoS™ control system to protect your equipment from damage and alert you to conditions that may alter your product, a poorly programmed recipe can alter or completely ruin your product. Therefore, understanding the recipe creation process is key to efficient operation and optimum product output.

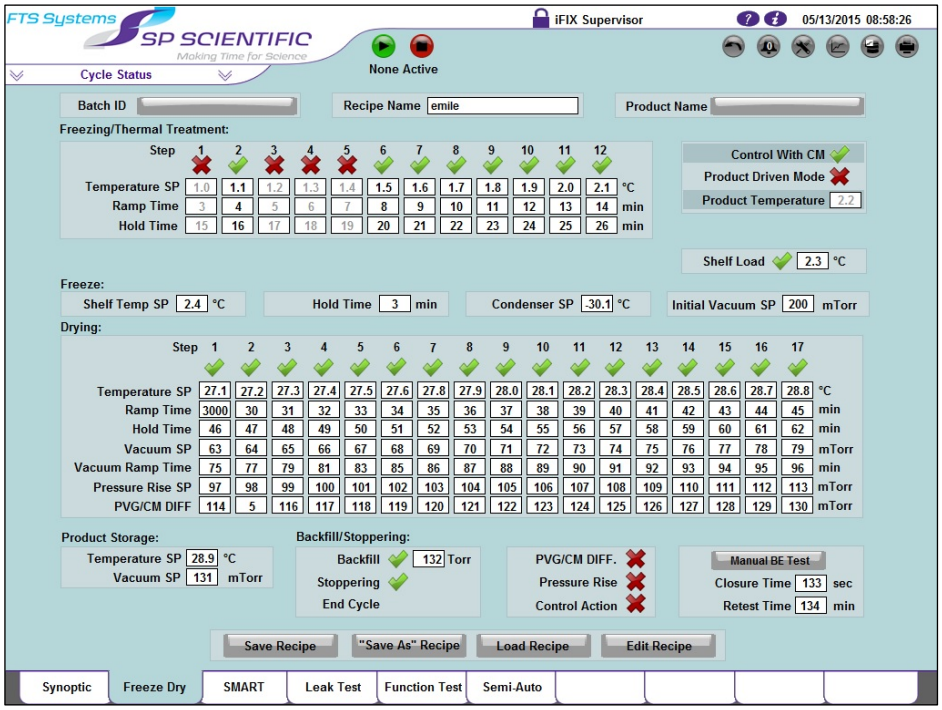
Efficient freeze-drying requires the knowledge and ability to maintain a product temperature below the product's highest freeze temperature (*i.e.,* transition temperature) during the phase commonly referred to as primary drying. This critical temperature is normally determined through product research. However, in the absence of product research it may still be possible to develop a cycle by trial and error, running at progressively lower frozen temperatures until satisfactory drying occurs. In either case, a product temperature target several degrees colder than the transition temperature is generally employed for safe measure. The shelf temperature setpoint during primary drying must be programmed such that the target product temperature is maintained.

The LyoS™ Freeze-Dry Recipe page is divided into several sequential phases, which have been derived from current lyophilization practices. A typical freeze-drying cycle consists of two main phases: Freezing, which may include Thermal Treatment, and Drying.

Conditions within the lyophilizer vary throughout the cycle to ensure that the resulting product includes the desired properties, and that the required stability is achieved.

THE PARAMETERS INCLUDED IN THE FOLLOWING IMAGES ARE FOR ILLUSTRATIVE PURPOSES ONLY. THESE PARAMETERS ARE NOT INTENDED TO BE USED AS A GUIDE FOR RUNNING A FREEZE-DRY CYCLE.

Note: *Your Freeze-Dry Recipe page may differ from the one shown above depending on your software configuration and purchased options.*



Freeze-Dry Recipe Page

Understanding the Recipe Screen

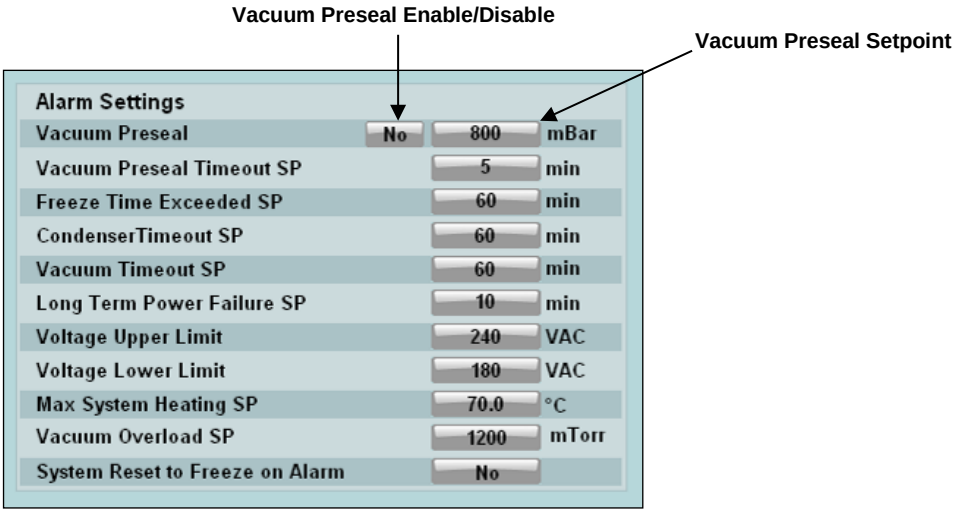
Within each recipe phase, the lyophilizer operates according to a clearly defined process with a logical start and end. The standard LyoS™ Freeze-Dry Recipe allows you to configure and perform the following:

Vacuum Preseal

Vacuum Preseal is used to the prevent the possibility of a vacuum leak occurring later on in a freeze-cycle (*i.e.,* the Evacuation phase).

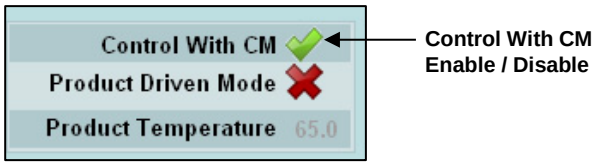
Vacuum Preseal is enabled from the Configuration page, which is accessible from the Maintenance menu pop-up. If enabled, the system will automatically initiate a pre-seal and evacuate the chamber(s) before starting the automatic freeze-dry cycle.

The Vacuum Preseal setting also allows you to specify a pre-seal setpoint. When Vacuum Preseal is enabled, the system will not advance to the next programmed phase until the Vacuum Preseal setpoint is obtained.



Control With CM

The Control With CM setting allows you to select a vacuum gauge to use for primary control. When enabled, the system relies on the capacitance manometer (CM) for controlling vacuum. When disabled, the system relies on the secondary vacuum gauge for vacuum control (*e.g.*, Pirani vacuum gauge).

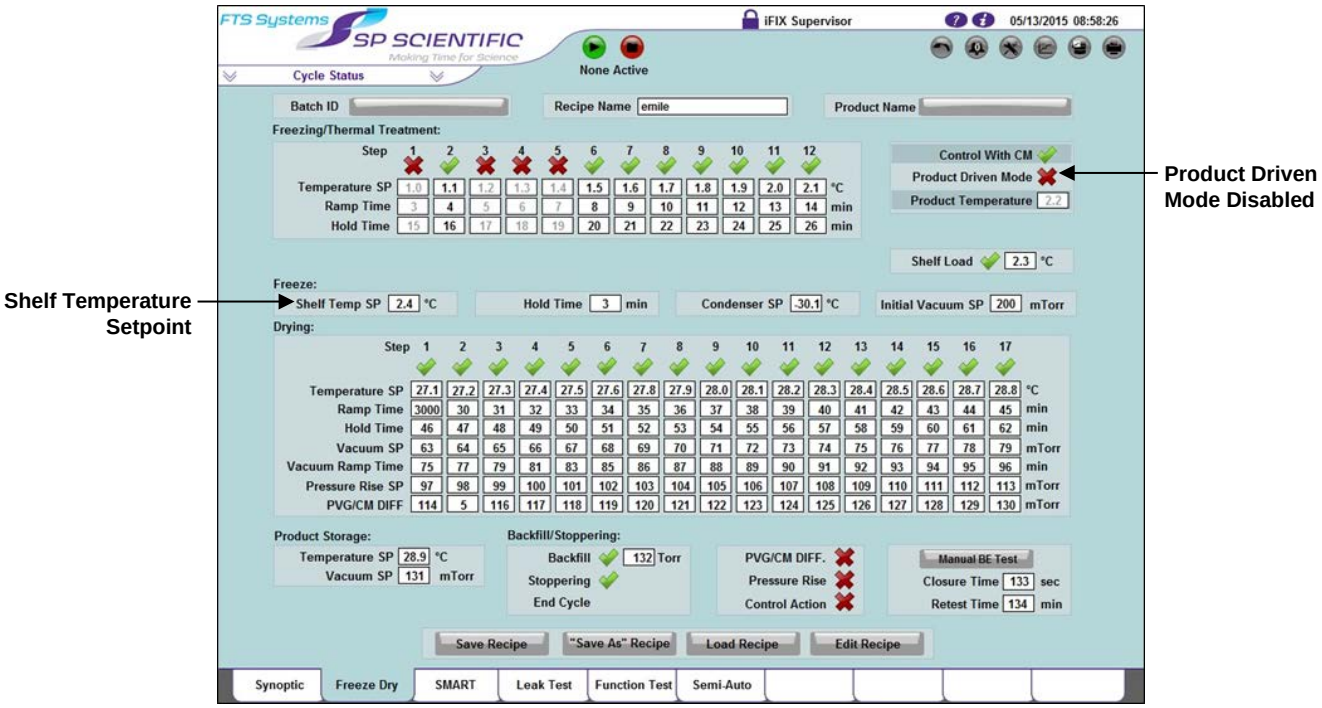


Note: *Data from both vacuum gauges will be displayed and recorded, regardless of which gauge is enabled.*

Product Driven Mode

Product Driven Mode Disabled

During all freeze-dry phases (*i.e.,* Thermal Treatment, Freeze, Hold, Condenser, Evacuate, and Drying), when Product Driven Mode is disabled, the system will control temperature at the shelf temperature setpoint (*i.e.,* Shelf Temp SP).



Product Driven Mode Disabled

Notes: *When Product Driven Mode is disabled, the temperature setpoint field below the word "Freeze" will read Shelf Temp SP. When Product Driven Mode is enabled, the temperature setpoint field below the word "Freeze" will read Product Temp SP.*

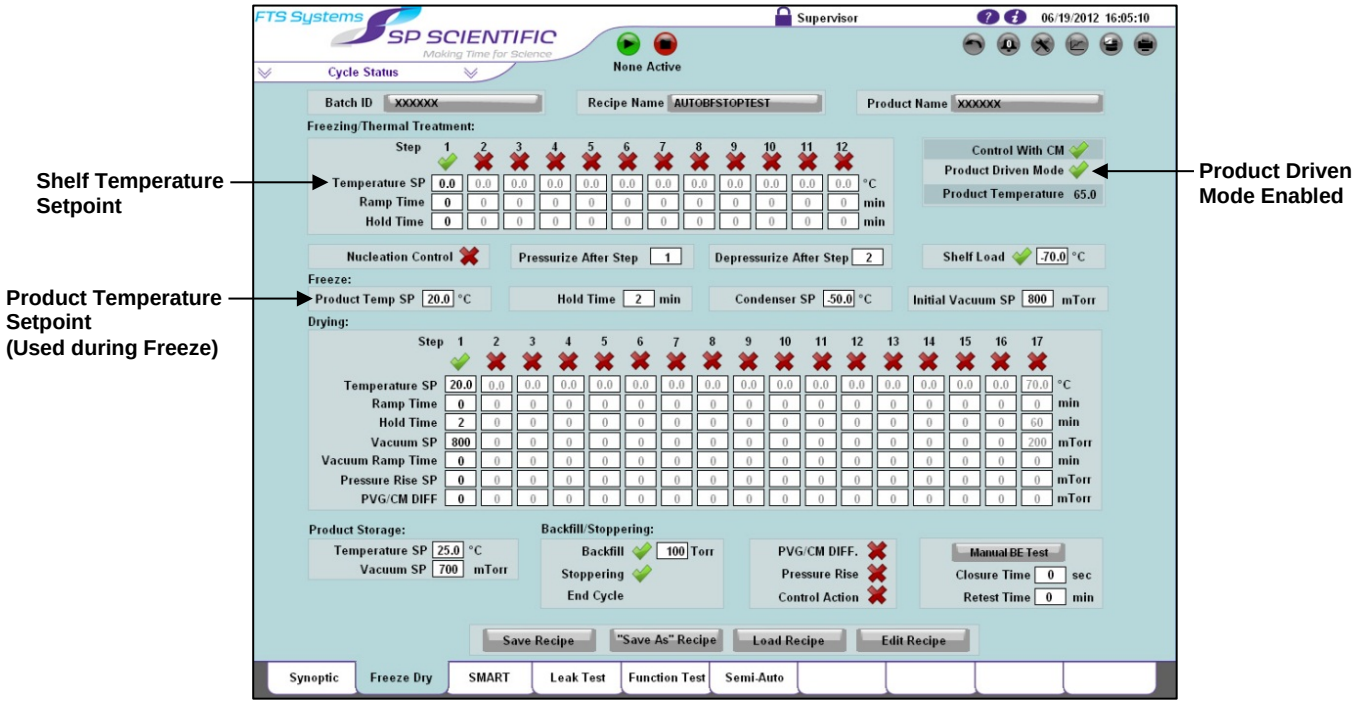
Your Freeze-Dry Recipe page may differ from the one shown above depending on your software configuration and purchased options.

Product Driven Mode Enabled

During the Freezing / Thermal Treatment and Drying phases, when Product Driven Mode is enabled, the system will control temperature at the shelf temperature setpoint (*i.e.,* Temperature SP).

During the Freeze phase, the system cools the shelves to the lowest possible temperature, advancing to the Hold step (*i.e.,* extra freeze) once the product average temperature (*i.e.,* Probe Avg), which is visible from the Cycle Status pull-down, meets or exceeds the product temperature setpoint (*i.e.,* Product Temp SP). The system continues cooling the shelves to the lowest possible temperature during the Hold, Condenser and Evacuate steps.

Note: *The Product Temp SP used during Freezing is different from the Product Temperature setpoint used during Drying.*



Product Driven Mode Enabled

Notes: *When Product Driven Mode is enabled, the temperature setpoint field below the word "Freeze" will read Product Temp SP. When Product Driven Mode is disabled, the temperature setpoint field below the word "Freeze" will read Shelf Temp SP.*

Your Freeze-Dry Recipe page may differ from the one shown above depending on your software configuration and purchased options.

Product Temperature Setpoint

During the Drying phase, when Product Driven Mode is enabled, the Product Temperature setpoint, which is entered in the field below the Product Driven Mode field, may be used to end the Drying phase early.

If at any time during Drying, the product average temperature (*i.e.,* Probe Avg), which is visible from the Cycle Status pull-down, meets or exceeds the Product Temperature setpoint, the cycle will immediately transition to the final Drying step (*i.e.,* step 17) where the system will control at the specified shelf temperature setpoint of that step (*i.e.* Temperature SP). The configurable range for the Product Temperature parameter is -70 to 70 °C.

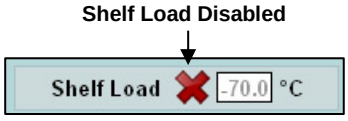
Note: *The Product Temperature setpoint used during Drying is different from The Product Temp SP used during freezing.*

Shelf Load

Shelf Load allows product to be loaded into the product chamber in one of two ways, at ambient temperature (*i.e.,* Shelf Load disabled) or in a controlled environment (*i.e.*, Shelf Load enabled).

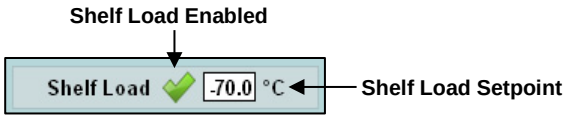
Product loaded at ambient temperature

If your product does not require a controlled environment for stability, it may be loaded into the product chamber at ambient temperature. If you are loading your product at ambient temperature, the Shelf Load field should be disabled (*i.e*. red X).



Product loaded in a controlled environment

If your product requires a controlled environment for stability, it may be loaded into the chamber over time at a defined Shelf Load temperature setpoint. Enable Shelf Load (*i.e.,* green checkmark) and define the Shelf Load temperature setpoint before starting your cycle.

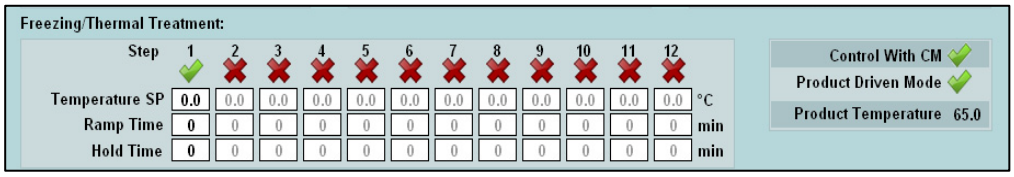


When the freeze-dry cycle is activated, the system will energize the heating and/or cooling system to maintain the shelf temperature at the desired setpoint. The configurable range for the Shelf Load parameter is -70 to 30 °C.

The system will not advance to the next phase (*e.g.,* Vacuum Preseal or Freezing / Thermal Treatment) until Shelf Load is disabled manually from the Freeze-Dry Recipe page. To disable, click on the green checkmark. If disabled successfully, the checkmark will change to a red X.

Freezing / Thermal Treatment

The Freezing / Thermal Treatment phase of the LyoS™ freeze-dry recipe provides 12 independently configurable thermal cycling (pre-freezing) steps that may be incorporated into any freezing routine. Within each step, you may program a shelf temperature setpoint within the range of -70 to 70 °C and Ramp and Hold intervals of up to 4,320 minutes. A green checkmark above a step column signifies that the step will be used as part of the freeze-dry cycle. Steps marked with a red X will be skipped during the cycle.



Notes: *Systems configured with Praxair's ControLyo™ Nucleation On-Demand Technology will include additional recipe parameters below the Freezing / Thermal Treatment steps, which may be utilized during thermal cycling.*

For more information, refer to Freeze-Dry Recipe Operation Section of Chapter 11: Praxair's ControLyo™ Nucleation On-Demand Technology.

Ramp Time

If a Ramp Time is programmed, the shelves will gradually adjust the temperature from the current shelf temperature to the temperature setpoint at a rate calculated by the PLC. Setting a Ramp Time allows for precise control of the rate of change from one shelf temperature setpoint to another.

The configurable range for this parameter is 0 to 4,320 minutes.

The PLC automatically calculates the rate based on the following formula:

([Shelf Temp. of the current step] – [Shelf Temp. of the previous step]) / (Time for current step) = Rate [°C/min]

Note: *Do not include a Ramp Time in the first step of the Freezing / Thermal Treatment phase; only use a Hold Time. This allows the system to determine a starting point for the calculation of a ramp rate for the following step(s).*

Hold Time

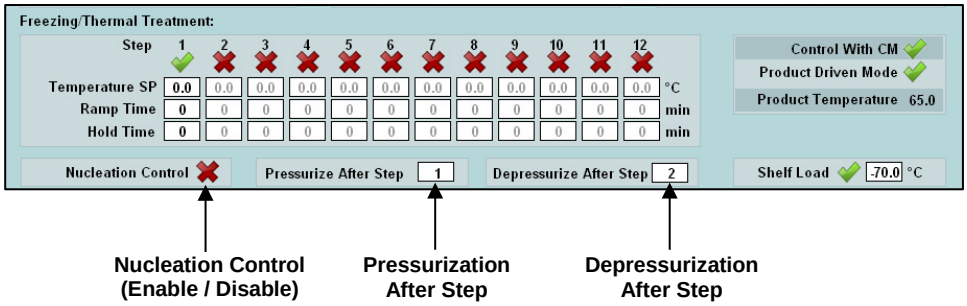
If no Ramp Time is entered, the shelves will achieve the step's temperature setpoint as quickly as possible and maintain that temperature for the length of time defined in the Hold Time field.

The configurable range for this parameter is 0 to 4,320 minutes.

Note: *If "Guaranteed Soak" is disabled, the step timer begins counting down as soon as the previous step ends, even if the shelf temperature setpoint has not been reached. If "Guaranteed Soak" is enabled, the step timer will not begin counting down until the shelf temperature is within the Temperature Deadband. Both Guaranteed Soak and Temperature Deadband may be set from the Configuration page.*

Praxair's ControLyo™ Nucleation On-Demand Technology Control

Systems configured with Praxair's ControLyo™ Nucleation On-Demand Technology will include additional recipe parameters below the Freezing / Thermal Treatment steps. These parameters may be utilized for Praxair's ControLyo™ Nucleation On-Demand Technology control during thermal cycling.



- **Nucleation Control (Enable / Disable).** The Nucleation Control field allows you to enable or disable Praxair's ControLyo™ Nucleation On-Demand Technology control for the automatic freeze-dry cycle.
- **Pressurization After Step.** Use the Pressurization After Step field to enter the desired Freezing / Thermal Treatment step. Once entered, Praxair's ControLyo™ Nucleation On-Demand Technology control will automatically begin. Purging will automatically precede the initial pressurization step according to the Nucleation Configuration Settings.

  Note: *Ensure that the programmed cycle sequence allows sufficient time for purge and pressurization steps to occur given the full Freezing / Thermal Treatment cycle sequence.*

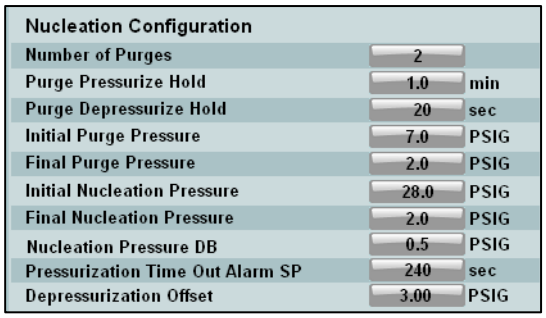
- **Depressurization After Step.** Use the Depressurization After Step field to enter the desired Freezing / Thermal Treatment step, after which depressurization will automatically begin.

  Notes: *The cycle step selected for the Depressurize After Step cannot occur before the cycle step selected for the Pressurization After Step. Depressurization will always occur after purging and pressurization.*

  For more information, refer to the Freeze-Dry Recipe Operation section of Chapter 11: Praxair's ControLyo™ Nucleation On-Demand Technology.

Nucleation Configuration Settings.

Prior to running a freeze-dry cycle configured to utilize Praxair's ControLyo™ Nucleation On-Demand Technology, ensure that the Nucleation Configuration Settings on the LyoS™ Configuration page are correct for your cycle.



Nucleation Configuration Settings for systems with the Praxair ControLyo™ Nucleation On-Demand Technology Option.

Note: *For more information, refer to the Nucleation Configuration Settings section of Chapter 10: Maintenance Menu.*

Freeze, Extra Freeze, Condenser and Evacuate

The Freeze heading is located between the Freezing / Thermal Treatment phase area and the Drying phase.

Below this title, from left to right, are fields for programming the Freeze, Hold (*i.e.,* extra freeze time), Condenser and Evacuate phases of the freeze-dry cycle. The fields include Shelf or Product Temperature Setpoint (this depends on whether Product Driven Mode is enabled on the Recipe page), Hold Time, Condenser Setpoint and Initial Vacuum Setpoint (*i.e.,* Evacuate phase). These inputs are critical when transitioning from Freezing / Thermal Treatment to the Drying phase. During this transition, the system will maintain the product at the shelf temperature setpoint while energizing the vacuum and condenser systems providing a low-pressure, unrestricted zone, which allows moisture to flow easily from the product.

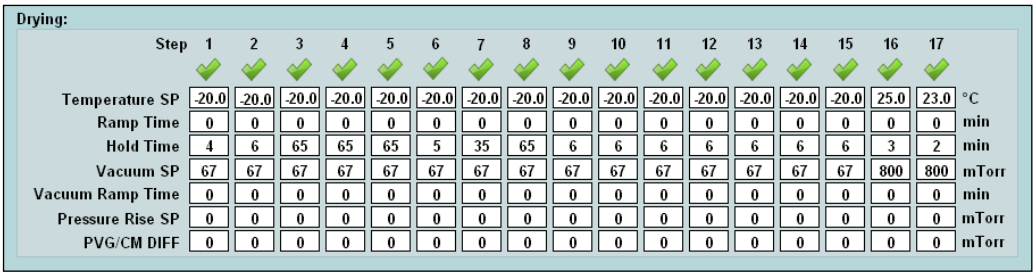
The configurable ranges for these parameters are as follows:

- **Shelf / Product Temp SP**: -70 to 20 °C
- **Hold Time**: 0 to 4,320 minutes
- **Condenser SP**: -70 to -30 °C
- **Initial Vacuum SP**: 20 to 1000 millitorr

Drying

During the Drying phase, the chamber pressure is reduced using vacuum. Heat is applied to the product causing the frozen water to sublime. Since vapor naturally travels toward cooler surfaces, the water vapor is collected on the surface of the condenser. The lyophilizer's condenser must have sufficient surface area and cooling capacity to hold all of the sublimed water from the batch at a temperature lower than the product temperature.[2]

Once all free water is absent from the product at the end of Drying, the shelf temperature may be increased without causing the product to melt. During the final step of the Drying phase, the temperature is increased to remove remaining bound water until the residual water content falls to the range required for optimum product stability.



Step	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	
Temperature SP	-20.0	-20.0	-20.0	-20.0	-20.0	-20.0	-20.0	-20.0	-20.0	-20.0	-20.0	-20.0	-20.0	-20.0	-20.0	25.0	23.0	°C
Ramp Time	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	min
Hold Time	4	6	65	65	65	5	35	65	6	6	6	6	6	6	6	3	2	min
Vacuum SP	67	67	67	67	67	67	67	67	67	67	67	67	67	67	67	800	800	mTorr
Vacuum Ramp Time	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	min
Pressure Rise SP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	mTorr
PVG/CM DIFF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	mTorr

Note: *The parameters displayed above are for illustrative purposes only.*

Drying Phase Steps

The LyoS™ Freeze-Dry Recipe page allows you to program up to 17 Drying steps. Within each step, you may program a temperature setpoint, which is monitored and controlled according to the temperature of the shelves and the temperature Ramp and Hold intervals. Unlike the steps in the Freezing / Thermal Treatment phase, Drying steps may be configured to control the system vacuum level according to the Vacuum Setpoint (SP) and Vacuum Ramp Time.

Note: *A Vacuum Ramp Time of zero (0) instructs the system to obtain the Vacuum SP as quickly as possible. Once the setpoint is obtained, the cycle will hold at the current step until all other step parameters are obtained.*

A green checkmark above a Drying step column signifies that the step will be used as part of the freeze-dry cycle. Steps marked with a red X are disabled and will not be executed during the cycle.

The configurable ranges for the parameters in the Drying phase are as follows:

- **Temperature SP**: -70 to 70 °C
- **Ramp Time**: 0 to 4,320 minutes
- **Hold Time**: 0 to 4,320 minutes
- **Vacuum SP**: 0 to 900 millitorr
- **Vacuum Ramp Time**: 0 to 4,320 minutes

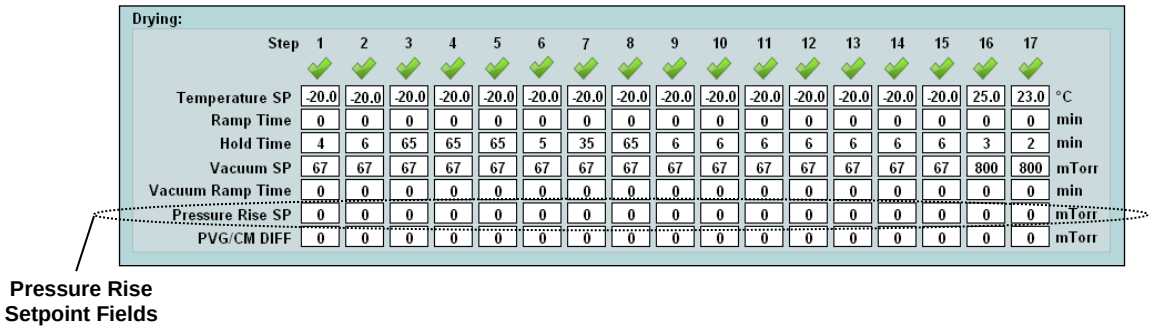
[2] During the Drying phase, the condenser is typically cooled to a minimum of 15 °C below the current product temperature.

Barometric Endpoint / Pressure Rise Testing

Barometric Endpoint testing can be a useful way of determining the endpoint of (primary) drying. It relies on closing the Isolation Valve between the product chamber and condenser chamber and observing the consequent rise in pressure. The time that the Isolation Valve is closed is generally short (*i.e.*, 15 to 30 seconds). The rate of pressure rise while the Isolation Valve is closed is an indication of product dryness.

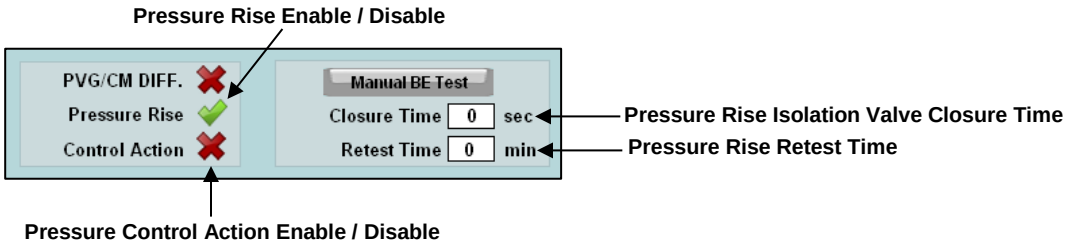
A row of programmable fields for each Drying step will be included on the Freeze-Dry Recipe layout for Barometric Endpoint / Pressure Rise testing. The configurable range for this parameter is 0 to 999 millitorr.

Note: *A value of zero (0) will disable the test for that step.*



Note: *The parameters displayed above are for illustrative purposes only and are not intended to be used as a guide for programming setpoints for Pressure Rise testing.*

Additional configuration fields are located at the bottom right corner of the Freeze-Dry Recipe page layout.



Note: *The parameters displayed above are for illustrative purposes only and are not intended to be used as a guide for configuring Pressure Rise testing.*

To enable Pressure Rise testing, you must enable Pressure Rise (as indicated by a green checkmark) and program a Pressure Rise SP (setpoint) in at least one Drying step. You will also need to enter an Isolation Valve Closure Time or Pressure Rise test time.

Note: *Pressure Rise testing will not begin until all configured hold times have expired for the active step.*

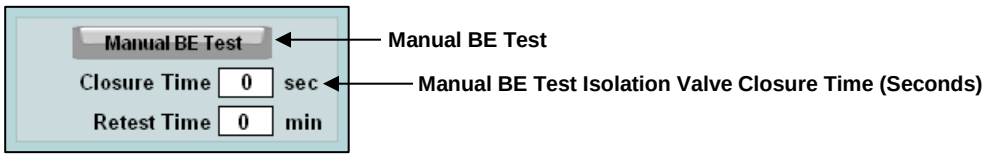
Enabling Pressure Rise causes the system to close the Isolation Valve, record the product chamber vacuum level and start the test timer according to the specified Closure Time setpoint for each Drying step programmed to perform a pressure rise test. When the valve Closure Time expires, the system subtracts the initial vacuum level from the current vacuum level. The Pressure Rise result, whether it meets your criteria for passing or not as defined by the Pressure Rise SP (setpoint), is displayed on the Cycle Status pull-down. The configurable range for Closure Time is 0 to 600 seconds.

If you prefer to continue testing the Pressure Rise for each step until a passing result is achieved, you may enable Pressure Control Action (indicated by green checkmark) and program a Retest Time. The configurable range for Retest Time is 0 to 3,200 minutes.

If both Pressure Rise and Control Action are enabled, and the cycle reaches a Drying step programmed to perform a pressure rise test, the system once again closes the Isolation Valve, records the product chamber vacuum level and starts the test timer according to your Closure Time setpoint. When the valve Closure Time expires, the system subtracts the initial vacuum level from the current vacuum level. The difference here is that if the resulting Pressure Rise is not less than or equal to your Pressure Rise SP (setpoint) for the tested step, the Isolation Valve opens and the cycle holds at the current step for the specified Retest Time. Once the Retest Time expires, the cycle repeats the Pressure Rise test for the active step. This process repeats until the Pressure Rise test passes according to your Pressure Rise SP (setpoint).

Manual BE (Barometric Endpoint) Test

The LyoS™ control system allows users to manipulate the Isolation Valve manually from the Freeze-Dry Recipe page while the Drying phase of a freeze-dry cycle is in process. This is achieved by clicking the Manual BE Test button on the Freeze-Dry Recipe page, which will trigger the Isolation Valve to close for the duration of time (in seconds) entered into the Closure Time field.



Note: *Manual BE is not enabled for use during the Freezing phases of a freeze-dry cycle.*

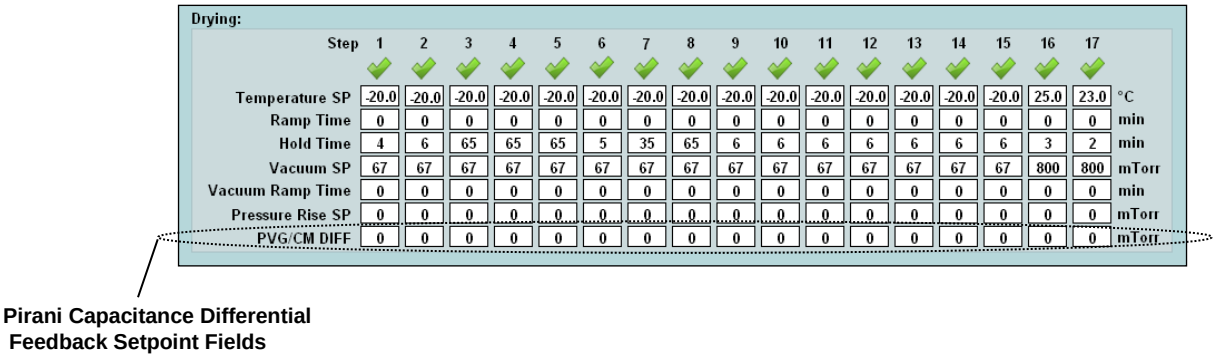
WARNING! LEAVING THE ISOLATION VALVE CLOSED FOR A LONG PERIOD OF TIME WILL INCREASE CHAMBER PRESSURE WHICH MAY DAMAGE YOUR PRODUCT OR SYSTEM. USE CAUTION WHEN CLOSING THE ISOLATION VALVE FOR AN EXTENDED PERIOD OF TIME.

Pirani Vacuum Gauge / Capacitance Manometer Differential Feedback (PVG/CM DIFF)

Pirani vacuum gauge / capacitance manometer differential feedback testing allows you to execute a vacuum differential test at the end of each Drying step to assist in determining the end of the Drying phase.

A row of programmable fields for each Drying step will be included on the Freeze-Dry Recipe layout for Pirani Capacitance Differential Feedback testing. The configurable range for this parameter is 0 to 999 millitorr.

Note: *A value of zero (0) will disable the test for that step.*

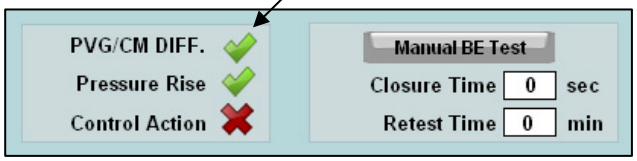


Pirani Capacitance Differential Feedback Setpoint Fields

Note: *The parameters displayed above are for illustrative purposes only and are not intended to be used as a guide for programming setpoints when performing Pirani Capacitance Differential Feedback (PVG/CM DIFF) testing.*

An additional configuration field is located in the bottom right corner of the Freeze-Dry Recipe page layout.

Pirani Vacuum Gauge / Capacitance Manometer Differential Feedback Enable / Disable



When enabled, the Pirani Vacuum Gauge / Capacitance Manometer Differential Feedback feature stops the system from advancing to the next step until the difference between the Pirani vacuum gauge and the capacitance manometer is less than the defined PVG/CM DIFF setpoint. The PVG/CM DIFF result is displayed on the Cycle Status pull-down.

Backfill / Stoppering

Your LyoS™ freeze-dry cycle page incorporates backfill and stoppering functions. These functions allow you to automatically backfill and/or activate the stoppering system at the end of the freeze-dry cycle. Enabling Backfill will also allow you to set a backfill setpoint. The configurable range for this parameter is 0 to 800 millibar (mBar).

If automatic backfill and stoppering are enabled at the start of the cycle, backfill and stoppering will occur automatically after the last programmed drying step. The vacuum pump will be deactivated and the backfill valve on the product chamber will open to allow nitrogen, room air or customer specified inert gas in until the backfill setpoint is reached. At that point, the valve will close and the shelves will compress. SP Scientific recommends performing backfill and stoppering with full trays of vials.

After stoppering, the vacuum pump remains off and the shelves heat or cool to the Product Storage shelf setpoint. Once the system completes the backfill and/or stoppering functions, the cycle will return to the Product Storage phase until the End Cycle function is selected.

Product Storage

The Product Storage phase allows you to define the conditions in which your product will be stored after the completion of the freeze-dry cycle. The system will remain at the Storage Temperature and Storage Pressure indefinitely until the cycle is cancelled or ended using the End Cycle function. The configurable ranges for these parameters are -70 to 70 °C and 0 to 1000 millitorr.

If automatic backfill and/or stoppering is enabled, the cycle will perform the required functions and then return to the Product Storage phase. The cycle must be ended manually.

If your LyoS™ control system is configured with SMART Freeze Dryer™ technology, the Final Shelf Setpoint temperature programmed from the SMART page will override the Product Storage Temperature SP programmed from the Freeze-Dry Recipe page when the system is operating in SMART Freeze Dryer™ technology mode.

End Cycle

Upon completion of the freeze-dry cycle, you will need to follow a series of steps to ensure your product may be removed safely from the product chamber.

Note: *Before removing your product from the chamber, you will need to release vacuum from the system and allow it to equalize to atmospheric pressure.*

Product Storage (Backfill and Stoppering Disabled)

If your system is in the Product Storage phase at the end of a freeze-dry cycle and neither automatic backfill or automatic stoppering were enabled as part of the cycle, a green checkmark will appear to the right of your Product Storage Temperature Setpoint.

Complete the Cycle

1. To end the freeze-dry cycle, select the green checkmark to the right of the Product Storage Temperature SP (setpoint).
2. The system will release vacuum from the system.

Backfill / Stopper Prior to End Cycle

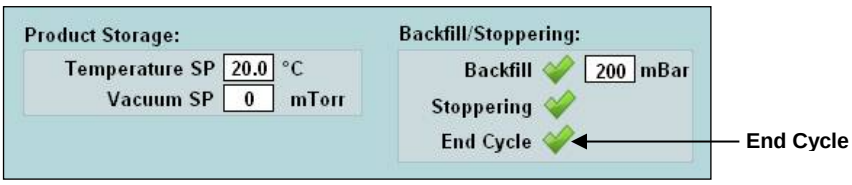
3. If you would prefer not end the cycle at this point, you may enable Backfill and/or Stoppering to begin backfilling the product chamber and/or activating the stoppering mechanism immediately.
4. Once the backfill and/or stoppering tasks are complete, a green checkmark will appear to the right of the End Cycle field.

5. Select this green checkmark to end the freeze-dry cycle.
6. The system will release vacuum from the system.

Product Storage (Backfill and/or Stoppering Enabled)

If backfill and/or stoppering are enabled as part of the freeze-dry cycle, the cycle will perform the required functions and return to the Product Storage phase.

7. Once the cycle returns to the Product Storage phase, a green checkmark will appear to the right of the End Cycle field.



8. Select this green checkmark to end the freeze-dry cycle.
9. The system will release vacuum from the system.

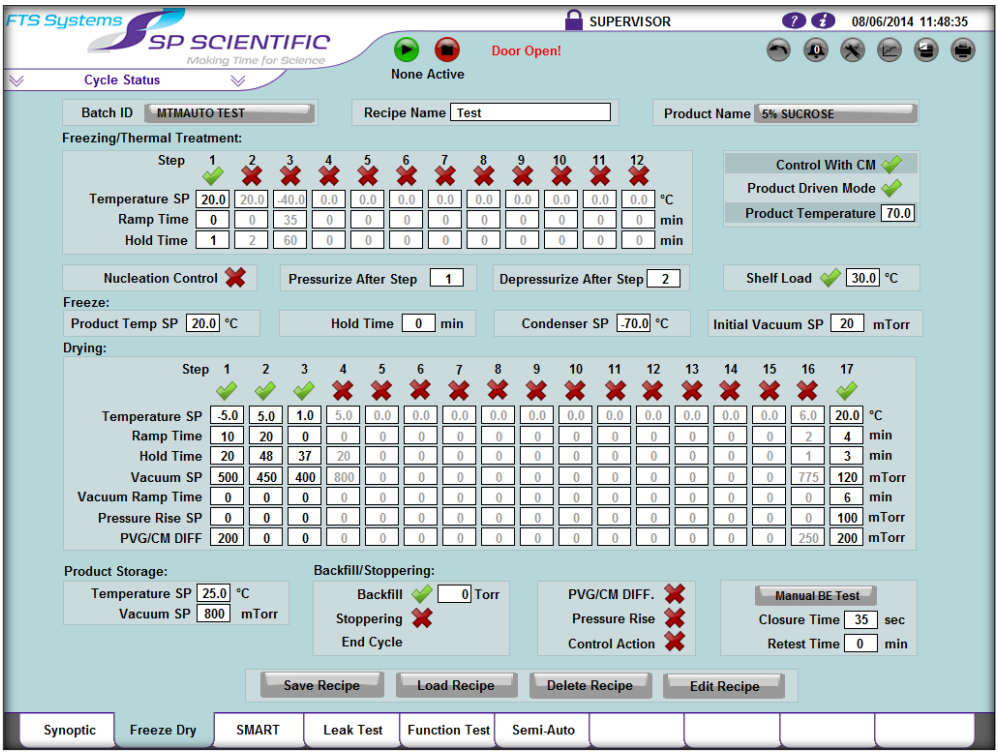
Recipe Management

Note: *If your system is configured with the SEC3 option, refer to Recipe Management section of Chapter 14: SEC3 Security Option (21 CFR Part 11 Compliant-Capable).*

After becoming acquainted with the Freeze-Dry Recipe page, you may create, save, load, delete and otherwise modify recipes using the LyoS™ Recipe Manager.

While completed recipes may be printed or discarded after use, recipes may also be saved and loaded for future use. To save, load or delete recipes, choose the appropriate button on the Freeze-Dry Recipe page. Recipes are maintained using Microsoft® Access®.

Note: *Recipes cannot be saved or loaded while an automatic freeze-dry cycle is active.*



Freeze-Dry Recipe Page

Notes: *Your actual Freeze-Dry Recipe page may differ from the one shown above depending on your software configuration and purchased options. The parameters displayed above are for illustrative purposes only.*

Creating and Modifying Recipes

To create or modify a recipe, select the Edit Recipe button on the Freeze-Dry Recipe page. All fields will turn gray, which signals that they are available for editing.

Recipe parameters may be modified and entered during an active freeze-dry cycle. However, since active recipes are accessed directly from the PLC they cannot be saved to the PC during the cycle. To save a recipe that was modified mid-cycle, wait for the active freeze-dry cycle to complete and refer to the Saving Recipes section of this chapter.

To prevent fields from unintended changes, select the Edit Recipe button again. Fields are unavailable for editing when their background appears solid white. Toggling the Edit recipe button locks and unlocks the ability to edit recipe fields.

Note: *You may also prevent editing of the Freeze-Dry Recipe and other automatic cycle parameters by limiting security access/privilege levels of individual users or user groups. For more information, refer to Chapter 13: SEC1 Standard Security or Chapter 14: SEC 3 Security Option (21 CFR Part 11 Compliant-Capable).*

Saving Recipes

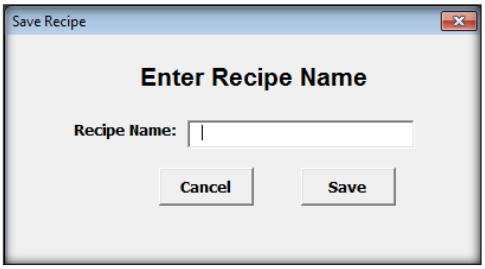
After entering Freeze-Dry Recipe parameters, your recipe may be saved and stored in the lyophilizer's PLC.

Note: *Communication between the PLC and the computer must be established for the Recipe Manager to operate properly. If you are having problems with recipe management functionality, check that all cables are connected and that data is displayed properly on the Synoptic page.*

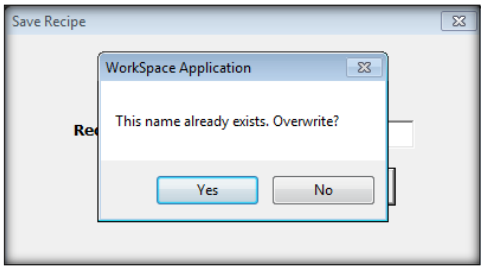
To save a recipe:

1. Click the Save Recipe button on the Freeze-Dry Recipe screen.

2. Enter a name for your recipe then click the Save button.



3. The Recipe Manager function will verify if the recipe name currently exists.
   a. If the recipe name is available, the recipe is saved and the system will close and exit.
   b. If the recipe name is availabe but an error message occurs, check the error message for what caused the error.
   c. If the recipe name currently exists, you will be prompted to overwrite the existing recipe.



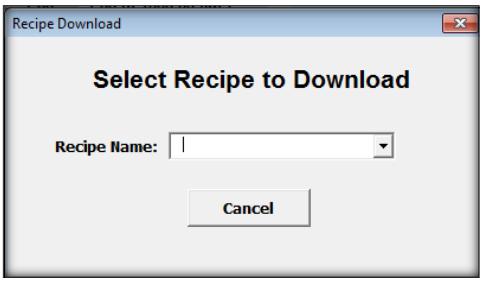
1. Click Yes to overwrite the existing recipe.
2. Choose No to enter a new name.

Loading Recipes

Once a recipe has been saved to the PLC, it may be loaded to the Freeze-Dry Recipe page for use.

To load a recipe to the Freeze-Dry Recipe page:

1. From the Freeze-Dry Recipe page, click the Load Recipe button.
2. The Recipe Download dialog will open. Select a Recipe from the combo box drop-down list.



3. Once selected, the recipe will download and exit out of the dialog box.
4. Choose cancel before selecting a recipe to exit the Recipe Download function.

Deleting Recipes

To delete a previously saved recipe:

1. Click the Delete Recipe button from the Freeze-Dry Recipe page.
2. The Delete Recipe dialog will open. Select a Recipe from the combo box drop-down list.

3. A message will appear asking you if you want to delete the recipe.

   Note: *Use caution when deleting recipes. Deleted recipes may not be recovered.*

4. Click Yes to delete and Exit or No to Cancel and Exit.

Running a Freeze-Dry Cycle

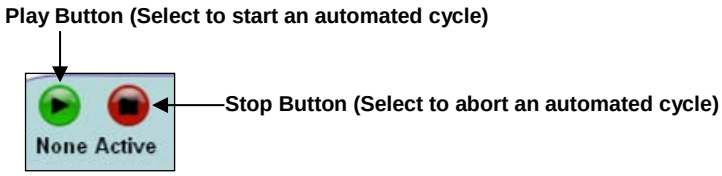
Before running your freeze-dry cycle, you may add a Batch ID and/or Product Name for identification purposes. This can be accomplished by selecting the Batch ID or Product Name button while the Freeze-Dry Recipe page is in editable mode, and entering the desired information into the corresponding pop-up field.

If a controlled temperature is desired for loading product, select Shelf Load field and, if required, enter a loading temperature to energize the shelf heating and cooling system.

Note: *The system will not advance to the Freezing / Thermal Treatment phase until Shelf Load is disabled manually from the Freeze-Dry Recipe page.*

Once a recipe has been programmed, saved and/or downloaded, you may click the Play button to begin the automated freeze-dry cycle. Click the Stop button at any time during an automatic cycle to abort the cycle.

Note: *You must have the Freeze-Dry Recipe page open when starting a freeze-dry cycle.*



The system will attempt to advance through the freeze-dry cycle, from Freezing / Thermal Treatment to the Storage phase, without the need for additional user inputs.

Recipe parameters may be modified during an active automatic cycle. However, since active recipes are accessed directly from the PLC they cannot be saved to the PC during the cycle.

Note: *To save a recipe that was modified mid-cycle, wait for the active freeze-dry cycle to complete and refer to the Saving Recipes section of this chapter.*

To advance out of the Storage phase, you must select the check mark to the right of the Temperature SP (setpoint) or the check mark to the right of the End Cycle field (if Backfill and/or Stoppering were enabled).

Note: *For more information, refer to the End Cycle section of this chapter.*

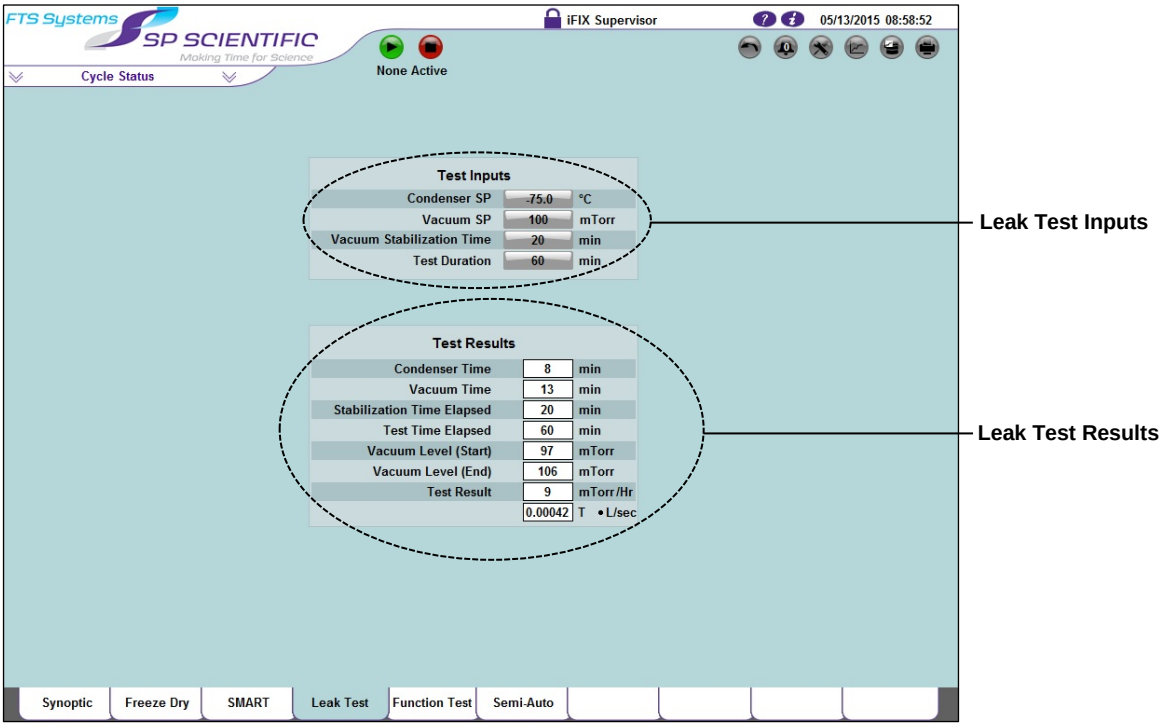
Chapter 6

Leak Test

Overview

Real or virtual vacuum leaks shall cause a decrease in the lyophilizer's ability to achieve the lowest specified vacuum (blank-off). The LyoS™ Leak Test page provides you with the means to test the tightness of the lyophilizer's complete vacuum system. By running a leak test cycle and evaluating the results, an acceptance value can be established and used for comparison against later tests to assure uniform operational performance.

Note: *The test should always be performed on a clean, dry and empty system.*



Leak Test Page

Note: *The parameters displayed above are for illustrative purposes only and are not intended to be used as a guide for performing a Leak Test.*

During the automated Leak Test, the system remains undisturbed for a selected period and the start and end vacuum levels are recorded. The Leak Rate is then calculated and results are displayed.

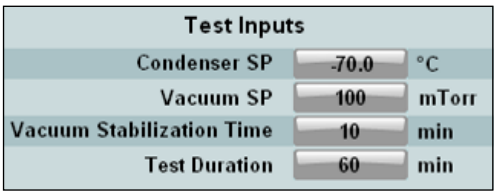
Units of Measure

The calculated results can be displayed in different units of measure based on the user's selection on the Configuration page. Calculated Rate of Rise will be displayed as mTorr/Hr or µBar/Hr and Volume Based Leak Rate can be displayed as T•L/sec or mBar•L/sec. It is important to select the preferred units of measure before performing the Leak Test. Once results are calculated, the system cannot convert the values.

Note: *Preferred units of measure for the results of the Leak Rate Test are selected using the Configuration page.*

Programming a Leak Test Cycle

The Leak Test page offers the following data input fields.



Condenser Setpoint

The Condenser Setpoint is the temperature setpoint that the condenser must achieve before the vacuum system will be energized. This value may be set close to the lyophilizer's lowest specified condenser temperature (blank-off), though condenser setpoints of -45 °C and -50 °C may be a sufficient starting point. The configurable range for this parameter is -75 to 20 °C.

Vacuum Setpoint

The Vacuum Setpoint is the pressure setpoint that the product chamber must achieve before the cycle begins the Leak Test. The configurable range for this parameter is 20 to 1000 millitorr, though a vacuum setpoint of 100 millitorr is usually sufficient.

Vacuum Stabilization Time

The Vacuum Stabilization Time is the amount of time the cycle allows for the condenser to pull-down to its lowest possible temperature. This timer begins after the condenser has reached the Condenser Setpoint and after the Vacuum Setpoint has been achieved. When the Vacuum Stabilization Time expires, the initial vacuum pressure, Vacuum Level (Start), is recorded and the leak test begins.

Be sure to allow the system sufficient time to stabilize in order to avoid inaccurate negative leak rate results. A Vacuum Stabilization Time of 10 to 15 minutes is sufficient in most cases. The configurable range for this parameter is 0 to 4,320 minutes.

Note: *Setting an insufficient stabilization time may provide inconsistent and inaccurate results. See Test Duration.*

Test Duration

The Test Duration parameter is the specified period during which the actual vacuum leak test is performed. The configurable range for this parameter is 5 to 4,320 minutes; however, a duration between 60 and 120 minutes is preferred for optimum results.

Note: *Since vacuum rate of rise is constant, longer test times are preferred and provide greater accuracy.*

The condenser remains at its lowest specified condenser temperature (blank-off) for the duration of the test. After the Test Duration, the final vacuum level (*i.e.,* Vacuum Level (End)), is recorded and the leak rate test results are displayed.

The system automatically releases vacuum at test completion.

Running a Leak Test

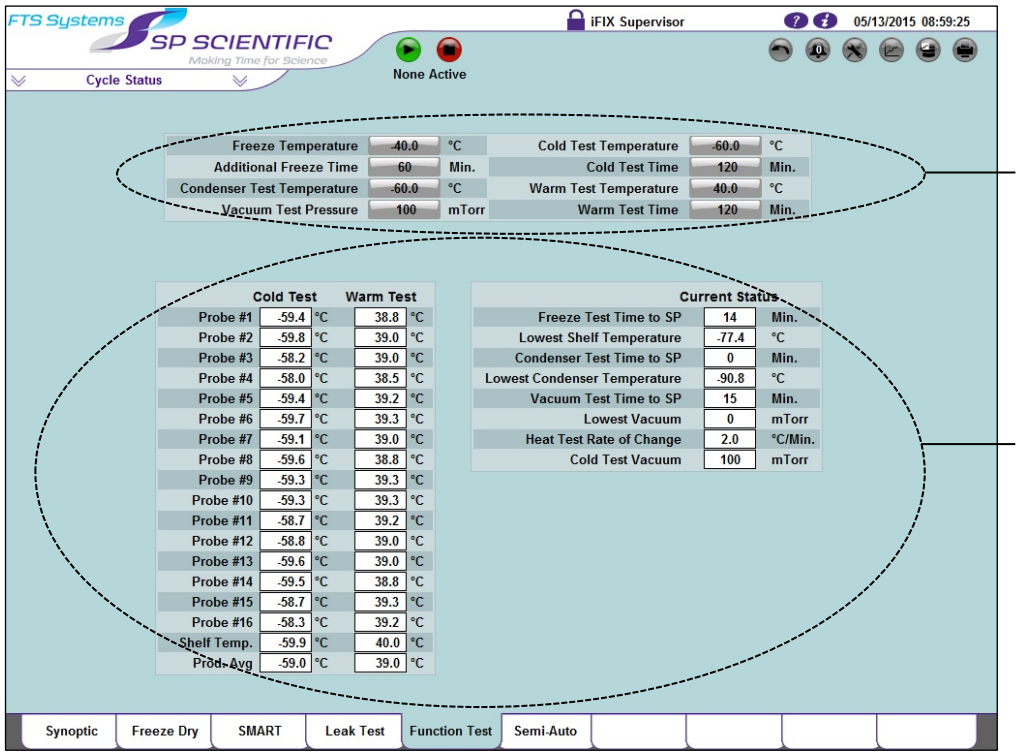
After programming your Leak Test, you may begin the leak test by selecting the Play button at the top of the Leak Test page.

After the cycle completes, the system will automatically release vacuum to atmospheric pressure. Leak Test results shall be displayed in the Test Results section of the page. Results may be printed by clicking Print button at the top of the Leak Test page.

Function Test

Overview

The Function Test page offers the ability to automatically test the performance of your lyophilizer with an emphasis on major subsystems, such as the shelf heat transfer system, refrigeration system and vacuum system.



Function Test Page

Notes: *Your Function Test page may vary from the page shown, depending on the options purchased with your system.*

The parameters displayed above are for illustrative purposes only and are not intended to be used as a guide for performing a Function Test.

By running an automated Function Test and evaluating the results, acceptance values can be established and used for comparison against later tests to assure uniform operational performance.

Note: *The test should always be performed on a clean, dry and empty system.*

Upon completion of the Function Test cycle, you will receive values for Freeze Test Time to Setpoint, Lowest Shelf Temperature, Condenser Test Time to Setpoint,

Lowest Condenser Temperature, Vacuum Test Time to Setpoint, Lowest Vacuum, Heat Test Rate of Change and Cold Test Vacuum.

Additionally, product probe test data at the specified Cold Test and Warm Test temperatures is captured and displayed in the Cold Test and Warm Test results data columns. This data may also be obtained from the Historical Trends page.

Using Product Probes for Testing

During the Function Test, you may test the lyophilizer's shelf temperature uniformity capabilities at specific cold and warm test temperatures. When testing the temperature uniformity capabilities of the product shelves, you may use the product probes supplied with your system.

ASSESSING THE SHELF TEMPERATURE UNIFORMITY CAPABILITIES OF YOUR LYOPHILIZER MAY REQUIRE RUNNING MULTIPLE FUNCTION TESTS WITH MULTIPLE PROBE PLACEMENT CONFIGURATIONS DEPENDING ON THE NUMBER OF SHELVES IN THE PRODUCT CHAMBER AS COMPARED TO THE NUMBER OF SUPPLIED PRODUCT PROBES.

ADDITIONAL EQUIPMENT, SUCH AS AN EXTERNAL DATA LOGGER MAY BE UTILIZED TO ASSIST IN MAPPING PRODUCT SHELVES DURING THE FUNCTION TEST, HOWEVER, IF THIS TYPE OF EQUIPMENT IS UNAVAILABLE SIMPLY RUN ADDITIONAL TESTS AND USE MULTIPLE PROBE PLACEMENT CONFIGURATIONS.

Product Probe Placement

SP Scientific recommends positioning product probes on similar locations on each shelf to accurately assess the uniformity across individual shelves as well as the uniformity from one shelf to another.

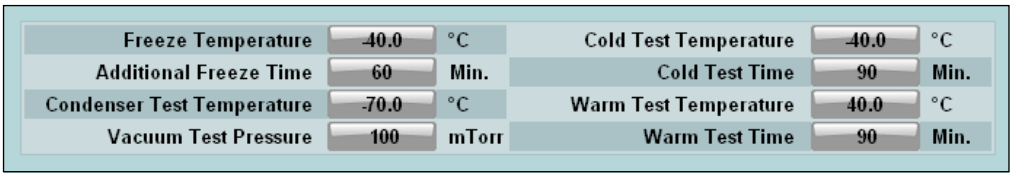
One suggestion is to position the first two product probes in the product chamber on the top usable shelf approximately one (1) to two (2) inches in from the side, and two (2) inches back from the front corners of the shelf. Additional probes should be positioned similarly on all other usable shelves. Intersperse product probes as evenly as possible throughout the chamber. If sufficient probes are available, position them on the middle areas of each shelf (*i.e.*, front/middle, middle/middle, back/middle).

When placing product probes on the shelves:

1. Make sure shelf surfaces are clean, dry and at room temperature.
2. Submerge the product probe end into the compound, ensuring that the compound completely covers the probe.
3. Secure the product probe with a piece of aluminum foil tape. To prevent the product probe wire from pulling the probe out of position, tape down the wire two inches back from the probe.
4. Repeat the procedure for the remaining product probes.

Programming a Function Test Cycle

The Function Test page includes several programmable value fields.



Freeze Temperature

The Freeze Temperature is the shelf temperature setpoint that the system will use to determine the Freeze Test Time to Setpoint. During the Freeze phase of the Function Test, the system shall direct all of the refrigeration system's cooling capacity to the shelves to provide maximum cooling until the shelves reach the Freeze Temperature setpoint. The time it takes for the shelves to reach the setpoint is calculated and displayed in the results area as the Freeze Test Time to SP (setpoint), which is commonly referred to as shelf pull-down.

The Lowest Shelf Temperature is also determined during this phase and updated accordingly throughout the test.

The configurable range for this parameter is -70 to 25 °C.

Additional Freeze Time

Additional Freeze Time is the amount of time that the shelves will continue to be cooled after reaching the Freeze Temperature setpoint and before entering the Condenser phase of the Function Test. While this phase is optional, the setpoint is typically used to allow the shelves time to pull-down to their lowest possible temperature (*i.e.*, Lowest Shelf Temperature). The Lowest Shelf Temperature is updated after this phase.

The configurable range for this parameter is 0 to 4,320 minutes.

Condenser Test Temperature

The Condenser Test Temperature is the temperature setpoint that the condenser must achieve before the vacuum system will be energized. During this phase, all of the refrigeration system's cooling capacity is directed to the condenser. The cycle advances to the next phase when the condenser temperature is equal to or less than the Condenser Test Temperature setpoint.

The Condenser Test Time to SP (setpoint), commonly referred to as condenser pull-down, as well as the Lowest Condenser Temperature are determined during this phase.

The configurable range for this parameter is -75 to -25 °C.

Vacuum Test Pressure

The Vacuum Test Pressure is the pressure setpoint that the system must achieve during the Function Test. The vacuum system maintains system pressure at the Vacuum Test Pressure setpoint during the Cold Test phase. The Lowest Vacuum and the Vacuum Test Time to Setpoint, commonly referred to as vacuum pull-down, are determined during this phase. Since the condenser continues to pull-down during this phase, the Lowest Condenser Temperature is updated after this phase.

The configurable range for this parameter is 20 to 900 millitorr.

Note: *During the Warm Test phase, the system is evacuated to the lowest possible vacuum (vacuum blank-off pressure).*

Cold Test Temperature

The Cold Test Temperature is the temperature that the shelves must achieve and maintain for the Cold Test phase of the test. For example, to test shelf temperature uniformity at -40 °C, enter -40 °C as your Cold Test Temperature setpoint.

During the Cold test phase, the vacuum system maintains system pressure at the Vacuum Test Pressure setpoint. Once the Cold Test Time expires, the system warms the shelves to the Warm Test Temperature setpoint as quickly as possible and maintains the shelf temperature at the setpoint for the duration of the Warm Test phase.

Data acquired during this phase shall be used to determine shelf temperature uniformity and the Heat Test Rate of Change. Cold Test probe readings are captured and displayed in the Cold Test results column.

The configurable range for this parameter is -60 to 0 °C.

Cold Test Time

The Cold Test Time setpoint is the amount of time that the shelves will hold at the Cold Test Temperature setpoint; essentially, the configured duration of the Cold Test phase.

The configurable range for this parameter is 5 to 4,320 minutes.

Warm Test Temperature

The Warm Test Temperature is the temperature that the shelves must achieve and maintain for the Warm Test phase of the test. This setpoint is also used to calculate the Heat Test Rate of Change. For example, to test shelf temperature uniformity at 40 °C with 40 °C as your cutoff temperature for determining the Heat Test Rate of Change, enter 40 °C as your Warm Test Temperature setpoint.

Note: *When the Shelf Temperature is 5 °C above the Cold Test Temperature setpoint, the system starts calculating the Heat Test Rate of Change.*

Upon completion of the Cold Test phase, the system warms the shelves to the Warm Test Temperature setpoint as quickly as possible and maintains the shelf temperature at the setpoint for the duration of the Warm Test phase. The system is evacuated to the lowest possible vacuum (vacuum blank-off pressure) and the results data for Lowest Vacuum is updated.

The Heat Test Rate of Change is calculated when the shelf temperature is 5 °C less than the Warm Test Temperature. Warm Test probe readings required for determining shelf temperature uniformity are captured and displayed in the Warm Test results column.

The configurable range for this parameter is 0 to 70 °C.

Warm Test Time

The Warm Test Time setpoint is the amount of time that the shelves will hold at the Warm Test Temperature setpoint; essentially, the configured duration of the Warm Test phase.

The configurable range for this parameter is 5 to 4,320 minutes.

Running a Function Test

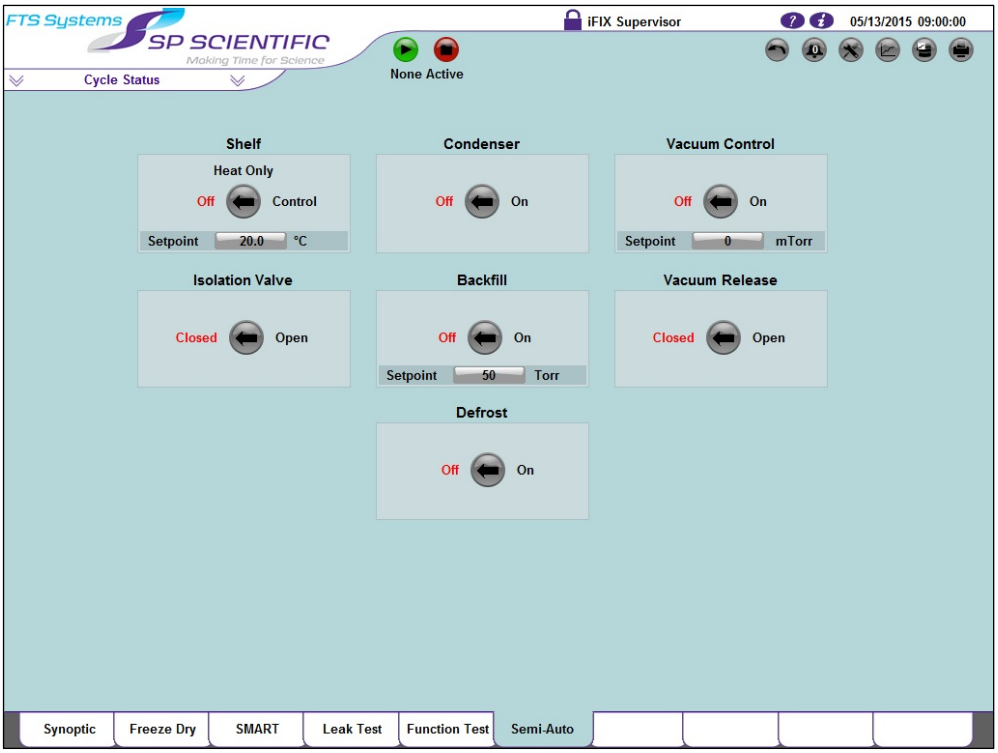
After programming your Function Test, you may begin the Function Test by selecting the Play button at the top of the Function Test page.

After the cycle completes, the system will automatically release vacuum to atmospheric pressure. Cold Test and Warm Test probe readings captured during the test shall be displayed in the Cold Test and Warm Test results columns.

Test results for Freeze Test Time to SP (*i.e.*, shelf pull-down time to setpoint), Lowest Shelf Temperature, Condenser Test Time to Setpoint (*i.e.*, condenser pull-down), Lowest Condenser Temperature, Vacuum Test Time to SP (vacuum pull-down time to setpoint), Lowest Vacuum and Heat Test Rate of Change are also displayed.

Overview

Semi-Auto operation offers the ability to activate individual functions of your freeze dryer from a single page.



Semi-Auto Page

Semi-Auto control may only be utilized when the system is in a “Idle” state and no automatic cycles are in progress. Once an automatic cycle is started, you cannot switch to Semi-Auto mode until you complete or abort the current cycle.

Note: *The Semi-Auto tab is only accessible when there is no active cycle.*

Standard Functions

Shelf

The Shelf function may be used to activate the shelf heating and cooling system. The Shelf function allows you to control the temperature of the shelves at a specific setpoint, or to only heat the shelves. During Shelf Control, the system activates the shelf solenoid, fluid pump and compressor(s) to reach the defined setpoint. When using the Heat function, the system activates the fluid pump and the fluid heater only.

Condenser

The Condenser function may be used to activate the compressor(s) and the condenser solenoid to cool the condenser. When the condenser function is activated, the system will attempt to reach the lowest condenser temperature.

Vacuum Control

The Vacuum Control function may be used to activate the vacuum pump and all associated valves. Enter a value in the setpoint field to control at a desired vacuum or enter a setpoint of zero (0) for full vacuum.

Isolation Valve

The Isolation Valve function may be used to toggle the chamber isolation valve between the open and closed positions.

Backfill

The Backfill function may be used to backfill the product chamber with an inert gas to a desired setpoint. This function opens the backfill solenoid valve as long as the current system pressure is less than the Backfill setpoint.

Vacuum Release

The Vacuum Release function may be used to release vacuum by admitting environmental air or gas, if available. This function opens the vacuum release solenoid and the backfill valve.

Defrost

The Defrost function may be used to activate the defrost system and melt condensed vapors (ice) away from the condenser coil. When the Defrost function is active, the condenser temperature will be regulated between 60 and 70 °C for the duration of time specified in the Defrost Time parameter on the Configuration page, or until the user turns the defrost function off. The individual system components activated by this switch may differ depending on the type of defrost system utilized for your lyophilizer.

ControLyo™ Functions

Depending on your lyophilizer's configuration, your Semi-Auto page may include additional functions. For example, systems configured with Praxair's ControLyo™ Nucleation On-Demand Technology will include the following Semi-Auto functions.

Note: *For more information, refer to Chapter 11: Praxair's ControLyo™ Nucleation On-Demand Technology.*

Pressurize

The pressurization process for controlled nucleation involves the introduction of a sterile filtered inert gas into the lyophilizer product chamber. The Pressurize function associated with Praxair's ControLyo™ Nucleation On-Demand Technology may be used to open the system's pressurization valve and pressurize the chamber with inert gas. The pressurize function includes purges and a final pressurization for nucleation.

Note: *The number of purges and purge pressure are set from the configuration page, which is accessible from the Maintenance menu.*

Depressurize

The depressurization process for controlled nucleation involves the rapid depressurization of the pressurized product chamber to a controlled setpoint above atmospheric pressure. The Depressurize function associated with Praxair's ControLyo™ Nucleation On-Demand Technology may be used to open the system depressurization valve, open the depressurization bypass and depressurize the chamber.

Chapter 9

Historical Data

Overview

The LyoS™ control system provides real-time trending, historical trending and reporting capabilities. Historical trending of process variables and setpoints is based on the control system configuration. The minimum scan time is 10 seconds (*i.e.*, the time it takes a variable or setpoint to update to the historical view plot). For most lyophilization applications, this scan time is more than sufficient to accurately trend critical process data.

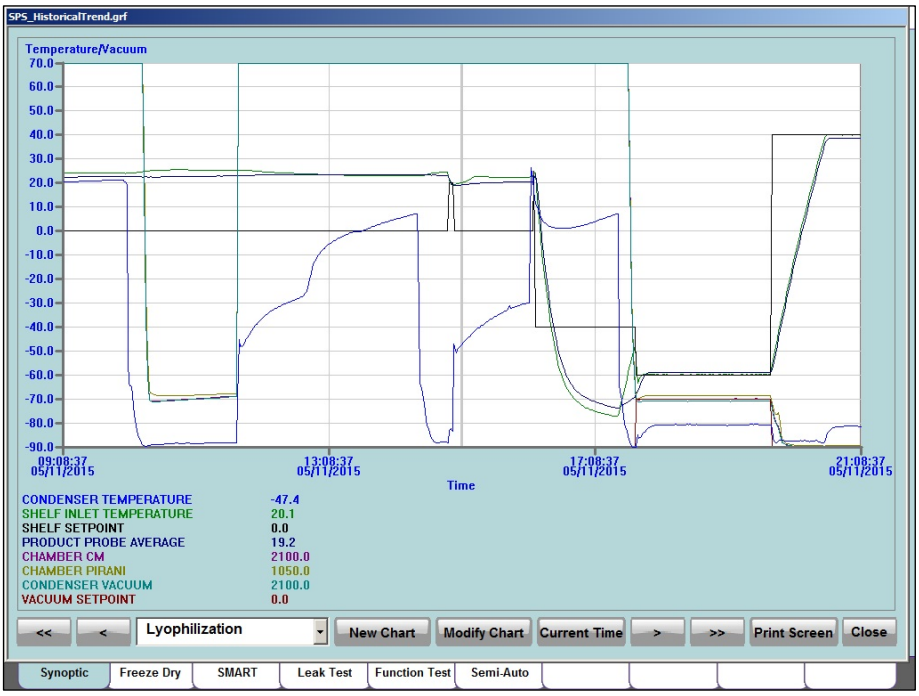
Proficy® Historian is included on the LyoS™ control system for secured historical data archiving. For control systems with SEC1 security, historical data files are stored in the **C:\Proficy Historian for SCADA 4.5 Data\Archives** directory. For control systems with SEC3 security, historical data files are stored in the **C:\Proficy Historian SCADA 5.0 Data\Archives** directory. With either SEC1 or SEC 3 security, files are stored without deletion until system resources are exhausted (*e.g.,* hard drive becomes too full to process data collection and storage). Each file has a unique date and time assigned as part of its file name structure.

DELETING HISTORICAL DATA FILES WILL REMOVE THEM FROM YOUR SYSTEM. BE SURE TO BACK UP DATA FILES PRIOR TO DELETION.

Selecting the Trend button from the top right corner of the LyoS™ layout launches a Historical Trend window, which opens over the LyoS™ control system's main layout.

Viewing Historical Data Trend

Historical data is displayed in an easy-to-read, customizable chart.



Historical Trend Window

The time and date values displayed below the Historical Trend chart will change based on where the moveable vertical axis is positioned. To move the axis, position the cursor directly on the axis and drag it to the desired location.

Several charts are available from the Historical Trend window. To view the various charts, click the combo box arrow and select the desired chart from the pull-down list.

Trend Data Pen List

The following table details standard and optional LyoS™ factory programmed charts and their related Pens:

Chart	Pen List
Lyophilization	Trends of Condenser Temperature, Shelf Inlet Temperature, Shelf Setpoint, Product Probe Average, Chamber CM, Chamber Pirani, Condenser Vacuum and Vacuum Setpoint.
Lyophilization_CL[3]	Trends of Condenser Temperature, Shelf Inlet Temperature, Shelf Setpoint, Product Probe Average, Chamber CM, Chamber Pirani, Condenser Vacuum, Vacuum Setpoint and ControLyo Chamber Pressure.
Probes 1_8	Trends of Product Probe 01, Product Probe 02, Product Probe 03, Product Probe 04, Product Probe 05, Product Probe 06, Product Probe 07, Product Probe 08, and Product Probe Average.
Probes 9_16	Trends of Product Probe 09, Product Probe 10, Product Probe 11, Product Probe 12, Product Probe 13, Product Probe 14, Product Probe 15, Product Probe 16, and Product Probe Average.
Service	Trends of Interstage Temperature, Condenser Temperature, Shelf Inlet Temperature, L1 Voltage and Ambient Temperature.
Pirani / Capacitance Manometer Differential (PRCM)	Trends of Chamber CM, Chamber Pirani, Vacuum Setpoint, Condenser Vacuum and PCRM Differential Display.
Barometric Endpoint (BE)	Trends of Chamber CM, Chamber Pirani, Vacuum Setpoint, Condenser Vacuum and Pressure Rise Delta.
Shelf in Vs Out	Shelf Outlet Temperature, Shelf Inlet Temperature and Shelf Setpoint.

Note: *The above list is neither exhaustive nor is it universally applicable; your lyophilizer may include fewer, additional and/or differently configured charts depending on the options ordered with your unit. Some of the charts listed above are only included on the LyoS™ software when the hardware options are purchased.*

[3] Lyophilization_CL is the basic lyophilization chart for units equipped with ControLyo™ Nucleation On-Demand technology. Units not equipped with this option will display the standard lyophilization chart.

Modifying the Active Chart

You may customize an active Historical Trend by selecting the Modify Chart button. The Chart Control Panel will appear.

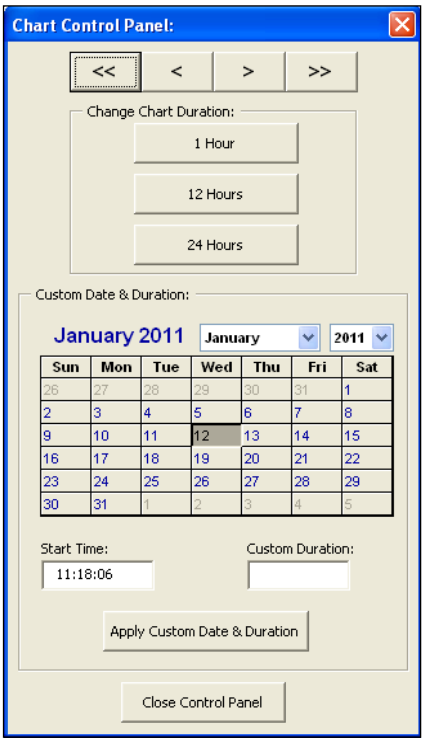


Chart Control Panel

Select the 1 Hour, 12 Hours or 24 Hours button to change the chart period. You may also shift the viewable period using the arrow buttons.

The Chart Control Panel also allows you to select a custom date, start time and period for the active chart. Changes may be applied by selecting the Apply Custom Date & Duration button.

After modifying the active Historical Trend chart, select the Close Control Panel button to return to the Historical Trend page.

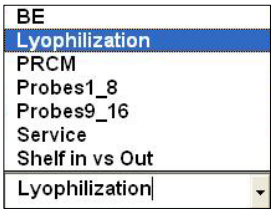
The active chart may also be modified by double-clicking the chart on the Historical Trend page. Display colors and chart axis options may be edited from the Historical Trend window. While changes made from the Historical Trend window may not be changed permanently, they may be printed using the Print screen button. Colors and chart options return to their default settings when the Historical Trend window is re-opened.

Functions

The Historical Trend window also allows you to create custom charts.

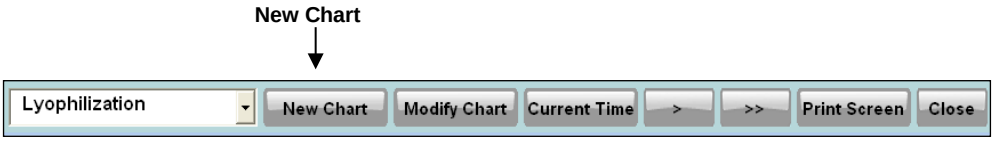
To create a new chart:

1. From the Historical Trend window, use the combo box pull-down list to select a template chart. This will be used as the basis for your new chart.

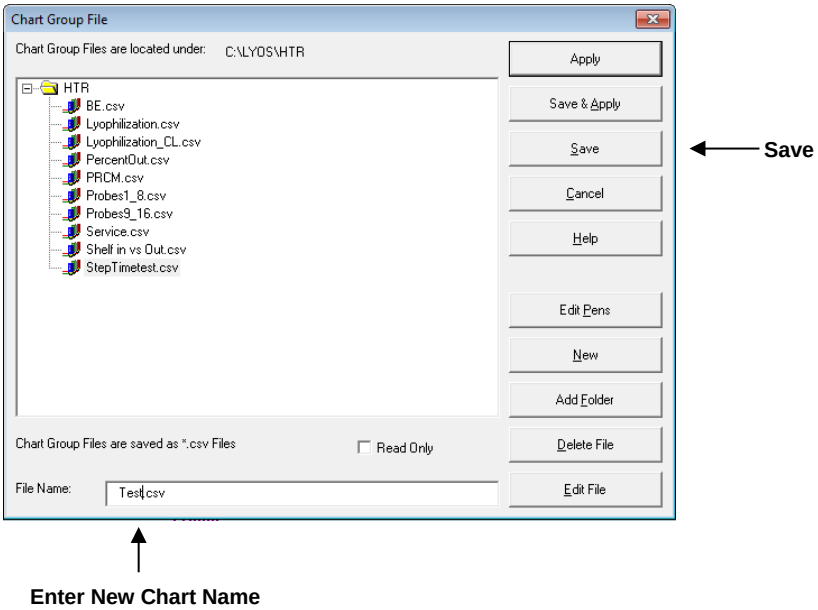


Note: *It is recommended that you use an existing chart group as a template when creating a new chart.*

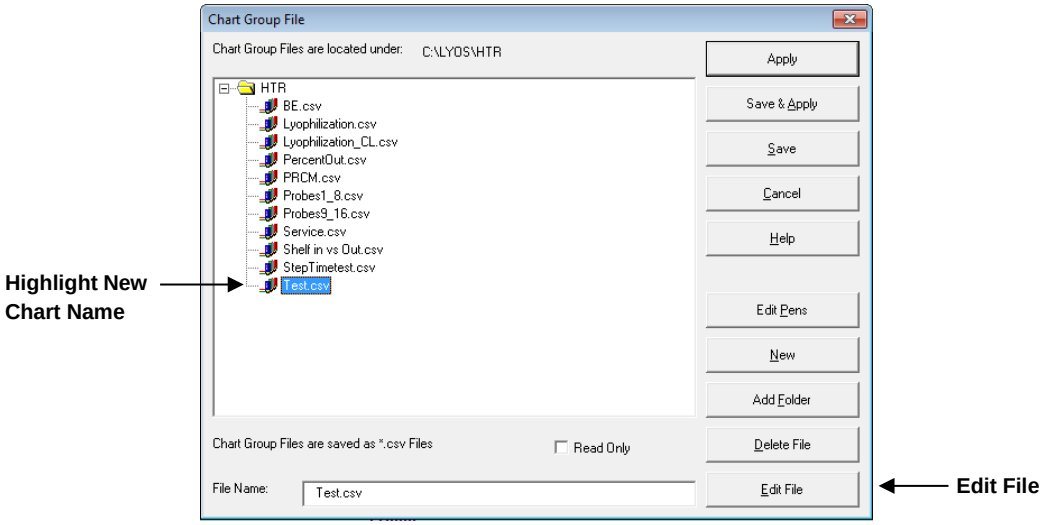
2. Click the New Chart button from the Historical Trend page.



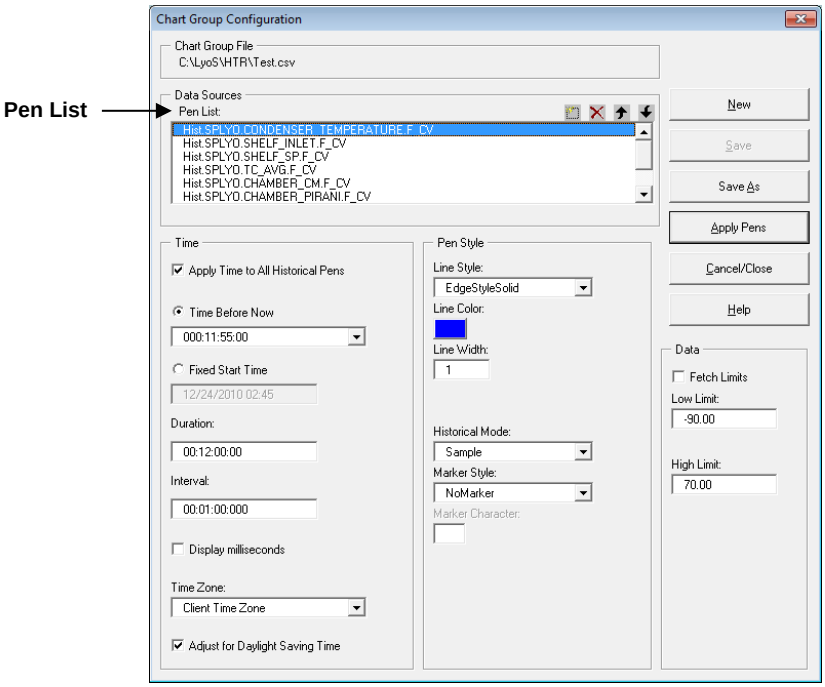
3. Enter a name for the new chart in the File Name field then click Save. The new chart name will be added to the list with chart data based on your selection from step 1.



4. Highlight the new chart name in the Chart Group File window then click Edit File.

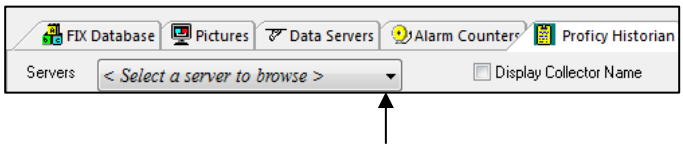


5. The Chart Group Configuration page will appear. The Pen List displays all variables for the chart. The list will depend on the template chosen for your new chart. The four pen modification buttons (*i.e.*, ) allow you to add, remove or reorder chart variables.



6. To modify a variable, double-click on it and click the adjacent "…" button (*i.e.*, [...]).

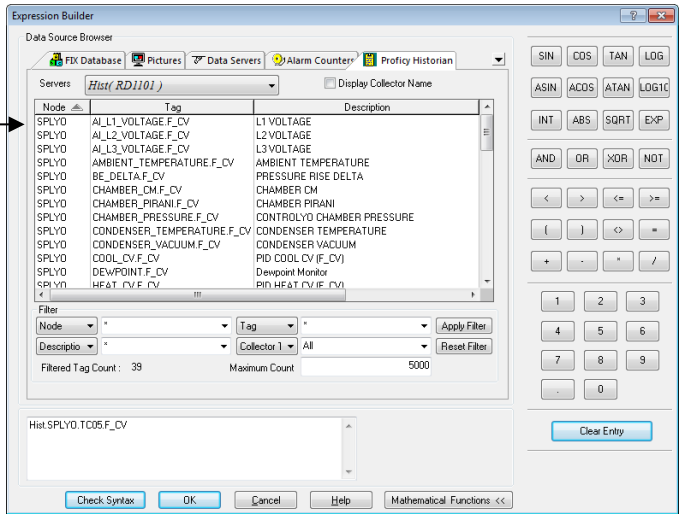
7. Select the Proficy Historian tab (*i.e.*, [Proficy Historian]) and select the applicable Server from the Servers pull-down menu.



Server Pull-Down Menu

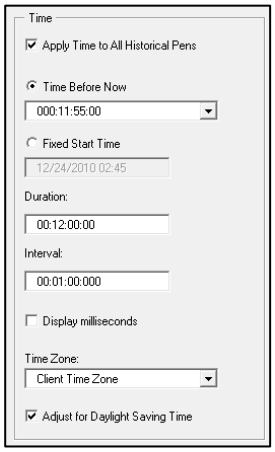
8. Available chart variables are listed on this page. To add a variable to your chart, select it from the list then click OK. Continue to modify the list of chart variables as needed.

List of Variables



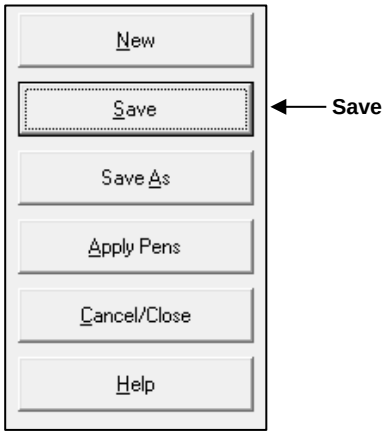
9. You may change the chart display properties for each variable in the Pen Style section of the Chart Group Configuration page.

10. If desired, define the chart group time properties in the Time section of the Chart Group Configuration page.



11. After configuring the new chart, click Save from the Chart Group Configuration page. You will return to the Historical Trend page.

Note: *You may need to exit and reload the Historical Trend page for changes to take effect.*



Backing Up Historical Data

For control systems with SEC1 security, historical data files are stored in the **C:\Proficy Historian for SCADA 4.5 Data\Archives** directory. For control systems with SEC3 security, historical data files are stored in the **C:\Proficy Historian SCADA 5.0 Data\Archives** directory. Files are labeled in YYMMDD**.H** format. Historical data may be backed up by copying all of the files contained within this directory to a CD, flash drive or other suitable media.

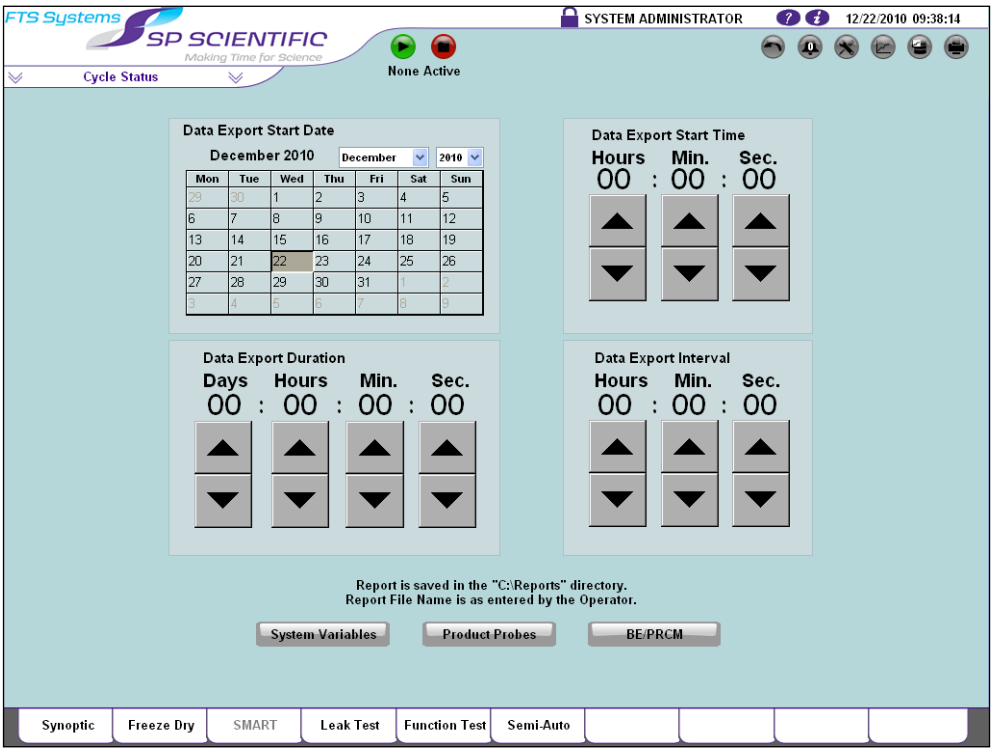
THE CURRENT HISTORICAL DATA FILE SHOULD NEVER BE MOVED OR DELETED AS IT CONTINUOUSLY RECEIVES DATA. RELOCATING OR DELETING THIS FILE COULD CAUSE YOUR DATA FILES TO BECOME CORRUPT.

Exporting Historical Data

The Historical Data Export function provides an easy way to export LyoS™ historical data into a comma-separated value (.csv) file that can be viewed with most spreadsheet applications.

Historical Data Export Button

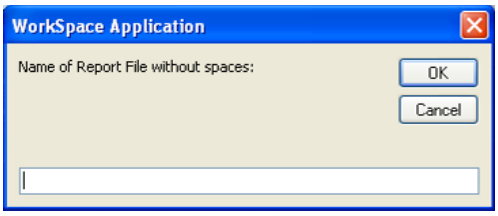
Selecting the Historical Data Export button from the top right corner of the LyoS™ layout launches the Historical Data Export function.



Historical Data Export Page

To export historical data using the Historical Data Export function:

1. Select a date, start time, duration (period) and interval.
2. Select the button corresponding to the data group you wish to export (*e.g.,* System Variables, Product Probes, BE/PRCM). A dialog box will open.



3. Enter a name for the report file you wish to export and click the OK button. After pressing OK, there will be a 30-second delay during which the clock in the upper right corner will pause. Do not attempt to use the system during this time. When the system resumes, the historical data file will have been saved as a *.csv file to the **C:\Reports** directory.

   Note: *The system does not automatically delete exported files as it does with encrypted historical data and alarm files. It is recommended that you develop a Standard Operating Procedure for archiving exported historical data.*

Reading Exported Historical Data in .csv format

The following is an example of a Historical Data file displayed in comma-separated value (.csv) format.

The data in the Historical Data file is exported from the LyoS™ control system application by another program that runs in the background, which then converts the data into a .csv file.

Note: *The data within that Historical Data file may or may not display temperature values to the nearest tenth, as whole number temperature values are truncated. For example, a temperature value of 25.0 will be displayed as 25.*

Intellution Historical Data Report												
Generated 03/14/2012 15:34:27												
Start Time: 03/14/12 07:00:00												
Duration: 00:01:00:00												
Interval: 00:01:00												
Historical Input Data path: C:\DYNAMICS\HTRDATA												
Retrieval moc (A)verage (H)igh (L)ow (R)aw												
Date	Time	SPLYO:CH	SPLYO:CH	SPLYO:CH	SPLYO:CC	SPLYO:CC	SPLYO:RC	SPLYO:SH	SPLYO:SH	SPLYO:SH	SPLYO:TC	SPLYO:VACUUM_SP.F_CV (S)
3/14/2012	07:00:00	15	19	-14	24.4	15	0	24.6	24.6	0	0	0
3/14/2012	07:01:00	15	19	-14	24.4	15	0	24.6	24.6	0	0	0
3/14/2012	07:02:00	15	19	-13.99	24.4	15	0	24.6	24.6	0	0	0
3/14/2012	07:03:00	15	19	-13.98	24.4	15	0	24.6	24.6	0	0	0
3/14/2012	07:04:00	15	19	-13.99	24.5	15	0	24.6	24.6	0	0	0
3/14/2012	07:05:00	15	19	-14	24.4	15	0	24.6	24.6	0	0	0
3/14/2012	07:06:00	15	19	-14	24.4	15	0	24.6	24.6	0	0	0
3/14/2012	07:07:00	15	19	-14	24.5	15	0	24.6	24.6	0	0	0
3/14/2012	07:08:00	15	19	-14	24.5	15	0	24.6	24.6	0	0	0
3/14/2012	07:09:00	15	19	-14	24.5	15	0	24.6	24.5	0	0	0
3/14/2012	07:10:00	15	19	-14.01	24.4	15	0	24.6	24.5	0	0	0
3/14/2012	07:11:00	15	19	-14.01	24.4	15	0	24.6	24.5	0	0	0
3/14/2012	07:12:00	15	19	-14	24.5	15	0	24.6	24.5	0	0	0
3/14/2012	07:13:00	15	19	-14.01	24.4	15	0	24.6	24.5	0	0	0
3/14/2012	07:14:00	15	19	-13.99	24.5	15	0	24.6	24.5	0	0	0
3/14/2012	07:15:00	15	18	-14	24.5	15	0	24.6	24.5	0	0	0
3/14/2012	07:16:00	2100	1022	0.39	26.7	2100	765	24.6	24.5	0	0	0

Proficy® Historian

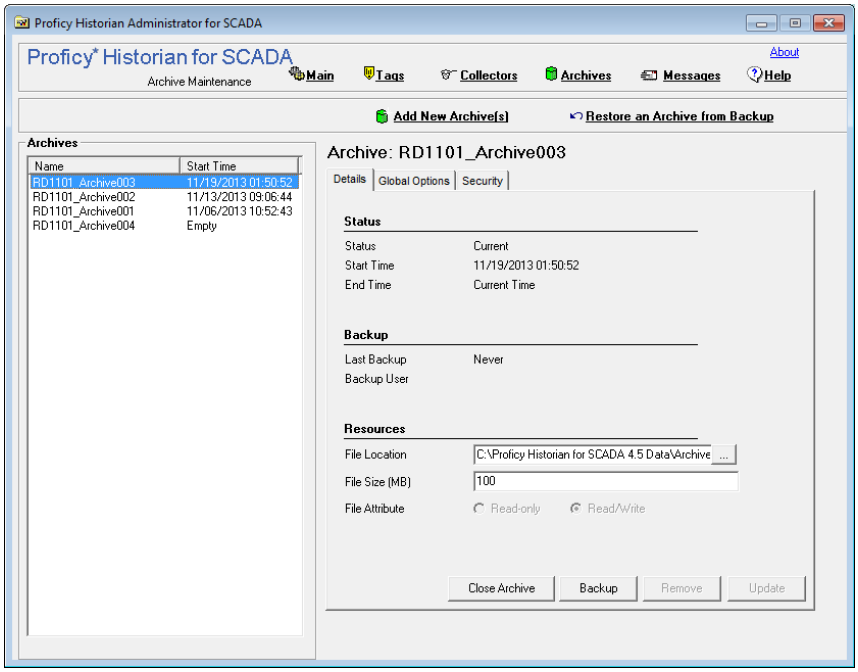
Note: *Based on your configured security system (i.e., SEC1 or SEC3), your control system workstation may show Proficy Historian for SCADA or Proficy Historian, along with a version number of 4.5 or 5.0. The following information is applicable for both security systems.*

All historical trending data is saved to Proficy® Historian archives. Maintenance and modifications of these archives is achieved through the Proficy® Historian Administrator.

To access through the Proficy® Historian Administrator, navigate to Start › All Programs › Proficy Historian for SCADA (or Proficy Historian) › Historian for SCADA Administrator.

Note: *You must be logged in as Supervisor to execute this task.*

Once the Proficy® Historian Administrator has successfully launched, click Archives (*i.e.,* **Archives**) to open the Archive Maintenance screen. Archives are listed on the left side of this screen. The active archive is displayed in blue text.



Archive Maintenance Screen

Add a New Archive

To add a new, blank archive, click Add a New Archive (*i.e.,* **Add New Archive(s)**). The system will prompt you for an archive name. After creation, the archive will appear in the Archives window and the Start Time will display “Empty.” This new archive will automatically become active when the currently active archive is closed.

Note: *If you do not create a new, blank archive, the system will automatically generate a new one when the active archive is closed.*

Close an Archive

The Close Archive command deactivates an active archive. To close an archive, select the appropriate archive in the Archives window. Click the Close Archive button located at the bottom of the Details tab and select Yes when asked to confirm the action. The selected archive will be closed and can then be moved, backed up or deleted. If you have not created a new, blank archive, the system will automatically create a new archive and mark it as active.

Archive Backup

To back up an archive, select an archive and click the Backup button located at the bottom of the Details tab. If you wish to back up the active archive, it must first be closed. After clicking Backup, the Historian Administrator will launch the Backup Archive destination window. Enter the destination for the archive backup and click OK. The backup (a .zip file) will be created at the destination specified. The original archive can then be deleted and the archive backup can be moved to an appropriate backup media.

Remove an Archive

To remove an archive from your computer, select an archive and click the Remove button on the bottom of the Details tab. The archive will be deleted from your system. You cannot remove active archives.

Note: *This process cannot be undone. Use caution when removing archives, and ensure that all archives are backed up to an appropriate media before removal.*

Restore an Archive

To restore a deleted archive from an archive backup (.zip file), click “Restore an Archive from Backup”(*i.e.,* 

). The system will prompt you for the archive name and location. You may search for the archive by clicking on the “…” button (*i.e.,* 

) next to the File Location field. After locating the file, click OK to restore the archive. It will be added to the Archives list.

Maintenance Menu

Overview

The Maintenance button opens the Maintenance menu pop-up, from which you may activate Component Mode, or open the Configuration or Calibration pages. To close the Maintenance menu pop-up, click Cancel.

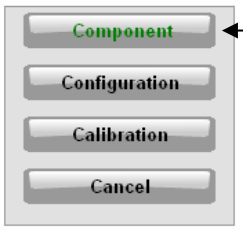
Maintenance Button

Maintenance Menu Pop-up

Component Mode

Component Mode allows you to manually control system components listed on the Synoptic page (*e.g.,* heater, fluid pump, vacuum pump, compressors, and associated valves).

To enable Component Mode, click the Component button on the Maintenance menu pop-up. The word Component will turn green to signify that you may begin controlling components from the Synoptic page.



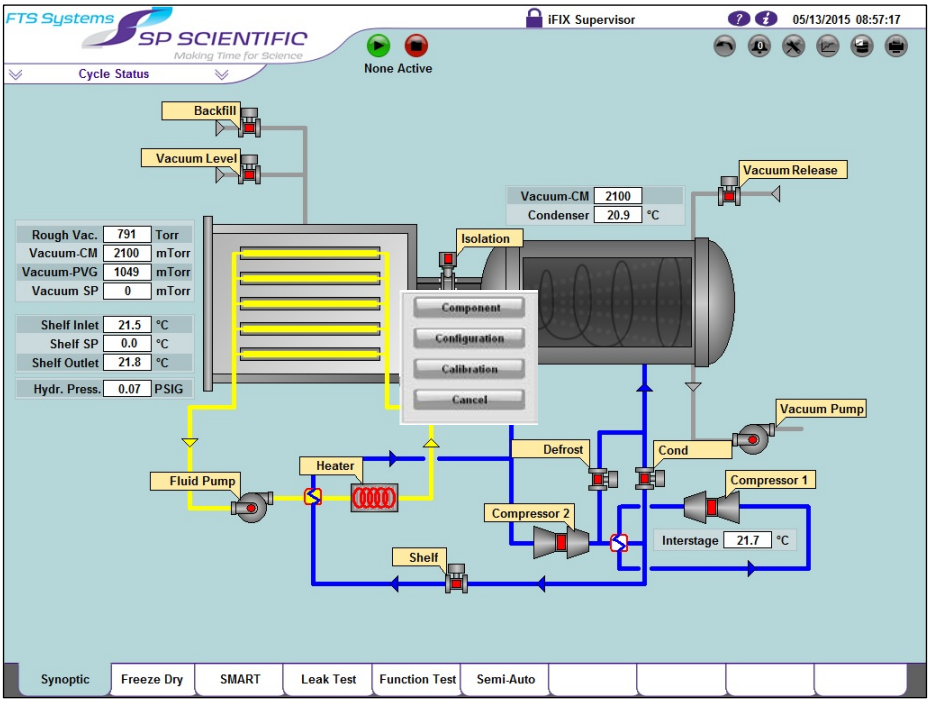
Component Mode Enabled

Note: *To enable Component Mode the system must be in an "Idle" state. No automatic cycles or Semi-Auto functions may be active.*

Synoptic Page

To activate or deactivate components from the Synoptic page, Component Mode must be enabled. To enable component mode, navigate to the Synoptic page then enable Component Mode from the Maintenance menu pop-up. Once enabled, select a component.

A component displaying red signifies that it is inactive, or in its default state. A component displaying green signifies that the component is active.

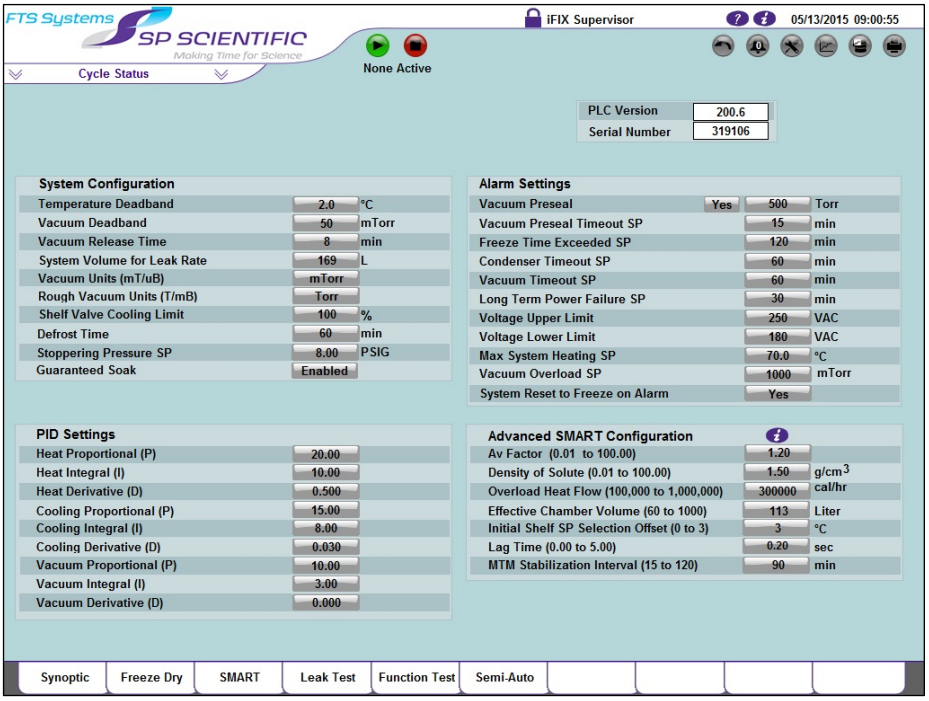


Synoptic Page with Maintenance Menu Pop-up Displayed

Note: *When using Component Mode to activate or deactivate components from the Synoptic page, consider adding descriptive callouts to the page for easy identification of system components. To add descriptive callouts, select the Question Mark Icon (i.e., ?).*

Configuration

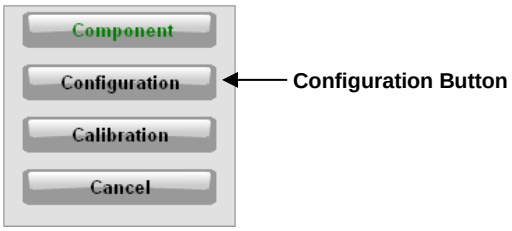
The Configuration page allows you to configure the system settings that will be used when operating your lyophilizer. Some settings instruct your system on how to react when encountering certain conditions (*e.g.,* Alarm Settings).



Configuration Page

Note: *The Configuration page on your lyophilizer may appear different than the one shown based upon the options ordered with your unit.*

To access the Configuration page, select the Configuration button from the Maintenance menu pop-up.



The Configuration page typically consists of three editable regions—System Configuration, PID Settings and Alarm Settings. However, units equipped with additional options such as Praxair's ControLyo™ Nucleation On-Demand Technology and/or SMART Freeze Dryer™ Technology will have up to five editable regions on the Configuration page.

System Configuration Settings

Temperature Deadband

The Temperature Deadband is the plus or minus range around the reference temperature. When the controlled temperature is within this deadband, the current temperature is seen as acceptable and the system is permitted to advance to the next relevant step or phase of the freeze-dry cycle. The configurable range of the Temperature Deadband is 0 to10 °C.

For Example:

If the temperature deadband is set to a value of 2 °C and the reference temperature (*i.e.,* setpoint) is 44 °C, all temperatures between 42 °C and 46 °C would fall within the deadband.

Vacuum Deadband

The Vacuum Deadband is the plus or minus range around the reference vacuum. When the controlled vacuum is within this deadband, the current vacuum is seen as acceptable and the system is permitted to advance to the next relevant step or phase of the freeze-dry cycle. The configurable range of the Vacuum Deadband is 0 to 100 millitorr/microbar.

For Example:

If the Vacuum Deadband is set to a value of 50 millitorr and the reference pressure (*i.e.,* setpoint) is 200 millitorr, all pressures between 150 millitorr and 250 millitorr would fall within the deadband.

Vacuum Release Time

The Vacuum Release Time is the length of time that the vacuum release valve will remain open. This is activated by performing an End Cycle routine from the Freeze-Dry Recipe page after a cycle is complete. The configurable range of the Vacuum Release Time is 0 to 10 minutes.

System Volume for Leak Rate

The System Volume for Leak Rate is the total system volume as determined at the factory. This volume is used by the LyoS™ software when calculating volume-based leak rates. The configurable range of the System Volume for Leak Rate is 0 to 32,000 liters.

THE SYSTEM VOLUME IS CALCULATED DURING THE DESIGN OF YOUR LYOPHILIZER. THIS PARAMETER IS SET AT THE FACTORY PRIOR TO SHIPMENT AND SHOULD NOT BE CHANGED. EDITING THE SYSTEM VOLUME PARAMETER COULD CAUSE SYSTEM TESTS (SUCH AS THE LEAK RATE TEST) TO YIELD INACCURATE RESULTS.

Vacuum Units (mT/uB)

The Vacuum Units (mT/uB) field allows you to select the units that will be used when measuring primary vacuum.

Rough Vacuum Units (T/mB)

The Rough Vacuum Units (T/mB) field allows you to select the units that will be used when measuring rough vacuum.

Shelf Valve Cooling Limit

The Shelf Valve Cooling Limit is used to limit the proportional cooling of the Shelf Valve. This setting is configured at the factory to ensure optimal control of the Shelf Valve during all required processes. The configurable range of the Shelf Valve Cooling Limit is 1 to 100 percent.

THE SHELF VALVE COOLING LIMIT IS CALCULATED DURING THE DESIGN OF YOUR LYOPHILIZER. THIS PARAMETER IS SET AT THE FACTORY PRIOR TO SHIPMENT AND SHOULD NOT BE CHANGED.

Defrost Time

The Defrost Time field is the length of time that the system will allow for the Semi-Auto Defrost function. When the Defrost timer expires, the Defrost function will turn off automatically. The configurable range of the Defrost Time is 1 to 60 minutes.

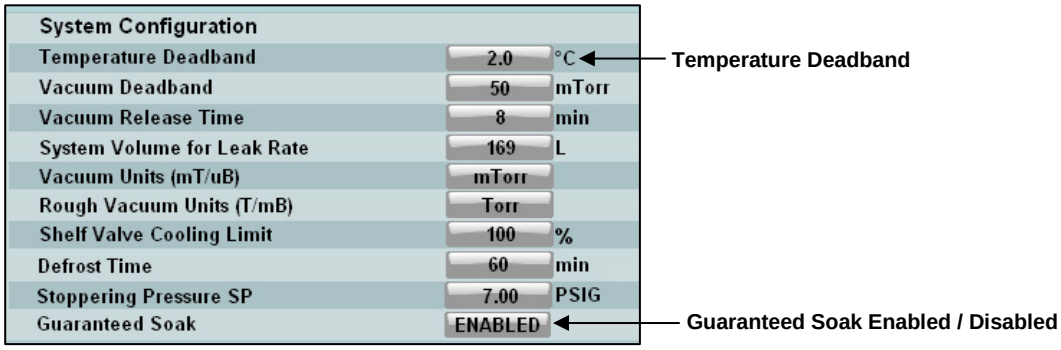
Stoppering Pressure SP

The Stoppering Pressure field allows the user to specify the maximum upward force that will be applied by the stoppering mechanism before it is deactivated. The configurable range of the stoppering pressure is 0 to 10 psig (pounds per square inch gauge).

Guaranteed Soak

If Guaranteed Soak is enabled, the step timer will not begin counting down until the product or shelf temperature is within the Temperature Deadband. Both Guaranteed Soak and Temperature Deadband may be set from the Configuration page. The time stops counting if the product or shelf temperature goes outside the Temperature Deadband.

If Guaranteed Soak is disabled, the step timer will begin counting down regardless of the product or shelf temperature. This feature is only active during Thermal Treatment and Drying phase steps that are programmed with a Hold time.



PID Settings

THE PID SETTINGS ARE CONFIGURED AT THE FACTORY (PRIOR TO SHIPMENT) FOR OPTIMAL PERFORMANCE. DO NOT CHANGE THE PID PARAMETERS.

Heat Proportional (P)

The Heat Proportional (P) setting is the multiplier that changes the relative strength of the control action. The higher the number, the more aggressively the system drives the heat toward the setpoint. A high setting tends to make the system behave as if it is on/off rather than proportional. A higher setting will also create more overshoot, but will reach the setpoint temperature faster. A lower setting will give "soft control", allowing the temperature to approach setpoint more slowly and with less overshoot. A higher setting will create more overshoot, but will reach the setpoint temperature faster. The configurable range of the Heat Proportional (P) setting is 0 to 327.6.

Heat Integral (I)

The Heat Integral (I) setting is used to determine how quickly the system will try to eliminate any control error remaining from the proportional control. The configurable range of the Heat Integral (I) setting is 0 to 327.6.

Heat Derivative (D)

The Heat Derivative (D) setting is used to determine how quickly the system reacts to a temperature change. The configurable range of the Heat Derivative (D) setting is 0 to 9.

Cooling Proportional (P)

The Cooling Proportional (P) setting is the multiplier that changes the relative strength of the control action. The higher the number, the more aggressively the system drives the cool toward the setpoint. A high setting tends to make the system behave as if it is on/off rather than proportional. A higher setting will also create more overshoot, but will reach the setpoint temperature faster. A lower setting will give "soft control", allowing the temperature to approach setpoint more slowly and with less overshoot. A higher setting will create more overshoot, but will reach the setpoint temperature faster. The configurable range of the Cooling Proportional (P) setting is 0 to 327.6.

Cooling Integral (I)

The Cooling Integral (I) setting is used to determine how quickly the system will try to eliminate any control error remaining from the proportional control. The configurable range of the Cooling Integral (I) setting is 0 to 327.6.

Cooling Derivative (D)

The Cooling Derivative (D) setting is used to determine how quickly the system reacts to a temperature change. The configurable range of the Cooling Derivative (D) setting is 0 to 9.

Vacuum Proportional (P)

The Vacuum Proportional (P) setting is the multiplier that changes the relative strength of the control action. The higher the number, the more aggressively the system drives the vacuum toward the setpoint. A high setting tends to make the system behave as if it is on/off rather than proportional. A higher setting will also create more overshoot, but will reach the setpoint temperature faster. A lower setting will give "soft control", allowing the vacuum to approach setpoint more slowly and with less overshoot. A higher setting will create more overshoot, but will reach the setpoint vacuum faster. The configurable range of the Vacuum Proportional (P) setting is 0 to 327.6.

Vacuum Integral (I)

The Vacuum Integral (I) setting is used to determine how quickly the system will try to eliminate any control error remaining from the proportional control. The configurable range of the Vacuum Integral (I) setting is 0 to 327.6.

Vacuum Derivative (D)

The Vacuum Derivative (D) setting is used to determine how quickly the system reacts to a vacuum level change. The configurable range of the Vacuum Derivative (D) setting is 0 to 9.

Alarm Settings

Vacuum Preseal

When the Vacuum Preseal is set to Yes, the system will evacuate the chamber to the Vacuum Preseal setpoint as the first phase of an automatic cycle. The Vacuum Preseal setting is applied to all automated cycles. If set to No, the cycle skips the first phase of each automatic cycle and does not evacuate the chamber. The configurable range is 20 to 900 millibar.

Vacuum Preseal Timeout SP (setpoint)

The Vacuum Preseal Timeout SP (setpoint) is the maximum length of time that the system will be permitted to evacuate the chamber to the specified Vacuum Preseal setpoint. If the Vacuum Preseal setpoint is not reached within Vacuum Preseal Timeout SP (setpoint) an alarm message is displayed and the system is returned to a “Ready” state. The configurable range is 1 to 30 minutes.

Freeze Time Exceeded SP (setpoint)

The Freeze Time Exceeded SP (setpoint) is the maximum length of time that the product or shelves will be permitted to achieve the Freeze temperature setpoint during the Freeze phase of an automatic free-dry cycle. The Freeze Time Exceeded alarm activates if the Freeze temperature setpoint is not obtained within the Freeze Time Exceeded SP (setpoint). The configurable range is 1 to 1440 minutes.

Condenser Timeout SP (setpoint)

The Condenser Timeout SP (setpoint) is the maximum length of time that the condenser will be permitted to achieve the condenser setpoint during the Condenser phase of an automatic freeze-dry cycle. If the Condenser Temperature does not reach the setpoint within the specified Condenser Timeout SP (setpoint), the system will reset to the Freeze phase (if configured) or hold in the current phase until the condition is corrected. The configurable range is 1 to 90 minutes.

Vacuum Timeout SP (setpoint)

The Vacuum Timeout SP (setpoint) is the maximum length of time that the vacuum system will be permitted to achieve the vacuum setpoint during the Evacuate phase of an automatic freeze-dry cycle. If the chamber vacuum does not reach the setpoint within the specified Vacuum Timeout SP (setpoint), the system will reset to the Freeze phase (if configured) or hold in the current phase until the condition is corrected. The configurable range is 1 to 90 minutes.

Long-Term Power Failure SP (setpoint)

The Long-Term Power Failure SP (setpoint) is the length of time that must expire during a power loss before the loss is considered a Long Term Power Failure. In the event of a long-term power loss, the system displays a Long Term Power Failure alarm notification. When power is restored, the cycle holds in the current phase and attempts to continue from where it left off. The cycle may be configured to reset the system to the Freeze phase following a long-term power failure. The configurable range is 1 to 60 minutes.

Note: *Any power losses for a period less than the Long-Term Power Failure SP (setpoint) shall be considered a Short-Term Power Failure.*

Voltage Upper Limit

When the power supply voltage is greater than or equal to the Voltage Upper Limit setpoint, the High Voltage alarm message is displayed. The configurable range is 180 to 450 VAC.

Voltage Lower Limit

When the power supply voltage is less than or equal to the Voltage Lower Limit setpoint, the Low Voltage alarm message is displayed. The configurable range is 180 to 400 VAC.

Max System Heating SP (setpoint)

The Maximum System Heating SP (setpoint) is the maximum allowable shelf temperature. When the shelf inlet temperature is higher than the Maximum System Heating SP (setpoint), the heater is disabled and an alarm message is displayed. The configurable range is 20 to 70 °C.

Vacuum Overload SP (setpoint)

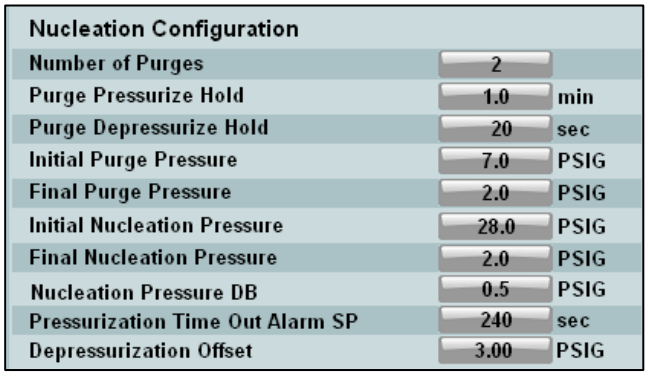
The Vacuum Overload SP (setpoint) is the maximum allowable vacuum reading. When the system vacuum exceeds the Vacuum Overload SP (setpoint) during the Drying phases of a freeze-dry cycle, the Vacuum Overload alarm message shall be displayed. The heater shall be disabled and the shelf solenoid energized. The configurable range is 0 to 2000 millitorr.

System Reset to Freeze on Alarm

Some emergency alarms can be configured to reset the freeze-dry cycle to the Freeze phase to protect product and/or protect the unit (*e.g.*, Long Term Power Failure alarm). However, this setting may not be appropriate for some products. If set to No, emergency alarms will not reset the unit to the Freeze phase.

Nucleation Configuration Settings

The following settings are for use with systems configured with Praxair's ControLyo™ Nucleation On-Demand Technology.



Nucleation Configuration Settings for systems with Praxair's ControLyo™ Nucleation On-Demand Technology Option.

Note: *The parameters displayed above are for illustrative purposes only and are not intended to be used as a guide for configuring nucleation settings.*

Number of Purges

Number of Purges is the number of pulse purge cycles the system will complete prior to Praxair's ControLyo™ Nucleation On-Demand Technology pressurization. The purging operation is typically repeated 2 to 5 times based on the freeze-dry recipe or process used. The purge pressure setpoints, the delays between purges and the number of purges are the configuration settings that determine the purge cycle operation. The configurable range of the Number of Purges setpoint is 0 to 10.

Purge Pressurize Hold

The Purge Pressurize Hold is the interval during and after pulse purge pressurization prior to pulse purge depressurization. The timer starts as the system tries to achieve the purge pressure setpoint and continues to hold until the timer expires. The configurable range of the Purge Pressurize Hold setpoint is 1 to 30 minutes.

Purge Depressurize Hold

The Purge Depressurize Hold is the interval after pulse purge depressurization before subsequent pulse purge pressurization. The timer starts as the system achieves the purge pressure setpoint and continues to hold until the timer expires. The configurable range of the Purge Depressurize Hold setpoint is 10 to 180 seconds.

Initial Purge Pressure

Initial Purge Pressure is the pulse purge sequence pressurization setpoint. During the pulse purge sequence, the product chamber is pressurized to the Initial Purge Pressure setpoint. The chamber pressure is then held at the purge pressure setpoint for the remaining duration of the Pressurize Hold setpoint. Upon completion of the Pressurize Hold timer, the product chamber is depressurized to the Final Purge Pressure setpoint. The pulse purge sequence may be repeated according to the Number of Purges setpoint. The configurable range of the Initial Purge Pressure setpoint is 7 to 28.5 psig.

Final Purge Pressure

Final Purge Pressure is the pulse purge sequence depressurization setpoint. Following pressurization to the Initial Purge Pressure setpoint, the product chamber pressure is held for the duration of the Pressurize Hold setpoint. Upon completion of the Pressurize Hold timer, the product chamber is depressurized to the Final Purge Pressure setpoint. The pulse purge sequence may be repeated according to the Number of Purges setpoint. The configurable range of the Final Purge Pressure setpoint is 1 to 3 psig.

When depressurization is initiated, the system terminates any active pressurization process. A 20-second warning delay will occur after a depressurization signal is received by the PLC. During this time, a buzzer will sound and an amber strobe will illuminate on the lyophilizer. Depressurization will be initiated approximately 3 seconds after this buzzer and strobe stop. The configurable range for the Final Nucleation Pressure setpoint is 1 to 3 psig.

Initial Nucleation Pressure

Initial Nucleation Pressure is Praxair's ControLyo™ Nucleation On-Demand Technology pressurization setpoint. After purging is complete, the system will pressurize the product chamber to the Initial Nucleation Pressure setpoint. The system will actively maintain the setpoint pressure in the product chamber to accommodate leaks and changes in gas density if the pressure in the product chamber falls below the Nucleation Pressure DB (deadband).
The configurable range is 7 to 28.5 psig.

Final Nucleation Pressure

Final Nucleation Pressure is Praxair's ControLyo™ Nucleation On-Demand Technology depressurization setpoint. During depressurization, the system will depressurize the product chamber to the Final Nucleation Pressure.

When depressurization is initiated, the system terminates any active pressurization process. A 20-second warning delay will occur after a depressurization signal is received by the PLC. During this time, a buzzer will sound and an amber strobe will illuminate on the lyophilizer. Depressurization will be initiated approximately 3 seconds after this buzzer and strobe stop. The configurable range for the Final Nucleation Pressure setpoint is 1 to 3 psig.

Nucleation Pressure DB

Nucleation Pressure DB is the deadband for pressurization. If the chamber pressure falls below this deadband after a pressurization event, the system will re-pressurized the product chamber to the Initial Nucleation Pressure setpoint. The configurable range of the Nucleation Pressure DB setpoint is 0.5 to 2.0 psig.

Pressurization Timeout Alarm SP (setpoint)

The Pressurization Timeout Alarm SP (setpoint) is the timer that is initiated with a pressurization process. The pressurization process is terminated if the Pressurization Time Out (PTO) expires prior to the product chamber pressure reaching the pressurization setpoint (*i.e.*, Initial Nucleation Pressure setpoint during Praxair's ControLyo™ Nucleation On-Demand Technology pressurization). The configurable range of the Pressurization Time Out (PTO) setpoint is 10 to 240 seconds.

Depressurization Offset

When the system is required by the PLC to release (*i.e.,* purge) pressure from the chamber, the depressurization valve opens and remains open until the system pressure reaches the final pressure setpoint (*i.e.,* Final Purge Pressure setpoint or Final Nucleation Pressure setpoint). However, due to a delay between the signal processed by the PLC and the actual closing of the depressurization valve, it may be difficult to maintain pressure at the final pressure setpoint unless an offset is configured.

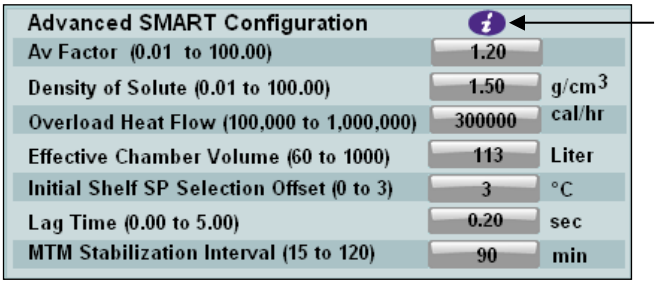
The Depressurization Offset allows you to compensate for the delay between the PLC signal and the mechanical operation of the valve by instructing the PLC to close the depressurization valve when the system pressure is between .5 and 5 psig above the final pressure setpoint. For example, if the final pressure setpoint is 2 psig and the Depressurization Offset is 3 psig, the PLC will signal the depressurization valve to close when the system pressure reaches 5 psig (*i.e.,* 2 psig + 3 psig). This will allow enough time for the depressurization valve to fully close by the time the system pressure reaches the final pressure setpoint.

The configurable range of the Depressurization Offset setpoint is .5 to 5 psig.

Advanced SMART Configuration Settings

The following settings are for use with systems configured with SMART Freeze Dryer™ Technology.

THE EFFECTIVE CHAMBER VOLUME IS CALCULATED DURING THE DESIGN OF YOUR LYOPHILIZER. THIS PARAMETER IS SET AT THE FACTORY PRIOR TO SHIPMENT AND SHOULD NOT BE CHANGED.



Configuration Settings for systems with SMART Freeze Dryer™ Technology Option.

A_v Factor.

The outer cross-sectional area of the vial. Allows an operator to redefine this factor based on custom or vial vendor specifications. The default setting is $A_v=1.2*A_p$, where A_p equals vial inner area.

Density of Solute

The default value is 1.50 g/cc. This value is used to make an initial estimate of Drying phase time (calculated during the first MTM) and to determine a safety margin below the critical product temperature which will be termed the target product temperature.

The product safety margins given various estimated Drying times are as follows:

Estimated Drying Time	Product Safety Margin
< 8 hours	-5 °C
8 - 48 hours	-3 °C
> 48 hours	-2 °C

Overload Heat Flow

Overload Heat Flow is a default value that can be used to limit the drying rate so that it will not exceed the maximum heat removal capacity (cal/hr) of the commercial freeze dryer to which the process will be scaled-up.

Effective Chamber Volume

Effective Chamber Volume is a default value in liters, which will not normally need to be changed. This value is used in the MTM equation.

Initial Shelf SP Selection Offset

This value allows factory technicians to tune the initial shelf setpoint selection during a SMART cycle based on the physical characteristics of the system. It is recommended that this value not be changed without consulting SP Scientific.

Lag Time

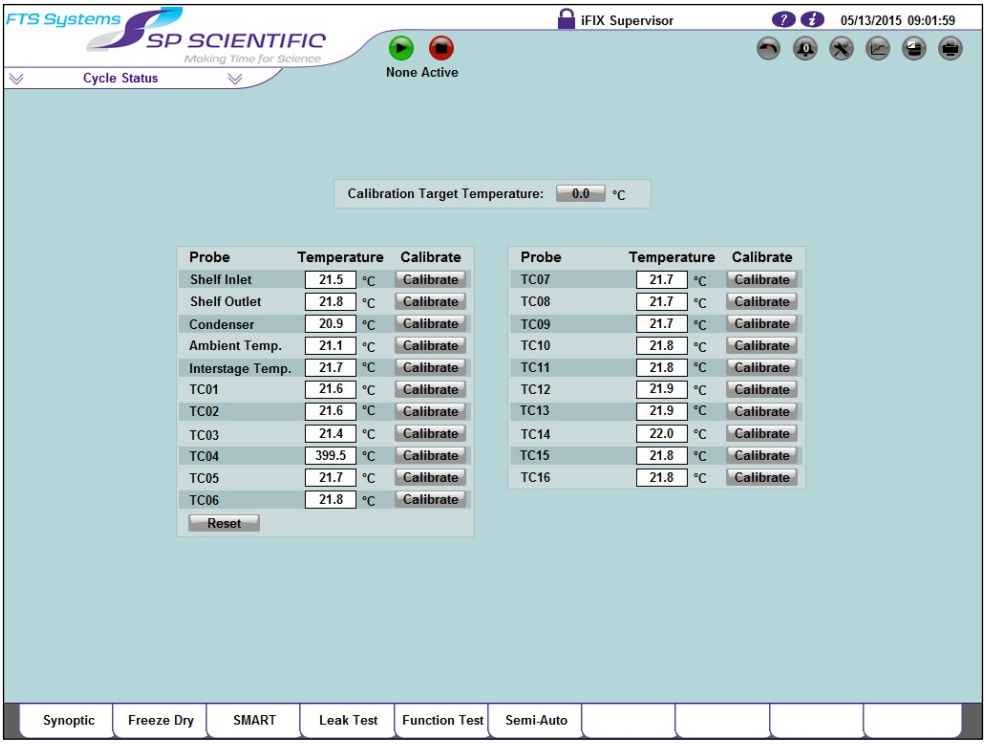
Lag time refers to the time between the PLC sending a signal to the isolation valve to close and the time when it is fully closed as registered by its proximity sensor.

MTM Stabilization Interval

This is the value (in minutes) that SMART / Auto MTM uses as the initial stabilization time in the step before taking the first manometric temperature measurement.

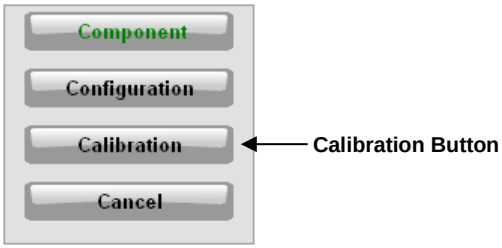
Calibration

The Allen-Bradley Thermocouple Modules located in the CompactLogix™ PLC may be easily calibrated from the LyoS™ Calibration page.



Calibration Page

Select the Calibration button of the Maintenance menu pop-up to open the Calibration page.



All temperature sensors (*i.e.*, shelf, condenser, ambient, interstage and product probes) connected to the Allen-Bradley Thermocouple Modules are listed on the calibration page. To calibrate a thermocouple, apply a known “zero” using an ice bath or a thermocouple simulator to the specific point. Thermocouple simulators should have a minimum range of -100 to 150 °C.

Compare the known value to the temperature reading for the point being tested. If the temperature reading is incorrect, enter the correct value in the Calibration Target Temperature field and click Calibrate for the point being calibrated. Wait for the reading to update and verify that the new reading is correct before continuing. The point is now calibrated.

You may select Reset to reset all temperature values back to their original readings without setting any calibrated values.

Chapter 11

Praxair's ControLyo™ Nucleation On-Demand Technology

THE FOLLOWING SECTION IS INTENDED FOR LYOSTAR™ 3 LYOPHILIZERS CONFIGURED WITH PRAXAIR'S CONTROLYO™ NUCLEATION ON-DEMAND TECHNOLOGY. FOR ADDITIONAL INFORMATION, REFER TO YOUR LYOSTAR™ 3 OPERATOR'S MANUAL.

Overview

Praxair's ControLyo™ Nucleation On-Demand Technology pressurizes and depressurizes the freeze dryer product chamber to induce controlled nucleation of freezing for materials contained within the product chamber.

Safety

1. Read the entire procedure before completing any steps in this procedure.
2. Eye protection is required at all times while operating the lyophilizer and within the room where the lyophilizer is located.
3. Users must read and follow the Material Safety Data Sheet (MSDS) and Personal Protective Equipment (PPE) requirements for all materials processed in the lyophilizer.
4. Appropriate hand protection should be used when handling any cold parts or equipment.
5. Sound levels may exceed 85 dB during depressurization of the freeze dryer. Stay at least three (3) feet away from Praxair's ControLyo™ Nucleation On-Demand Technology Depressurization manifold during the depressurization event and wear appropriate hearing protection. A warning buzzer and an amber strobe light on the lyophilizer will activate for approximately 20 seconds to signal an impending depressurization. The depressurization will occur approximately 3 seconds after the buzzer and strobe stop.
6. Without proper ventilation, operation of ControLyo™ may cause the oxygen concentration of ambient air to drop below acceptable levels. To ensure that ventilation is adequate for the depressurization process, the volume to vent percentage ratio (V_V/V_R) must be less than 6.5%, where V_V equals the product chamber volume multiplied by 10, and V_R equals the total volume of the room in which the lyophilizer is located. In addition, SP Scientific recommends the use of an O_2 sensor to monitor oxygen concentration while operating ControLyo™.

   Note: *The volume of a standard LyoStar™ 3 chamber is 3.99 ft^3 (.113 m^3).*

Control System Overview

Lyophilizer operation is controlled by a programmable logic controller (PLC).

1. Pressurization may only occur if the following conditions are met:
   a. Lyophilizer doors are closed and latched.
   b. Lyophilizer product chamber pressure is below the active pressurization setpoint.
   c. Depressurization signal is not active.
2. The pressurization function is designed to maintain pressure in the product chamber to accommodate small leaks. The PLC will automatically re-pressurize the product chamber if pressure falls below the pre-set deadband (*i.e.*, Nucleation Pressure DB) but only after the chamber has reached the pressurization setpoint.
3. Pressurization is generally stopped after receiving a depressurization signal.
4. The PLC will stop the pressurization process if the rate of pressure loss after pressurization is greater than a pre-set rate. This may occur if a system valve is open or a relief valve is activated.
5. The PLC will default to the minimum depressurization pressure if the setpoint received is too low.

   Note: *The minimum depressurization pressure is defined by the setpoint's configurable limits. For more information, refer to the Nucleation Configuration Settings section of Chapter 10: Maintenance Menu.*
6. The pressure in the freeze dryer product chamber must be at least 3 to 4 psi above the depressurization setpoint for a controlled depressurization to be successfully triggered. The PLC will prohibit a depressurization if this difference between the setpoint and the product chamber pressure is not met. These conditions also apply to pressure purging operations.
7. The PLC will default to a preset maximum pressurization pressure if the setpoint received is too high. This is defined by the configurable limits Nucleation Configuration Settings.

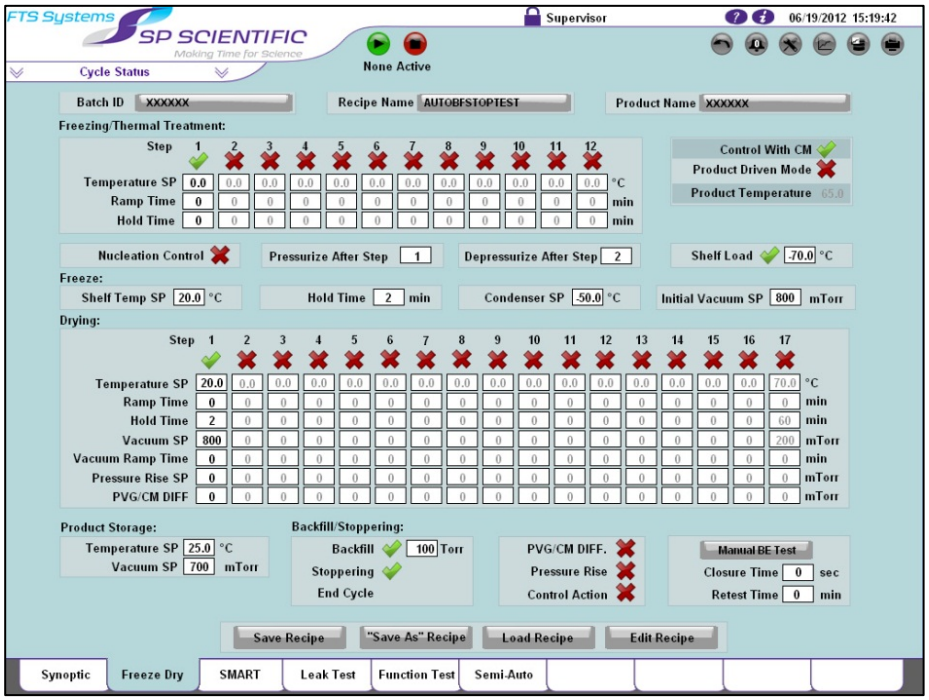
   Note: *The maximum pressurization pressure is defined by the setpoint's configurable limits. For more information, refer to the Nucleation Configuration Settings section of Chapter 10: Maintenance Menu.*
8. A warning delay will occur after a depressurization signal is received. A warning buzzer and an amber strobe light on the lyophilizer will activate for approximately 20 seconds to signal the impending depressurization. The depressurization will occur approximately 3 seconds after this buzzer and strobe stop.

Equipment Preparation

Before starting a freeze-dry cycle with Nucleation Control enabled, ensure the following conditions are met:

1. Energize power to the main power cabinet.
2. Check the gas supply source.
   a. When using a gaseous cylinder supply, ensure that the supply cylinder (*e.g.*, Argon or Nitrogen) has an adequate amount of gas for the cycle and the supply cylinder pressure is above 200 psig.
   b. When using a liquid Dewar supply, ensure that an appropriate sized vaporizer is used with a pressure regulator.
3. Confirm that the chamber is not pressurized.
4. Ensure that the lyophilizer chamber is clean, dry and particle free to avoid nucleation from dust and microparticles.

Freeze-Dry Recipe Operation



Freeze-Dry Recipe Page

Note: *The parameters displayed above are for illustrative purposes only and are not intended to be used as a guide for running a freeze-dry cycle with ControLyo™ Nucleation on Demand Technology. Your Freeze-Dry Recipe page may differ from the one shown above depending on your software configuration and purchased options.*

To operate Praxair's ControLyo™ Nucleation On-Demand Technology via the Freeze-Dry Recipe page:

1. Read and follow the Material Safety Data Sheets (MSDS) and Personal Protective Equipment (PPE) requirements for the sample materials.
2. Load samples into the lyophilizer.
3. Attach sensors to the samples as necessary (*e.g.*, attach thermocouples on the outside surface of the designated vials).
4. Plug thermocouples into the lyophilizer's thermocouple jack panel.
5. Close and secure the product chamber and condenser doors.

   Note: *The product chamber door must be latched before the system will allow the product chamber to be pressurized.*

WARNING! THE LYOPHILIZER IS NOT SAFE TO PRESSURIZE WHEN THE DOOR IS ONLY CLOSED. THE DOOR MUST BE SECURELY LATCHED TO HOLD PRESSURE.

DO NOT ATTEMPT TO UNLATCH THE CHAMBER DOORS AT ANY TIME WHEN THE LYOPHILIZER IS PRESSURIZED.

6. Input the desired values for nucleation control into the Nucleation Configuration Settings of the Configuration page.

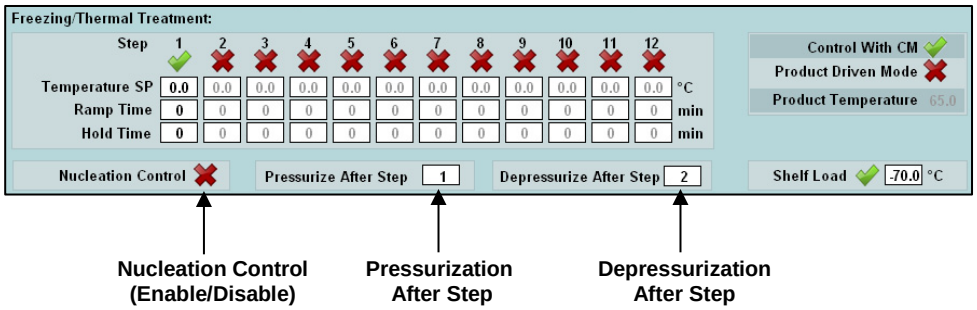
   Note: *For more information, refer to the Nucleation Configuration Settings section of Chapter 10: Maintenance Menu.*

Nucleation Configuration		
Number of Purges	2	
Purge Pressurize Hold	1.0	min
Purge Depressurize Hold	20	sec
Initial Purge Pressure	7.0	PSIG
Final Purge Pressure	2.0	PSIG
Initial Nucleation Pressure	28.0	PSIG
Final Nucleation Pressure	2.0	PSIG
Nucleation Pressure DB	0.5	PSIG
Pressurization Time Out Alarm SP	240	sec
Depressurization Offset	3.00	PSIG

Nucleation Configuration Settings for systems with Praxair's ControLyo™ Nucleation On-Demand Technology Option.

7. Ensure that the appropriate gas supply source for Praxair's ControLyo™ Nucleation On-Demand Technology is connected to the lyophilizer. If the appropriate supply source is connected, open the gas supply valve.

8. Program an automatic freeze-dry cycle. Enable Praxair's ControLyo™ Nucleation On-Demand Technology Control and program the additional Praxair's ControLyo™ Nucleation On-Demand Technology fields (*i.e.*, Pressurize After Step and Depressurize After Step).



Note: *The parameters displayed above are for illustrative purposes only and are not intended to be used as a guide for running a freeze-dry cycle with ControLyo™ Nucleation on Demand Technology.*

9. Start the automatic freeze-dry cycle. The cycle will proceed as programmed.

WARNING! DO NOT ATTEMPT TO OPEN THE LYOPHILIZER CHAMBER DOORS WHEN THE PRODUCT CHAMBER IS UNDER PRESSURE. IF IT IS NECESSARY TO OPEN A CHAMBER DOOR, THE PRODUCT CHAMBER MUST BE DEPRESSURIZED TO ATMOSPHERIC PRESSURE.

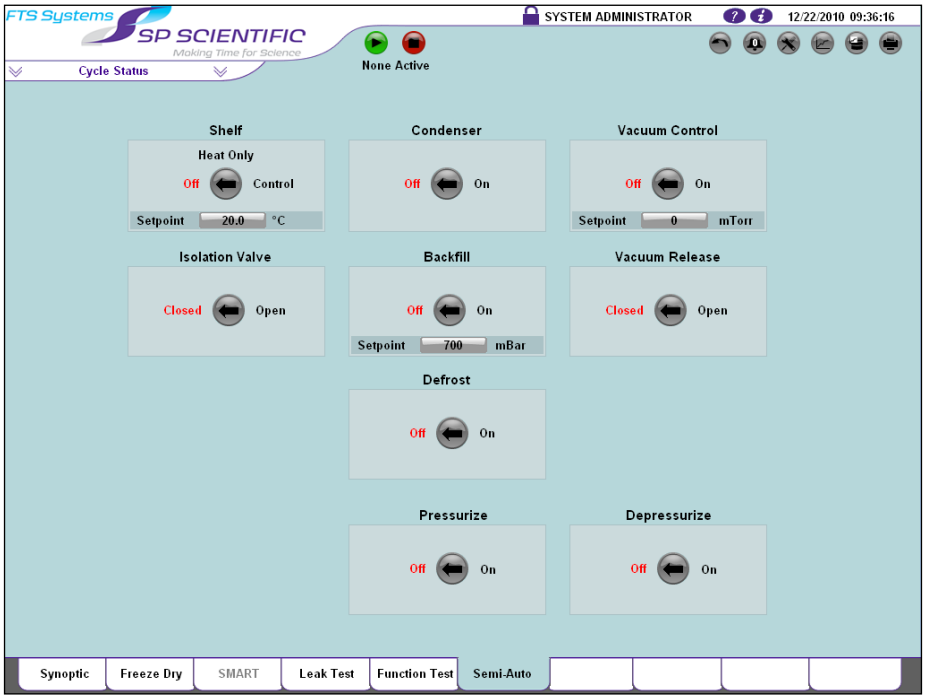
10. After the Freezing / Thermal Treatment step selected in the Nucleation Control section of the Freeze-Dry Recipe page, Praxair's ControLyo™ Nucleation On-Demand Technology System will purge the freeze dryer product chamber as per the Nucleation Control Settings. The pulse purge sequence begins with pressurization to the Initial Purge Pressure setpoint followed by a Pressurize Hold step. Upon completion of the Pressurize Hold timer, the product chamber is depressurized to the Final Purge Pressure setpoint. The pulse purge sequence is repeated according to the Number of Purges setpoint.
11. After purging is complete, the system will pressurize the product chamber to the Initial Nucleation Pressure setpoint. The system will actively maintain pressure in the product chamber at the Initial Nucleation Pressure setpoint to accommodate leaks and changes in gas density if the pressure in the product chamber falls below the Nucleation Pressure DB (deadband).
12. Depressurization will begin automatically according to the Depressurize After Step setpoint.

13. When the system triggers a depressurization, any pressurization process in progress will automatically be terminated. A warning delay will occur approximately 20 seconds after a depressurization signal is received. During this time, a buzzer will sound and an amber strobe will illuminate on the lyophilizer. The depressurization will occur approximately 3 seconds after this buzzer and strobe stop. The system will depressurize the product chamber to the Final Nucleation Pressure setpoint.

THE PRESSURE IN THE PRODUCT CHAMBER MAY INCREASE SEVERAL PSIG SHORTLY AFTER DEPRESSURIZATION IS COMPLETE. IN SUCH CASES, THE DEPRESSURIZATION BYPASS VALVE WILL OPEN AUTOMATICALLY AND VENT THE CHAMBER QUICKLY TO THE FINAL NUCLEATION PRESSURE.

14. The remaining steps of the automated cycle will be completed as normal. These steps include final freezing and drying, as a minimum. If enabled, backfill and stoppering may be performed.
15. Upon completion of the automatic cycle, you will need to manually end the freeze-dry cycle and return the system to atmospheric pressure.
16. Open the freeze dryer product chamber door and remove samples. Proper Personal Protective Equipment (PPE) should be worn before handling the samples.

Semi-Auto Operation



Semi-Auto Page

To operate Praxair's ControLyo™ Nucleation On-Demand Technology via the Freeze-Dry Recipe page:

1. Read and follow Material Safety Data Sheets (MSDS) and Personal Protective Equipment (PPE) requirements for the sample materials.
2. Load samples into the lyophilizer.
3. Attach sensors to the samples as necessary (*e.g.*, attach thermocouples on the outside surface of the designated vials).
4. Plug thermocouples into the lyophilizer's thermocouple jack panel.
5. Close and secure the product chamber and condenser doors.

   Note: *The product chamber door must be latched before the system will allow the product chamber to be pressurized.*

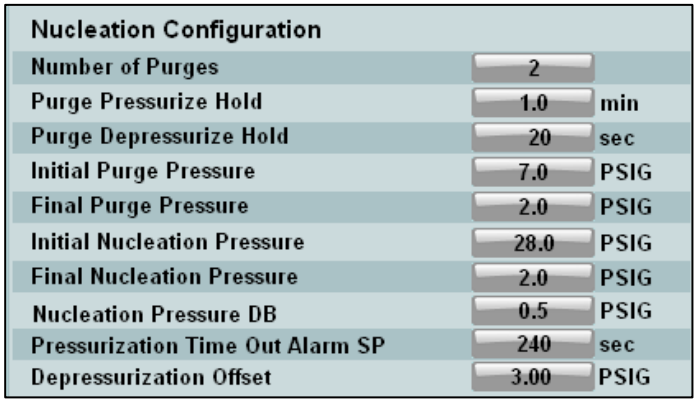
WARNING! THE LYOPHILIZER IS NOT SAFE TO PRESSURIZE WHEN THE DOOR IS ONLY CLOSED. THE DOOR MUST BE SECURELY LATCHED TO HOLD PRESSURE.

DO NOT ATTEMPT TO UNLATCH THE CHAMBER DOORS AT ANY TIME WHEN THE LYOPHILIZER IS PRESSURIZED.

6. Prepare Praxair's ControLyo™ Nucleation On-Demand Technology system for operation (*e.g.*, connect inert gas supply, open supply valve, etc.). Make sure all other openings are sealed so the lyophilizer can hold the pressure required for nucleation.

7. Input the desired values for nucleation control into the Nucleation Configuration Settings of the Configuration page.

   Note: *For more information, refer to the Nucleation Configuration Settings section of Chapter 10: Maintenance Menu.*



Nucleation Configuration Settings for systems with Praxair's ControLyo™ Nucleation On-Demand Technology Option.

Note: *The parameters displayed above are for illustrative purposes only and are not intended to be used as a guide for running a freeze-dry Cycle with ControLyo™ Nucleation on Demand Technology.*

8. Ensure that the appropriate gas supply source for Praxair's ControLyo™ Nucleation On-Demand Technology is connected to the lyophilizer. If the appropriate supply source is connected, open the gas supply valve.

Purge the product chamber.

9. Activate the Pressurize function from the Semi-Auto page. The Pressurization Valve will open and a sequence of pulse purges as defined by the Nucleation Configuration Settings will commence.

   The pulse purge sequence begins with pressurization to the Initial Purge Pressure setpoint followed by a Pressurize Hold step. Upon completion of the Pressurize Hold timer, the product chamber is depressurized to the Final Purge Pressure setpoint. The pulse purge sequence is repeated according to the Number of Purges setpoint.

10. After purging is complete, the system will pressurize the product chamber to the Initial Nucleation Pressure setpoint. The system will actively maintain pressure in the product chamber at the Initial Nucleation Pressure setpoint to accommodate leaks and changes in gas density if the pressure in the product chamber falls below the Nucleation Pressure DB (deadband).

Cool product samples.

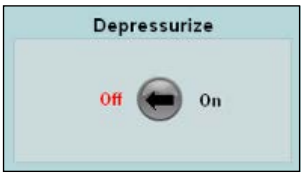
11. From the Semi-Auto page, cool product shelves to the desired nucleation (*e.g.*, 1 to 2 °C below the thermodynamic freezing point of your product). The shelf temperature should be set at a temperature such that the product is maintained below the target nucleation temperature during the depressurization.

    Note: *The pressurization and cooling events do not need to follow a certain sequence prior to the depressurization step that induces nucleation (e.g., pressurization followed by product cooling or product cooling followed by pressurization). To optimize batch uniformity, it is generally recommended that product temperatures and chamber pressure be approximately equilibrated at the desired values prior to depressurization.*

12. Allow samples to cool until warmest sample temperature is -1 °C or colder, as dictated by the thermodynamic freezing point of your product. To improve nucleation uniformity, hold the shelf temperature for a minimum of 60 minutes to achieve temperature equilibration in all samples.

Induce nucleation by depressurizing the product chamber.

13. Activate the Depressurize function from the Semi-Auto page to quickly release the chamber pressure to the Final Nucleation Pressure setpoint.



14. Activating the Depressurize function will automatically stop any pressurization process. A warning delay will occur approximately 20 seconds after a depressurization signal is received. During this time, a buzzer will sound and an amber strobe will illuminate on the lyophilizer. The depressurization will occur approximately 3 seconds after this buzzer and strobe stop. The system will depressurize the product chamber to the Final Nucleation Pressure setpoint.

THE PRESSURE IN THE PRODUCT CHAMBER MAY INCREASE SEVERAL PSIG SHORTLY AFTER DEPRESSURIZATION IS COMPLETE. IN SUCH CASES, THE DEPRESSURIZATION BYPASS VALVE WILL OPEN AUTOMATICALLY AND VENT THE CHAMBER QUICKLY TO THE FINAL NUCLEATION PRESSURE.

15. Complete your process using the necessary Semi-Auto functions.
16. Return the system to atmospheric pressure prior to opening the chamber door.
17. Open the freeze dryer product chamber door and remove samples from freeze dryer. Proper Personal Protective Equipment (PPE) should be worn when handling product samples.

Chapter 12

SMART Freeze Dryer™ Technology

THE FOLLOWING SECTION IS INTENDED FOR LYOSTAR™ 3 LYOPHILIZERS CONFIGURED WITH SMART FREEZE DRYER™ TECHNOLOGY.

Overview

SMART Freeze Dryer™ technology is a patented method for the development of freeze-dry cycles for aqueous-based pharmaceuticals and biopharmaceuticals. The technology has been licensed and co-developed by the University of Connecticut and Purdue University and incorporated into the LyoStar™ 3's optional SMART Freeze Dryer™ cycle mode.

The SMART Freeze Dryer™ cycle combines the Manometric Temperature Measurement (MTM) technique with automatic shelf temperature and vacuum setpoint control to maintain a target product temperature during Drying. Parameters for Freezing and the final step(s) of Drying can be automatically selected by the system or manually modified as needed.

The SMART Freeze Dryer™ cycle requires a comprehensive understanding of the thermal characteristics of the product formulation, as well as basic properties of the product presentation and container. Depending on the nature of the product, you will need to enter a eutectic (T_{eu}), glass transition (T_g') or collapse (T_c) temperature, as well as the number of vials in the batch, the vial inner area, the type of vials used, the fill volume, and the fill weight, among other variables.

NOTE: *SMART FREEZE DRYER™ TECHNOLOGY IS BASED UPON THE EXPERIENCE AND RESEARCH OF RESPECTED PROFESSIONALS IN THE FIELD OF PHARMACEUTICAL FREEZE-DRYING DEVELOPMENT. SMART FREEZE DRYER™ TECHNOLOGY SHOULD BE VIEWED AS A DEVELOPMENT TOOL THAT MAY AID IN THE DEVELOPMENT OF FREEZE-DRY CYCLES. HOWEVER, NO GUARANTEE IS MADE CONCERNING THE APPLICABILITY OF THE METHOD TO ANY PARTICULAR PRODUCT, AND SMART FREEZE DRYER™ TECHNOLOGY MAY NOT WORK FOR YOUR PARTICULAR PRODUCT.*

SMART Freeze Dryer™ Technology Basic Operation

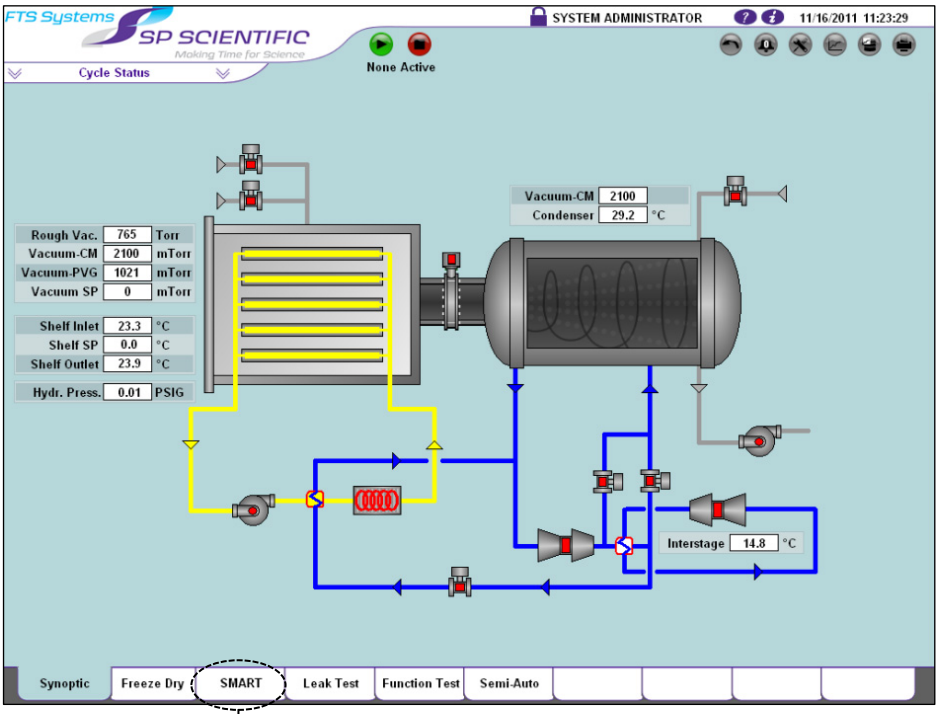
Prior to initiating a SMART Freeze Dryer™ cycle, make note of your system's current shelf temperature. For consistency, SP Scientific recommends running SMART Freeze Dryer™ cycles with same initial shelf temperature. You may consider starting with the shelves at an ambient temperature.

THE PARAMETERS INCLUDED IN THE FOLLOWING IMAGES ARE FOR ILLUSTRATIVE PURPOSES ONLY. THESE PARAMETERS ARE NOT INTENDED TO BE USED AS A GUIDE FOR RUNNING A SMART FREEZE DRYER™ CYCLE.

Cycle Parameters

To enter SMART Freeze Dryer™ cycle parameters:

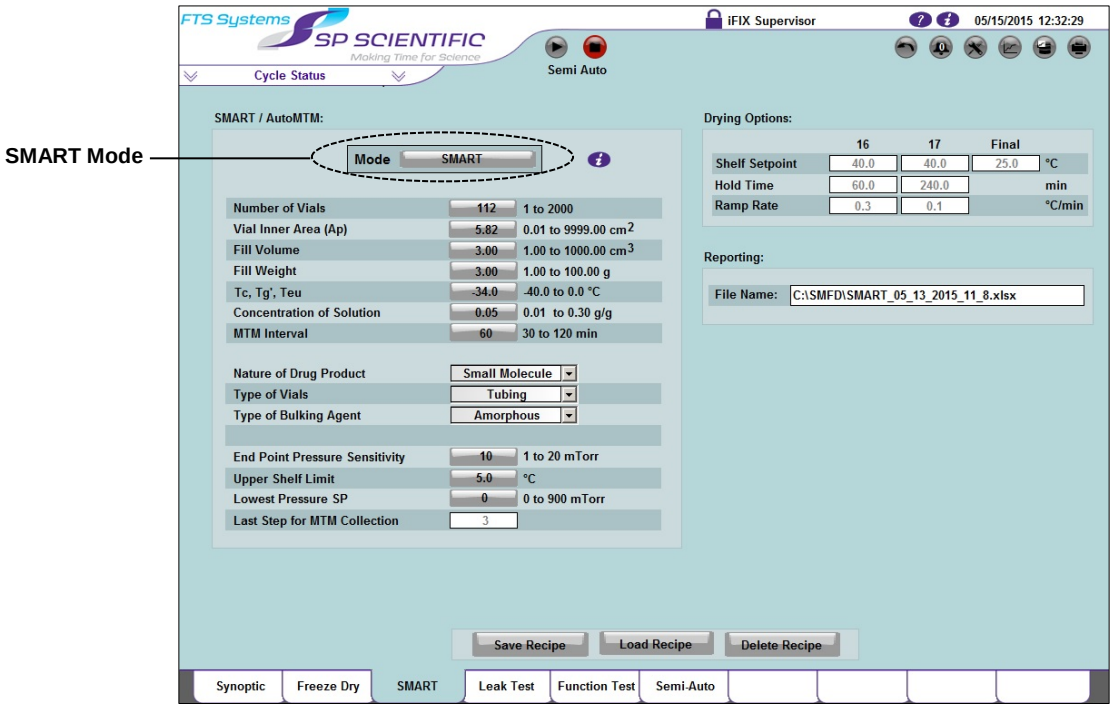
1. Select the SMART navigation tab.



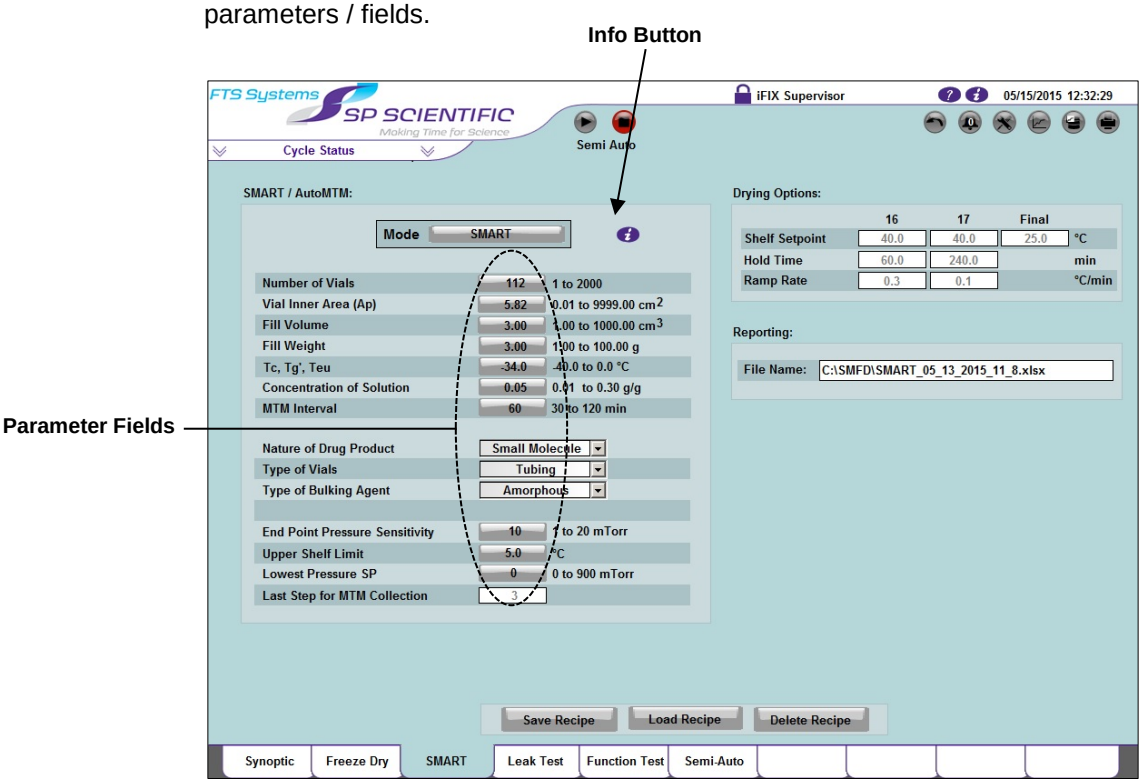
SMART Navigation Tab

2. From the SMART Freeze Dryer™ page, set the cycle Mode to SMART Freeze Dryer™ technology.

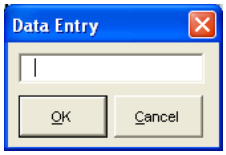
   Note: *Click the Mode button to toggle between SMART and AUTO MTM modes.*



3. Click the gray parameter fields to enter SMART Freeze Dryer™ cycle parameters. Click the SMART page Info button to open a description of the parameters / fields.



4. Each time you click a gray parameter field, the Data Entry pop-up window will appear. Enter a value and click OK to enter.



Data Entry Pop-Up

Data Parameters are defined as follows:

Note: *Click the SMART page Info button to open a description of configurable parameters.*

- **Number of Vials.** The total number of vials containing product in the batch. A minimum number of vials is necessary to generate accurate data. Approximately 291 cm^2 of product surface area is required. This equates to approximately one third to one-half of one tray of vials.
- **Vial Inner Area (A_P) (cm^2).** The surface area of the inner bottom surface of the vial in square centimeters (cm^2). This information can be obtained from the vial supplier or calculated from vial drawings using the formula $\mathbf{A=\pi*r^2}$, where r = the inner vial radius. The vials used should all have the same surface area. A common brand of 5 cc vial has 2.91 cm^2 inner area. A 20 cc vial has approximately 5.82 cm^2.
- **Fill Volume (cm^3).** The fill volume of the solution in one vial in cubic centimeters. The fill volume should be the same for each vial in the batch.
- **Fill Weight (g).** The net weight of a single vial's fill volume in grams. The fill weight should be the same for each vial in the batch.
- **T_c / T_g' / T_{eu} (°C).** The formulation's collapse temperature (Tc), glass transition temperature (Tg'), or eutectic temperature (Teu). Input the appropriate parameters depending on the nature of the product. Where more than one value exists, the lowest value should be used for the safest cycle.
- **Concentration of Solution (g/g).** The amount of solute per unit amount of solution (g/g).
- **MTM Interval (min).** This value shall determine how often the Isolation Valve is closed during Drying to perform the pressure rise measurements and manometric temperature measurements (MTM).
- **Nature of Drug Product.** For information only, select either protein or small molecule depending on the type of product. This information will be included in the SMART data file that is generated during the cycle.
- **Type of Vials.** The type of glass vials being used (*e.g.,* tubing or molded). Tubing vials are generally recommended for lyophilization applications. This parameter will help determine the heat transfer coefficient used by the program.

- **Type of Bulking Agent.** The appropriate value according to the type of bulking agent being used (*e.g.,* none, unsure, crystalline or amorphous). This selection will determine the default freezing program, default upper shelf point limit in drying, ramp rates and shelf setpoints during the last step(s) of drying.

  If Crystalline is selected, the SMART Freeze Dryer™ cycle will include an annealing step during the Freezing phase (*i.e.,* the shelf temperature shall be raised just above the formulation's critical temperature and held for 4 hours. After 4 hours has elapsed, the system will lower the temperature of the shelves to -40 °C). Upon conclusion of the Freezing / Thermal Treatment phase, the system ramps to drying steps 16 and 17 at a rate of 0.3 °C/minute. The shelf setpoint for step 16 is -40 °C, the shelf setpoint for step 17 is 50 °C and the final shelf setpoint is 25 °C.

  If Amorphous is selected, the Freezing phase will not include an annealing step, as explained previously. Instead, the system ramps to drying step 17 at a rate of 0.1 °C/minute. The shelf setpoint for step 17 is 40 °C and the final shelf setpoint is 25 °C.

  Enter **None** if no bulking agent is being used. Enter **Unsure** if the bulking agent is unknown.

- **End Point Pressure Sensitivity (mTorr).** In order to move into the final Drying steps, the program monitors the calculated P_{ice} against the chamber pressure setpoint. When the vapor pressure of ice is less than the End Point Pressure Sensitivity value for two consecutive manometric temperature measurements (MTM), the program will advance to the final steps of the Drying phase.

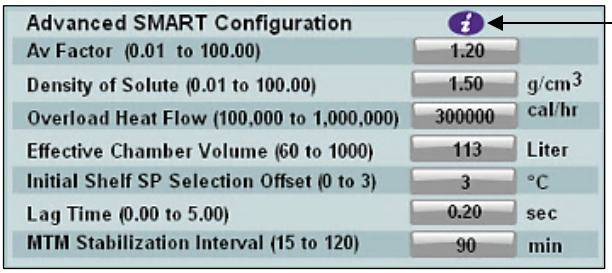
- **Upper Shelf Limit.** This is the upper shelf setpoint limit during Drying. Depending on the Bulking Agent Type selected, the system may populate this field with recommended default parameters. You may increase or decrease these limits as desired.

  If Amorphous is selected, the default upper shelf setpoint limit will be 5 °C. If Crystalline is selected, the default upper shelf setpoint limit will be 25 °C.

- **Lowest Pressure SP.** This is the lowest allowable pressure setting for your product. Using a 0 disables this override and will use the pressure valve calculated by SMART.

Advanced SMART Freeze Dryer™ Configuration

Additional SMART Freeze Dryer™ parameters are accessible from the Configuration page.



Info Button (Click to open a description of parameters / fields)

THE ADVANCED SMART CONFIGURATION PARAMETERS ARE PRESET AT THE FACTORY PRIOR TO SHIPMENT. SP SCIENTIFIC RECOMMENDS THAT YOU RECORD THE FACTORY SETTING FOR FUTURE REFERENCE BEFORE MODIFYING THESE PARAMETERS.

The Advanced SMART Configuration settings are defined as follows:

- **A_V Factor.** This parameter is based on the outer cross-sectional area of the vial. The operator may redefine this factor based on custom or vial vendor specifications. The default setting is $A_v=1.2*A_p$, where A_p equals vial inner area.
- **Density of Solute.** This value is used to estimate the Drying phase time, which is calculated during the first manometric temperature measurements (MTM). The Density of Solute is also used to determine a safety margin below the critical product temperature, which shall be termed the target product temperature.

  The following table outlines the product safety margin as based on various estimated Drying times:

Estimated Drying Time	Product Safety Margin
< 8 hours	-5 °C
8 - 48 hours	-3 °C
> 48 hours	-2 °C

- **Overload Heat Flow.** This value is used to limit the drying rate so that it will not exceed the maximum heat removal capacity (cal/hr) of a commercial freeze dryer once the process is upscaled.
- **Effective Chamber Volume.** This is the lyophilizer's product chamber volume in liters that will be used in the MTM equation. This value is preset at the factory and should not be modified.
- **Initial Shelf SP Selection Offset.** This value allows factory technicians to tune the initial shelf setpoint selection during a SMART cycle based on the physical characteristics of the system.

Note: *It is recommended to consult SP Scientific before changing this value.*

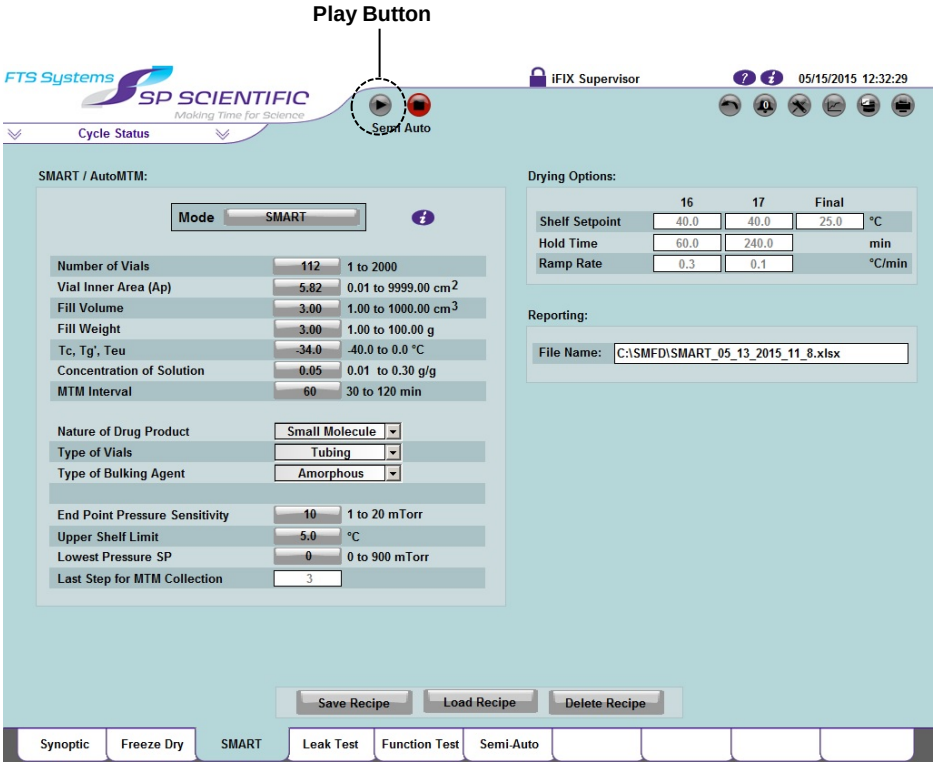
- **Lag Time.** This parameter refers to the delay between the feedback to the programmable logic controller (PLC) that the isolation valve is fully closed and the start of the manometric temperature measurements (MTM) calculated during the SMART cycle.
- **MTM Stabilization Interval.** This is the value (in minutes) that SMART / Auto MTM uses as the initial stabilization time in the first step before taking the first manometric temperature measurement.

Initiating a SMART Freeze Dryer™ Cycle

To start a SMART Freeze Dryer™ cycle:

1. Enter all SMART Freeze Dryer™ cycle parameters and select the green play button from the SMART page to begin the cycle.

   Note: *Before starting a SMART Freeze Dryer™ cycle, ensure that Guaranteed Soak is enabled on the Configuration page.*

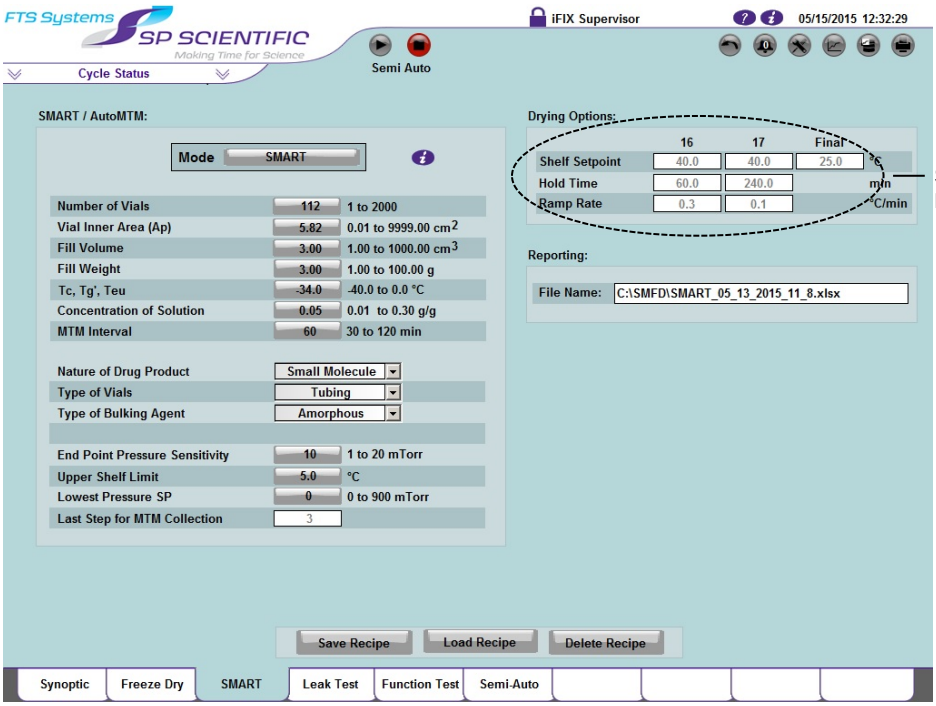


2. An hourglass icon will appear on the SMART page with the words, Starting SMART. Please Wait…

3. After approximately 15 seconds, the refrigeration system will energize and the cycle will begin at the Freezing/Thermal Treatment phase.

   Note: *When using the default SMART settings, all ramp rates are programmed at 1 °C per minute during the Freezing/Thermal Treatment phase.*

4. Between the start of the cycle and the moment that the cycle transitions to the first Drying phase step, you may edit the final Drying step(s) and the Final Shelf Setpoint temperature. These parameters are located in the upper right area of the SMART page.



SMART Drying Phase Options

Note: *During a SMART Freeze Dryer™ cycle, the Final Shelf Setpoint specified on the SMART page will override the Product Storage Temperature Setpoint defined by the user on the Freeze-Dry Recipe page.*

   a. The system allows you to edit Drying steps 16 and 17, as well as the Final Shelf Setpoint from the SMART page for cycles in which the Type of Bulking Agent was specified as Crystalline, None or Unsure.

   b. The system allows you to edit Drying step 17 only, as well as the Final Shelf Setpoint from the SMART page for cycles in which the Type of Bulking Agent was specified as Amorphous.

5. Upon completion of the Freezing/Thermal Treatment phase, the system will transition through the Freeze phase.

6. Once the system completes the Freeze phase, the cycle will transition to the Drying phase. The shelves are heated or cooled according to the initial Temperature Setpoint, and the chamber pressure is modified according to the Vacuum Setpoint.

7. Once the setpoints are obtained, the system stabilizes and the isolation valve closes. At this point, the system begins calculating the manometric temperature measurements (MTM).

   a. The isolation valve closes for 25 seconds. During this period, pressure readings are taken at a rate of 10 readings per second.

   b. The system uses the pressure readings (*i.e.,* pressure rise data) to determine the estimated Drying time. Based on the estimated Drying time estimate, the system will select a product temperature safety margin.

Estimated Drying Time	Product Safety Margin
< 8 hours	-5 °C
8 - 48 hours	-3 °C
> 48 hours	-2 °C

   c. The system compares the calculated MTM product temperature with the target product temperature. If the temperatures differ by more than 1 °C, the system adjusts shelf temperature accordingly.

8. The PLC collects the pressure rise data and uses it to solve the MTM equation. MTM temperature and other SMART Freeze Dryer™ cycle data are captured in the SMART Freeze Dryer™ data file. This Microsoft® Excel® file (*.xlsx) is saved to the system's hard drive at **C:\SMFD**.

   Note: *Each data file is saved with a unique date and 24-hour time stamp assigned as part of its file name structure (e.g., the file SMART_09_16_2011_16_22 is based on the SMART Freeze Dryer™ cycle that was run on September 16, 2011 at 16:22).*

NEVER ACCESS SMART DATA FILES WHILE THE SMART CYCLE IS ACTIVE. IF THE FILE IS OPEN WHILE DATA COLLECTION IS IN PROGRESS, DATA COLLECTION WILL BE INTERUPPTED.

SMART Freeze Dryer™ Cycle Data Files

NEVER ACCESS SMART DATA FILES WHILE THE SMART CYCLE IS ACTIVE. IF THE FILE IS OPEN WHILE DATA COLLECTION IS IN PROGRESS, DATA COLLECTION WILL BE INTERUPPTED.

SMART Freeze Dryer™ cycle data points are captured in the SMART Freeze Dryer™ data file. This Microsoft® Excel® file (*.xlsx) is saved to the system's hard drive at **C:\SMFD**.

Each SMART Freeze Dryer™ data file is saved with a unique date and 24-hour time stamp assigned as part of its file name structure (*e.g.,* the file *SMART_09_16_2011_16_22* is based on the SMART Freeze Dryer™ cycle that was run on September 16, 2011 at 16:22).

The SMART Freeze Dryer™ cycle data is categorized as follows:

- **Time Pass (min).** Time elapsed during the Drying phase.
- **Time Interval (min).** Time elapsed since last MTM measurement.
- **P_{ice} (mTorr).** Vapor pressure at the ice surface at the end of the manometric temperature measurement (MTM).
- **R_p (cm^2*Torr*hr/gr).** Resistance of the dried layer in the product.
- **$Tp_{(MTM)}$ (°C).** Temperature of the product at the ice surface as determined by the manometric temperature measurement (MTM).
- **$dQ/dt_{(MTA-1)}$ (cal/hr/vial).** Rate of heat transfer.
- **L_{ice} (cm).** Thickness of the ice in the product.
- **$T_{s(set)}$ (°C).** Calculated shelf temperature.
- **P_0 (mTorr).** Recorded chamber pressure when the PLC sends the "close" signal to the isolation valve.
- **T_b (°C).** Product temperature at the bottom of the vial.
- **K_v x 10^4 (cal/sec*cm^2*K).** Vial heat transfer coefficient.
- **W_{subl} (g/vial).** Accumulated mass loss.
- **dm/dt (g/hr/vial).** Rate of sublimation.
- **L_{dry} (cm).** Thickness of the dried layer.

End SMART Freeze Dryer™ Cycle

Upon completion of the SMART Freeze Dryer™ cycle, SP recommends that you follow the same series of steps that you would typically follow when ending a standard freeze-dry cycle. The following process will ensure that your product may be removed safely from the product chamber.

Note: *Before your product may be removed from the chamber, you will need to release vacuum from the system and allow it to equalize to atmospheric pressure.*

Product Storage (Backfill and Stoppering Disabled)

If your system is in the Product Storage phase at the end of a freeze-dry cycle and neither automatic backfill or automatic stoppering were enabled as part of the cycle, a green checkmark will appear to the right of your Product Storage Temperature Setpoint.

Complete the Cycle

1. To end the freeze-dry cycle, select the green checkmark to the right of the Product Storage Temperature SP (setpoint).
2. The system will release vacuum from the system.

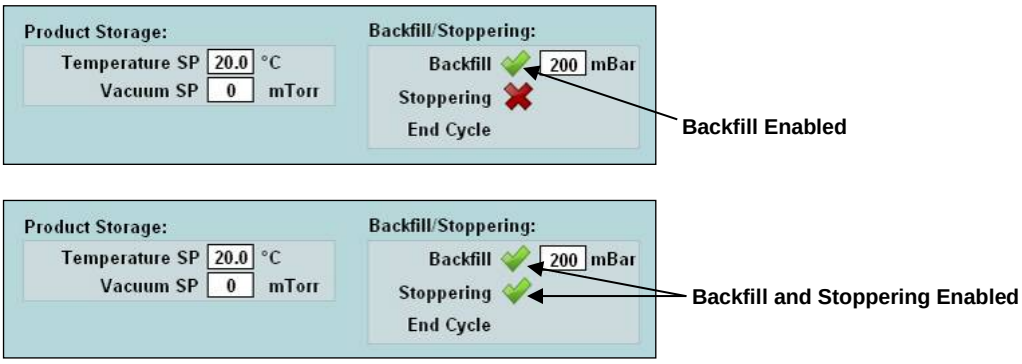
Backfill / Stopper Prior to End Cycle

1. If you would prefer not to end the cycle at this point, you may enable Backfill and/or Stoppering to begin backfilling the product chamber and/or activating the stoppering mechanism immediately.
2. Once the backfill and/or stoppering tasks are complete, a green checkmark will appear to the right of the End Cycle field.
3. Select this green checkmark to end the freeze-dry cycle.

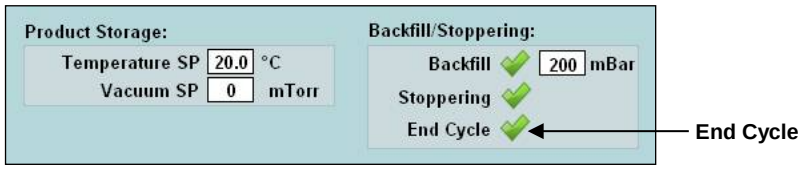
4. The system will release vacuum from the system.

Product Storage (Backfill and/or Stoppering Enabled)

If backfill and/or stoppering are enabled as part of the freeze-dry cycle, the cycle will perform the required functions and return to the Product Storage phase.



1. Once the cycle returns to the Product Storage phase, a green checkmark will appear to the right of the End Cycle field.



2. Select this green checkmark to end the freeze-dry cycle.
3. The system will release vacuum from the system.

Auto MTM

Auto MTM Basic Operation

Automatic Manometric Temperature Measurement, or Auto MTM, allows for the collection of SMART Freeze Dryer™ data when executing an existing Freeze-Dry recipe.

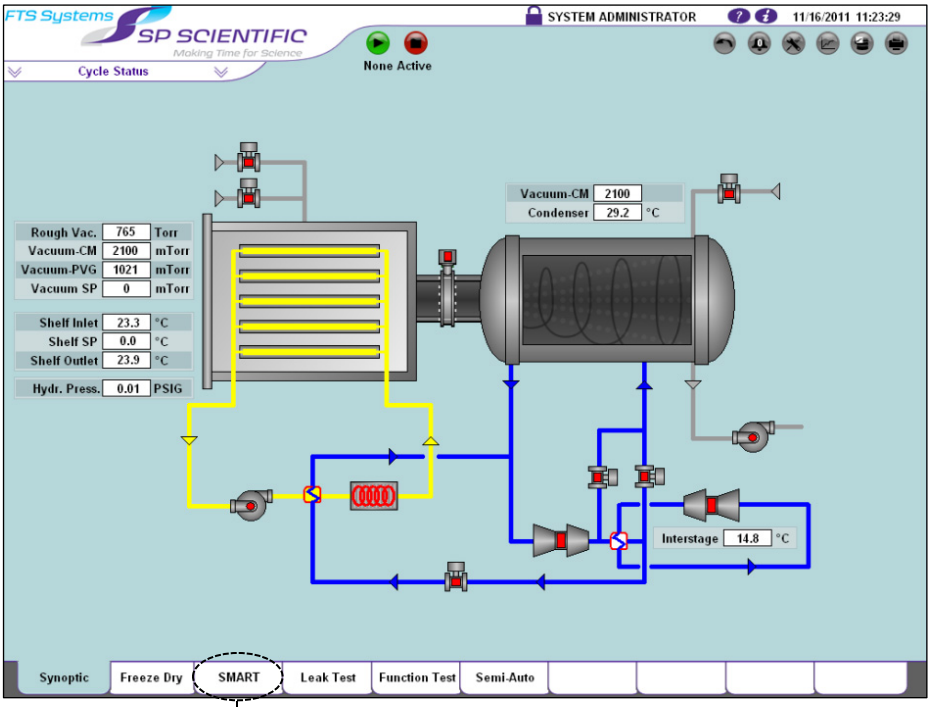
WHEN LOADING OR ENTERING FREEZE-DRY RECIPES FOR USE WITH AUTO MTM, SP SCIENTIFIC RECOMMENDS USING DRYING PHASE STEPS WITH A MINIMUM HOLD TIME EQUAL TO OR GREATER THAN THE MTM STABILIZATION INTERVAL.

To begin the Auto MTM run:

1. Enter recipe parameters on the Freeze-Dry page or load an existing recipe to the Freeze-Dry page.

   Note: *For proper execution of the Freeze-Dry recipe, do not change any setpoints, ramp rates or hold times after the Auto MTM run has begun.*

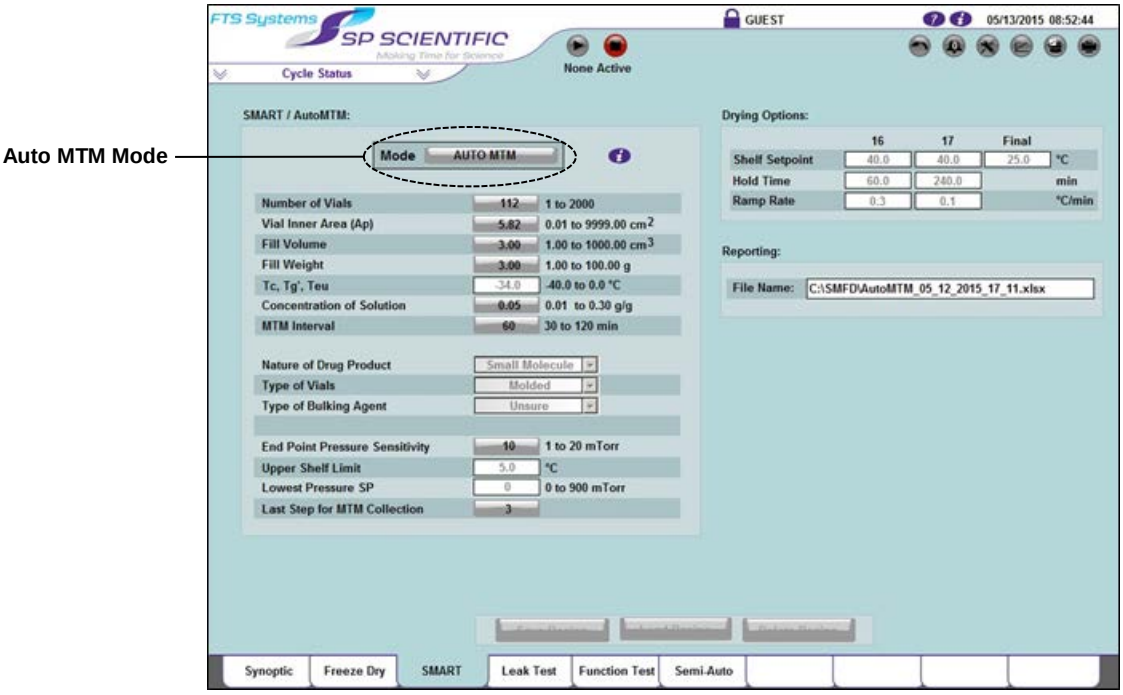
2. Select the SMART navigation tab.



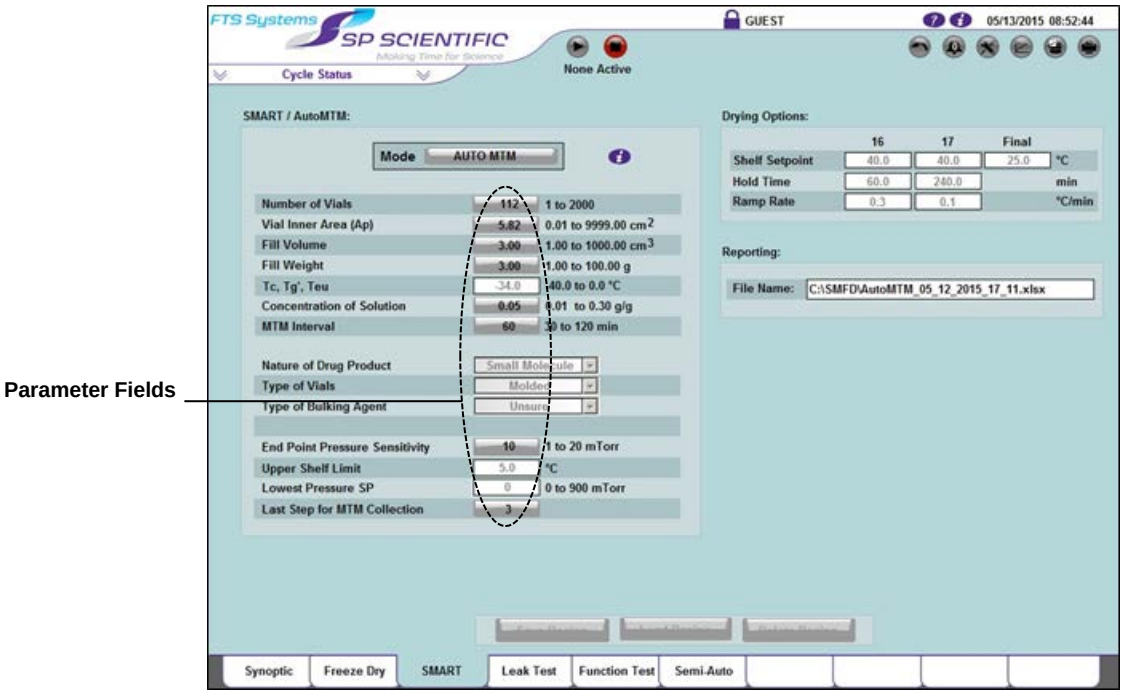
SMART Navigation Tab

3. From the SMART Freeze Dryer™ page, set the cycle Mode to AUTO MTM.

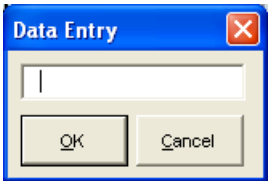
   Note: *Click the Mode button to toggle between SMART and AUTO MTM modes.*



4. Click the gray parameter fields to enter Auto MTM cycle parameters.



5. Each time you click a gray parameter field, the Data Entry pop-up window will appear. Enter a value and click OK to enter.

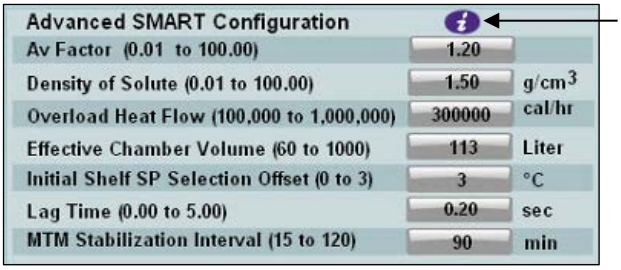


Data Parameters are defined as follows:

- **Number of Vials.** Enter the total number of vials containing product in the batch. A minimum number of vials is necessary to generate accurate data. Approximately 291 cm^2 of product surface area is required. This equates to approximately one third to one-half of one tray of vials.
- **Vial Inner Area (A_P) (cm^2).** The surface area of the inner bottom surface of the vial in square centimeters (cm^2). This information can be obtained from the vial supplier or calculated from vial drawings using the formula **$A=\pi*r^2$**, where r = the inner vial radius. The vials used should all have the same surface area. *E.g.,* a common brand of 5 cc vial has 2.91 cm^2 inner area. A 20 cc vial has approximately 5.82 cm^2.
- **Fill Volume (cm^3).** The fill volume of the solution in one vial in cubic centimeters. The fill volume should be the same for each vial in the batch.
- **Fill Weight (g).** The net weight of a single vial's fill volume in grams. The fill weight should be the same for each vial in the batch.
- **Concentration of Solution (g/g).** The amount of solute per unit amount of solution (g/g).
- **MTM Interval (min).** This value shall determine how often the Isolation Valve is closed during Drying to perform the pressure rise measurements and manometric temperature measurements (MTM).
- **Last Step for MTM Collection.** When using the Auto MTM mode of operation, you may want to take MTM measurements during some or all steps of the Drying phase. Use this field to program the last sequential step of the recipe for which you want to calculate MTM data.

Advanced Auto MTM Configuration

Additional parameters used for Auto MTM are accessible from the Configuration page under the heading Advanced SMART Configuration.



Info Button (Click to open a description of parameters / fields)

THE ADVANCED SMART CONFIGURATION PARAMETERS ARE PRESET AT THE FACTORY PRIOR TO SHIPMENT. SP SCIENTIFIC RECOMMENDS THAT YOU RECORD THE FACTORY SETTING FOR FUTURE REFERENCE BEFORE MODIFYING THESE PARAMETERS.

The Advanced SMART Configuration settings are defined as follows:

- **A_V Factor.** This parameter is based on the outer cross-sectional area of the vial. The operator may redefine this factor based on custom or vial vendor specifications. The default setting is $A_v=1.2*A_p$, where A_p equals vial inner area.
- **Density of Solute.** This value is used to estimate the Drying phase time, which is calculated during the first manometric temperature measurements (MTM). The Density of Solute is also used to determine a safety margin below the critical product temperature, which shall be termed the target product temperature. The following table outlines the product safety margin as based on various estimated Drying times:

Estimated Drying Time	Product Safety Margin
< 8 hours	-5 °C
8 – 48 hours	-3 °C
> 48 hours	-2 °C

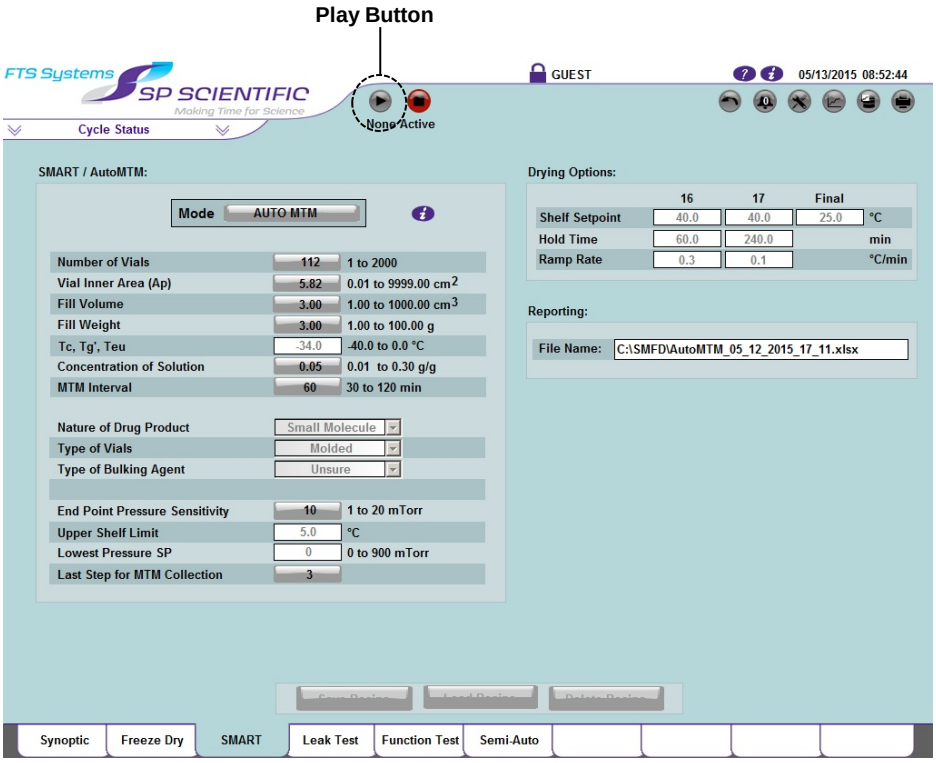
- **Overload Heat Flow.** This value is used to limit the drying rate so that it will not exceed the maximum heat removal capacity (cal/hr) of a commercial freeze dryer once the process is upscaled.
- **Effective Chamber Volume.** This is the lyophilizer's product chamber volume in liters that will be used in the MTM equation. This value is preset at the factory and should not be modified.
- **Initial Shelf SP Selection Offset.** This value allows factory technicians to tune the initial shelf setpoint selection during a SMART cycle based on the physical characteristics of the system. It is recommended that this value not be changed without consulting SP Scientific.
- **Lag Time.** This parameter refers to the delay between the feedback to the programmable logic controller (PLC) that the isolation valve is fully closed

and the start of the manometric temperature measurements (MTM) calculated during the SMART cycle.

- **MTM Stabilization Interval.** This is the value (in minutes) that SMART / Auto MTM uses as the initial stabilization time in the first step before taking the first manometric temperature measurement.

Initiating an Auto MTM Cycle

1. Enter all Auto MTM cycle parameters and select the green play button from the SMART page to begin the cycle.



2. An hourglass icon will appear on the SMART page with the words, “Starting AutoMTM. Please Wait…”

3. After approximately 15 seconds, the refrigeration system will energize and the freeze-dry cycle will begin.

4. Upon completion of the Freezing/Thermal Treatment phase, the system will transition through the Freeze phase.
5. Once the system completes the Freeze phase, the cycle will transition to the Drying phase. The shelves are heated or cooled according to the initial Temperature Setpoint, and the chamber pressure is modified according to the Vacuum Setpoint.
6. Once the setpoints are obtained, the system stabilizes only in step 1 for the MTM Stabilization Time Setpoint. The isolation valve then closes and the system begins automatically calculating the manometric temperature measurements (MTM).

   Note: *After the system calculates the MTM, it rechecks the remaining step time. If the remaining step time is greater than or equal to the MTM Interval (as set from the SMART page), the system will continue to calculate MTM at the specified intervals. If the remaining step time is less than the MTM Interval, the system will perform a final MTM calculation and then advance to the next step.*

   a. The isolation valve closes for 25 seconds. During this period, pressure readings are taken at a rate of 10 readings per second.
   b. The system uses the pressure readings (*i.e.,* pressure rise data) to determine the estimated Drying time.
7. The PLC collects the pressure rise data and uses it to solve the MTM equation. MTM temperature and other Auto MTM cycle data are captured in the Auto MTM data file. This Microsoft® Excel® file (*.xlsx) is saved to the system's hard drive at **C:\SMFD**.

   Note: *Each data file is saved with a unique date and 24-hour time stamp assigned as part of its file name structure. For example, the file AutoMTM_09_20_2011_15_25 is based on the Auto-MTM cycle that was run on September 20, 2011 at 15:25.*

NEVER ACCESS AUTO MTM DATA FILES WHILE THE AUTO MTM CYCLE IS ACTIVE. IF THE FILE IS OPEN WHILE DATA COLLECTION IS IN PROGRESS, DATA COLLECTION WILL BE INTERUPPTED.

Auto MTM Cycle Data Files

Auto MTM cycle data points are captured in the Auto MTM cycle data file. This Microsoft® Excel® file (*.xlsx) is saved to the system's hard drive at **C:\SMFD**.

Each data file is saved with a unique date and 24-hour time stamp assigned as part of its file name structure. For example, the file AutoMTM_09_20_2011_15_25 is based on the Auto-MTM cycle that was run on September 20, 2011 at 15:25.

The Auto MTM cycle data is categorized as follows:

- **Time Pass (min).** Time elapsed during the Drying phase.
- **Time Interval (min).** Time elapsed since last MTM measurement.
- **P_{ice} (mTorr).** Vapor pressure at the ice surface at the end of the manometric temperature measurement (MTM).
- **R_p (cm^2*Torr*hr/gr).** Resistance of the dried layer in the product.
- **$T_{p(MTM)}$ (°C).** Temperature of the product at the ice surface as determined by the manometric temperature measurement (MTM).
- **$dQ/dt_{(MTA-1)}$ (cal/hr/vial).** Rate of heat transfer.
- **L_{ice} (cm).** Thickness of the ice in the product.
- **$T_{s(set)}$ (°C).** Calculated shelf temperature.
- **P_0 (mTorr).** Recorded chamber pressure when the PLC sends the "close" signal to the isolation valve.
- **T_b (°C).** Product temperature at the bottom of the vial.
- **$K_v \times 10^4$ (cal/sec*cm²*K).** Vial heat transfer coefficient.
- **W_{subl} (g/vial).** Accumulated mass loss.
- **dm/dt (g/hr/vial).** Rate of sublimation.
- **L_{dry} (cm).** Thickness of the dried layer.

End Auto MTM Freeze-Dry Cycle

Upon completion of the Auto MTM freeze-dry cycle, SP recommends that you follow the same series of steps that you would typically follow when ending a freeze-dry cycle. The following process will ensure that your product may be removed safely from the product chamber.

Note: *Before your product may be removed from the chamber, you will need to release vacuum from the system and allow it to equalize to atmospheric pressure.*

Product Storage (Backfill and Stoppering Disabled)

If your system is in the Product Storage phase at the end of a freeze-dry cycle and neither automatic backfill or automatic stoppering were enabled as part of the cycle, a green checkmark will appear to the right of your Product Storage Temperature Setpoint.

Complete the Cycle

1. To end the freeze-dry cycle, select the green checkmark to the right of the Product Storage Temperature SP (setpoint).
2. The system will release vacuum from the system.

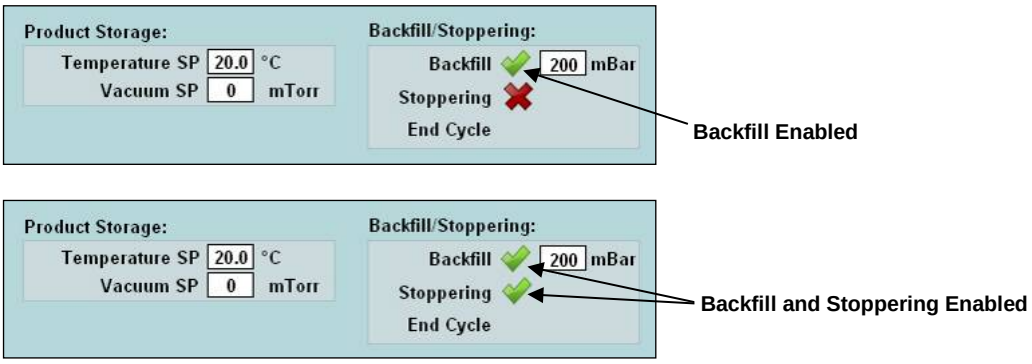
Backfill / Stopper Prior to End Cycle

1. If you would prefer not to end the cycle at this point, you may enable Backfill and/or Stoppering to begin backfilling the product chamber and/or activating the stoppering mechanism immediately.
2. Once the backfill and/or stoppering tasks are complete, a green checkmark will appear to the right of the End Cycle field.

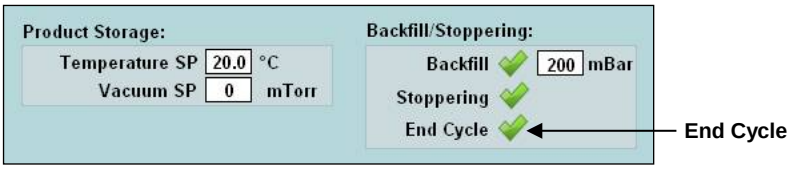
3. Select this green checkmark to end the freeze-dry cycle.
4. The system will release vacuum from the system.

Product Storage (Backfill and/or Stoppering Enabled)

If backfill and/or stoppering are enabled as part of the freeze-dry cycle, the cycle will perform the required functions and return to the Product Storage phase.



1. Once the cycle returns to the Product Storage phase, a green checkmark will appear to the right of the End Cycle field.



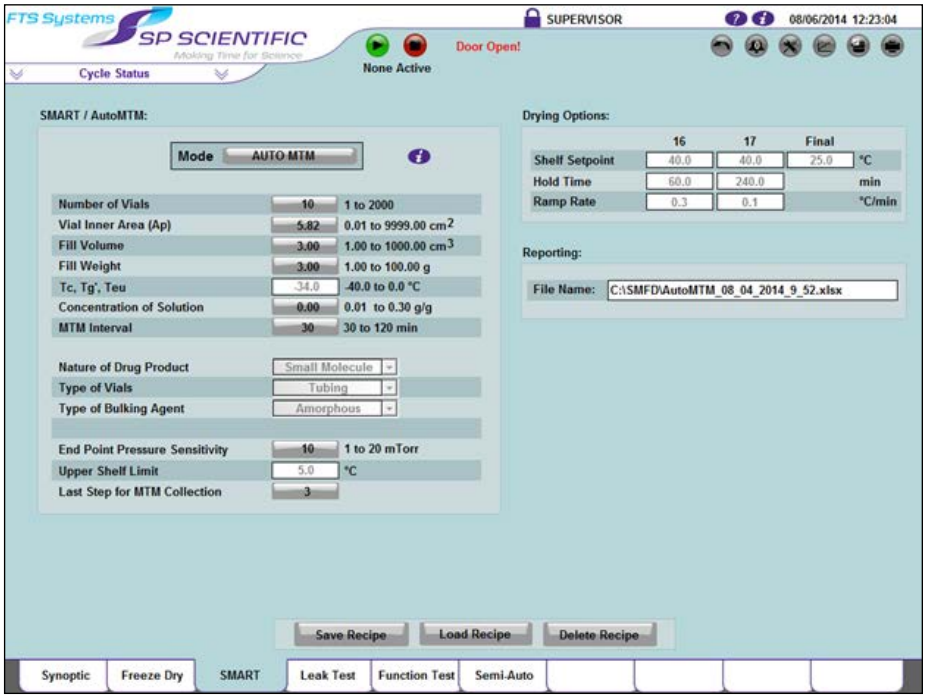
2. Select this green checkmark to end the freeze-dry cycle.
3. The system will release vacuum from the system.

Recipe Management for SMART and Auto MTM

After becoming acquainted with the SMART and Auto MTM modes on the SMART Freeze Dryer™ page, you may create, save, load, delete and otherwise modify recipes using the LyoS™ Recipe Manager.

While completed recipes may be printed or discarded after use, recipes may also be saved and loaded for future use. To save, load or delete recipes, select the appropriate button on the SMART Freeze Dryer™ page. Recipes are maintained using Microsoft® Access®.

Note: *Recipes cannot be saved or loaded while a SMART Freeze Dryer™ cycle is active.*



Freeze-Dry Recipe Page

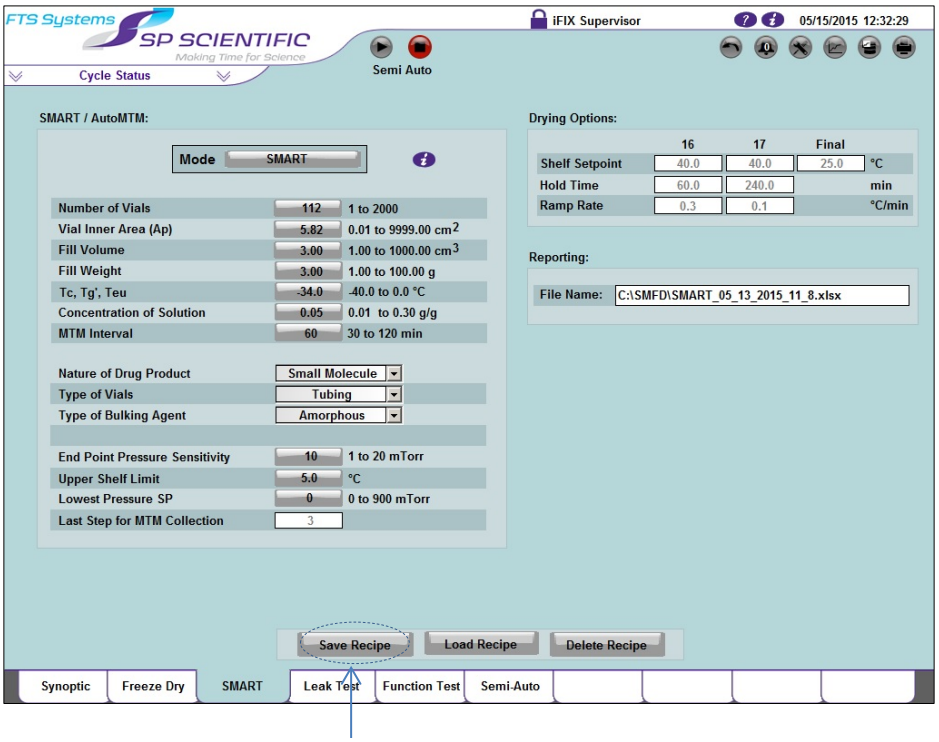
Saving Recipes

After entering SMART Freeze Dryer™ cycle parameters, your recipe may be saved and stored in the lyophilizer's PLC.

Note: *Communication between the PLC and the computer must be established for the Recipe Manager to operate properly. If you are having problems with recipe management functionality, check that all cables are connected and that data is displayed properly on the Synoptic page.*

To save a recipe:

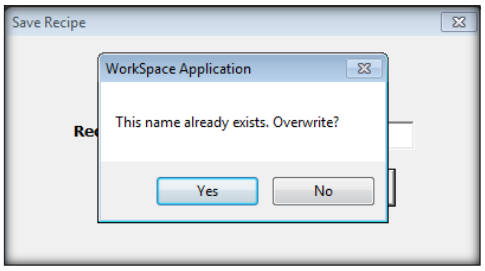
1. Click the Save Recipe button on the SMART Freeze Dryer screen.



Save Recipe Button

2. Enter a name for your recipe then click the Save button.

3. The Recipe Manager function will verify if the recipe name currently exists.
   a. If the recipe name is available, the recipe is saved and the system will close and exit.
   b. If the recipe name is available but an error message occurs, check the error message for what caused the error.
   c. If the recipe name currently exists, you will be prompted to overwrite the existing recipe.



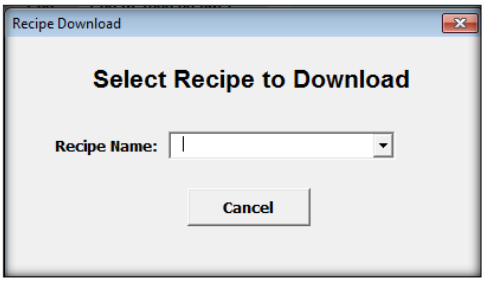
   1. Click Yes to overwrite the existing recipe.
   2. Choose No to enter a new name.

Loading Recipes

Once a recipe has been saved to the PLC, it may be loaded to the SMART Freeze Dryer™ Recipe page for use.

To load a recipe to the SMART Freeze Dryer™ page:

1. From the SMART Freeze Dryer™ page, click the Load Recipe button.
2. The Recipe Download dialog will open. Select a Recipe from the combo box drop-down list.



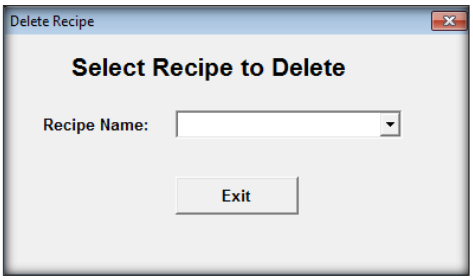
3. Once selected, the recipe will download and exit out of the dialog box.
4. Choose cancel before selecting recipe to exit.

WARNING! EXECUTING A SMART FREEZE DRYER™ CYCLE WITH MISSING RECIPE DATA OR INVALID PARAMETERS WILL CAUSE UNPREDICTABLE RESULTS, INCLUDING THE POSSIBILITY OF DAMAGE TO YOUR UNIT OR PRODUCT. ALWAYS CONFIRM RECIPE DATA BEFORE STARTING A SMART FREEZE DRYER™ CYCLE.

Deleting Recipes

To delete a previously saved recipe:

1. Click the Delete Recipe button from the SMART Freeze Dryer™ page.
2. The Delete Recipe dialog will open. Select a Recipe from the combo box drop-down list.



3. Click the Delete button. A message will appear asking you if you want to delete the recipe.

   Note: *Use caution when deleting recipes. Deleted recipes may not be recovered.*

4. Click Yes to Delete and Exit or No to Cancel and Exit.

Chapter 13

SEC 1 Standard Security

THE FOLLOWING SECTION IS INTENDED FOR LYOSTAR™ 3 LYOPHILIZERS CONFIGURED WITH STANDARD SEC 1 SECURITY.

Note: *To verify the security of your system, open the alarm summary page of the LyoS™ control system. If the Alarm summary page does not include an SQL Alarms and Events button, your system has standard SEC1 security.*

If the alarm summary page includes an SQL Alarms and Events button, your system is configured with the SEC3 security option. Refer to *Chapter 14: SEC3 Security Option (21 CFR Part 11 Compliant-Capable)**.*

Overview

The LyoS™ control system contains a multi-level, password-protected security system that permits complete access and functionality to users with the maximum-security level, and limited viewing and functionality to those with lesser security levels.

Security Access Levels

The standard security access levels are identified as Guest, Operator (Oper) and Supervisor (Super), with Supervisor having the highest level of security privileges. The default login and password for each security level is as follows:

Login	Password
Guest	Guest
Operator	Oper
Supervisor	Super

Note: *The login names and guest password are not case sensitive, while the operator and supervisor passwords are case sensitive.*

By default, the lowest security level (*i.e.*, Guest) does not require logging in to the system. The LyoS™ automatically opens to this level when the control system is started up. The login/logoff function is accessed by clicking the padlock icon ( ) on the top of the LyoS™ main layout. All logins are recorded in the Alarm History file, which is located in the in the **C:\LyoS\alm** directory. It is recommended that each user be provided with a unique login and password. Only the supervisor level may perform this function.

Note: *For information on un-locking security users, contact SP Scientific. For information on creating users, refer to the* *Configuring Proficy® Security* *section of this chapter.*

Access to Pages and Screens

The following table illustrates the LyoS™ control system pages/screens and the corresponding access/privilege levels with the SEC 1 option. A “Yes” indicates that the page/screen is accessible by the specified access/privilege levels. A “No” indicates that the page/screen is not accessible by the specified access/privilege levels.

Screen Description	Guest	Operator	Supervisor
Alarm Summary	Yes	Yes	Yes
Alarm Print	Yes	Yes	Yes
Calibration	Yes	Yes	Yes
Configuration	Yes	Yes	Yes
Cycle Status	Yes	Yes	Yes
Freeze Dry (Recipe)	Yes	Yes	Yes
Function Test	Yes	Yes	Yes
Historical Data Export	Yes	Yes	Yes
Historical Trend	Yes	Yes	Yes
Information Button (*e.g.,* Main header, SMART screen, Configuration page AdVanced SMART/AutoMTM section)	Yes	Yes	Yes
Leak Test	Yes	Yes	Yes
Maintenance	Yes	Yes	Yes
Probe Avg Button (Product Probes pop-up)	Yes	Yes	Yes
Semi-Auto	Yes	Yes	Yes
SMART	Yes	Yes	Yes
Synoptic	Yes	Yes	Yes

Note: *The Access to Pages and Screens table may differ from the one shown above depending on your software configuration and purchased options.*

Access to System Functions

The following table illustrates the functions of the LyoS™ control system and the corresponding access/privilege levels with the SEC 1 option. A “Yes” indicates that the system function may be access/performed by the specified access/privilege levels. A “No” indicates that the system function may not be access/performed by the specified access/privilege levels.

System Functions	Guest	Operator	Supervisor
Access to Microsoft® Office	No	No	Yes
Acknowledge Alarms	No	Yes	Yes
Automatic Cycle Setpoints (Freeze-Dry Cycle)	No	No	Yes
Automatic Cycle Setpoints (Leak Test, Function Test)	No	Yes	Yes
Calibration Settings	No	No	Yes
Cancel Current Cycle (Stop button)	No	Yes	Yes
Cycle Continue	No	Yes	Yes
End Freeze-Dry Cycle	No	Yes	Yes
Information Button pop-up (*e.g.,* Main header Vapor Pressure Over Ice table, SMART screen data parameter definitions, AdVanced SMART/AutoMTM Configuration page definitions)	Yes	Yes	Yes
Maintain iFIX Proficy® Security	No	No	Yes
Print	Yes	Yes	Yes
Print Screen (Historical Trend)	Yes	Yes	Yes
Recipe Downloading	No	Yes	Yes
Recipe Saving	No	No	Yes
Semi-Auto Control	No	Yes	Yes
Shutdown System	No	No	Yes
Start Automatic Cycle	No	Yes	Yes
System Configuration Settings	No	No	Yes
Microsoft® Windows® Desktop	No	No	Yes

Note: *The Access to System Functions table may differ from the one shown above depending on your software configuration and purchased options.*

Configuring Proficy® Security

Standard LyoS™ systems may require modification of the user security levels within the GE Proficy® HMI/SCADA iFIX software. In order to create or modify user levels, you must be logged in with the system default access and privileges of a Supervisor.

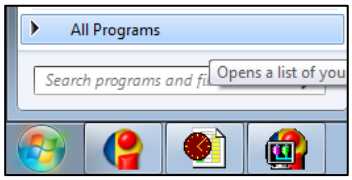
Note: *Proficy® user accounts operate independently from those created within the Microsoft® Windows® operating system environment. Windows® user names cannot be used to login to the LyoS™ control system.*

To configure Proficy® Security from the LyoS™ control system:

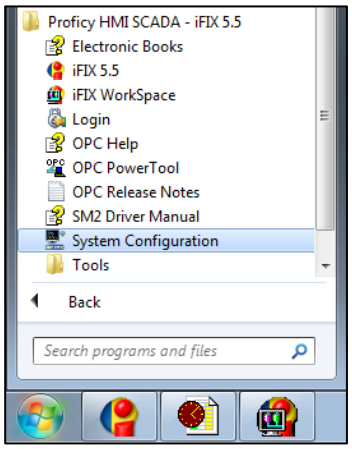
1. Login as a Supervisor or higher.
2. Hit the Windows® key on your keyboard to open the Windows® Start Menu.

Windows® Key

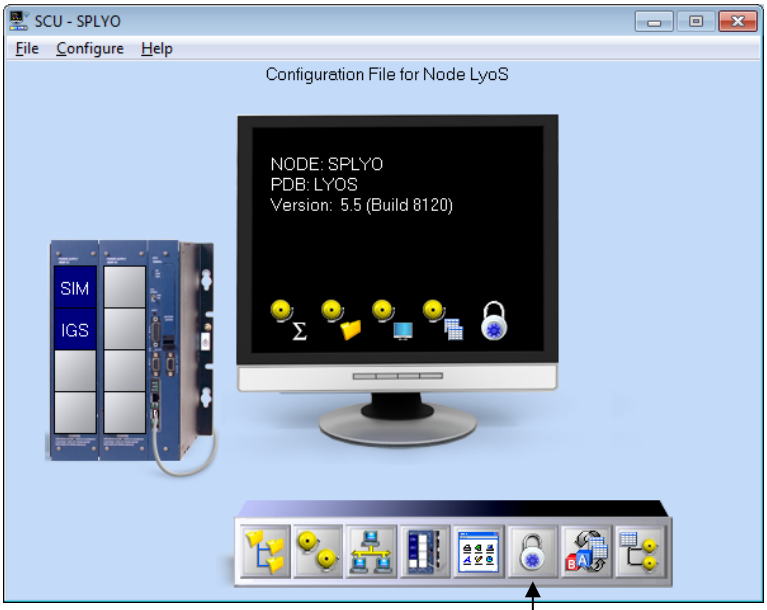
3. Click All Programs.



4. Click Proficy® HMI SCADA then click System Configuration.

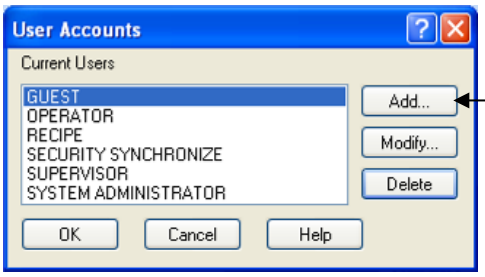


5. Click the security padlock icon from the Security Configuration Utility (SCU) screen.



6. Click the User Accounts icon.

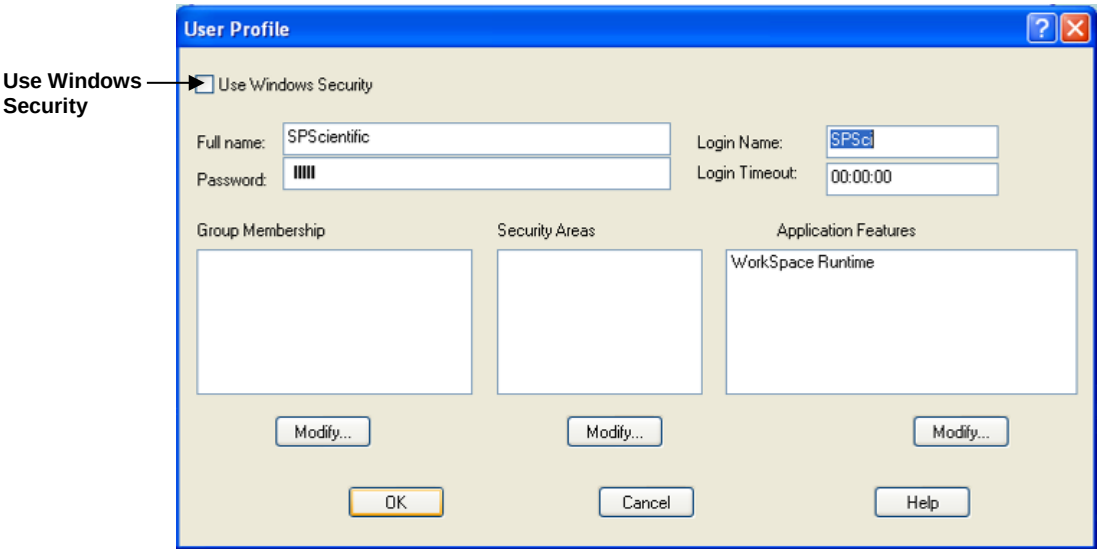
7. Click the Add button to create a new User Account.



WARNING! DO NOT DELETE ANY FACTORY INSTALLED USER ACCOUNTS FROM THE SYSTEM, EVEN IF THEY ARE UNUSED. DELETING FACTORY INSTALLED USER ACCOUNTS MAY CAUSE THE LYOS™ WORKSTATION TO MALFUNCTION.

8. Complete the Full name, Login Name, Password and Login Timeout fields. SP Scientific recommends setting the Login Timeout to 00:00:00.

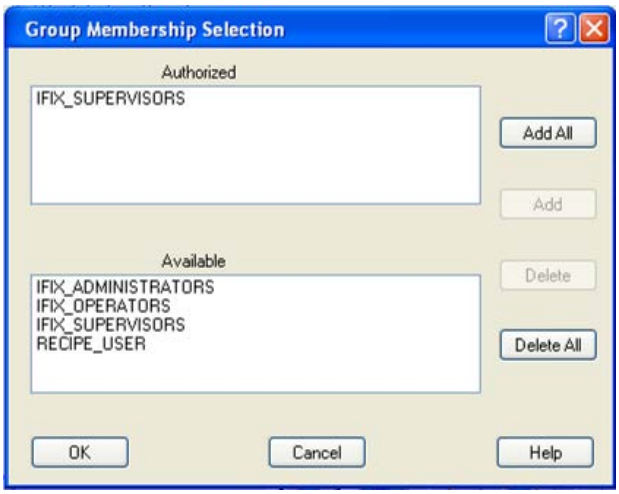
Note: *The "Use Windows® Security" must remain unchecked. Do not attempt to link users to Windows® security using this procedure.*



9. Click the Modify button under the Group Membership area.

10. Select the appropriate group from the Available list and click Add. Low-level users should be added to the IFIX_OPERATORS group, while high-level users should be added to the IFIX_SUPERVISORS group.

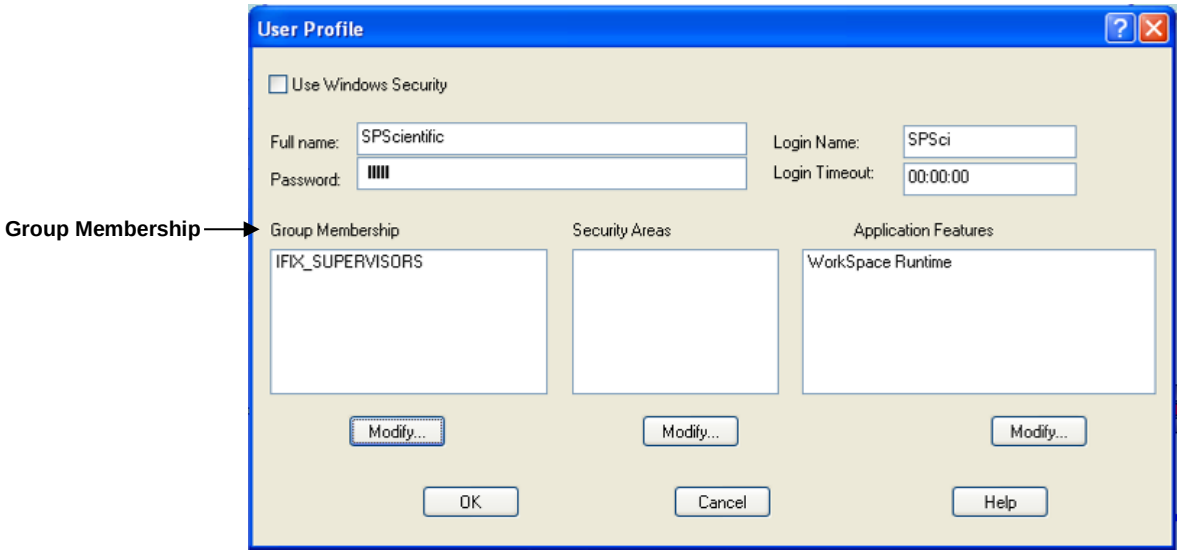
Note: *For group access and privileges, refer to the Security Access Levels section of this chapter.*



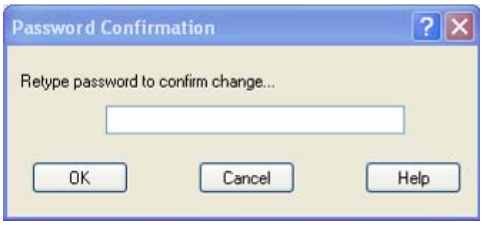
WARNING! DO NOT DELETE ANY FACTORY INSTALLED GROUP ACCOUNTS FROM THE SYSTEM, EVEN IF THEY ARE UNUSED. DELETING FACTORY INSTALLED GROUP ACCOUNTS MAY CAUSE THE LYOS™ WORKSTATION TO MALFUNCTION.

11. Click the OK button when the appropriate group is selected.

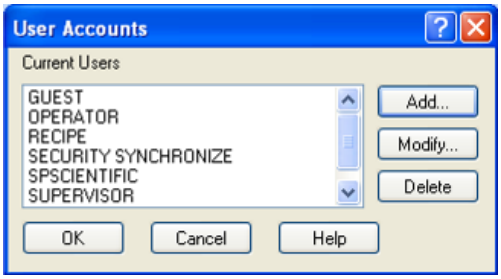
12. Verify that the correct security group appears in the Group Membership area and click the OK button.



13. Enter a password for the new user, then click the OK button.

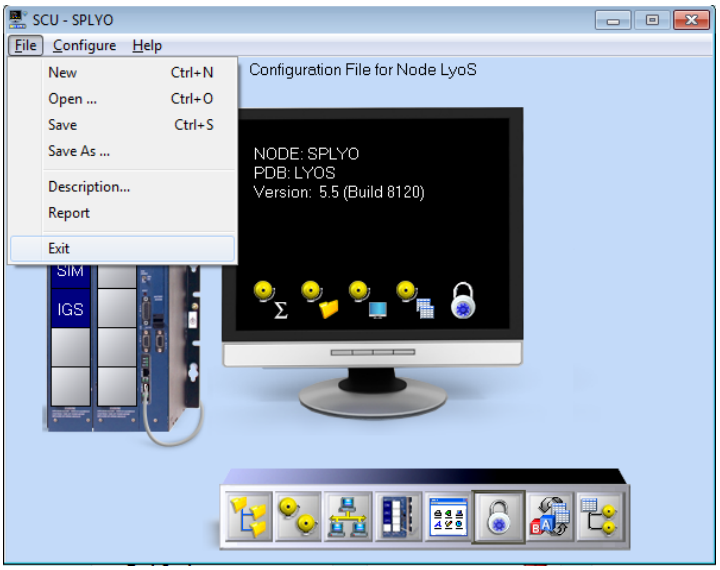


14. Confirm that the new user has been added to the list of Current Users and click the OK button.



15. Select File then Save or hit Ctrl+S.

16. Select File then Exit or hit Alt+F4 to return to the System Configuration Utility Screen (SCU).
17. Select File then Save.
18. Select File then Exit to close the System Configuration Utility Screen (SCU).



19. Test the new user account by logging in and out. Ensure that the appropriate security rights were assigned before allowing new users to log in to their accounts.

SEC 3 Security Option (21 CFR Part 11 Compliant-Capable)

Chapter **14**

THE FOLLOWING SECTION IS INTENDED FOR LYOSTAR™ 3 LYOPHILIZERS CONFIGURED WITH SEC 3 SECURITY OPTION.

Note: *To verify the security of your system, open the alarm summary page on the LyoS™ control system. If the alarm summary page includes an SQL Alarms and Events button, your system is configured with the SEC3 security option.*

If the Alarm summary page does not include an SQL Alarms and Events button, your system has standard SEC1 security. Refer to Chapter 13: SEC1 Standard Security.

Overview

The U.S. Food and Drug Administration (FDA) released the Guideline on General Principles of Process Validation in 1987, setting forth a series of strict rules and regulations for manufacturing processes. Current regulations in place for governing food and drugs in the U.S. are set forth in Title 21 of the Code of Federal Regulations (21 CFR). These regulations include the requirement known as “Current Good Manufacturing Practices” (cGMP), which is constituted in 21 CFR Parts 210 and 211.

The U.S. FDA has also put in place a series of guidelines for qualifying computerized systems to help protect both manufacturers and consumers from the insecurities brought about by introducing automated, software-controlled processes into a production process. The FDA’s 21 CFR Part 11 deals specifically with computerized systems, describing guidelines pertaining to the maintenance and submission of electronic records created, modified, maintained, archived, retrieved, and/or transmitted by manufacturers. With the SEC3 security option, the LyoS™ control system becomes 21 CFR Part 11 compliant-capable.

Note: *SP Scientific offers customized validation packages to guide you in the validation of your lyophilizer and control system. Contact SP Scientific for more information.*

Features and Components

If your LyoS™ control system has been configured with the 21 CFR Part 11 compliance-capable option (*i.e.,* SEC3), it will include the following features and installed components:

- Microsoft® SQL Server for secured data storage of alarms and events.
- Three (3) levels of Proficy® iFIX security, incorporated directly into the Microsoft® Windows® operating system environment.
- An advanced system of electronic signatures for logging system changes.

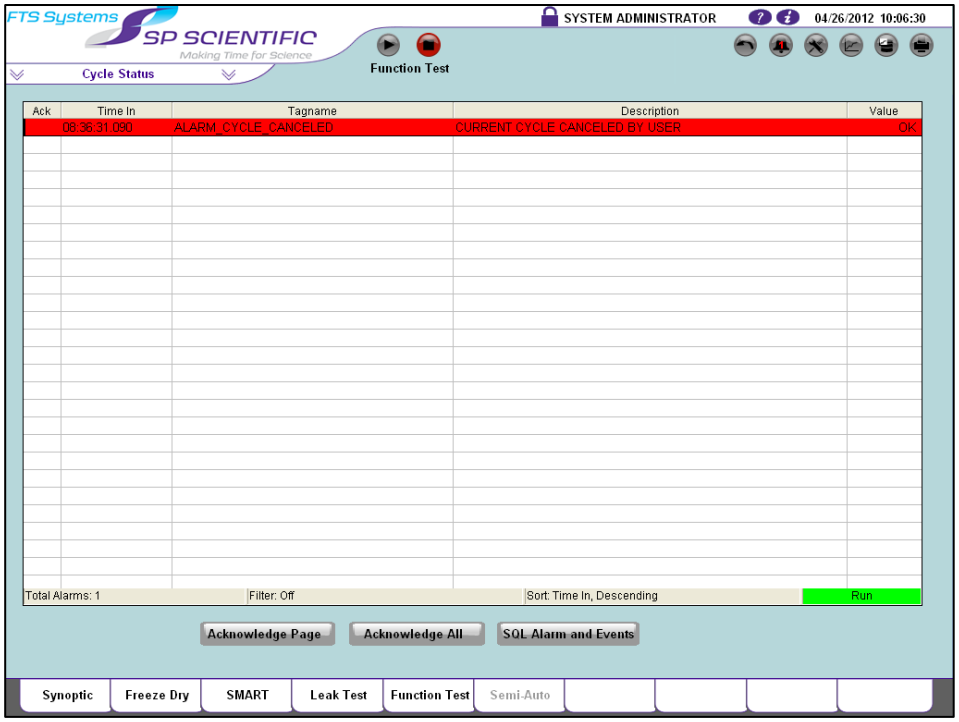
Alarm Summary

The Alarm Summary button provides access to the Alarm Summary page. The Alarm Summary page provides a detailed list of all active alarms along with access to past alarms and events using the SQL Alarms and Events button. The Alarm Summary button also displays the current number of unacknowledged alarms (*i.e.*, the number over the Alarm Summary button will change accordingly and flash red when an alarm is active).

Note: *If the Alarm Button displays a zero (0), this does not necessarily mean that the system did not trigger any alarms. It means that if alarms were triggered, they may have already been "acknowledged." You may visit the Alarm Summary page at any time for a list of current alarms.*

The column headings of the Alarm Summary page are defined as follows:

1. **Ack.** Indicates whether the alarm has been acknowledged by the operator. A checkmark indicates that the alarm has been acknowledged.
2. **Time In.** Displays the time that the alarm was logged in the system.
3. **Tagname.** Displays the alarm name as used by the system program.
4. **Description.** Identifies the alarm condition.
5. **Value.** Displays the type and or status of the Alarm message (*e.g.,* Alarm, OK, etc.).



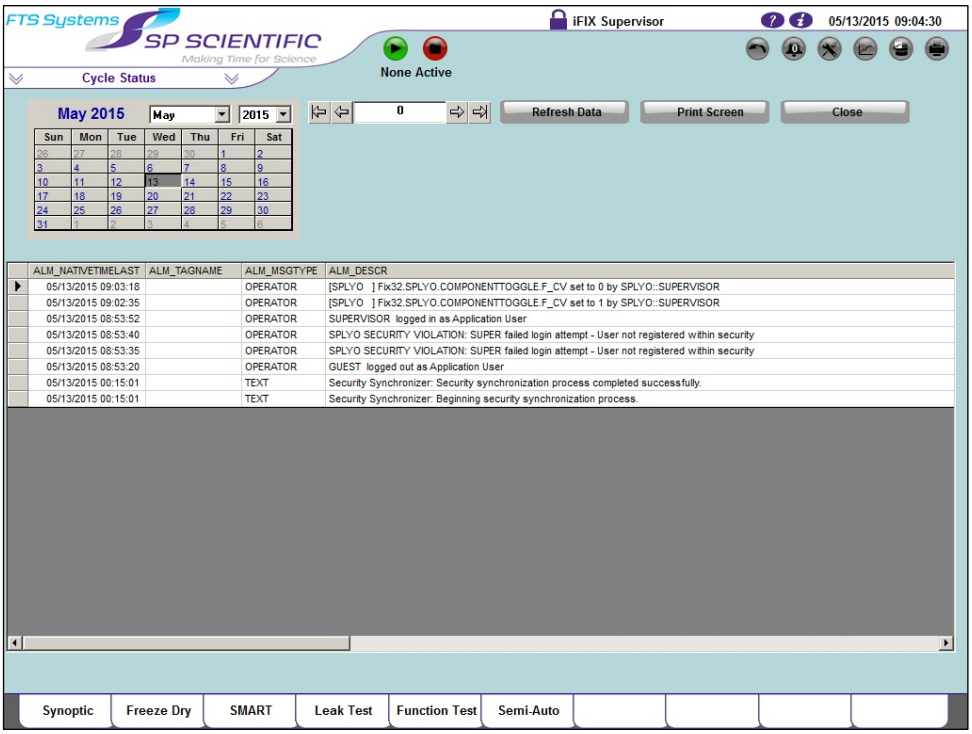
Active alarms may be acknowledged using the Acknowledge Page and Acknowledge All buttons. A check mark is placed to the left of active alarms that have been acknowledged, but not cleared. Once an alarm is acknowledged, the PC horn will also silence. In order for an alarm to be removed from the page, the condition causing the alarm must be corrected.

Note: *If the Alarm Summary page is filled with active, unacknowledged alarms, the Acknowledge All button may need to be clicked several times to acknowledge all alarms.*

View Alarm and Event Data

The LyoS™ control system stores daily alarm and event data files until disk space has reached its limit.

1. Click the SQL Alarms and Events button on the Alarm Summary page.
2. The SQL Alarms and Events page appears with a list of Alarms and Events that may be searched for by date. The dates are formatted as mm/dd/yyyy (*e.g.,* 04/26/2012).



Note: *To close the SQL Alarms and Events page at any time, click the Close button.*

3. Use the calendar tool to select the date of Alarms and Events you wish to view. The page will default to the current date. To view a previous date, use the drop down month and year menus located within the calendar.
4. Click the Print Screen button (*i.e.,*) to print the SQL Alarms and Events page. Only the Alarms and Events that are visible on the screen will be printed. To change what alarms are visible, use the up and down scroll arrows on the right side of the screen.

   Note: *To print a complete list of Alarms and Event files, refer to the Reading Alarm and Event Files section of this chapter.*

Security Access Levels

The LyoS™ control system contains an extensive multi-level security system that permits complete access to users with the appropriate security level, as well as limited viewing of screens with no operations permitted to those without clearance.

Note: *Microsoft® Windows® security settings cannot be used with the Proficy® iFIX software on a standard LyoS™ system. The SEC3 security option must be purchased. If you do not require 21 CFR Part 11 compliance but would like this feature, or if you require factory configuration of the security system, please contact SP Scientific.*

The three (3) default user levels of a standard SEC3 system are as follows:

Login	Password
Guest	guest
Operator	oper
Supervisor	super

Note: *The login names and guest password are not case sensitive, while the operator and supervisor passwords are case sensitive.*

By default, the lowest security level (Guest) does not require logging in to the system. The computer automatically boots to this level. The login/logoff function is accessed by clicking on the lock icon ( ) on the top of the LyoS™ main layout. All logins are recorded in the Alarm History file, allowing you to track changes made by each user. It is recommended that each user be provided with a unique login and password. Only the supervisor level may perform this function.

Three (3) or more unsuccessful login attempts may cause the iFIX user account to become locked out. User accounts may be unlocked through Microsoft® Windows® security settings.

Note: *For information on un-locking security users, contact SP Scientific. For information on creating users, refer to the Configuring Windows® 7 Security section of this chapter.*

Access to Pages and Screens

The following table illustrates the LyoS™ control system pages/screens and the corresponding access/privilege levels with the SEC 3 option. A “Yes” indicates that the page/screen is accessible by the specified access/privilege levels. A “No” indicates that the page/screen is not accessible by the specified access/privilege levels.

Screen Description	Guest	Operator	Supervisor
Alarm Summary	Yes	Yes	Yes
Calibration	Yes	Yes	Yes
Configuration	Yes	Yes	Yes
Cycle Status	Yes	Yes	Yes
Freeze Dry (Recipe)	Yes	Yes	Yes
Function Test	Yes	Yes	Yes
Historical Data Export	Yes	Yes	Yes
Historical Trend	Yes	Yes	Yes
Information Button (*e.g.,* Main header, SMART screen, Configuration page AdVanced SMART/AutoMTM section)	Yes	Yes	Yes
Leak Test	Yes	Yes	Yes
Maintenance	Yes	Yes	Yes
Probe Avg Button (Product Probes pop-up)	Yes	Yes	Yes
Semi-Auto	Yes	Yes	Yes
SMART	Yes	Yes	Yes
SQLAlarmsEvents Screen	Yes	Yes	Yes
Synoptic	Yes	Yes	Yes

Note: *The Access to Pages and Screens table may differ from the one shown above depending on your software configuration and purchased options.*

Access to System Functions

The following table illustrates the functions of the LyoS™ control system and the corresponding access/privilege levels with the SEC 3 option. A “Yes” indicates that the system function may be access/performed by the specified access/privilege levels. A “No” indicates that the system function may not be access/performed by the specified access/privilege levels.

System Functions	Guest	Operator	Supervisor
21 CFR 11 Electronic Signature, “Performed By” Function	No	No	Yes
Access to Microsoft® Office	No	No	Yes
Acknowledge Alarms	No	Yes	Yes
Automatic Cycle Setpoints (Freeze-Dry Cycle)	No	No	Yes
Automatic Cycle Setpoints (Leak Test, Function Test)	No	Yes	Yes
Calibration Settings	No	No	Yes
Cancel Current Cycle (Stop button)	No	Yes	Yes
Cycle Continue	No	Yes	Yes
End Freeze-Dry Cycle	No	Yes	Yes
Information Button pop-up (*e.g.,* Main header Vapor Pressure Over Ice table, SMART screen data parameter definitions, AdVanced SMART/AutoMTM Configuration page definitions)	Yes	Yes	Yes
Maintain Security User Accounts in Microsoft® Windows®	No	No	Yes
Print	Yes	Yes	Yes
Print Screen (Historical Trend)	Yes	Yes	Yes
Recipe Downloading	No	Yes	Yes
Recipe Saving	No	No	Yes
Semi-Auto Control	No	Yes	Yes
Shutdown System	No	No	Yes
Start Automatic Cycle	No	Yes	Yes
System Configuration Settings	No	No	Yes
Microsoft® Windows® Desktop	No	No	Yes

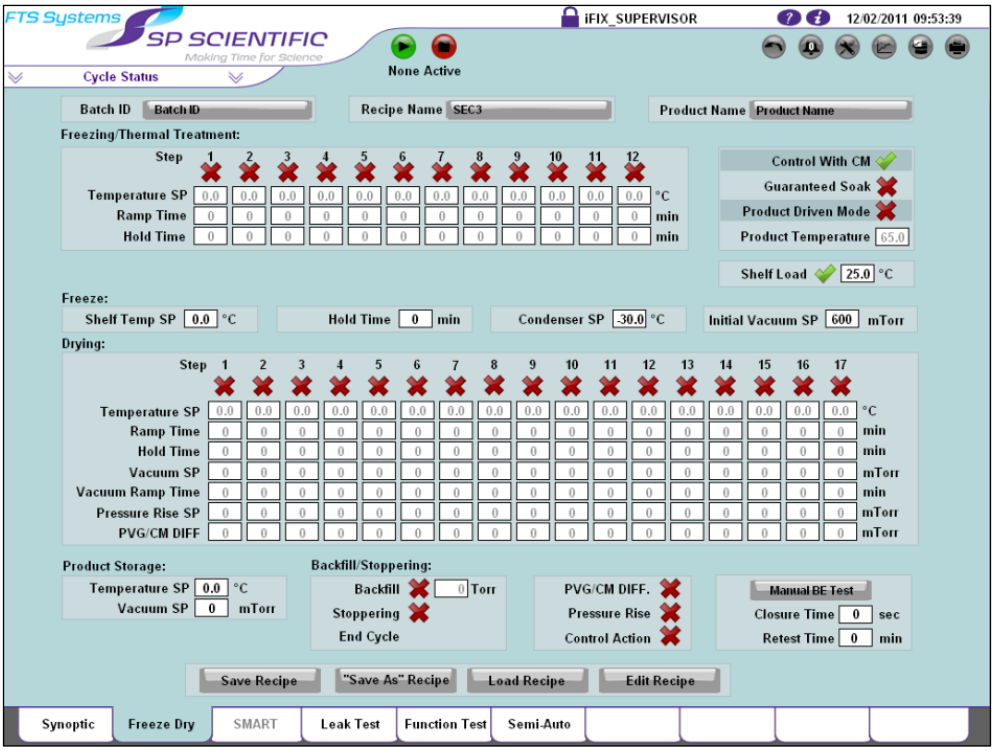
Note: *The Access to System Functions table may differ from the one shown above depending on your software configuration and purchased options.*

Recipe Management

SEC3 (21 CFR Part 11) systems are highly secure systems, and as such, the recipe management system and recipe entry are handled somewhat differently than standard systems.

Like standard systems, parameters on the Freeze-Dry Recipe screen cannot be modified, with the exception of the Batch ID and product name field. However, users with security level Supervisor or higher are able to make recipe modifications. If a setpoint value must be changed during a freeze-dry cycle, a user with security level Supervisor or higher must log in to execute the required changes.

Note: *In default SEC3 systems, Supervisor is the highest user setting. However, as SP Scientific offers customized security configurations, higher security levels may be present on your system.*



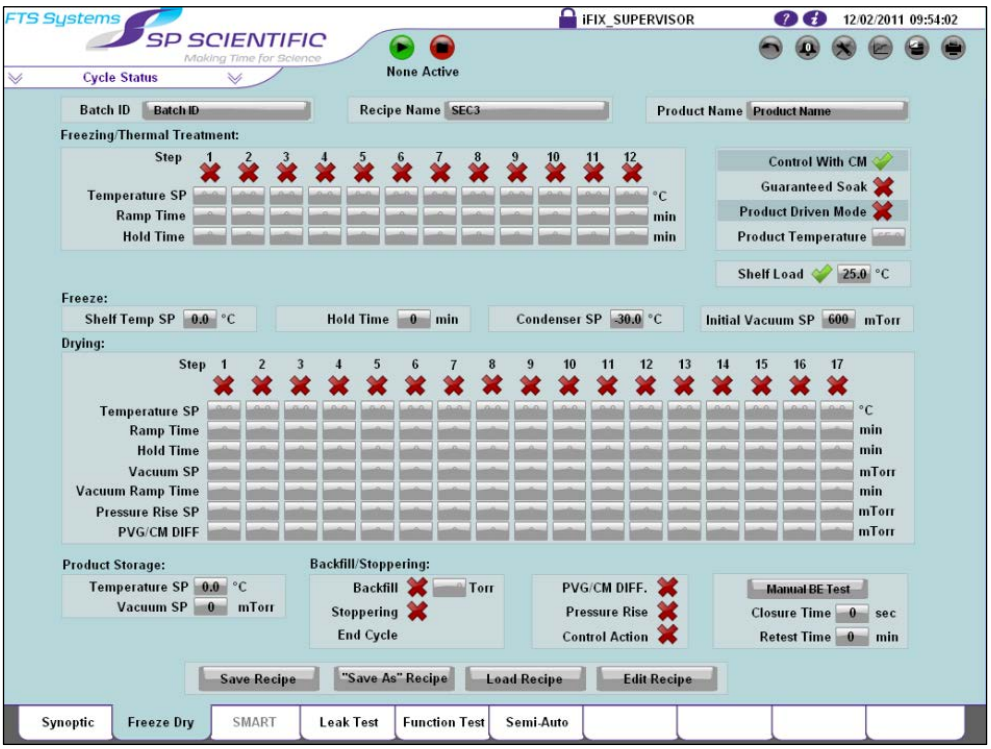
Note: *Your Freeze-Dry Recipe page may differ from the one shown above depending on your software configuration and purchased options.*

Creating and Saving a Freeze-dry Recipe

Recipe parameters in an SEC3 system are identical to those of standard systems However, the SEC3 option allows only users with security level Supervisor or higher to create or save recipes.

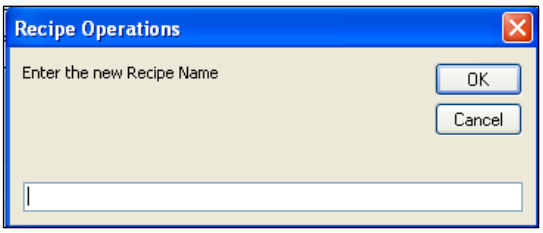
To edit recipe values, click the Edit Recipe button from the Freeze-Dry Recipe screen. The recipe fields will then turn from white to gray and become available for editing.

An electronic signature is required to enable, disable and edit most fields and options.



Note: *Your Freeze-Dry Recipe page may differ from the one shown above depending on your software configuration and purchased options.*

After entering data into all fields, the recipe can be saved using the “Save As” Recipe button. Changes are not automatically saved. The Recipe Operations screen will open, prompting you to change the name of a recipe before saving. This can be useful for backing up recipes or modifying a recipe and saving it with a new name. Enter the desired recipe name and click OK. The Recipe Name field will update automatically.

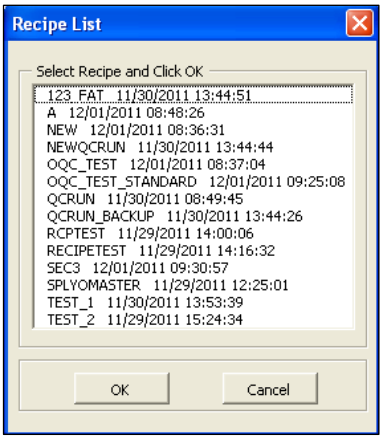


Loading an Existing Recipe

Users with security clearance Operator or higher can load recipes from the Freeze-Dry Recipe screen. Parameters cannot be modified, with the exception of the Batch ID and Product Name.

Note: *It is recommended that a Standard Operating Procedure (SOP) be in place instructing users to change the Batch ID each time a cycle is executed.*

To load a recipe, click the Load Recipe button, the Recipe List screen will open. From the Recipe List screen, select a recipe to load and click OK.



Modifying an Existing Recipe

Existing recipes can be modified with an SEC3 system. However, only users with security level Supervisor or higher can have access to this functionality.

From The Freeze-Dry Recipe screen, select the Edit Recipe button. The freeze-dry recipe fields will turn gray. An electronic signature is required to enable, disable and edit most fields and options. After modifying data from existing fields, the recipe can be saved using the Save Recipe button. The modified recipe is then saved.

Note: *If a modified recipe needs to be saved under a new Recipe Name, refer to the Creating and Saving a Freeze-Dry Recipe section of this chapter.*

Deleting Recipes

Recipes saved on an SEC3 system cannot be deleted through the user interface. To delete a recipe:

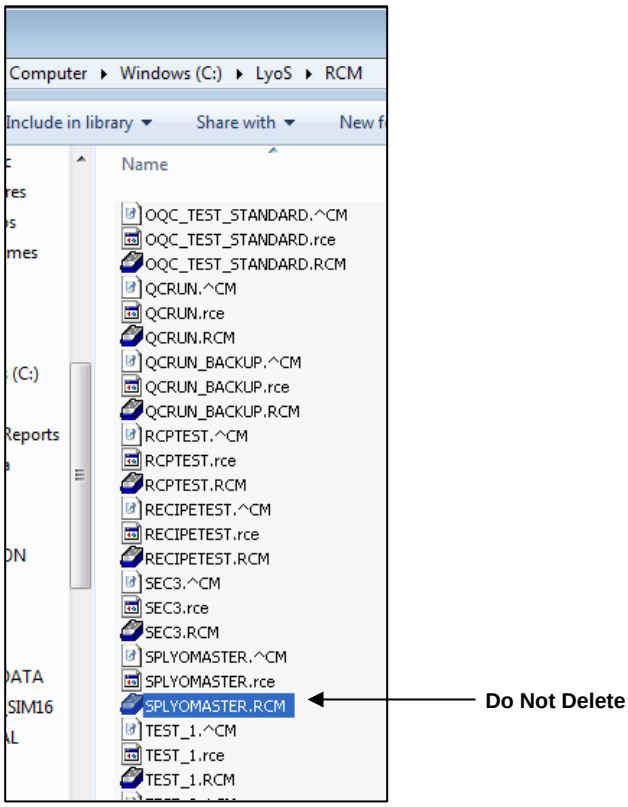
1. Navigate to the **C:\LyoS\RCM** directory.

   Note: *You must be logged in as a Supervisor or higher to complete this task.*

2. Recipe files must be manually deleted. There are multiple file extensions associated with each recipe. Be sure to delete all files associated with the recipe you wish to delete. Do not delete **SPLYOMASTER.RCM**.

   Note: *If you have a technical question or are unsure of how to properly delete a recipe, please contact SP Scientific and ask for help with your LyoS™ control system.*

WARNING! NEVER DELETE THE FILE **SPLYOMASTER.RCM**. IT IS THE MASTER RECIPE FILE AND IS REQUIRED FOR THE RECIPE MANAGEMENT SYSTEM TO WORK PROPERLY.



Configuring Windows® 7 Security

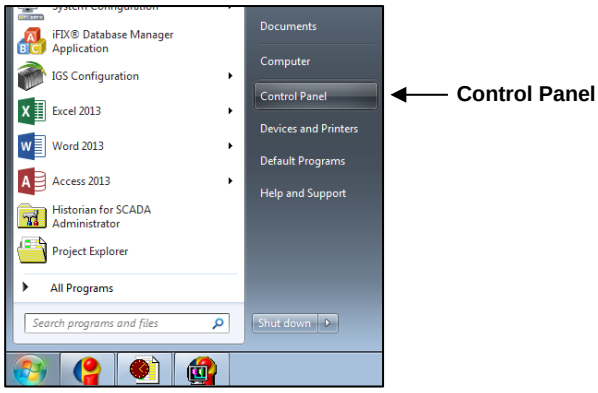
Proficy® iFIX security can be synchronized with the Microsoft® Windows® 7 environment. This option is standard with all SEC3 (21 CFR Part 11) systems.

To configure Microsoft® Windows® 7 security:

1. Login as a Supervisor or higher.
2. Hit the Windows® key on your keyboard to open the Windows® Start Menu.

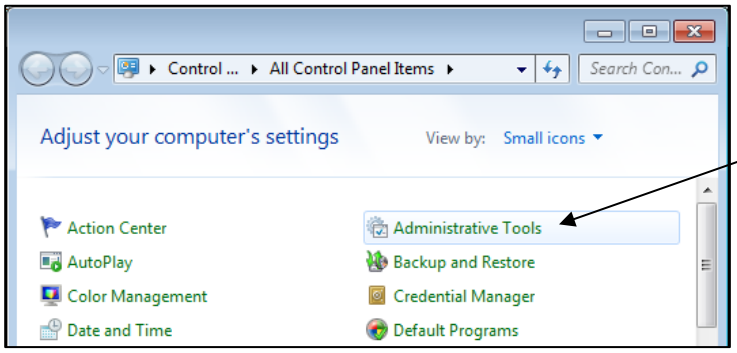
Windows® Key

3. Click Control Panel from the Start Menu.



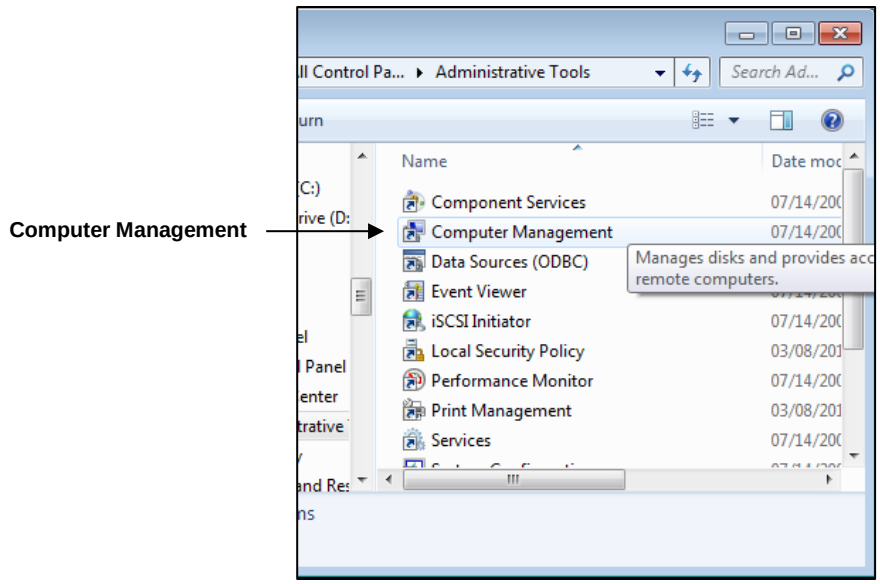
Control Panel

4. Double-click Administrative Tools.

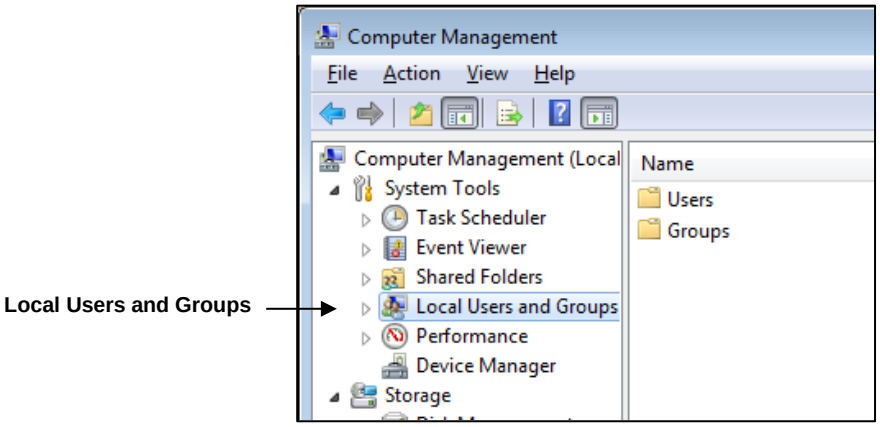


Administrative Tools

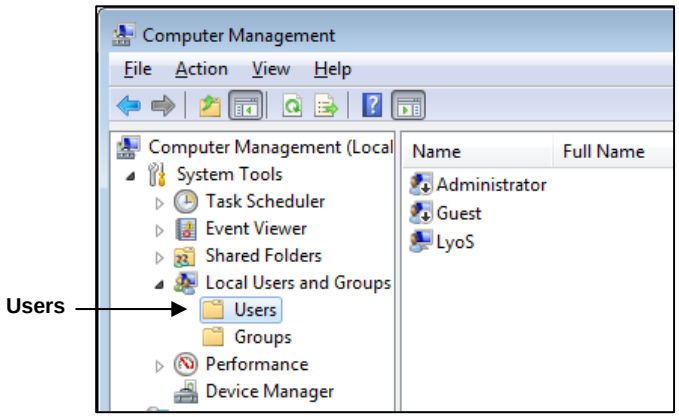
5. Double-click Computer Management.



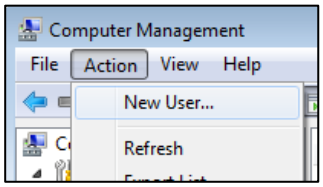
6. Double-click Local Users and Groups.



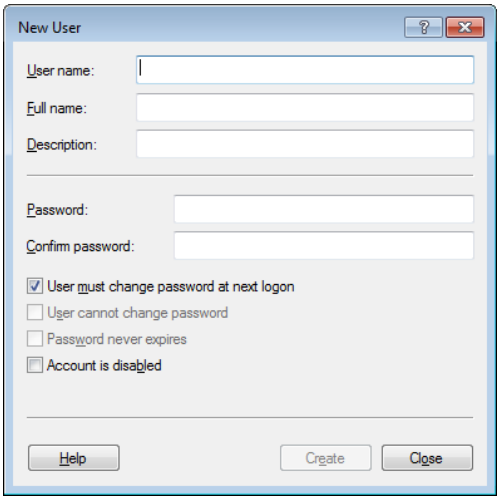
7. Double-click Users.



8. Click Action from the menu bar and select New User.



9. Enter appropriate information into all fields. The username is case sensitive, should be eight (8) characters or less and may only contain alphanumeric characters.

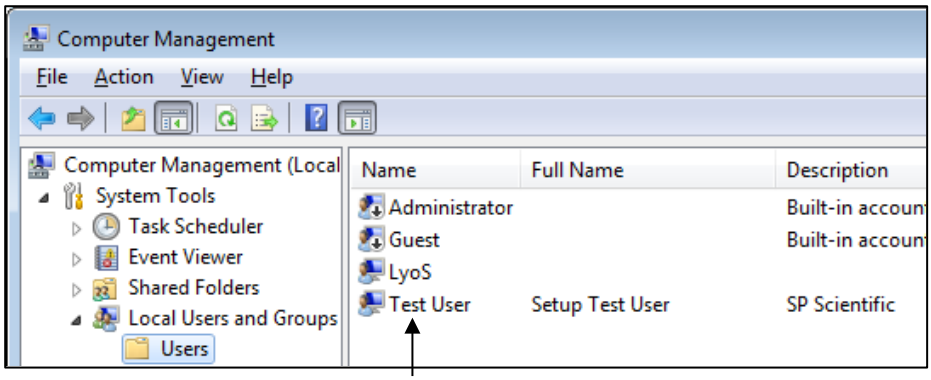


Notes: *It is recommended that your Standard Operating Procedure (SOP) includes the use of a generic default password (e.g., "Welcome") that all new users can initially log in to the system with. Keep in mind that passwords are case sensitive.*

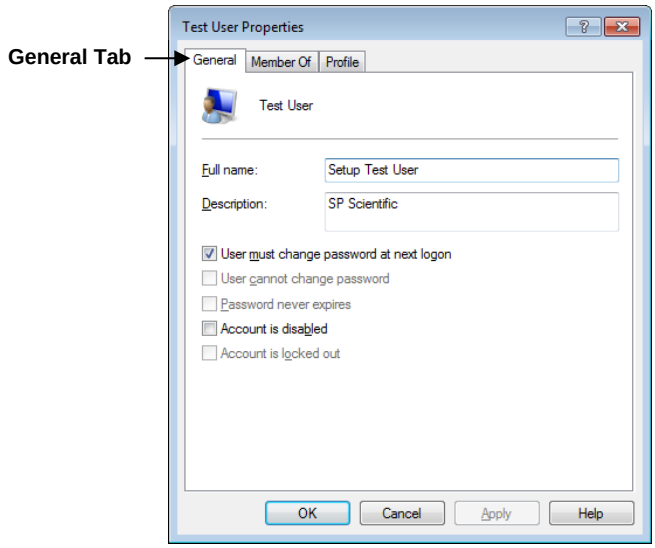
Ensure that the "User must change password at next login" checkbox is checked. This is important for 21 CFR Part 11 compliance and means that the user will be prompted at initial login to enter a unique password.

10. Click the Create button once all fields are filled in. The system will immediately default to another blank new user. You may continue to create new users or click Close to continue.

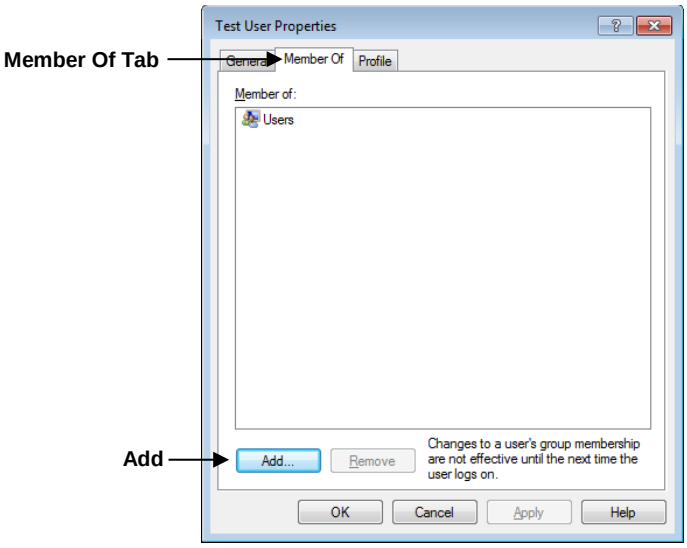
11. Verify that the new user has been added to the Users group list on the right.



12. Double-click on the new user.
13. Verify that all the information in the General tab is correct.

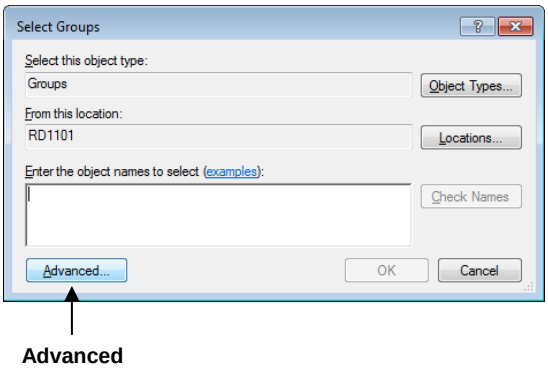


14. Click on the Member Of tab then click the Add button.

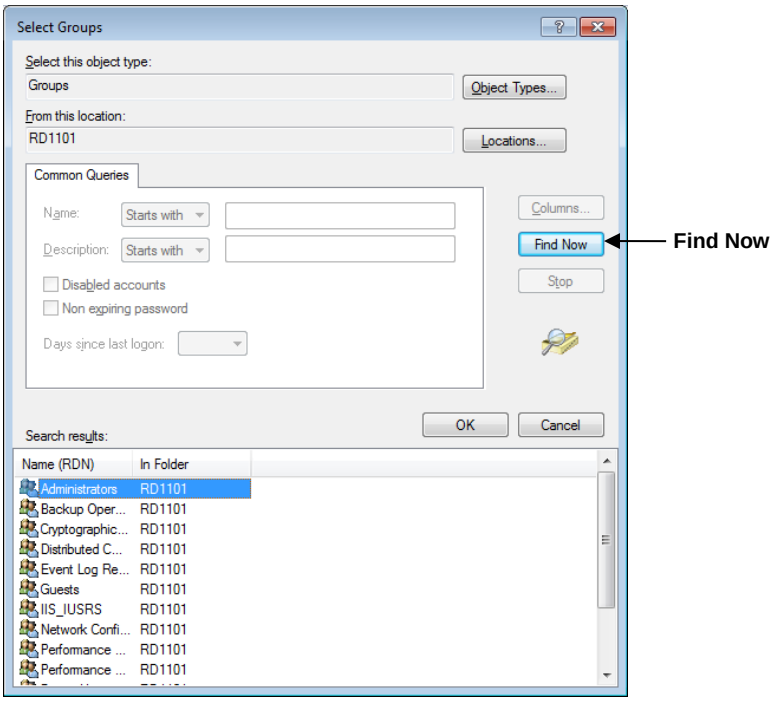


Note: *By default, all new accounts appear as part of the Users group.*

15. Click the Advanced button to access the list of available security groups.



16. Click Find Now to display the full list of available security groups.

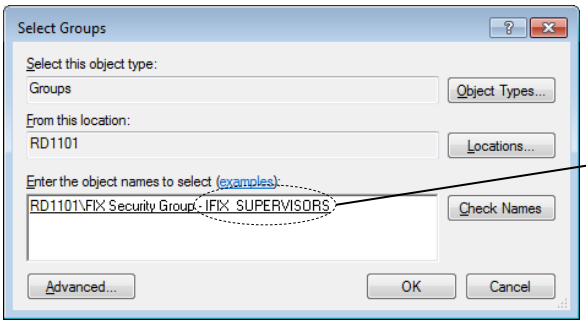


17. Scroll through the list until iFix Security Groups appear. Select either IFIX_OPERATORS or IFIX_SUPERVISORS, depending on the security level you wish to grant the particular user.

Notes: *Refer to the Security Access Levels section of this chapter for information regarding security permissions.*

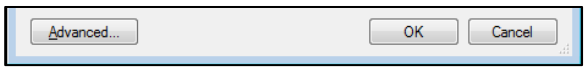
*When adding users to the **IFIX_SUPERVISORS** group, you must also add them to the local **Administrators** group. This will grant the user administrator access to Windows® 7, which is required for various functions such as SQL database backup and new user creation.*

18. Click the OK button once you have selected the appropriate group.
19. Verify that the selected security group is correct.

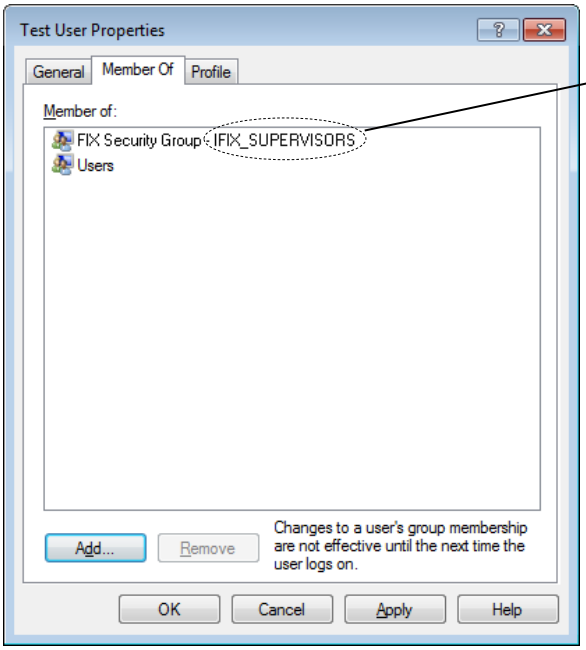


When adding users to the IFIX_SUPERVISORS group, you must repeat the process and add those same users to the local Administrators group.

20. Click the Advanced button to add additional security groups as needed. When finished, click OK to confirm that the correct security group(s) has been chosen.



21. Confirm that the appropriate security group(s) is listed in the Test User Properties window and click the Apply button.



When adding users to the IFIX_SUPERVISORS group, you must repeat the process and add those same users to the local Administrators group.

22. After clicking Apply, click the OK button. The new user setup is complete.

Synchronizing Security Settings

Before new users can log in to the LyoS™ control system, security permissions must be transferred to the Proficy® iFIX software through the “Security Synchronizer”.

***Note**: Security synchronization is a scheduled task and will occur automatically on a regular basis. Only use the following procedure if you have added new users whose login requires immediate use.*

To synchronize Windows® 7 security with the Proficy® iFIX software:

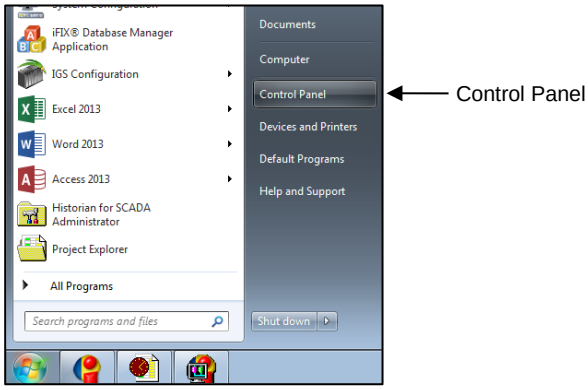
1. Launch the Proficy® iFIX software.

   ***Note:** The Proficy® iFIX software must be running for the security synchronizing process to work properly.*

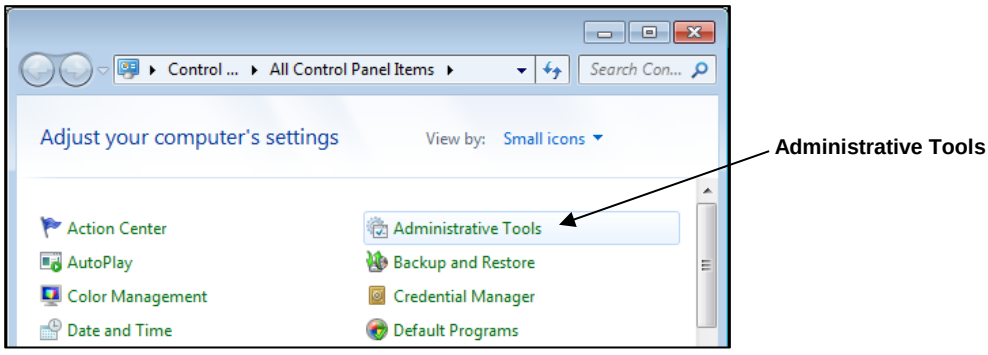
2. Login as a Supervisor or higher.
3. Hit the Windows® key on your keyboard to open the Windows® Start Menu.

Windows® Key

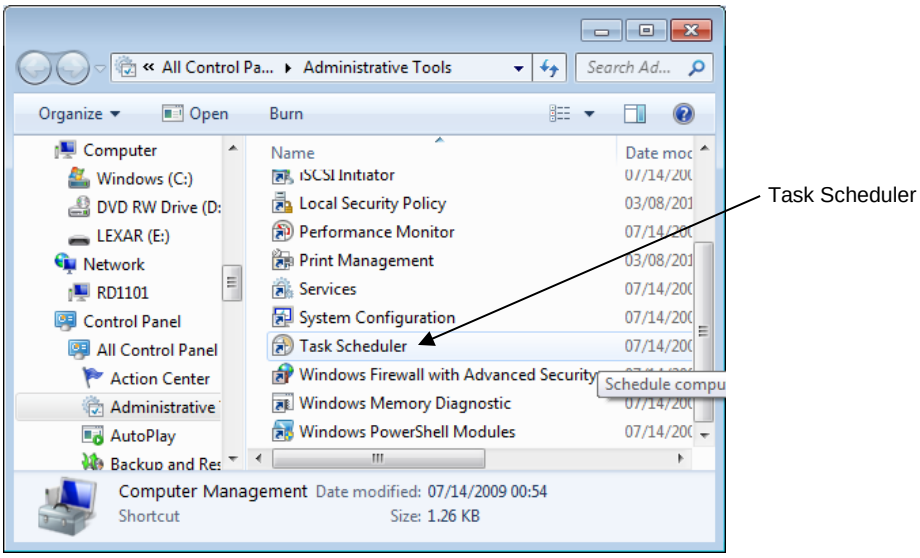
4. Click Control Panel from the Start Menu.



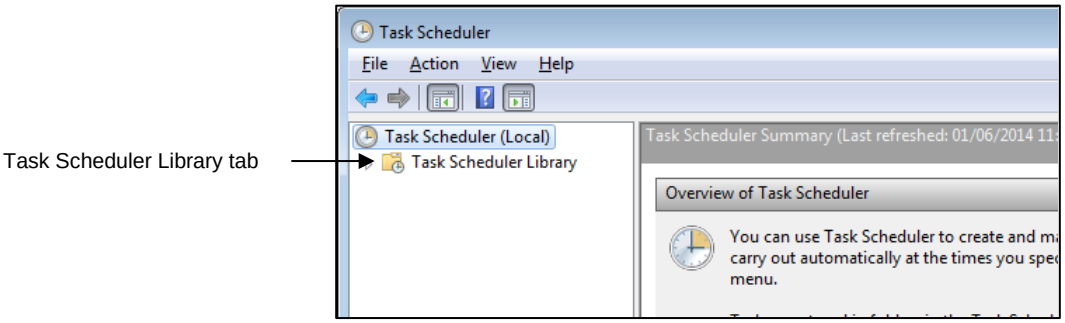
5. Double-click Administrative Tools.



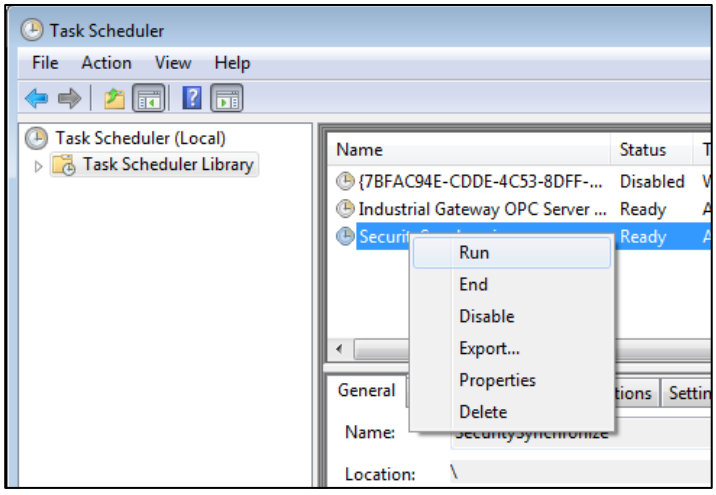
6. Double-click on Task Scheduler.



7. When the Scheduled Tasks window opens, select the Task Scheduler Library tab.



8. Right-click on the task named SecuritySynchronize and select Run. This command immediately synchronizes Windows® 7 security information with the Proficy® iFIX software.



9. Once the synchronization process is complete, close the Task Scheduler and related control panel screens.

10. To verify synchronization, return to the LyoS™ software and access the Alarm Summary page by clicking the Alarm Summary icon / button.

11. Select SQL Alarms and Events and confirm that the top line reads “Security Synchronizer: Security Synchronization process completed successfully.”

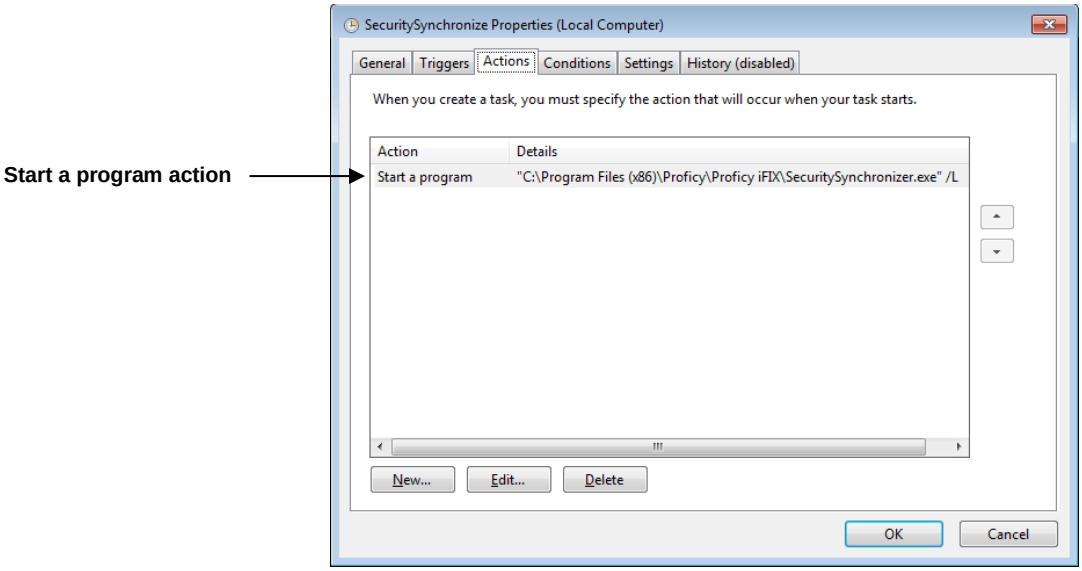
ALM_MSGTYPE	ALM_DESCR
TEXT	Security Synchronizer: Security synchronization process completed successfully.
TEXT	Security Synchronizer: Beginning security synchronization process.

If synchronization is not successful, you may receive the message “Security Synchronizer: Source of Windows® security not specified (Domain, Local). Synchronization aborted.”

ALM_MSGTYPE	ALM_DESCR
TEXT	Security Synchronizer: Beginning security synchronization process.
TEXT	Security Synchronizer: Source of Windows security not specified (Domain, Local). Synchronization aborted.

a. If synchronization was not successful, navigate to Scheduled Tasks by following steps 3 - 7. Open the Security Synchronize properties (*i.e.,* right-clicking and selecting Properties).

Ensure that under the Actions tab, the Start a program action reads **“C:\Program Files (x86)\Proficy\Proficy iFIX\SecuritySynchronizer.exe” /L.**



Note: *If your SecuritySynchronize settings match those shown above and you still cannot synchronize, or if you receive an error not listed, please contact SP Scientific for assistance.*

b. If synchronization was successful, attempt to log in to the iFIX software with the new user account. The system will prompt you for a login name and password.

Note: *Passwords are case sensitive. If the test is successful and you need to change a user password, select Change Password from the Login window. Based on new user settings, a Change Windows Password dialog box may automatically appear. If this occurs, enter the old password and new password then click OK.*

It is critical that 21 CFR Part 11 computer systems be set to have passwords that expire after a set period of time. Password expiration can be set to a company standard within the local policies of the computer. This can be completed by accessing Local Security Policy from Administrative Tools.

Additional Security Suggestions for 21 CFR 11 Systems

The computer is configured at the factory to have a 15-minute timeout period. When the system is idle (*e.g.,* no keyboard strokes or mouse movement) for 15 minutes, the current user is logged out and the guest account is logged in. However, it is recommended that a Standard Operating Procedure (SOP) be in place instructing users to log off after use or when stepping away from the system.

It is also recommended that the computer tower be kept in a locked box so that it cannot be manually rebooted to bypass the standard startup procedure.

Be sure to Backup data frequently. Data files are large and should be moved to an appropriate backup media that is capable of storing the files. Historical trend files are located in the **C:\Proficy Historian SCADA 5.0 Data\Archives** directory.

Notes: *For further information, refer to the Proficy® Historian section of Chapter 9: Historical Data.*

For information or for further assistance regarding setting up security on a 21 CFR Part 11 system, please contact SP Scientific Service.

Microsoft® SQL Server 2005

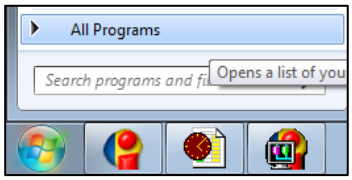
SQL Database Backup

All alarms and events are stored in the Windows® SQL database on an SEC3 system. To back up the SQL database on a system utilizing Microsoft® SQL Server 2005:

1. Login as a Supervisor or higher.
2. Hit the Windows® key on your keyboard to open the Windows® Start Menu.

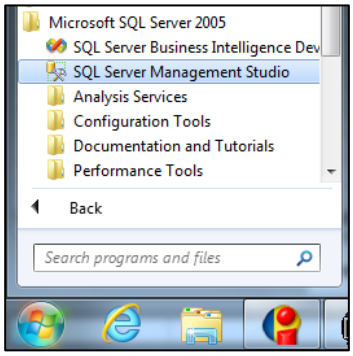
Windows® Key

3. Click All Programs.

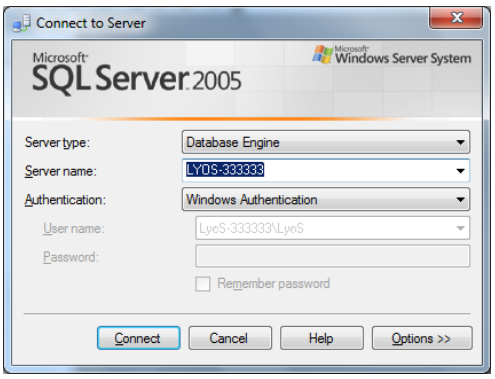


4. Click Microsoft SQL Server 2005 then click SQL Server Management Studio.

Microsoft SQL Server 2005 →



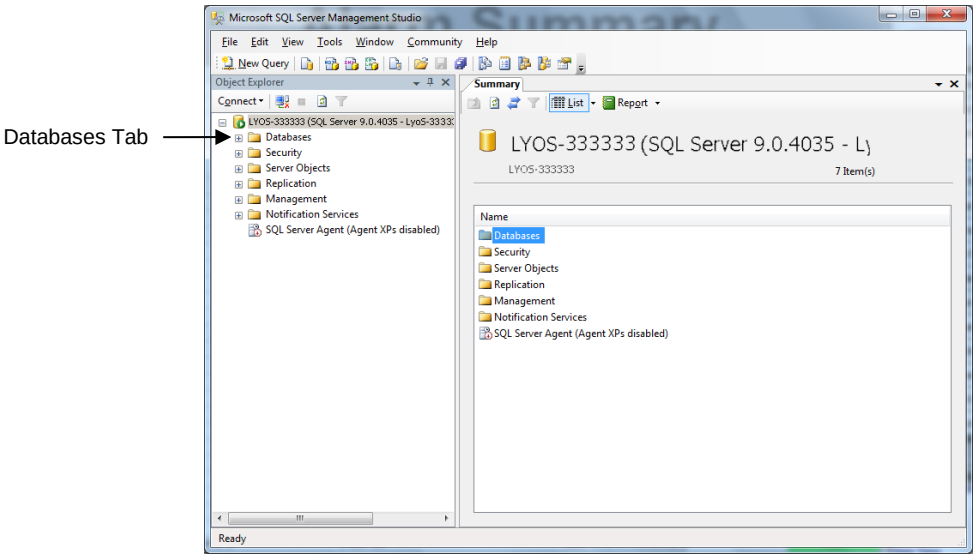
5. Once the Manager Studio launches, you will be prompted to log into the SQL Server. Using the Server name pull-down arrow, select the server that displays LyoS followed by your unit's serial number (*e.g.,* LyoS-333333).



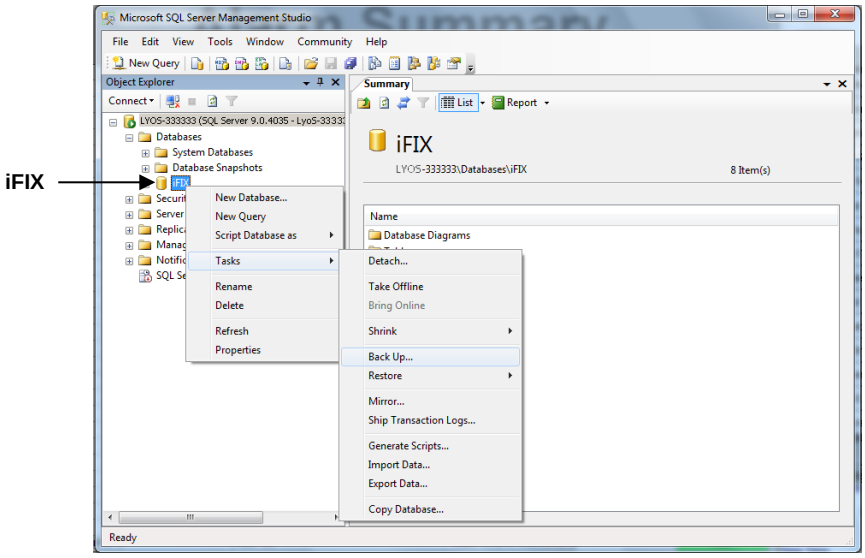
← Server Name

6. Click the Connect button.
7. The main Microsoft SQL Server Management Studio window will open. Expand the LyoS server that was selected during login. Expand the Databases tab.

   Note: *This is accomplished by clicking the plus (+) icon next to each tree level or by double-clicking the name of each level of the tree.*



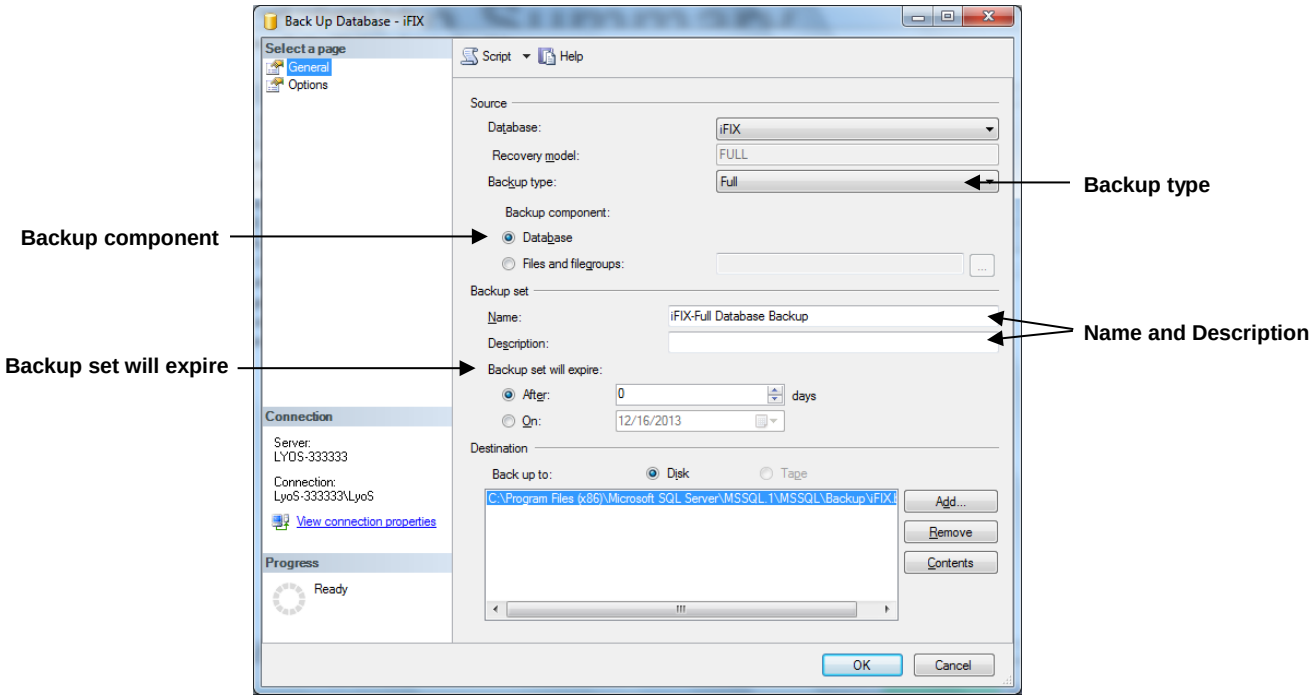
8. Under the Databases tree, right-click iFIX. Select Tasks then click Back Up.



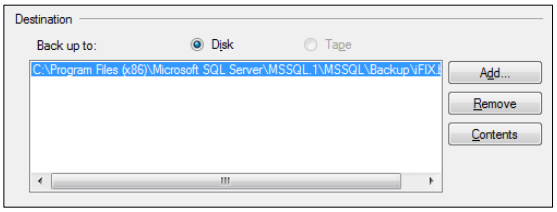
9. The Back Up Database window will open with the General page displayed. Enter the name for the database backup in the Name field.

   If desired, you may enter a description of the backup in the Description field along with setting a backup expiration time in the Backup set will expire fields (*i.e.*, After or On).

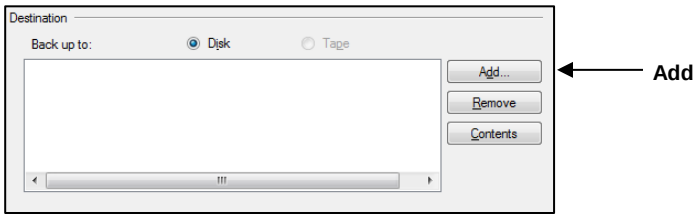
   Note: *Ensure that the "Backup type" field is set to "Full" and the "Backup Component" button is set to Database. The Backup set will expire and either be set to expire after a specific amount of days (i.e., the After field) or after a specific date (i.e., the On field).*



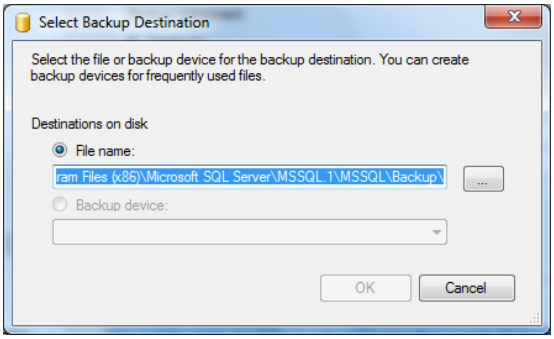
10. If your backup media is already configured, it will appear under "Back up to". Select the media and skip to step 13. If no backup media is selected, continue to the next step.



11. Click the Add button under Destination. The Select Backup Destination window will open.

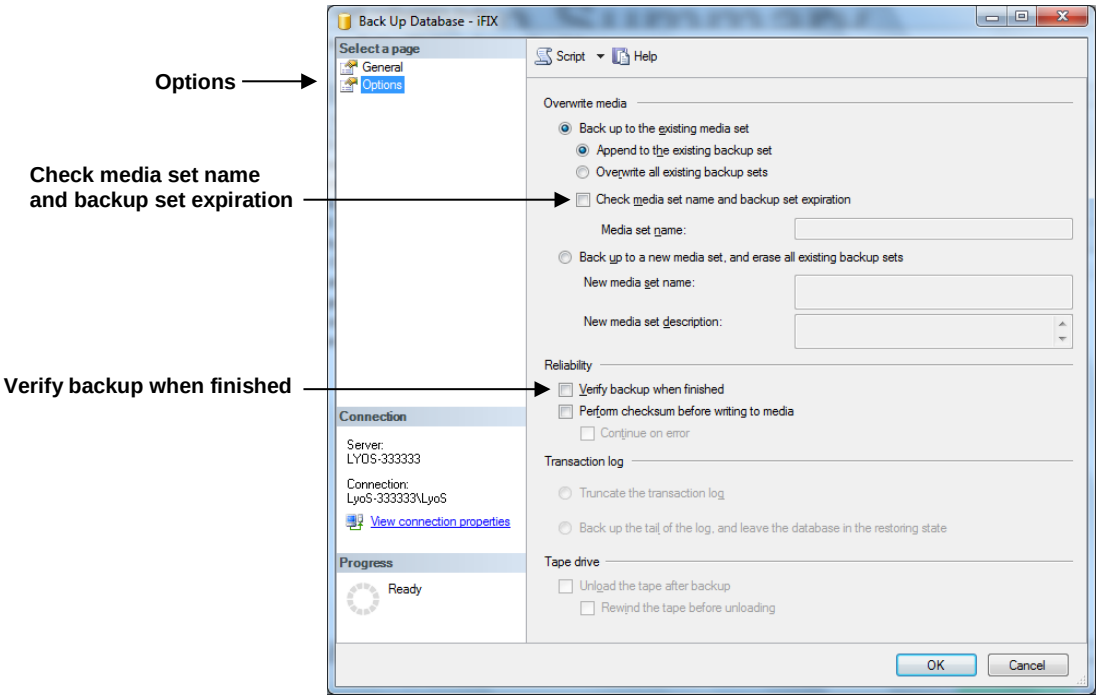


12. Enter a file name into the File name field and click the OK button. You will be returned to the Back Up Database window.



13. Select Options from the page list on the left-hand side of the Back Up Database window. The Options page will open.

    Select the “Check media set name and backup set expiration” box to prevent accidental overwrites or writing to expired media. Select the “Verify backup when finished” box to force the backup to be verified after saving.



14. Click the OK button to begin the backup process.
15. A system prompt will inform you of successful process completion.

    Note: *If the backup is not successful, attempt the backup process a second time. If the process fails again, contact SP Scientific.*

16. The Microsoft® SQL Server Management Studio may now be closed.

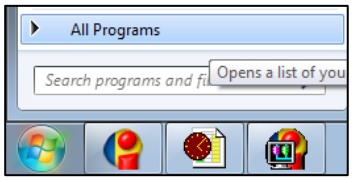
SQL Database Restoration

It may be pertinent to restore an old version of the SQL database. To restore the SQL database on a system utilizing Microsoft® SQL Server 2005:

1. Login as a Supervisor or higher.
2. Hit the Windows® key on your keyboard to open the Windows® Start Menu.

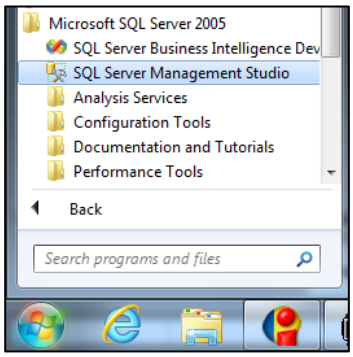
Windows® Key

3. Click All Programs.

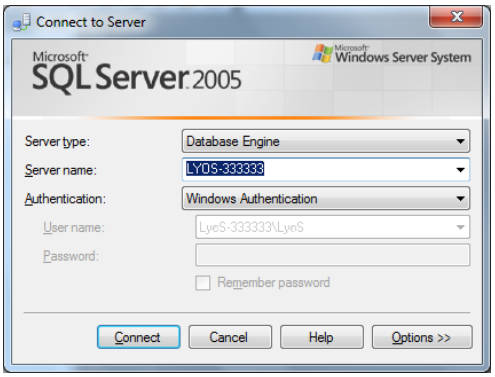


4. Click Microsoft SQL Server 2005 then click SQL Server Management Studio.

Microsoft SQL Server 2005 →

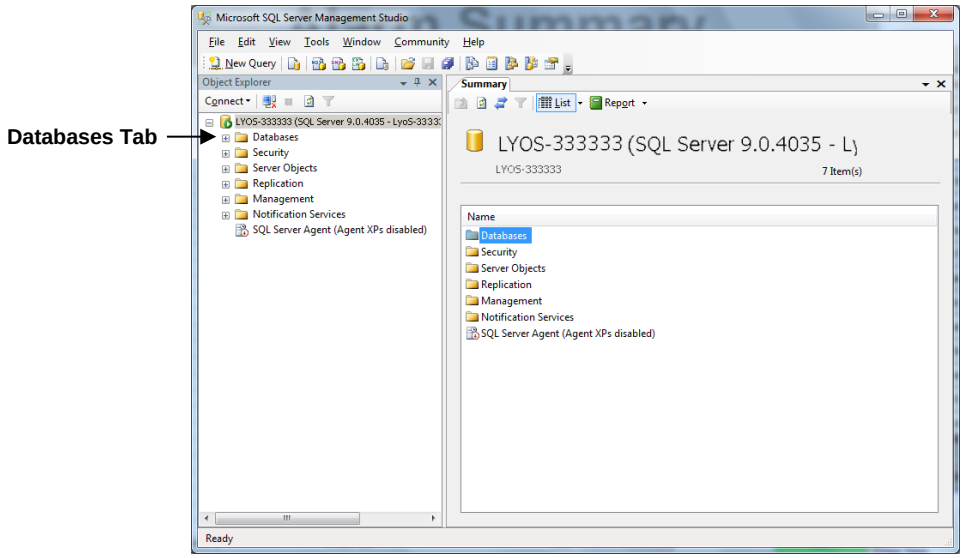


5. Once the Manager Studio launches, you will be prompted to log into the SQL Server. Using the Server name pull-down arrow, select the server that displays LyoS followed by your unit's serial number (*e.g.,* LyoS-333333).

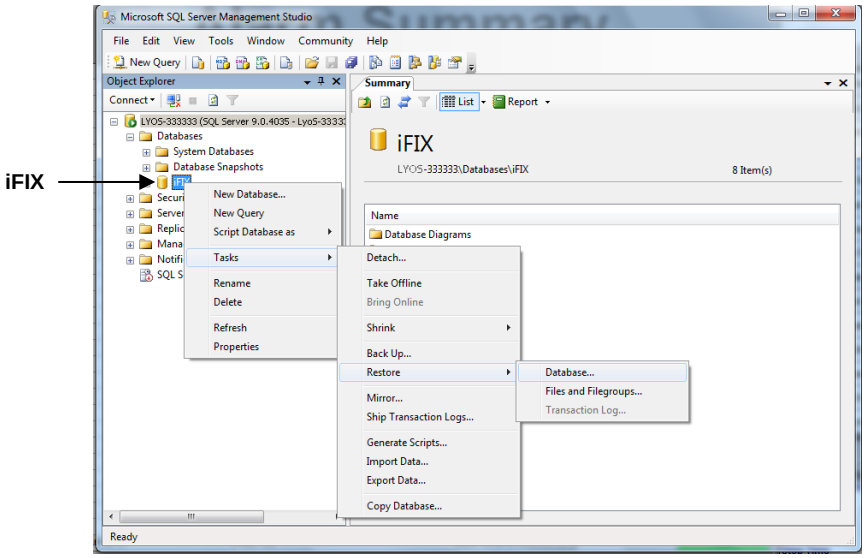


6. Click the Connect button.
7. The main Microsoft SQL Server Management Studio window will open. Expand the LyoS server that was selected during login then expand the Databases tab.

   Note: *This is accomplished by clicking the plus (+) icon next to each tree level or by double-clicking the name of each level of the tree.*



8. Under the Databases tree, right-click iFIX. Select Tasks, Restore then click Database.

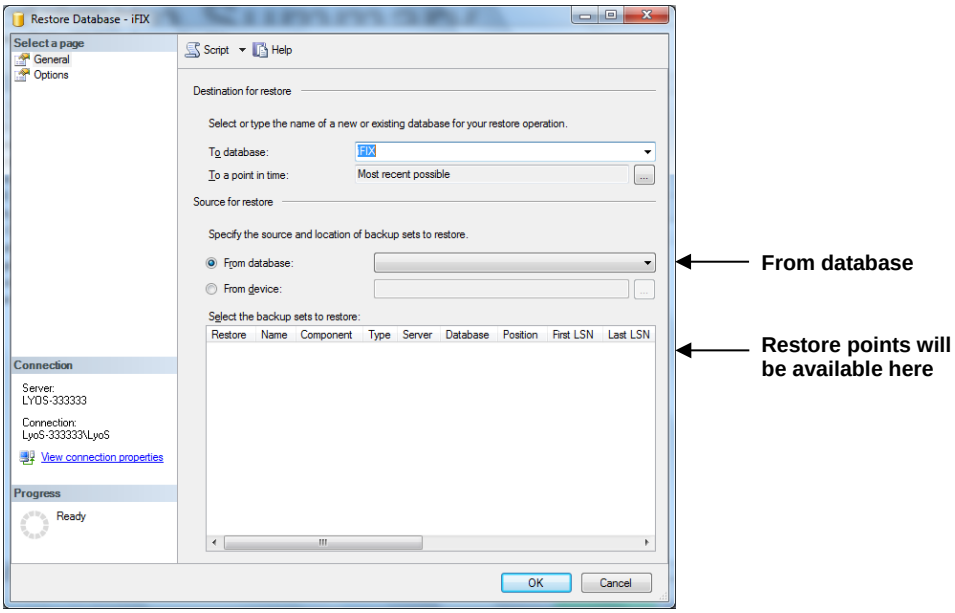


9. The Restore Database window will open with the General page displayed.

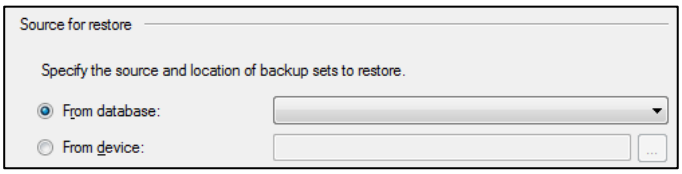
   Specify a source for the restore database.

   c. To restore from the most recent database backup created and saved by your LyoS™ control system, click the From database drop-down field and select iFIX. Select a restore point available on the bottom of the screen.

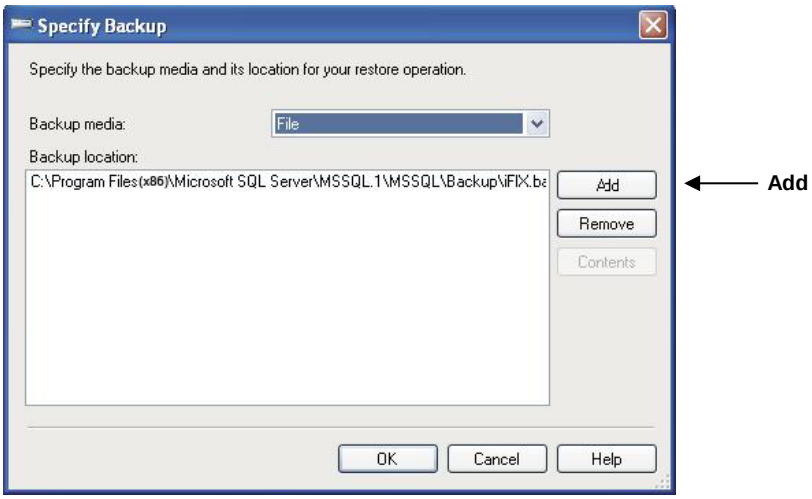
      Note: *This method restores from the most recently created backup. You may incur errors if the backup was saved to a location that no longer exists (e.g., an external storage medium that has been disconnected or a directory that has been deleted). If this occurs, continue to step 9b.*



d. You may also restore the database from a specific file or portable media source (*e.g.,* a USB flash drive) by selecting “From device” and clicking the “**…**” button to the right of the field. The Specify Backup window will open.



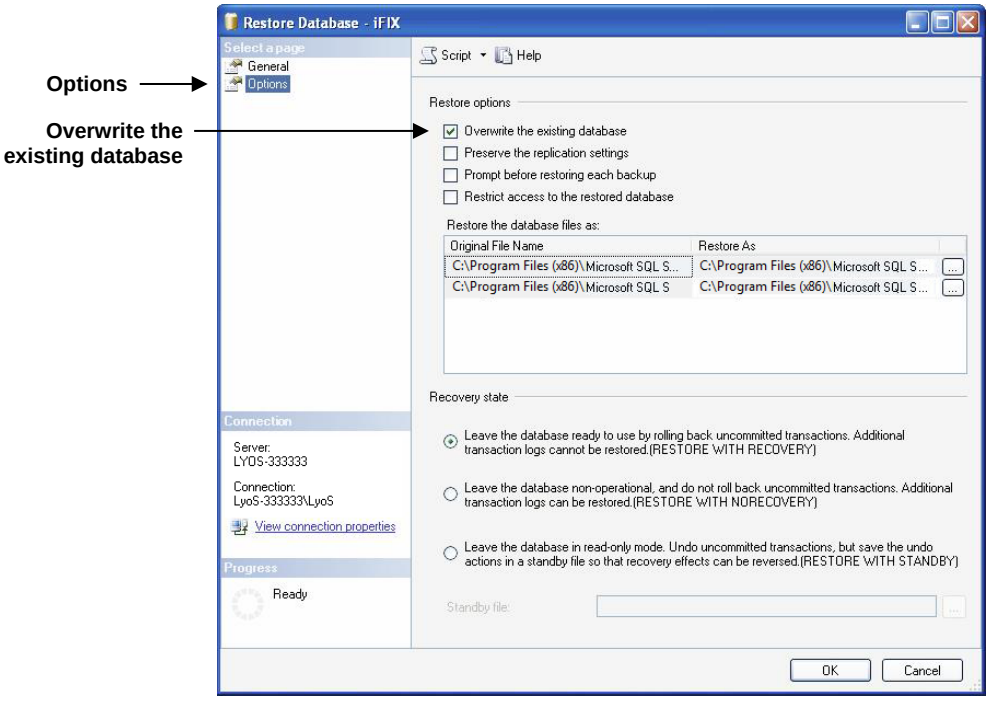
Click Add then locate and select the database. After locating and selecting the database, it will appear in under Backup location. Click the OK button to return to the Restore Database window.



Note: *The default backup directory is* ***C:\Program Files (x86)\Microsoft SQL Server\MSSQL.1\MSSQL\Backup****. If you encounter errors while attempting to restore from the iFIX database, attempt to restore the system by specifying the backup file found in this location.*

10. Select Options from the page list on the left-hand side of the Restore Database window. The Options page will open.

    Select the “Overwrite the existing database” box. If desired, other restore settings may be selected based on your preferences.



11. Click OK to begin the restoration process.
12. A system prompt will inform you of successful process completion.

    Note: *If the backup is not successful, attempt the backup process a second time. If the process fails again, contact SP Scientific.*

13. The Microsoft® SQL Server Management Studio may now be closed.

Chapter 15

Batch Reports

Overview

The Batch Reporting feature operates in the system background, scheduling the items to be reported. System variables are collected during phase transitions, as well as at five-minute intervals during the Function and Leak Tests and at 10-minute intervals during the Freeze Dry cycle.

Batch Report Files

Batch Report files are automatically generated and stored on the computer hard drive as a secure PDF file. Files are located in the **C:\Batch_Reports** directory and can be accessed with a login of Supervisor or higher. The file is named by cycle name followed by the start date and time to ensure unique names for each report (*e.g.,* Leak_Report_10_12_13_14).

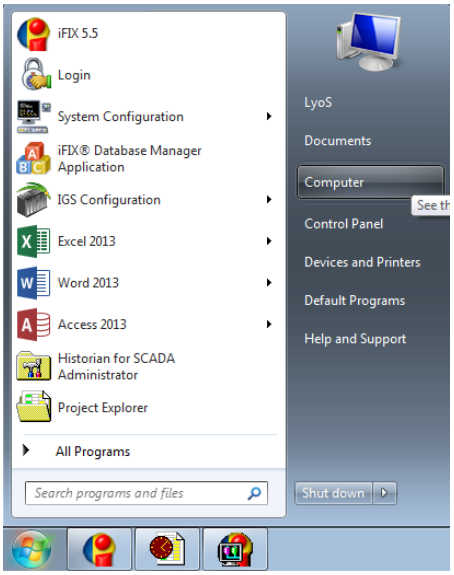
To view and/or print Batch Report Files:

1. Login as a Supervisor or higher.

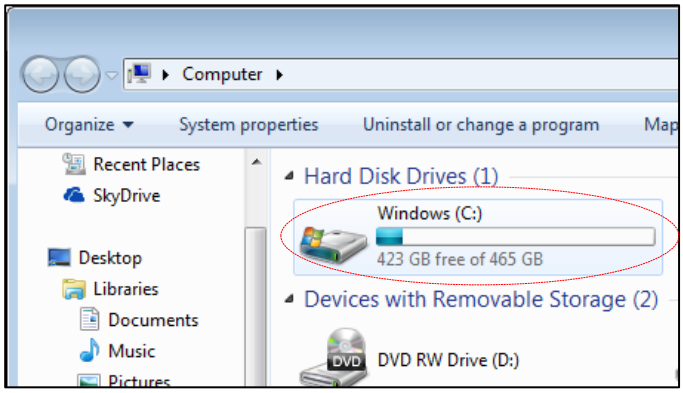
2. Hit the Windows® key on your keyboard to open the Windows® Start Menu.

Windows® Key

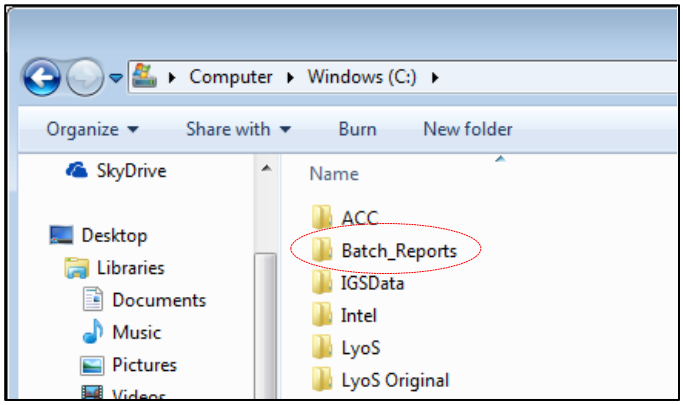
3. Click Computer.



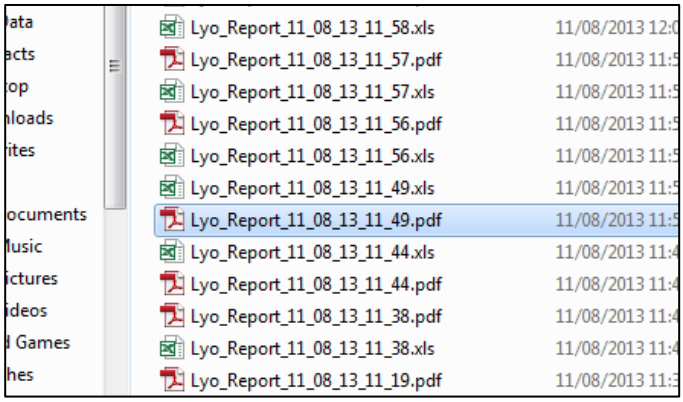
4. Locate and open the **C:** drive.



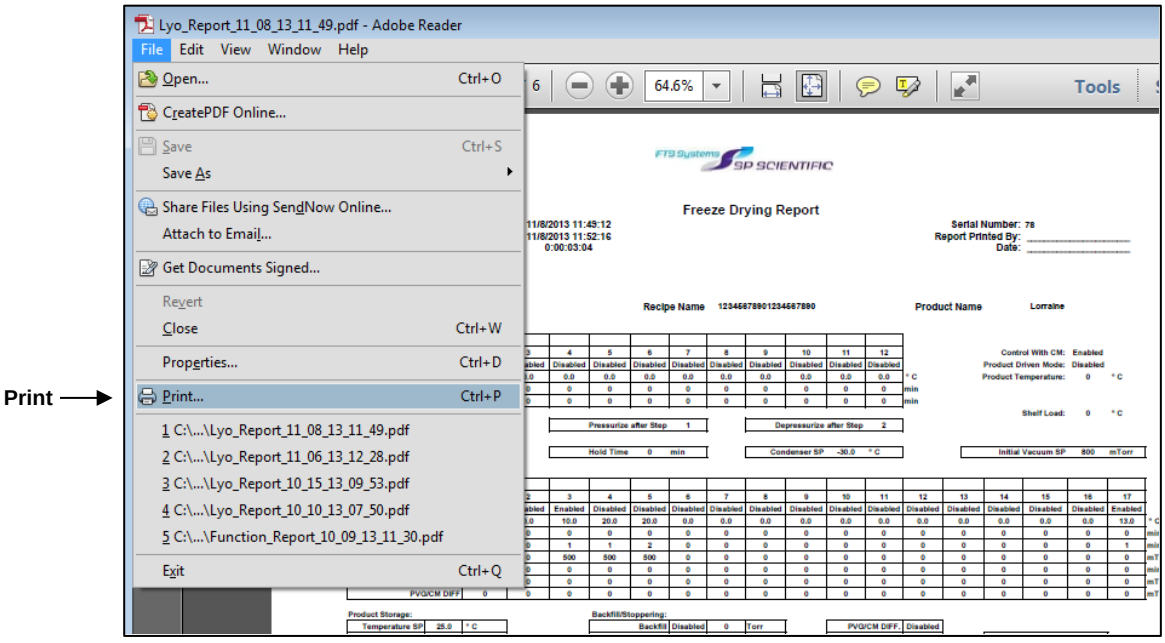
5. Locate and open the **C:\Batch_Reports** directory.



6. Double-click the report you wish to view and/or print (*e.g.*, Lyo_Report_11_08_13_11_49). The PDF will open.



7. Click File then Print or hit Ctrl + P to print.



Freeze-Dry Cycle

The following information is collected for the freeze-dry cycle Batch Report.

System Variables

Product Probe Temperatures, Product Probe Average, Condenser Temperature(s), Shelf Temperature(s), Shelf Reference, Vacuum(s) and Vacuum Reference.

Note: *System variables are collected during phase transitions, as well as at 10-minute intervals during the freeze-dry cycle.*

Recipe

The active Recipe is captured at the end of the cycle. Changes made during the cycle are noted in the Event section of the report. The Recipe printout displays the actual Recipe used during the cycle, as well as any new setpoints.

Alarms

Any alarm that occurs during the Start and End times of the cycle will be recorded in the Report. The system queries the database based on the captured start and end times of the active cycle.

Events

Any event (non-alarm message) that occurs during the Start and End times of the cycle will be recorded in the Report. The system queries the database based on the captured start and end times of the current cycle running.

Data

Collected data (System Variables) is compiled and trended.

Leak Test

The following information is collected for the Leak Test Report.

System Variables

Condenser Temperature(s) and Vacuum(s)

Note: *System variables are collected during phase transitions, as well as at five-minute intervals during the Leak Test cycle.*

Data

The active cycle setpoints and results are captured at the end of the cycle.

Function Test

The following information is collected for the Function Test Report.

System Variables

Product Probes, Product Probe Average, Condenser Temperature(s), Shelf Temperature(s), Shelf Reference and Vacuum(s).

Note: *System variables are collected during phase transitions, as well as at five-minute intervals during the Function Test cycle.*

Data

The active cycle setpoints and results are captured at the end of the cycle.

Overview

Your LyoS™ control system is configured with several alarms and warnings according to your software configuration.

The following alarms are available for LyoS™ control systems. Many of the alarms rely on the Alarm Settings as programmed on the LyoS™ Configuration page. For more information, refer to Chapter 10: Maintenance Menu.

Abort MTM Data Collection (SMART/Auto MTM)

The Abort MTM Data Collection SMART/Auto MTM alarm can indicate that something is preventing the isolation valve to fully close. If the isolation valve cannot fully close during a SMART Freeze Dryer™ or Auto MTM cycle, the system will be unable to perform the required calculations and, therefore, will not collect manometric temperature measurement (MTM) data.

Alarm Specifications	
Active	During an automatic SMART Freeze Dryer™ or Auto MTM cycle when the system is collecting manometric temperature measurement (MTMs) data.
Sensor	Isolation valve proximity sensor.
Condition	Isolation valve failed to close. The system is unable to collect manometric temperature measurement (MTM) data.
Action	The following alarm message is displayed: • ABORT MTM DATA COLLECTION SMART/AUTOMTM The cycle will continue, but the system will not collect data.
Restore	The isolation valve closes. The Auto MTM cycle or SMART cycle is terminated. The alarm is acknowledged.
Hardware	Isolation valve with closed position proximity switch.
Notes	Included on LyoStar™ 3 lyophilizers configured with SMART Freeze Dryer™ technology.

Barometric Endpoint Test Failed

Barometric End Point or Pressure Rise Testing can be a useful method of determining product dryness. It relies on closing an Isolation Valve between the product chamber and the condenser chamber and consequently observing the rise in pressure. The time that the Isolation Valve is closed is generally small (*i.e.,* 15 to 30 seconds). The rate of pressure rise while the Isolation Valve is closed is an indication of product dryness. If the test is performed and the results do not meet the specified criteria, the system triggers an alarm message.

Alarm Specifications	
Active	At the end of a Drying step, upon completion of the Pressure Rise Test with Control Action set to Yes.
Sensor	Chamber vacuum transducer.
Condition	The calculated pressure differential from the start of the test to the end of the test is greater than the specified pressure differential setpoint (Pressure Rise SP).
Action	The following alarm message is displayed: • BE TEST FAILED, REPEAT TEST The cycle will not advance to the next step. The test is repeated at the specified Retest Time interval.
Restore	The Pressure Rise test yields a result that is less than the Pressure Rise SP. The alarm is acknowledged.
Hardware	Vacuum transducer and isolation valve with a closed proximity switch.
Notes	Standard on all LyoStar™ 3 lyophilizers with the LyoS™ control system.

Condenser Overload

An increasing condenser temperature during a freeze-dry cycle may be a sign of condenser failure. The temperature of the condenser is monitored against the condenser setpoint to determine if there is a failure. Upon report of the Condenser Overload alarm, the cycle may hold in the current phase and attempt to continue from where the cycle was halted or reset the cycle to the Freeze phase. This is dependent on the System Reset to Freeze on Alarm configuration setting.

Note: *The System Reset to Freeze on Alarm setting is programmed from the Configuration page.*

Alarm Specifications	
Active	Any time following the start of the freeze-dry cycle's Evacuation phase.
Sensor	Condenser temperature.
Condition	The temperature of the condenser is greater than the Condenser SP (setpoint) at any point following the Evacuation phase of a freeze-dry cycle.
Action	The following alarm message is displayed: • CONDENSER OVERLOAD If System Reset to Freeze on Alarm is set to Yes, the active cycle shall reset to the Freeze phase. If System Reset to Freeze on Alarm is set to No, the cycle will remain in the current phase until the condition is corrected or the cycle is canceled. The heater and Vacuum Level Control will be disabled.
Restore	If System Reset to Freeze on Alarm is set to Yes, the condenser condition is corrected and the Play button is selected to continue the cycle from the Freeze phase. The alarm is acknowledged. If System Reset to Freeze on Alarm is set to No, the condenser condition is corrected. The alarm is acknowledged.
Hardware	Type T Thermocouple.
Notes	Standard on all LyoStar™ 3 lyophilizers with the LyoS™ control systems. The EMERGENCY CONTACT CLOSED alarm is linked to the Condenser Overload alarm.

Condenser Timeout

If the temperature of the condenser does not reach the Condenser SP (setpoint) within the specified Condenser Timeout SP configuration setting, the system may have failed. Upon report of the Condenser Timeout alarm, the cycle may hold in the current phase and attempt to continue from where the cycle was halted or reset the cycle to the Freeze phase. This is dependent on the System Reset to Freeze on Alarm configuration setting.

Note: *The System Reset to Freeze on Alarm setting is programmed from the Configuration page.*

Alarm Specifications	
Active	During the Condenser phase of a freeze-dry cycle.
Sensor	Condenser temperature.
Condition	During condenser pull-down, the condenser temperature does not reach setpoint within the specified Condenser Timeout SP configuration setting.
Action	The following alarm message is displayed: • CONDENSER TIMEOUT If System Reset to Freeze on Alarm is set to Yes, the active cycle shall reset to the Freeze phase. If System Reset to Freeze on Alarm is set to No, the cycle will remain in the current phase until the condition is corrected or the cycle is canceled.
Restore	If System Reset to Freeze on Alarm is set to Yes, the condenser condition is corrected and the Play button is selected to continue the cycle from the Freeze phase. The alarm is acknowledged. If System Reset to Freeze on Alarm is set to No, the condenser condition is corrected. The alarm is acknowledged.
Hardware	Type T Thermocouple.
Notes	Standard on all LyoStar™ 3 lyophilizers with the LyoS™ control systems. The EMERGENCY CONTACT CLOSED alarm is linked to the Condenser Timeout alarm.

ControLyo™ Nucleation On-Demand Technology Depressurization Failed Cancel Cycle

The Depressurization Failed Cancel Cycle alarm indicates the system is not able to release pressure during depressurization. If the system cannot release pressure during depressurization, the system triggers an alarm message.

Alarm Specifications	
Active	During a freeze-dry cycle while utilizing ControLyo™ Nucleation On-Demand Technology (*i.e.,* Nucleation Control is enabled).
Sensor	Chamber pressure sensor.
Condition	The system does not release pressure during depressurization.
Action	The following alarm message is displayed: • Depressurization Failed. Cancel Cycle! The System will hold until the cycle is canceled.
Restore	Cancel the current freeze-dry cycle and correct the condition. The alarm is acknowledged. The cycle is restarted.
Hardware	ControLyo™ Nucleation On-Demand Technology
Notes	Included on LyoStar™ 3 lyophilizers with the LyoS™ control system and ControLyo™ Nucleation On-Demand Technology.

ControLyo™ Nucleation On-Demand Technology Maximum Leak Rate Allowed

The CL Maximum Leak Rate Allowed alarm indicates that a leak could be present within the system. If the system's pressure drops too quickly, the system triggers an alarm message.

Alarm Specifications	
Active	During a freeze-dry cycle while utilizing ControLyo™ Nucleation On-Demand Technology (*i.e.,* Nucleation Control is enabled).
Sensor	Chamber pressure sensor.
Condition	The system's pressure drops too quickly.
Action	The following alarm message is displayed: • CL Maximum Leak Rate Allowed! The System will hold until the cycle is canceled.
Restore	Cancel the current freeze-dry cycle and correct the condition. The alarm is acknowledged. The cycle is restarted.
Hardware	ControLyo™ Nucleation On-Demand Technology
Notes	Included on LyoStar™ 3 lyophilizers with the LyoS™ control system and ControLyo™ Nucleation On-Demand Technology.

ControLyo™ Nucleation On-Demand Technology Pressurization Timed Out

The Pressurization Timed Out alarm indicates a failure within the system that will prevent it from reaching the pressure setpoint. If the system pressure does not reach the pressure setpoint within the Pressurization Timed Out Alarm SP, the system triggers an alarm message.

Alarm Specifications	
Active	During a freeze-dry cycle while utilizing ControLyo™ Nucleation On-Demand Technology (*i.e.,* Nucleation Control is enabled).
Sensor	Chamber pressure sensor.
Condition	The system's pressure does not reach the pressure setpoint within the Pressurization Timed Out Alarm SP.
Action	The following alarm message is displayed: • Pressurization Timed Out The System will hold until the cycle is canceled.
Restore	Cancel the current freeze-dry cycle and correct the condition. The alarm is acknowledged. The cycle is restarted.
Hardware	ControLyo™ Nucleation On-Demand Technology
Notes	Included on LyoStar™ 3 lyophilizers with the LyoS™ control system and ControLyo™ Nucleation On-Demand Technology.

Current Cycle Canceled By User

In some cases, it may be necessary to terminate an automatic cycle early. When an active cycle is canceled, an alarm message is displayed.

Alarm Specifications	
Active	Always active.
Sensor	The Stop button is selected and the Cancel Current Cycle pop-up window is acknowledged (*i.e.,* the user enters Yes).
Condition	The user selects the Stop button during an automatic cycle and confirms cancellation of the cycle from the Cancel Current Cycle pop-up window.
Action	The following alarm message is displayed: • CURRENT CYCLE CANCELED BY USER The active automatic cycle, Semi-Auto function, or individual component is interrupted. ***Note:*** *Automatic cycles include Freeze-Dry, Function Test, Leak Test, etc. Individual components may be activated from the Synoptic screen when using Component Mode.*
Restore	The system returns to the ready state and the words “None Active” appear under the Play and Stop buttons. The alarm is acknowledged.
Hardware	None.
Notes	Standard on all LyoStar™ 3 lyophilizers with the LyoS™ control system.

Door is Open

This test shall be used to verify that Door is Open alarm is generated when the chamber door is open and that the pressurization valve interlock is functioning properly. If the chamber door is open during the start of a cycle, the system triggers an alarm message.

Alarm Specifications	
Active	Always active.
Sensor	Door switch.
Condition	The chamber door is open.
Action	The following alarm message is displayed: • DOOR IS OPEN
Restore	Close the chamber door.
Hardware	Door switch.
Notes	Included on LyoStar™ 3 lyophilizers with the LyoS™ control system and ControLyo™ Nucleation On-Demand Technology.

Emergency Contact Closed

The Emergency Contact Closed (ECC) alarm is linked to specific system alarms, such as Condenser Overload, Condenser Timeout, Freeze Time Exceeded, Low Voltage, Long-Term Power Failure, Maximum System Heating, No Water Flow Detected To Compressors, Short-Term Power Failure, Vacuum Overload, Vacuum Preseal Timeout, Vacuum Timeout and High Voltage. All of these alarms are intended to alert the operator to the most critical potential risks to the equipment, process, or product.

The ECC alarm relay includes a dry contact, which is illustrated on the system's electrical drawing, allowing it to be integrated within a facility's Building Management System, therefore alerting facility personnel to potential risks related the lyophilizer. As an example, some customers have opted to connect this relay to a strobe light or audible device such as a horn.

Alarm Specifications	
Active	Always active.
Sensor	The following alarms: Condenser Overload, Condenser Timeout, Freeze Time Exceeded, Long-Term Power Failure, Low Voltage, Maximum System Heating, No Water Flow Detected To Compressors, Pressurization Timed Out, UPS on Battery, Vacuum Overload, Vacuum Preseal Timeout, Vacuum Timeout, and High Voltage. ***Note:*** *When the above listed alarm conditions are present, the system shall also trigger the Emergency Contact Closed (ECC) alarm.*
Condition	The system identifies an alarm condition that is linked to the Emergency Contact Closed (ECC) alarm.
Action	The following alarm message is displayed: • EMERGENCY CONTACT CLOSED
Restore	The alarm condition that triggered the ECC alarm is corrected and the alarm is acknowledged. The ECC alarm is acknowledged.
Hardware	None.
Notes	Standard on all LyoStar™ 3 lyophilizers with the LyoS™ control system. The EMERGENCY CONTACT CLOSED alarm is linked to the following alarms: Condenser Overload, Condenser Timeout, Freeze Time Exceeded, Long-Term Power Failure, Low Voltage, Maximum System Heating, No Water Flow Detected To Compressors, Pressurization Timed Out, UPS on Battery, Vacuum Overload, Vacuum Preseal Timeout, Vacuum Timeout, and High Voltage.

Freeze Time Exceeded

If the product shelves are unable to obtain the Freeze setpoint within a specified period during the Freeze phase of a freeze-dry cycle, your system may have a compressor failure or other refrigeration problem.

Alarm Specifications	
Active	During the Freeze phase of a freeze-dry cycle.
Sensor	Shelf Inlet Resistance Temperature Detector (RTD) in the Shelf Mode or Product Probes in Product Mode.
Condition	Shelf Inlet Temperature or Product Average Temperature does not reach the Freeze Temperature setpoint within a specified period of time.
Action	The following alarm message is displayed: • FREEZE TIME EXCEEDED The system remains in the active Freeze phase until the condition is corrected or cycle is canceled.
Restore	The Shelf Inlet temperature or Product Average Temperature meets the Freeze Temperature setpoint. The alarm is acknowledged.
Hardware	Resistance Temperature Detector (RTD) and Type T Thermocouple.
Notes	Standard on all LyoStar™ 3 lyophilizers with the LyoS™ control system. The EMERGENCY CONTACT CLOSED alarm is linked to the Freeze Time Exceeded alarm.

Heat Step Not Satisfied

The Heat Step Not Satisfied alarm is active during the Freezing / Thermal Treatment and Drying steps of a freeze-dry cycle. During these steps, the system monitors the Shelf Inlet temperature against the Temperature Setpoint. If at the end of the step the Shelf Inlet temperature is not within the Temperature Deadband of the temperature setpoint, the Heat Step Not Satisfied alarm message appears.

Note: *The Temperature Deadband is programmed from the Configuration page.*

If you receive the Heat Step Not Satisfied alarm message during a freeze-dry cycle, check the Freezing / Thermal Treatment or Drying step when the Hold and/or Rate time is complete. The actual Shelf Inlet temperature will likely be outside the range of the Temperature Deadband as it relates to the Temperature Setpoint. The system will hold the cycle at the current step and continue to work toward obtaining the temperature setpoint until the Shelf Inlet temperature is within the Temperature Deadband of the Temperature Setpoint. This condition permits the system to continue heating and/or cooling to the desired setpoint.

Alarm Specifications	
Active	During the Freezing/Thermal Treatment or Drying steps of a freeze-dry cycle.
Sensor	Shelf Inlet temperature thermocouple.
Condition	At the end of a Freezing/Thermal Treatment or Drying step, the Shelf Inlet temperature is not within the Temperature Deadband of the shelf temperature setpoint.
Action	The following alarm message is displayed: • HEAT STEP NOT SATISFIED The system will hold the cycle at the current step until the Shelf Inlet temperature is within the Temperature Deadband.
Restore	The Shelf Inlet temperature is within the Temperature Deadband of the shelf temperature setpoint.
Hardware	Type T thermocouple.
Notes	Standard on all LyoStar™ 3 lyophilizers with the LyoS™ control system.

High Voltage

The High Voltage alarm occurs when the actual voltage supplied to the system is greater than or equal to the Voltage Upper Limit setpoint (VAC), which is programmed from the Configuration page.

Alarm Specifications	
Active	Always active.
Sensor	Voltage transducer.
Condition	The voltage supplied to the system is greater than or equal to the Voltage Upper Limit setpoint.
Action	The following alarm message is displayed: • HIGH VOLTAGE
Restore	High voltage condition corrected. The alarm is acknowledged.
Hardware	Voltage transducer.
Notes	Standard on all LyoStar™ 3 lyophilizers with the LyoS™ control system. The EMERGENCY CONTACT CLOSED alarm is linked to the High Voltage alarm.

Isolation Valve Failure to Close

The Isolation Valve can play a crucial role in the execution of a successful freeze-dry cycle. The integrity of the entire product run is put at risk if the Isolation Valve fails to operate as expected. The Isolation Valve Failure to Close alarm is designed to quickly alert the operator in the case of an Isolation Valve failure.

Alarm Specifications	
Active	Anytime the isolation valve is sent a request by the PLC to close.
Sensor	Isolation valve proximity sensor.
Condition	Isolation valve failed to close when requested by the PLC.
Action	The following alarm message is displayed: • ISOLATION VALVE FAILURE TO CLOSE
Restore	Isolation valve closes, cycle canceled or semi-auto mode function canceled. The alarm is acknowledged.
Hardware	Isolation valve with closed position proximity switch.
Notes	Standard on all LyoStar™ 3 lyophilizers with the LyoS™ control system.

Isolation Valve Failure to Open

The Isolation Valve can play a crucial role in the execution of a successful freeze-dry cycle. The integrity of the entire product run is at risk if the Isolation Valve fails to operate as expected. The Isolation Valve Failure to Open alarm is designed to quickly alert the operator in the case of an Isolation Valve failure.

Alarm Specifications	
Active	Anytime the isolation valve is sent a request by the PLC to open.
Sensor	Isolation valve proximity sensor.
Condition	The isolation valve failed to open when requested by the PLC.
Action	The following alarm message is displayed: • ISOLATION VALVE FAILURE TO OPEN
Restore	Isolation valve opens, cycle canceled or semi-auto mode function canceled. The alarm is acknowledged.
Hardware	Isolation valve with open position proximity switch.
Notes	Standard on all LyoStar™ 3 lyophilizers with the LyoS™ control system.

Long-Term Power Failure

In the event of a long-term power loss, the system displays a Long-Term Power Failure alarm message. A long-term power failure is defined as a power loss that extends beyond the period specified in the Long-Term Power Failure SP (setpoint).

Note: *The Long-Term Power Failure SP (setpoint) is programmed from the Configuration page.*

When power is restored, the cycle may hold in the current phase and attempt to continue from where the cycle was halted, or reset the cycle to the Freeze phase. This is dependent on the System Reset to Freeze on Alarm configuration setting.

Notes: *The System Reset to Freeze on Alarm setting is programmed from the Configuration page.*

Upon a power failure or communication loss, other alarms may appear depending on the scan time.

Alarm Specifications	
Active	Always active.
Sensor	Programmable logic controller (PLC) clock.
Condition	The power failure period is greater than the Long-Term Power Failure SP (setpoint).
Action	The following alarm message is displayed: • LONG-TERM POWER FAILURE If System Reset to Freeze on Alarm is set to Yes, upon power being restored to the system, the active cycle shall reset to the Freeze Phase. If System Reset to Freeze on Alarm is set to No, upon power being restored to the system, the cycle continues from the last phase and/or step it was in prior to the power loss.
Restore	If System Reset to Freeze on Alarm is set to Yes, power is restored and the Play button is selected to continue the cycle from the Freeze phase. The alarm is acknowledged. If System Reset to Freeze on Alarm is set to No, power is restored. The alarm is acknowledged.
Hardware	Programmable logic controller (PLC) clock.
Notes	Standard on all LyoStar™ 3 lyophilizers with the LyoS™ control systems. The EMERGENCY CONTACT CLOSED alarm is linked to the Long-Term Power Failure alarm.

Low Voltage

The Low Voltage alarm message appears when the actual voltage supplied to the system is less than or equal to the Voltage Lower Limit setpoint.

Note: *The Voltage Lower Limit setpoint is programmed from the Configuration page.*

Alarm Specifications	
Active	Always active.
Sensor	Voltage transducer.
Condition	The voltage supplied to the system is less than or equal to the Voltage Lower Limit setpoint.
Action	The following alarm message is displayed: • LOW VOLTAGE
Restore	The low voltage condition is corrected. The alarm is acknowledged.
Hardware	Voltage transducer.
Notes	Standard on all LyoStar™ 3 lyophilizers with the LyoS™ control system. The EMERGENCY CONTACT CLOSED alarm is linked to the Low Voltage Failure alarm.

Maximum System Heating

Excessive shelf heat can be a sign of a Heater failure. The Maximum System Heating alarm is displayed when the Shelf Inlet temperature exceeds the Max System Heating SP (setpoint).

Note: *The Max System Heating SP (setpoint) is programmed from the Configuration page.*

Alarm Specifications	
Active	Always active.
Sensor	Shelf Inlet thermocouple.
Condition	Shelf Inlet temperature exceeds the Maximum System Heating SP (setpoint).
Action	The following alarm message is displayed: • MAXIMUM SYSTEM HEATING The Heater is disabled.
Restore	The Shelf Inlet returns to a temperature that is below the Maximum System Heating SP (setpoint). The cycle continues and control is restored. The alarm is acknowledged.
Hardware	Type T thermocouple.
Notes	Standard on all LyoStar™ 3 lyophilizers with the LyoS™ control system. The EMERGENCY CONTACT CLOSED alarm is linked to the Maximum System Heating alarm.

No Water Flow Detected To Compressors Alarm

In a water-cooled lyophilizer system, the compressors require a constant flow of water in order to function properly. When the water supply is interrupted, the system generates the No Water Flow Detected To Compressors alarm. This alarm is designed to quickly alert the operator that the water supply is insufficient to properly cool the system.

Alarm Specifications	
Active	Always active.
Sensor	Differential Pressure Switch.
Condition	The Differential Pressure Switch detects that the compressors are operating with an insufficient supply of water.
Action	The following alarm message is displayed: • NO WATER FLOW DETECTED TO COMPRESSORS The compressors are disabled.
Restore	Adequate water supply is restored to the unit. The alarm is acknowledged.
Hardware	Differential Pressure Switch.
Notes	Custom option available on Water-Cooled LyoStar™ 3 lyophilizers with the LyoS™ control system. The EMERGENCY CONTACT CLOSED alarm is linked to the No Water Flow Detected to Compressors alarm.

Pressure Step Not Satisfied

When the system vacuum is unable to obtain the desired setpoint by the end of a Drying step, the system may be experiencing a vacuum pump failure or an incorrect recipe parameter may have been entered. This type of condition shall trigger the Pressure Step Not Satisfied alarm message

Note: *The Vacuum Deadband is programmed from the Configuration page.*

If you receive the Pressure Step Not Satisfied alarm message during a freeze-dry cycle, check the Drying step when the Hold and/or Rate time is complete. The chamber's primary vacuum reading (*e.g.,* Chamber CM) will likely be outside the range of the Vacuum Deadband as it relates to the Vacuum SP. In the event of a Pressure Step Not Satisfied condition, the cycle always continues to the next programmed step.

Alarm Specifications	
Active	At the end of the Drying steps of a freeze-dry cycle.
Sensor	Chamber vacuum transducer.
Condition	The Vacuum setpoint is greater than zero, but not within the Vacuum (Acceptance) Deadband during the end of a Drying step.
Action	The following alarm message is displayed: • PRESSURE STEP NOT SATISFIED
Restore	The alarm is acknowledged.
Hardware	Chamber vacuum transducer.
Notes	Standard on all LyoStar™ 3 lyophilizers with the LyoS™ control system.

PVG/CM Step Not Satisfied

The PVG/CM Step Not Satisfied alarm is active during the Drying phase of a freeze-dry cycle. The alarm message is displayed when the calculated Pirani/Capacitance Manometer differential is greater than the PVG/CM DIFF setpoint.

Alarm Specifications	
Active	During the Drying phase of a freeze-dry cycle.
Sensor	Capacitance manometer and Pirani vacuum transducer.
Condition	The calculated PVG/CM differential is greater than the specified PVG/CM DIFF setpoint for the active step.
Action	The following alarm message is displayed: • PVG/CM STEP NOT SATISFIED The system will hold the cycle at the current step until the calculated PVG/CM differential is lower than or equal to the specified PVG/CM DIFF setpoint for the active step.
Restore	The calculated PVG/CM differential is lower than or equal to the specified PVG/CM DIFF setpoint for the active step or the setpoint is changed to a value that is greater than the actual differential between the sensors. The alarm is acknowledged.
Hardware	Capacitance manometer and Pirani vacuum transducer.
Notes	Standard on all LyoStar™ 3 lyophilizers with the LyoS™ control system.

Short-Term Power Failure

In the event of a short-term power loss, the system displays a Short-Term Power Failure alarm message. A short-term power failure is defined as a power loss that occurs within the period specified in the Long-Term Power Failure SP (setpoint).

Notes: *The Long Term Power Failure SP (setpoint) is programmed from the Configuration page.*

Upon a power failure or communication loss, other alarms may appear depending on the scan time.

When power is restored, the cycle continues from the last phase and/or step it was in prior to the power loss.

Alarm Specifications	
Active	Always active.
Sensor	Programmable logic controller (PLC) clock.
Condition	The power failure period is within the Long Term Power Failure SP (setpoint).
Action	The following alarm message is displayed: • SHORT-TERM POWER FAILURE. When power is restored, the cycle continues from the last phase and/or step it was in prior to the power loss.
Restore	Power is restored and the cycle continues. The alarm is acknowledged.
Hardware	Programmable logic controller (PLC) clock.
Notes	Standard on all LyoStar™ 3 lyophilizers with the LyoS™ control system.

UPS On Battery

When the system is powered exclusively by the Uninterruptible Power Source (UPS), the system displays an alarm message. The programmable logic controller (PLC) shuts down when battery power expires.

Note: *Typical UPS on battery backup time is approximately 100 - 130 minutes. The programmable automation controller shall shut down when the battery expires.*

Alarm Specifications	
Active	Always active.
Sensor	UPS on Battery Alarm from the Uninterruptible Power Source (UPS).
Condition	UPS On Battery alarm contact opens due to system running on UPS power.
Action	The following alarm message is displayed: • UPS ON BATTERY.
Restore	Power is restored to the system and the UPS battery is running normally. The alarm is acknowledged.
Hardware	UPS with On Battery alarm contacts.
Notes	Standard on all LyoStar™ 3 lyophilizers with the LyoS™ control system.

Vacuum Overload

Chamber vacuum levels rising too much during Drying may be an indication of system failure. If the chamber's primary vacuum reading (*e.g.,* Chamber CM) exceeds the Vacuum Overload SP (setpoint) during the Drying phase, the Vacuum Overload alarm message is displayed.

Note: *The Vacuum Overload SP (setpoint) is programmed from the Configuration page.*

Upon report of the Vacuum Overload alarm, the cycle may hold in the current phase and attempt to continue from where the cycle was halted or reset the cycle to the Freeze phase. This is dependent on the System Reset to Freeze on Alarm configuration setting.

Note: *The System Reset to Freeze on Alarm setting is programmed from the Configuration page.*

Alarm Specifications	
Active	During the Drying phase of a freeze-dry cycle.
Sensor	Chamber vacuum transducer.
Condition	The chamber vacuum reading is equal to or greater than the Vacuum Overload SP (setpoint).
Action	The following alarm message is displayed: • VACUUM OVERLOAD If System Reset to Freeze on Alarm is set to Yes, the active cycle shall reset to the Freeze phase. If System Reset to Freeze on Alarm is set to No, the cycle remains in the current step until the condition is corrected. The heater will be disabled and the shelf solenoid will be enabled.
Restore	If the System Reset to Freeze on Alarm configuration setting is set to Yes, the vacuum condition is corrected and the Play button is selected to continue the cycle from the Freeze phase. The alarm is acknowledged. If System Reset to Freeze on Alarm is set to No, the vacuum condition is corrected. The alarm is acknowledged.
Hardware	Primary vacuum transducer.
Notes	Standard on all LyoStar™ 3 lyophilizers with the LyoS™ control systems. The EMERGENCY CONTACT CLOSED alarm is linked to the Vacuum Overload alarm.

Vacuum Preseal Timeout

When the Vacuum Preseal function is enabled, the system will evacuate the product chamber to the Vacuum Preseal setpoint before starting an automatic cycle. If a leak or similar condition prevents the vacuum level from reaching the Vacuum Preseal setpoint within the period specified in the Vacuum Preseal Timeout SP (setpoint) field, the system will reset to the ready state, display an alarm message and await corrective action.

Note: *The Vacuum Preseal Timeout SP (setpoint) is programmed from the Configuration page.*

Alarm Specifications	
Active	During preseal.
Sensor	Chamber pressure transducer.
Condition	The Vacuum Preseal setpoint is not obtained within the specified Vacuum Preseal Timeout SP (setpoint).
Action	The following alarm message is displayed: • VACUUM PRESEAL TIMEOUT The system is reset to a Ready state.
Restore	Correct the vacuum condition. Acknowledge the alarm. Restart the cycle.
Hardware	Chamber pressure transducer.
Notes	Standard on all LyoStar™ 3 lyophilizers with the LyoS™ control system. The EMERGENCY CONTACT CLOSED alarm is linked to the Vacuum Preseal Timeout alarm.

Vacuum Timeout

If during a freeze-dry cycle the chamber's primary vacuum level does not reach the vacuum setpoint within the specified Vacuum Timeout SP (setpoint), the vacuum pump and/or system may have failed. This condition will generate a Vacuum Timeout alarm.

Note: *The Vacuum Timeout SP (setpoint) is programmed from the Configuration page.*

Upon report of the Vacuum Timeout alarm, the cycle may hold in the current phase and attempt to continue from where the cycle was halted or reset the cycle to the Freeze phase. This is dependent on the System Reset to Freeze on Alarm configuration setting.

Note: *The System Reset to Freeze on Alarm setting is programmed from the Configuration page.*

Alarm Specifications	
Active	Evacuation phase of a freeze-dry cycle.
Sensor	Chamber vacuum transducer.
Condition	The chamber vacuum level does not reach the vacuum setpoint within the specified Vacuum Timeout SP (setpoint).
Action	The following alarm message is displayed: • VACUUM TIMEOUT If System Reset to Freeze on Alarm is set to Yes, the active cycle shall reset to the Freeze phase. If System Reset to Freeze on Alarm is set to No, the cycle remains in the current step until the condition is corrected or the cycle is canceled.
Restore	If System Reset to Freeze on Alarm is set to Yes, the vacuum condition is corrected and the Play button is selected to continue the cycle. The alarm is acknowledged. If System Reset to Freeze on Alarm is set to No, the vacuum condition is corrected. The alarm is acknowledged.
Hardware	Chamber vacuum transducer.
Notes	Standard on all LyoStar™ 3 lyophilizers with the LyoS™ control systems. The EMERGENCY CONTACT CLOSED alarm is linked to the Vacuum Timeout alarm.

SP Scientific

3538 Main Street
Stone Ridge, NY 12484 USA

(800) 251-1531
(845) 687-0071

935 Mearns Road
Warminster, PA 18974 USA

(800) 523-2327
(215) 672-7800

815 State Route 208
Gardiner, NY 12525 USA

(800) 431-8232
(845) 255-5000

www.SPScientific.com