

## TECHNICAL SPECIFICATION

### StirLIN-1.5 Liquid Nitrogen System



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## 1. INTRODUCTION

The Stirling Cryogenics cryogenerators are based on technology which has been used for over more than sixty years, serving customers all over the world under all possible conditions.

This experience has culminated in our current range of systems called StirLIN, producing liquid nitrogen in volumes from 60 to more than 3.000 liters per day.

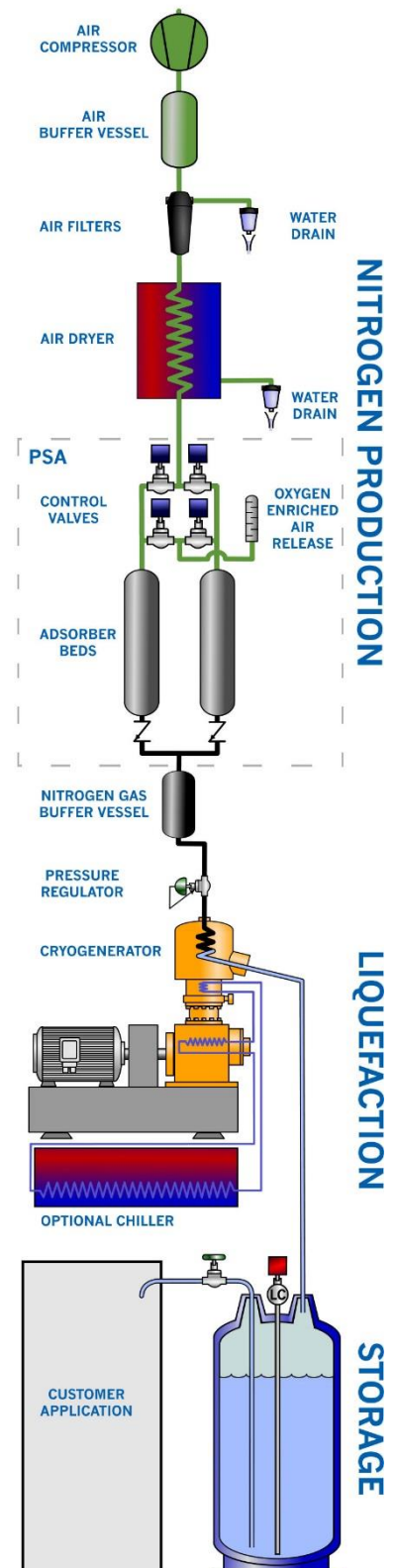
Our fully automatic StirLIN allows the user to concentrate on his core activity, eliminating all issues involved with the purchasing and logistics of bulk liquid nitrogen supply.

This document contains detailed technical information and specifications for the StirLIN-1.5. We trust that this information demonstrates that our system will be a valuable asset in meeting your liquid nitrogen demand.

Thank you for your interest in our company and our products and we look forward to receiving your valuable response.

## 2. SYSTEM PROCESS DESCRIPTION

1. Ambient air is taken in by a compressor and fed to a buffer vessel.
2. The air then passes a number of filters for cleaning and to remove moisture and particles.
3. An air dryer removes the remaining moisture.
4. The dry, clean air is directed via PLC controlled valves to one of the two-adsorber beds of the Pressure Swing Adsorption (PSA) unit. The principle of PSA is based on the property of carbon molecular sieve to adsorb oxygen molecules until saturation. The time for adsorption in an adsorber bed is approximately one minute. After this time, the automatic valves will switch over to the second adsorber bed. The PSA bed just taken off-line is now regenerated by releasing oxygen enriched air (with 25-30% oxygen) to atmosphere. Continuous switching from one bed to the other generates a constant flow of purified nitrogen gas.
5. The nitrogen gas flows, via a buffer vessel, to an adjustable pressure regulator. This is set to the pressure at which the customer requires the liquid nitrogen to be stored in the vessel.
6. The Stirling Cryogenics Cryogenerator will extract heat from the nitrogen gas flow, due to which it is first cooled and then liquefied at cryogenic temperature. This cooling power is generated by the Cryogenerator using the Stirling cycle. The produced liquid nitrogen flows by gravity through an insulated line into the storage vessel.
7. Water cooling required for the cryogenerator can either be tap water, or by a dedicated water chiller available from Stirling Cryogenics
8. The PLC will stop the StirLIN when the vessel is full, and automatically re-starts when the level drops to 80% due to liquid withdrawal.
9. Liquid nitrogen can be withdrawn from the vessel via a flexible delivery line by opening a manually operated valve. In this way small dewars can be filled. Also applications with an auto-fill system or other specific systems can be accommodated
10. Liquid nitrogen withdrawal is independent from the system's operation mode. There is no requirement for a mechanical transfer pump.



### 3. TYPICAL StirLIN FEATURES

This chapter introduces the functionality and specifications of the StirLIN range and the advantages that on-site liquid nitrogen production will provide to your organization.

- Ease of installation.  
With the system room and utilities prepared prior to the arrival of the system, the StirLIN will be producing liquid nitrogen within a few days after opening of the crate.  
During the visit of one of our service engineers the StirLIN will be installed and commissioned. Your personnel will be trained how to optimally operate the system.

- Fully automatic operation by PLC control.  
All StirLIN systems are monitored, controlled and safeguarded by a Programmable Logical Controller (PLC). Through the display, the operator is continuously informed about the operational status of the system such as the liquid nitrogen level in the storage vessel. For efficient troubleshooting, messages of the safety devices are indicated as error codes that refer to the operator manual for further action.

The PLC will automatically stop and start the StirLIN depending the level of liquid in the storage vessel. In case of power or water supply failure, the PLC automatically re-starts the StirLIN when the supply is restored.

- Adjustable liquid nitrogen pressure.  
The StirLIN is equipped with a pressure regulator to adjust the pressure at which the liquid nitrogen is kept in the storage vessel. This allows the customer to choose the pressure that best suits his application. This also prevents high losses by flashing due to unnecessary over pressure in the storage vessel.
- Efficient production.  
The StirLIN's are designed around the highly efficient Stirling cycle. Economical use of electrical energy results in low electricity consumption per liter of LN2 produced.
- Easy liquid nitrogen dispense.  
The storage vessel is equipped with a manual valve and a flexible delivery hose. Dispensing of liquid nitrogen can be done in several ways, depending on the type of dewar to be filled and specific customers request:
  - Open dewars are filled by placing them beside the StirLIN vessel and dispensing the liquid through the flexible hose into the dewar opening.
  - Closed dewars can be filled by connecting the flexible hose to their fill connection and opening valves according instructions of dewar manufacturer.
  - For applications with an auto-fill system, an optional direct connection hose can be installed between the StirLIN vessel and the application.
- Low noise level.  
The noise level of the StirLIN is only 70 – 74 dBA depending on the type of StirLIN. This allows a normal conversation in the system room in direct vicinity of the system.
- Built for stringent climate conditions (and adaptable to extremes).  
Functional specifications of StirLIN systems are defined at the nominal conditions of 250 m

altitude and 25°C air temperature. Their working range is however much larger. At altitudes up to 2.000 m or temperatures up to 45°C ambient temperature a standard StirLIN will still perform. For more extreme circumstances a StirLIN can be adapted to your specific climatic conditions such as high altitude or hot deserts.

The StirLIN-1.5 can be easily be adapted to cope with high altitudes (up to 3000 m) and for producing higher product purities, in order to conform to special specifications.

- The StirLIN range is available for all common, worldwide used, 3-phase power supplies, i.e. 110V to 500V and 50 Hz or 60 Hz.

## 4. StirLIN CUSTOMER SERVICE

### Worldwide service support

StirLIN systems are made for the future, not just to meet the sheer functional specifications; they are designed to ensure minimal service effort. This is supported by our Customer Service philosophy and organization.

- **Low operator attention**  
The operators' activities are limited to a daily routine check, regular cleaning/replacement of filters and simple compressor oil changes.
- **Low maintenance**  
Maintenance on the StirLIN shall be done every 2 years of operation and will take approximately one day. We advise regular inspection and cleaning of components, preferably once a year, and depending of ambient conditions. In dusty circumstances special attention should be given to regular cleaning and/or replacement of filters, especially with respect of air compressor and chiller, and in general remove dust from all plant components.
- **On-site maintenance**  
Maintenance on all components of the StirLIN systems including the Stirling Cryogenics cryogenerator can be done on-site. There is no requirement of shipping components back to the factory for maintenance or repair, meaning less down-time and transport costs.
- **10 Years supply of spare parts**  
Stirling Cryogenics guarantees the supply of spare parts for any given StirLIN component for a period of 10 years after shipment of a system.
- **World-wide Service Network**  
Stirling Cryogenics Service Engineers or its Certified Service Representatives are available from Stirling Cryogenics to assure service support anywhere in the world.

### Maintenance

Preventive maintenance should be done every 2 years or after 8000 hours of operation. Specific inspection and maintenance sets are available for this maintenance. At 36,000 operating hours each StirLIN system requires a more extensive (major) maintenance. All maintenance can be done at site.

As an option, also customer technicians can be trained to perform this maintenance but they need to be officially certified. A (regular) training at our premises is mandatory in this case.

Inspection/Maintenance	Interval [operating hours]	Duration (on site)
Cleaning of components	regularly	
Preventive (minor) maintenance	Every 2 years or 8000 hours	8 hours
Extensive (major) maintenance	36,000 hours	16 hours

## Service Level Agreements

Since Stirling Cryogenics cryogenic systems are the most reliable on the market they are often provided with new product related parts for new product applications. When our machines are maintained properly, many years of high performance and uninterrupted productivity are ensured at an extremely cost-effective level.

In case you cannot find what you need in our service program, we are more than happy to develop a tailor made service program specifically for your facility.

- **Parts warranty**  
Every new machine includes standard 12 months warranty on parts as mentioned in the Orgalime Conditions which are applicable for Stirling Cryogenics Cryogenic systems. In this tender we agree on a 24 months warranty (max. 30 months after date of shipment).
- **Parts purchase**  
In order to maximize your production output, parts can be purchased to ensure availability for planned maintenance as well as unexpected maintenance. Depending on your requirements and budget, parts can be offered.
- **Response times /24/7**  
To ensure minimum downtime in case of emergencies, we can offer shortened response times. This minimizes the time for an engineer to arrive on site in case of emergencies in order to ensure a swift restart of production. This in combination with a ensured 24/7 helpdesk service to support you at our best.
- **Remote service**  
Stirling Cryogenics can provide maximum technical support while not being on site via remote service. By logging into the machine remotely, our engineers can monitor the machine status, make changes when required and advise operators and maintenance personnel.
- **Training**  
Stirling Cryogenics can provide training in the format that best meets the needs of your facility and staff helping your employees to become valuable experts. Typically the training consists of a balanced combination of classroom-style training and hands-on training at the machinery, optimizing skill development. The training includes handouts and teaching aids as needed.
- **Preventive maintenance**  
Stirling Cryogenics can handle preventive maintenance of your machinery. While the maintenance is performed by our experts, an optimum condition of the machine can be ensured, resulting in maximum up-times.

## 5. StirLIN-1.5 SCOPE OF SUPPLY

The Scope of Supply of the StirLIN-1.5 consists not only of the actual system but also includes all additional materials to ensure a proper installation and functioning of the system.

Main system:

- Nitrogen gas production module including:
  - One air compressor
  - One air buffer vessel
  - One air dryer
  - One set of air filters
  - One Pressure Swing Adsorption module (PSA)
  - One nitrogen buffer vessel
  - One control box with monitor display using PLC technology
- Liquid nitrogen production module including:
  - One 1-cylinder SPC-1 Stirling Cryogenics cryogenerator
  - One 1-cylinder SPC-1(500) Stirling Cryogenics cryogenerator
  - One 1.000 liters storage vessel, equipped with three necks; two connected to the cryogenerators with an insulated pipeline, the other containing a level sensor to measure the liquid level and a flexible hose with a manual valve to dispense liquid.

Additional materials:

- Set of Installation materials and
- Helium gas cylinder
- Pressure regulator for helium gas cylinder
- Oil for cryogenerator and compressor

Documentation (in English):

- Pre-installation manual including lay-out details
- Operating and maintenance instructions
- CE declaration of conformity

The StirLIN-1.5 will be tested at the factory for its performance according out standard test procedure. Customer can witness the final 2 days of Factory Acceptance Test at its own cost. Additional factory acceptance test/requirements need to be discussed and might be subject to additional charges.

## Options

### ***Voltage Stabilizer:***

The main function of a stabilizer is to make the output voltage that feeds the StirLIN connected to it as much as possible equivalent to the ideal electrical power supply, ensuring that the oscillations in electrical power are offset, and its output maintain a stable value, preventing them from being experienced by StirLIN and thereby avoiding their damage.



## 6. TECHNICAL SPECIFICATION StirLIN-1.5

The StirLIN- liquid nitrogen system has the following specifications.

Liquid nitrogen production capacity at nominal conditions<sup>1</sup>

LN <sub>2</sub> produced at	[barg]	1	3	5
Purity (nitrogen + inerts)	[%]	>99.5	99.0	98.5
Production capacity	[l/h]	17.2	21.5	24.7
Expanded to atmospheric pressure (usable liters) <sup>2</sup>	[l/h]	<b>15.7</b>	<b>16.9</b>	<b>17.3</b>

<sup>1</sup> Working range; system room temperature 5-50°C, altitude 0-3,000 m, relative humidity 20-95%.

<sup>2</sup> When high-pressure liquid nitrogen is transferred and expanded to a lower pressure, up to 30 percent of the liquid quantity can be lost through evaporation flashing. That is why Stirling Cryogenics presents its production also as the amount of liquid nitrogen available when used at normal atmospheric pressure, besides the amount produced in a liquid vessel at higher pressure. This is what we call usable liters of liquid nitrogen.

Additional specifications

		StirLIN-1.5	water chillers
System size	l x w x h; m	3.54 x 3.54 x 1.80	1.64 x 1.27 x 1.60
Advised system room	l x w x h; m	5.00 x 5.00 x 2.50	Included in the main room
Weight	kg	2.200	800
Power supply	V / Hz	adapted for local power supply	
Power consumption	kW	27	9
Noise level <sup>3</sup>	dBA	72	63
Liquid nitrogen storage capacity	Litres	1,000	N/A
Maintenance interval (apart from oil and filter changes)	Running hours	8,000	N/A

<sup>3</sup> Measured at 1,5m from the ground and 1m distance from the system. Peaks during blow off of PSA can occur.

StirLIN systems meet the European CE and PED safety standards, as well as the IP54 and IEC 60204.

For other national standards that may be applicable in your country, please contact Stirling Cryogenics to discuss the consequences.

Lay-out:

Refer to the attached drawing, which gives the main sizes of the system components and the different elements required in the room. The room set-up is an example to give an idea of required size.

When an existing system room is chosen, a new specific drawing can be made.

Chillers and StirLIN-1.5 will fit in a 25 m<sup>2</sup> room. A 50 m<sup>2</sup> room is more than sufficient to hold Chillers, StirLIN-1.5 and Voltage Stabilizer.

**Remarks:**

- Sizes are in mm. These sizes can be subject to (small) changes in the course of time, due to possible change and/or improvement in individual components. In case required, actual sizes to be reconfirmed at time of order.
- Actual system room lay-out will be determined with the customer during the order stage based on actual system room availability.
- Ventilation is required for proper functioning of the system and safety of personnel. Ducts are recommended for areas with ambient temperatures above 25°C.
- Doors are not shown because their position depends on building lay-out. Doors must be placed near the dewar fill area.
- Chiller maximum distance is 8 m from the StirLIN.

## 7. Standard Lay-out

