

TECHNICAL SPECIFICATION

SPC-1T Stirling Process Cryogenerator



Reference 80 8014_00
Issue Date April 20, 2016

1. INTRODUCTION

In this technical specification the different technical aspects of SPC-1T are described, together with different optional sub-systems to integrate the SPC-1T into a larger total system.

Typical characteristics of the SPC-1T are:

- a quick start up,
- low energy consumption
- reliable operation
- worldwide technical support and service
- Stirling technology with highest efficiency

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

Yours sincerely,

2. PROCESS DESCRIPTION

Stirling Cryogenics Cryogenerators utilize the highly efficient Stirling thermodynamic cycle to produce low temperatures down to cryogenic temperatures. Stirling Cryogenics Cryogenerators come generally in 2 configurations: as a one cylinder unit (SPC-1) or as a 4 cylinder unit (SPC-4). Both are available in single stage (for temperatures down to approx. 60K) and 2-stage configuration (for temperatures down to 15K).

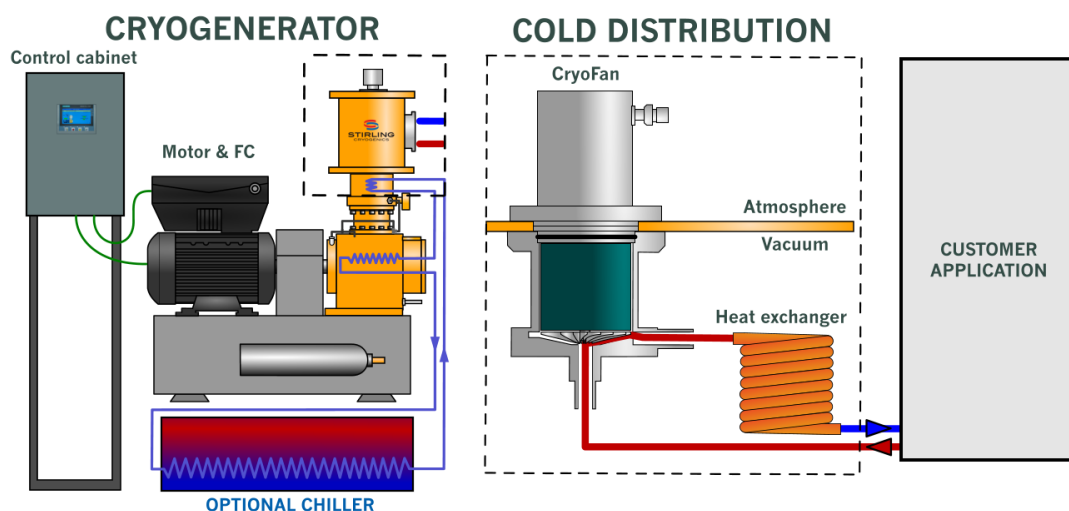
Stirling 1 Cylinder 2-Stage Cryogenerator (SPC-1T).

The SPCT-1T is a two-stage Stirling cryogenerator which simultaneously provides refrigeration at 20 K and at 80 K temperature levels by means of two separate heat exchangers. The SPC-1T uses pressurized helium gas as medium to transfer cold to the application. The helium is transferred by use of two cryogenic fans. These fans each have their own frequency converter which allows them to run at any speed up to 350Hz. Isolation losses on the system are minimized by means of specific vacuum insulation on the cryogenerator head. Transfer line assembly and other equipment connected to the cryogenerator are vacuum isolated as well.

By default each heat exchangers consists of a wound spiral tube and a cold gas fan. The fans circulate the gas in separate loops.

The cryogenerator has 4 process connections: two connections (in- and outlet) for the 20K application and 2 connections for the 80K application.

Typically the 20K stage is connected to the main application, and the 80K stage is used to cool a heat shield or secondary application at liquid nitrogen temperatures. Using the 80K stage however is not mandatory and not using it will actually increase the cooling capacity of the 20K stage by 5-7%.



CryoFan (CryoZone brand):

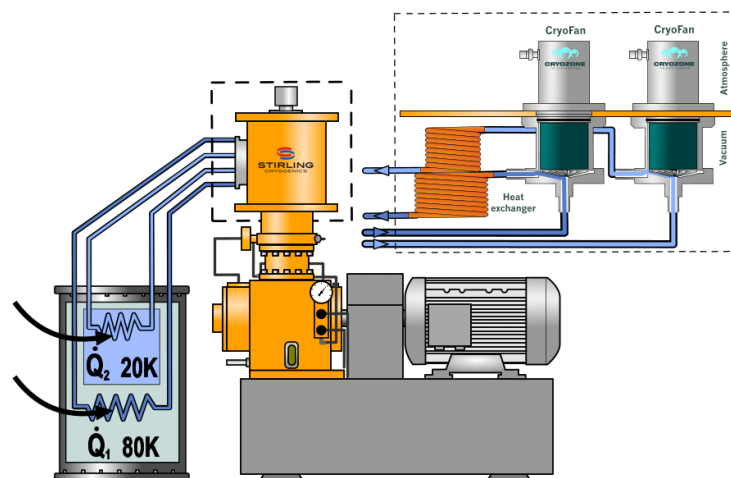
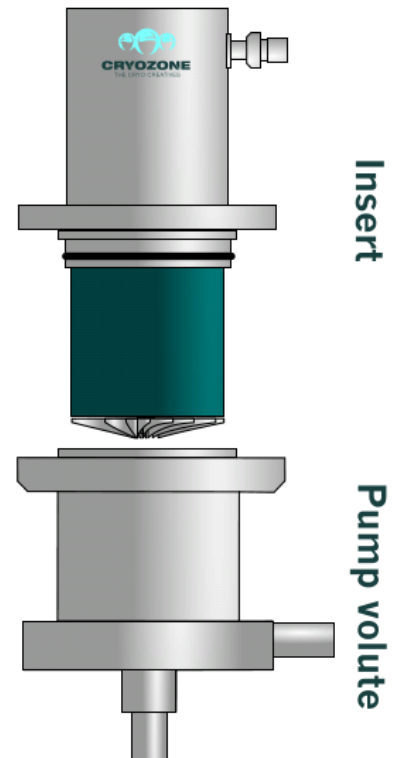
CryoZone's CryoFan are high speed cryogenic gas circulators, specially designed to transport cryogenic gasses with minimum losses.

All CryoFans have the same generic design concept. The main parts are the impeller and volute. Their dimensional shape determines the functionality and efficiency of the fan. The impeller and volute are positioned in the vacuum/cryogenic part of the system. The impeller is driven by a 'high-RPM' electric motor to generate the flow. The electrical motor is located at the outside/warm part of the cryogenic system. All components are placed within a single housing, since in the CryoFan design, the motor is installed within the pressurized gas area. This positioning avoids the use of a rotating seal and hence the risk of leakage.

In order to create a thermal barrier between the motor (at ambient temperature) and the cold impeller, a long thin stainless steel shaft is utilized. To avoid a cold bearing (which is prone to wear and tear), a cantilever set-up is used with a highly balanced shaft and impeller. This set-up ensures a minimum MTBF of 36.000 hours. The motor with shaft and impeller can be mounted from the outside. This allows removal of the complete insert for maintenance, without disrupting the vacuum.

The CryoFan(s) are mounted in the vacuum area of the cold head of the Cryogenerator.

The capacity of the CryoFans is controlled through the speed (RPM) of the fan from approx. 25-100%. This is integrated in the control unit for easy control.



3 System control

The System Control of the SPC-1T is based on a Siemens PLC (S7-1200 version 12). This control unit is an integral part of the SPC scope of supply.

The System Control will safeguard the proper functioning of the SPC-1T, protecting it from internal and external faults (no oil pressure, no water flow, etc) and will control the capacity of the SPC-1T using a frequency converter to adapt the motor speed.

With a remote signal from the customer, the cryogenerator is operated (start/stop).

With the RPM-regulation of the frequency convertor, it is possible to go down to 73% of the maximum cooling power at the prevailing temperature and pressure. The cryogenerator RPM is adjusted by a frequency controller (between 73-100% of max. RPM) which is controlled by a 4-20 mA signal from the customer. The PLC will dampen the customers control signal to prevent the cryogenerator from ramping up or down too fast.

The temperature of each stage and the incoming and outgoing gas temperatures of each stage can be read on the PLC and these temperatures will be sent to the customer as an 2-20 mA signal for monitoring.

2.1 Control modes

In all modes the SPC-1T cryogenerator is only allowed to start if the fan is running. The fan speed can be manually set on the User Interface between 6000 and 21000 RPM in all modes.

2.1.1 Normal mode

The SPC-1T cryogenerator is in operation, both fans are running and all standard safety controls are active. The cryogenerator can either be started on the User Interface or via the standard remote ON/OFF control if the system is in normal mode.

2.1.2 Test modes

There are 2 test modes:

Mode 1 - Cryogenerator test mode: the cryogenerator is in operation for 15 minutes

Mode 2 - CryoFan test mode: both fans are running but the cryogenerator is not in operation.

4 SCOPE OF SUPPLY

1 SPC-1T Cryogenerator:

- Basic 1-cylinder 2-stage Cryogenerator
- 2-stage thermodynamic Stirling cycle section
- Vacuum insulated cold head, including 2 heat-exchangers
- Electric motor and coupling
- Mounting frame and skid
- VJ Line connection
- Internal helium gas lines and water lines
- Connections to power, water and helium supply/buffer
- Safety sensors (for monitoring the Cryogenerator)
- Temperature sensor in 20K cold head

2 Noordenwind CryoFans:

- Integrated in the vacuum area of the cold head

Note:

- If applicable 1 CryoFan is also possible
- Other CryoFans are available upon request

Connection pieces:

Counter connection(s) for the VJ line to connect to the customer's application

1 Control panel:

- For automatic control of Cryogenerator (start/stop, safe guarding);
- To control the frequency converter of the Cryogenerator for capacity control (70-100% of cooling capacity)
- CryoFans speed (= flow control)
- Operator interface with Siemens TFT touchscreen

Others:

- Documentation including operating and maintenance instructions (English language)
- the SPC-1T will be manufactured, assembled and tested in Son, The Netherlands
- Stirling Cryogenics Cryogenerators 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 us for other options

Options:

Set of consumable parts for 0-12.000 operating hours & maintenance tools

- All consumables parts to operate the initial 12.000 operating hours
- Maintenance tool set for 6.000hrs maintenance

Services (on-site):

- Installation and commissioning
- Site acceptance test
- Basic operator training

Remote access:

To reduce support cost and shorten the response time, the SPC-1T can optionally be supplied with an industrial VPN router for easy remote access to the PLC and HMI. This offers the possibility to troubleshoot systems remotely without going on-site.

5 Gross cooling power

The SPC-1T Cryogenerator gross cooling power is shown in the graph below.

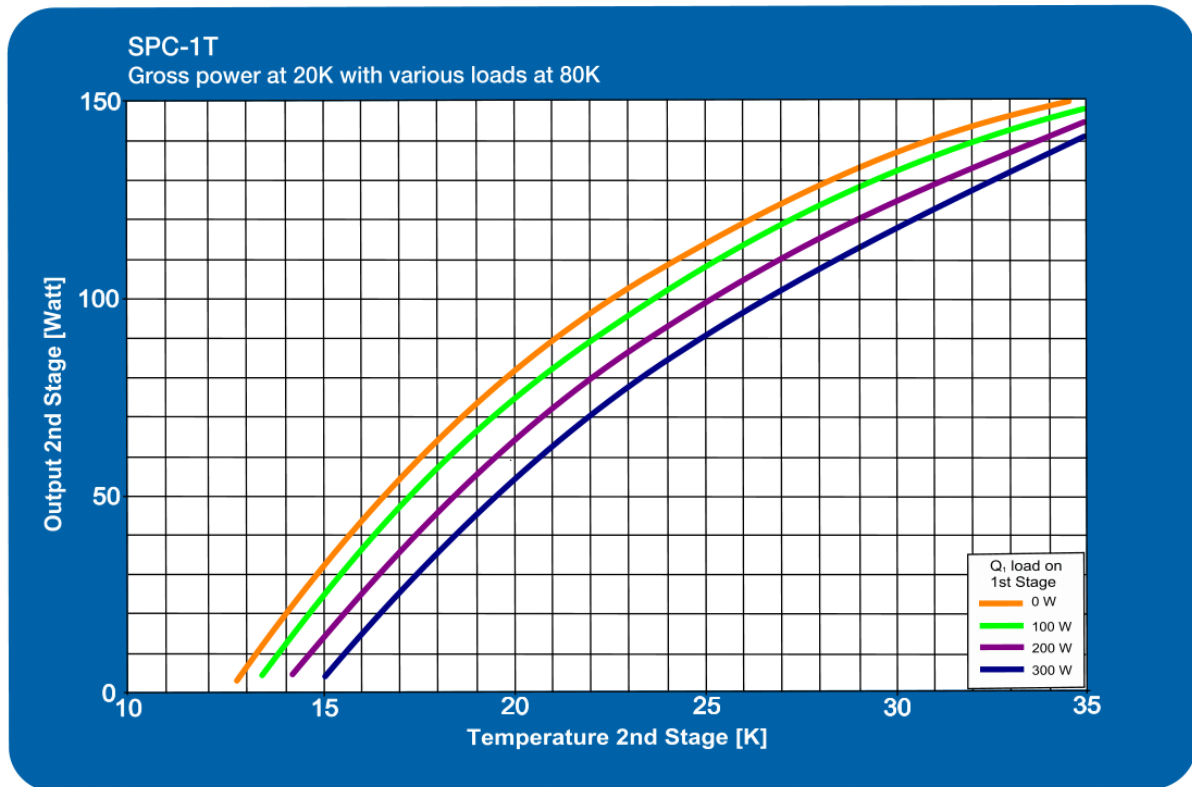


Figure 1: gross cryogenerator capacity.

The net cooling power will be lower due to fan isolation losses and increased static losses via the fan shaft.

See our technical specification for the Noordenwind CryoFan for calculating the fan losses.

6 CryoFan characteristics

Both Noordenwind CryoFans produce a static head in meters depending on the speed of the fan and the volume flow produced by the fan.

This is independent of the medium (type of gas) used, as well as the operating pressure. The specific medium and operating pressure will influence the dynamic losses of the fan.

The actual dP generated by the CryoFan depends on the density of the specific medium that is being used, so at actual gas temperature and pressure.

The actual dP is calculated with $dP \text{ (Pa)} = \rho \text{ (kg/m}^3) \cdot g \text{ (m/s}^2) \cdot h \text{ (m)}$.

The Noordenwind CryoFan can operate between 6.000 and 21.000 RPM and, based on the operating speed, the generated head and volume flow will vary.

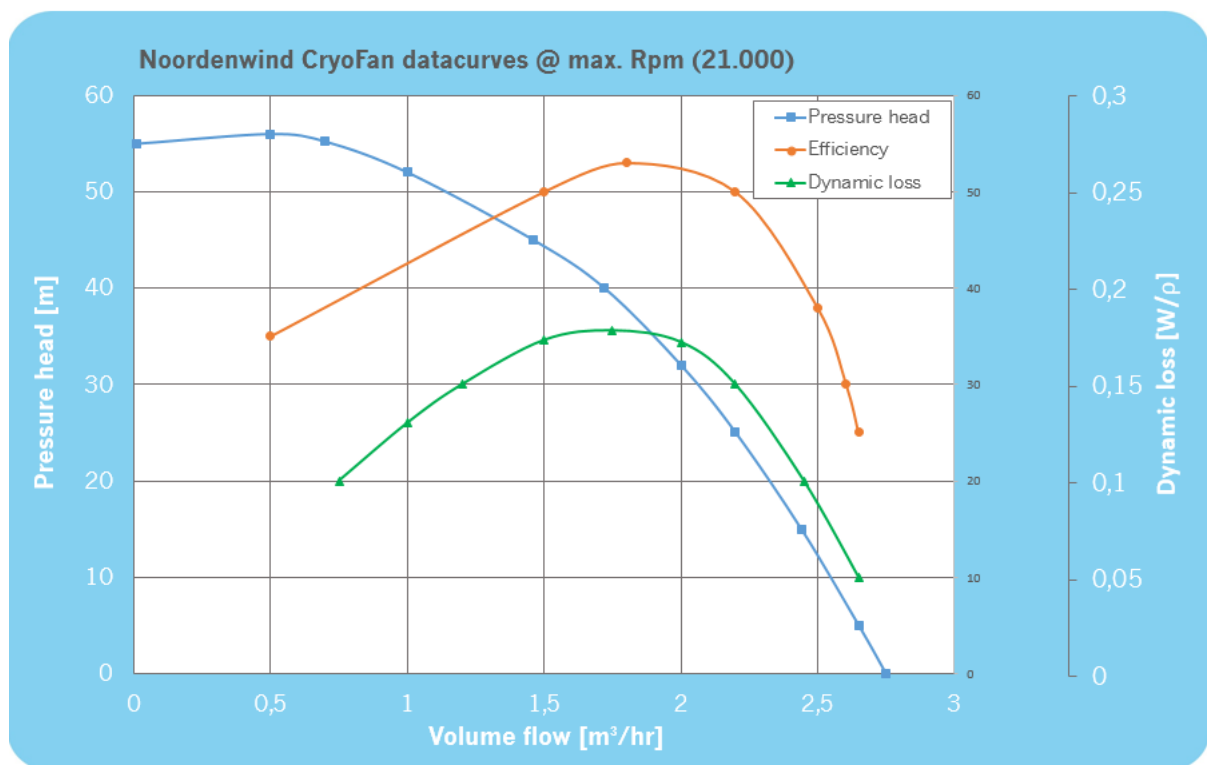


Figure 2: performance of the Noordenwind fan.

7 TECHNICAL SPECIFICATIONS

Capacity (@0W load on 1 st stage):	175W at 60K at system outlet 30W at 15K at system outlet
Available dP for customers application	See enclosed fan and SPC-1T curve.
Power consumption	11 kW
Power supply	3Phs, 400V-480V, 50Hz-60Hz , incl. variable frequency drive
Required cooling water supply	1.000 l/h at 15°C(incl. 20% EG)
Dimensions	0,86m x 0,62m x 1,13m (l x w x h)
Weight	550 kg
Noise level	<74 dBA.
MAWP	30 bar (435 psi)
(maximum allowable process pressure)	
Normal process pressure	25 bar (363 psi)

8 INSTALLATION

Installation of a SPC-1T Cryogenerator is relatively easy. It involves locating the StirLNG-4 at its (final) position and connecting it to all applicable interfaces.

Electric power availability and connections is part of the customer site preparation (according to local regulations).

Installation of the SPC-1T is mandatory required to be performed by one of our service engineers.

(see Appendix 1 for SPC-1T dimensions and connection positions).

9. SERVICE AND MAINTENANCE

Service

With our Service Agreements we cover all required (preventive) maintenance to ensure a reliable operating of the SPC-1T. Depending on customer's personal needs, the service concept can be individualized and tailored to the specific requirements.

With this approach we offer a choice of options for planning and performing maintenance. Whether you're prioritizing high levels of product safety, want to keep a tight hold on your maintenance costs at all times, or wish to optimize your total cost of ownership.

Maintenance

Each SPC-1T requires preventive (minor) maintenance only after each 6,000 operating hours. Specific Consumable parts sets are available for this maintenance (please see our price quotation). At 36,000 operating hours each SPC-1T requires a more extensive (major) maintenance.

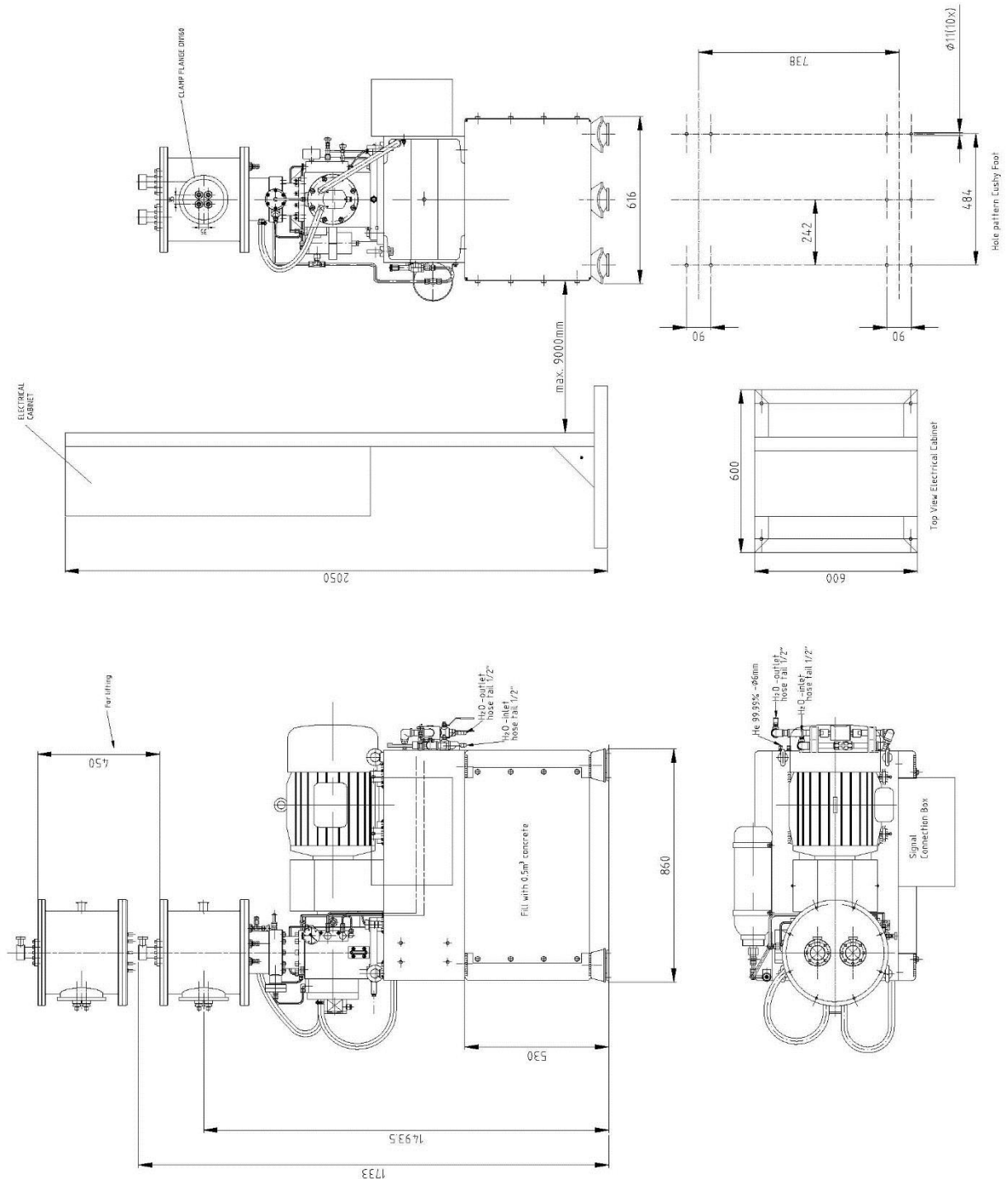
All maintenance inspections can be done at site by our Service engineers.

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.

Maintenance inspection	Interval [operating hours]	Duration (on site)
Preventive (minor) maintenance	every 6,000 hours	8 hours
Extensive (major) maintenance	36,000 hours	16 hours

Note: the SPC-1T has to be shut down (to be warmed up) at least 24 hours before commencing with each maintenance

APPENDIX 1



Final layout is subject to change due to configuration of the system